Competency Focused Practice Questions

Mathematics (Volume 2) | Grade 10

Co-created by

CBSE Centre for Excellence in Assessment

and

Educational Initiatives

Preface

Assessments are an important tool that help gauge learning. They provide valuable feedback about the effectiveness of instructional methods; about what students have actually understood and also provide actionable insights. The National Education Policy, 2020 has outlined the importance of competency-based assessments in classrooms as a means to reform curriculum and pedagogical methodologies. The policy emphasizes on the development of higher order skills such as analysis, critical thinking and problem solving through classroom instructions and aligned assessments.

Central Board of Secondary Education (CBSE) has been collaborating with Educational Initiatives (Ei) in the area of assessment. Through resources like the Essential Concepts document and A- Question-A-Day (AQAD), high quality questions and concepts critical to learning have been shared with schools and teachers.

Continuing with the vision to ensure that every student is learning with understanding, Question Booklets have been created for subjects for Grade 10th and 12th. These booklets contain competency-based items, designed specifically to test conceptual understanding and application of concepts.

Process of creating competency-based items

All items in these booklets are aligned to the NCERT curriculum and have been created keeping in mind the learning outcomes that are important for students to understand and master. Items are a mix of Free Response Questions (FRQs) and Multiple-Choice Questions (MCQs). In case of MCQs, the options (correct answer and distractors) are specifically created to test for understanding and capturing specific errors/misconceptions that students may harbour. Each incorrect option can thereby inform teachers on specific gaps that may exist in student learning. In case of subjective questions, each question also has a detailed scoring rubric to guide evaluation of students' responses.

Each item has been reviewed by experts, to check for appropriateness of the item, validity of the item, conceptual correctness, language accuracy and other nuances.

How can these item booklets be used?

There are 197 questions in this booklet.

The purpose of these item booklets is to provide samples of high-quality competency-based items to teachers. The items can be used to–

- get an understanding of what good competency-based questions could look like
- give exposure to students to competency-based items
- assist in classroom teaching and learning
- get inspiration to create more such competency-based items

Students can also use this document to understand different kinds of questions and practice specific concepts and competencies. There will be further additions in the future to provide competency focused questions on all chapters.

The item booklets are aligned with the 2022-23 curriculum. However, a few questions from topic which got rationalized in 2023-24 syllabus are also there in the booklet which may be used as a reference for teachers and students.

Please write back to us to give your feedback.

Team CBSE

Table of Contents

Chapter - 1
Polynomials

Multiple Choice Questions

Q: 1 **$p(x)$ is a polynomial given by:**

$p(x) = -2x + 8x^2 - 1$

At which of the following points will the graph of $p(x)$ intersect the positive x-axis?

(i) $\frac{1}{2}$

(ii) $\frac{1}{4}$

1 only (i)
2 only (ii)
3 both (i) and (ii)
4 (none, it never intersects positive x-axis)

Q: 2 **Which of these are the zeros of the polynomial $x(x - 7)$?**

1 only 0
2 only 7
3 both 0 and 7
4 (the polynomial does not have any zero)

Q: 3 **Which of these are the quotient and the remainder when $(2x^3 - 9x + 3x^2 + 12)$ is divided by $(x - 1)$?**

1 quotient = $(2x^2 - 7x - 4)$ and remainder = 8.
2 quotient = $(2x^2 + 7x + 4)$ and remainder = 16.
3 quotient = $(2x^2 + 5x - 4)$ and remainder = 8.
4 quotient = $(2x^2 + 5x + 4)$ and remainder = 16.

Q: 4 **Which of these is the coefficient of x^2 in the quotient when $(x^4 + x^3 + x + 1)$ is divided by $(x - 4)$?**

1 0 **2** -3 **3** 5 **4** 1

Q: 5 **$(3a^3 - 2a^2 - 9a + 17)$ is divided by $(a - 2)$. What is the coefficient of a in the quotient?**

1 -2 **2** 3 **3** -9 **4** 4

Q: 6 **$P(t)$ is a polynomial in t such that,**

$P(t) = (t^2 + 5t - 14)(t^2 - 7t + 10)(t^2 + 2t - 35)$

Which of these is the square root of $P(t)$?

1 $(t + 2)(t - 5)(t + 7)$
2 $(t - 2)(t - 5)(t + 7)$
3 $(t + 2)(t + 5)(t - 7)$
4 $(t - 2)(t - 5)(t - 7)$

Q: 7 **Which of the following polynomials has the highest degree?**

1 $-x^7 + 1$

2 $\frac{4x^7+14x^2-32x}{x}$

3 $2980x^3 + 1217x^2 - 472x + 1232$

4 $-754x^4 - 122x^3 + 42x^2 + 199x + 211$

Q: 8 **Which of these are the zeroes of $x^2 + 7x + 12$?**

1 3 and 4 **2** (-3) and (-4) **3** (-3) and 4 **4** 3 and (-4)

Free Response Questions

Q: 9 **($\frac{-2}{5}$) is one of the zeroes of the polynomial $5x^2 + 2x - 7$. (T/F)** **[1]**

Justify your answer.

Q: 10 **Given $f(x) = x^3 + 7x^2 + 3x - 12$** **[1]**

Find the value of $f(2)$. Show your work.

Q: 11 **Given $f(x) = x^4 + x^2 + 4$ and $g(x) = x^2 - 1$.** **[1]**

Find the quotient and remainder when $f(x)$ is divided by $g(x)$. Show your work.

Q: 12 **$f(x) = x^2 + 10x + 21$** **[1]**

Find the zeroes of the above polynomial. Show your work.

Q: 13 **The graph of a polynomial passes through (6, 0), (0, -2) and (-1, 0).** **[2]**

Write two factors of the polynomial. Justify your answer.

Q: 14 **$p(x) = (x + 5)^2 - 7(x - k)$; where k is a constant.** **[2]**

If $p(x)$ is divisible by x, find the value of k. Show your steps.

Q: 15 **p and q are zeroes of the polynomial $3x^2 + 4x - 4$.** **[2]**

Without finding the actual values of p and q, evaluate $(1 - p)(1 - q)$. Show your steps.

Q: 16 **Shown below is an expression:** **[2]**

$\frac{x^2-2\sqrt{3}x-9}{x+\sqrt{3}}; x \neq -\sqrt{3}$

At how many points does the graph of the above expression intersect the *x* -axis? Show your work.

Q: 17 **When a polynomial is divided by (2 *x* - 1), the quotient is (3 *x* - 2) and the remainder is (*x* - 3).** **[2]**

Find the polynomial. Show your work.

Q: 18 ***p*** **(*x*) is a polynomial given by *a* x^2 - 4 *x* + *3*, where *a* is a non-zero real number. One of the zeroes of *p* (*x*) is 3 times the other zero.** **[3]**

i) Find the value of *a*. Show your work.
ii) Based on the value of a, what would be the shape of the graph of *p* (*x*)? Give a reason for your answer.

Q: 19 **A polynomial is given by *p* (*x*) = x^3 + 3 x^2 - 4 *x* + *c*, where *c* is a constant.** **[3]**

The sum of two zeroes of *p* (*x*) is zero.

Using the relationship between the zeroes and coefficients of a polynomial, find the:

i) zeroes of *p* (*x*).
ii) value of *c*.

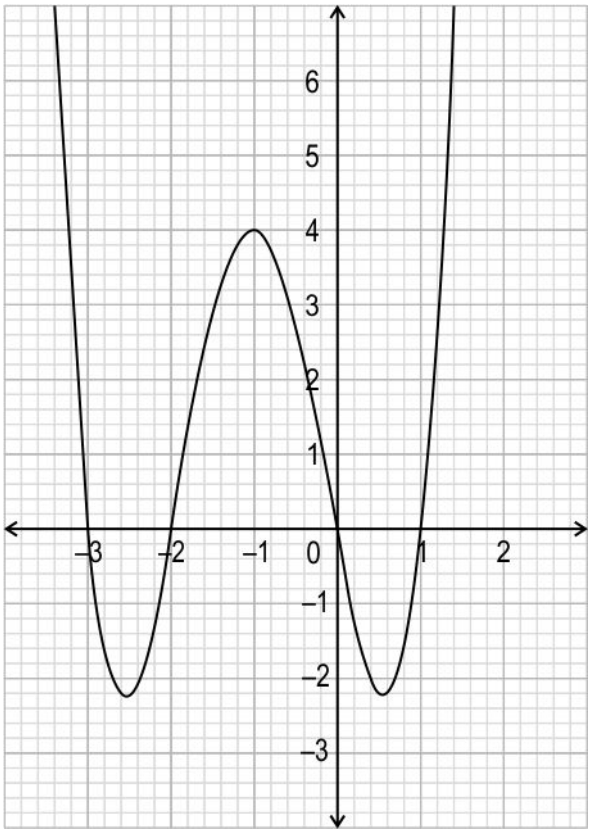
Show your steps.

Q: 20 **Anand multiplied a variable with 6, subtracted 27 and added the square of the original variable. He expressed the final expression as a product of 2 factors.** **[3]**

His friend, Amit, said that the factors will always have a difference of 6.

Is Amit right? Show your work.

Q: 21 **The graph of the polynomial $f(x) = x^4 + 4x^3 + x^2 - 6x$ is shown below.** **[3]**



Identify all the zeroes of the polynomial from the graph. Verify your answer.

Q: 22 **$p(x) = x^3 + (k - 3)x^2 - (k + 4)x - 6$, where k is a non-zero real number and $(x + 2)$ is a factor of $p(x)$.** **[5]**

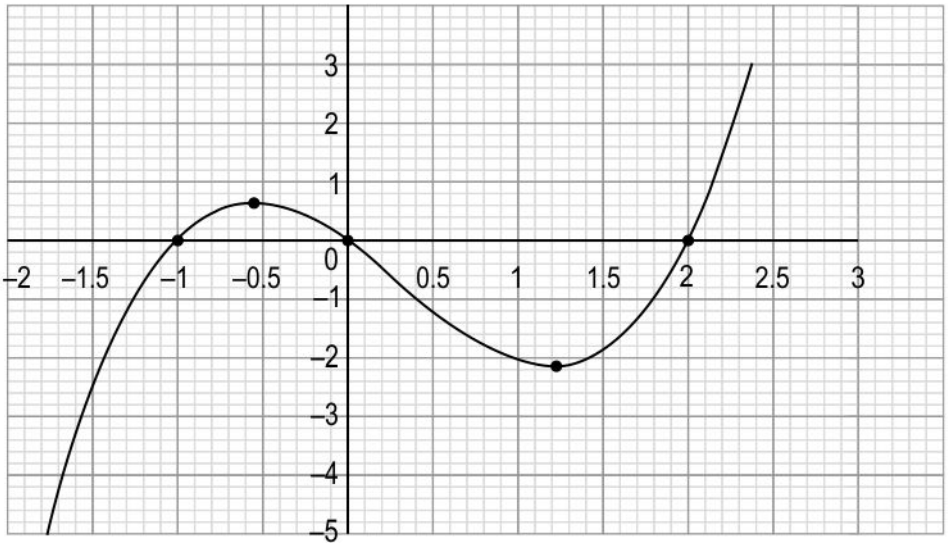
Find the zeroes of $p(x)$. Show your work.

Q: 23 **$f(x) = ax^2 + bx + 325$ is a polynomial where a and b are real numbers. The zeroes of $f(x)$ are distinct prime numbers. Find the:** **[5]**

i) zeroes of $f(x)$.
ii) values of a and b.

Show your work and give valid reasons.

Q: 24 **Shown below is the graph of a polynomial of the form $ax^3 + bx^2 + cx + d$.** **[5]**



i) Find the zeroes of the polynomial.
ii) Find the polynomial.
iii) Identify the values of a, b, c, and d.
iv) Find the quadratic polynomial $x^2 + px + q$, whose sum of the zeroes is equal to the coefficient d of the polynomial in (iii) and the product of the zeroes is $\frac{-1}{16}$.

Show your work and give valid reasons.

Case Study

Answer the questions based on the given information.

The revenue (in Rs) of a firm is represented by the polynomial $R(x) = 5x^3 + 4x^2 + 7$, and the expenditure (in Rs) by the firm is represented by the polynomial $E(x) = 3x^3 + 2x - 1$ where x is the number of items produced by the firm in a year.

Q: 25 **Find the profit polynomial $P(x)$. Show your work.** **[1]**

Q: 26 **If the firm produces 100 products in a year, find the revenue and profit (in Rs) for the firm using the polynomials. Show your work.** **[2]**

Q: 27 **Tax is calculated on the profit using the polynomial $T(y) = 0.3y + 100$, where y represents the profit earned.** **[2]**

Determine the tax amount (in Rs) to be paid on the profit generated from 10 items. Show your work.

Q.No	Correct Answers
1	1
2	3
3	3
4	3
5	4
6	2
7	1
8	2

Q.No	What to look for	Marks
9	**Writes False(F).**	**0.5**
	Justifies the answer. For example, substituting $x = \frac{-2}{5}$ in the given polynomial does not yield 0, so $\frac{-2}{5}$ is not a zero.	**0.5**
10	**Finds the value of f (2) as:** **$(2)^3 + 7(2)^2 + 3(2) - 12 = 30$**	**1**
11	**Divides $x^4 + x^2 + 4$ by $x^2 - 1$ using the long division method to get quotient as $x^2 + 2$ and the remainder as 6.** $$\begin{array}{r} x^2+2 \\ x^2-1\overline{)\,x^4+0x^3+x^2+0x+4} \\ -\,x^4+0x^3-x^2 \\ \hline 2x^2+0x+4 \\ -\,2x^2+0x-2 \\ \hline 6 \end{array}$$	**1**
12	**Factorizes the given polynomial and finds the roots as (-3) and (-7). The working may look as follows:** **$f(x) = x^2 + 10x + 21 = x^2 + 3x + 7x + 21 = 0$** **$\Rightarrow x(x + 3) + 7(x + 3) = 0$** **$\Rightarrow (x + 7)(x + 3) = 0$** **$\Rightarrow (x + 7) = 0$ or $(x + 3) = 0$** **$\Rightarrow x = (-7)$ or $x = (-3)$** ***(Note: Award full marks if the correct roots are obtained by any alternative approach.)***	**1**
13	**Writes that $P(x) = 0$ at $x = 6$ or $P(6) = 0$ and hence $(x - 6)$ is a factor of the polynomial.** **(Award 0.5 marks if only the factor is written.)**	**1**

Q.No	What to look for	Marks
	Writes that P(*x*) = 0 at *x* = -1 or P(-1) = 0 and hence (*x* + *1*) is a factor of the polynomial. **(Award 0.5 marks if only the factor is written.)**	**1**
14	**Simplifies the given polynomial as:** $p(x) = x^2 + 3x + 7k + 25$	**0.5**
	Writes that, if *p* (*x*) is divisible by *x* , *p* (0) = 0. **OR** **Writes that the remainder of $\frac{p(x)}{x}$, which is 7k + 25, should be 0.**	**1**
	Finds the value of *k* as $\frac{-25}{7}$.	**0.5**
15	**Expands (1 - *p*)(1 - *q*) to get 1 - (*p* + *q*) + *pq* .**	**0.5**
	Finds the sum of the zeroes i.e. *p* + *q* = ($\frac{-4}{3}$).	**0.5**
	Finds the product of the zeroes i.e. *pq* = ($\frac{-4}{3}$).	**0.5**
	Uses the above steps to find the value of (1 - *p*)(1 - *q*) as 1 - ($\frac{-4}{3}$) +($\frac{-4}{3}$) = 1.	**0.5**
16	**Factorises the numerator to rewrite the given expression as:** $\frac{(x-3\sqrt{3})(x+\sqrt{3})}{(x+\sqrt{3})}$	**1**
	Writes that the graph of the above expression, (*x* - 3√3), intersects the *x*- axis at exactly one point i.e. (3√3, 0).	**1**
17	**Applies the remainder theorem to write the polynomial as:** **(2 *x* - 1)(3 *x* - 2) + (*x* - 3).**	**1**

Q.No	What to look for	Marks
	Simplifies the above expression to find the polynomial as $6x^2 - 6x - 1$.	**1**
18	**i) Assumes the roots of $p(x)$ to be m and n to write the relation as $m = 3n$.**	**0.5**
	Finds the relation between β and a using the sum of the roots as: **$m + n = 3n + n = 4n = \frac{4}{a}$** **$\Rightarrow n = \frac{1}{a}$**	**0.5**
	Finds the value of a using the product of the roots as: **$m.n = 3n^2 = \frac{3}{a}$** **$\Rightarrow a = 1$.**	**1**
	ii) Writes that, since a is positive, the graph of $p(x)$ is an open upward parabola or open upwards like U. ***(Note: Award half mark if the student just writes parabola instead of upward parabola.)***	**1**
19	**i) Assumes the values of zeroes of $p(x)$ as $(-\alpha)$, α and β.**	**0.5**
	Writes the sum of zeroes as: **$-\alpha + \alpha + \beta = -3$** **Finds β as -3.**	**0.5**
	Writes the equation for the sum of the products of zeroes taken two at a time as: **$-\alpha^2 - \alpha\beta + \beta\alpha = -4$** **Finds α^2 as 4.**	**1**
	Finds the zeroes of $p(x)$ as (-2), 2 and (-3).	**0.5**

Q.No	What to look for	Marks
	ii) Writes the equation for the product of zeroes as (- $\alpha^2 \beta$) = (- c) and finds the value of c as (-12).	**0.5**
20	**Assumes the original variable as x and frames the expression as 6 x - 27 + x^2.**	**1**
	Factorises the above expression as (x - 3)(x + 9).	**1**
	Concludes that Amit was wrong as the above factors have a difference of 12.	**1**
21	**Identifies all the zeroes of the polynomial from the graph as: (-3), (-2), 0 and 1.**	**1**
	Verifies f (-3) = 0 as: **f (-3) = $(-3)^4 + 4(-3)^3 + (-3)^2 - 6(-3) = 81 - 108 + 9 + 18 = 0$** **Similarly verifies for the rest of the three roots.** ***(Note: Award half mark for each correct verification.)***	**2**
22	**Writes that, since p (x) is divisible by (x + 2), p (-2) = 0 and finds the value of k as 3.**	**1**
	Uses the above step and writes p (x) as x^3 - 7 x - 6.	**1**

Q.No	What to look for	Marks
	Divides *p* (*x*) by (*x* + 2) and finds the quotient as x^2 - 2 *x* -3: $x + 2 \;\overline{)\; x^3 - 0x^2 - 7x - 6}$; $x^2 - 2x - 3$ $-\,(x^3 + 2x^2)$ $-2x^2 - 7x - 6$ $-\,(-2x^2 - 4x)$ $-3x - 6$ $-\,(-3x - 6)$ 0	**1**
	Factorizes the quotient as (*x* + 1)(*x* - 3).	**1**
	Finds the zeroes of *p* (*x*) as (-2), (-1) and 3.	**1**
23	**i) Writes the equation for the product of zeroes as:** **product of zeroes = $\frac{325}{a}$.**	**1**
	Writes the prime factorisation of 325 as $5^2 \times 13$.	**0.5**
	Writes that since the zeroes are distinct prime numbers, finds the zeroes of *f* (*x*) as 5 and 13.	**1**
	Finds the value of *a* as $\frac{325}{65}$ = 5.	**0.5**
	ii) Writes the equation for the sum of zeroes as: **5 + 13 = $\frac{-b}{5}$.**	**1**
	Solves the above equation to find the value of *b* as (-90).	**1**

Q.No	What to look for	Marks
24	i) Finds the zeroes of the polynomial as (-1) , 0 and 2 since the y -coordinate = 0 at x = -1, 0 and 2.	1
	ii) Uses the three zeroes to form the polynomial as $x(x + 1)(x - 2) = x^3 - x^2 - 2x$.	1
	iii) Compares the polynomial in the question and that obtained in (ii) and finds the values of $a = 1$, $b = -1$, $c = -2$ and $d = 0$.	1
	iv) Finds the values of p and q using the relationship between the roots and the coefficients as: $\frac{-p}{1} = d$ => p = 0 and $\frac{q}{1} = \frac{-1}{16}$ => $q = \frac{-1}{16}$	1.5
	Finds the polynomial as $x^2 - \frac{1}{16}$ by substituting the above values in the given polynomial expression.	0.5
25	Subtracts E(x) from R(x) to find P(x) as $2x^3 + 4x^2 - 2x + 8$.	1
26	Finds the revenue made by the company from 100 products as: $R(100) = 5(100)^3 + 4(100)^2 + 7$ => R(100) = 5000000 + 40000 + 7 = Rs 50,40,007.	1
	Finds the profit made by the company from 100 products as: $P(100) = 2(100)^3 + 4(100)^2 - 2(100) + 8$ => P(100) = 2000000 + 40000 - 200 + 8 = Rs 20,39,808	1
27	Finds profit for 10 items as: $P(10) = 2(10)^3 + 4(10)^2 - 2(10) + 8$ => P(10) = 2000 + 400 - 20 + 8 = Rs 2388.	1

Q.No	What to look for	Marks
	Finds tax as: **T(2388) = 0.3(2388) + 100 = Rs 816.4.**	**1**

Chapter - 2
Probability

Multiple Choice Questions

Q: 1 **A library receives a shipment for a series of encyclopedias. The shipment includes volumes 31 - 40. These encyclopedias arrived in a box and are not ordered.**

One encyclopedia is picked at random from the box without looking into it.

What is the probability that the volume of the encyclopedia picked is a multiple of 2 OR 5?

1 $\frac{1}{10}$ **2** $\frac{5}{10}$ **3** $\frac{6}{10}$ **4** $\frac{7}{10}$

Q: 2 **In basketball, different shots have varying point values – a two-point shot is taken from inside the three-point line, while a three-point shot is taken from outside the three-point line.**

In a basketball match, a player shot 5 three-point shots and 9 two-point shots out of the 35 shots he made.

A particular shot he took was chosen at random. What is the probability that the shot that was chosen was NEITHER a three-point shot NOR a two-point shot?

1 $\frac{1}{7}$ **2** $\frac{2}{5}$ **3** $\frac{3}{5}$ **4** $\frac{6}{7}$

Q: 3 **Jyoti and Dara are playing a game of tic-tac-toe. The probability of Jyoti winning the game is 0.7.**

What is the probability that Jyoti NOT winning the game?

1 0.7 **2** 0.5
3 0.3 **4** (cannot be determined)

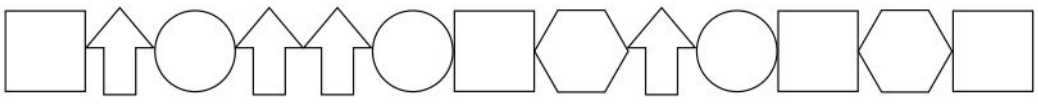
Q: 4 **A card is drawn at random from a well shuffled standard deck of 52 cards.**

What is the probability that the card drawn is NEITHER a black card NOR a three?

(*Note: A deck of cards is divided into four suits - 2 black and 2 red. Each suit contains 13 ranks including numbered cards 2 through 10, and the face cards (jack, queen, king), along with the ace.)*

1 $\frac{22}{52}$ **2** $\frac{24}{52}$ **3** $\frac{26}{52}$ **4** $\frac{28}{52}$

Q: 5 **Matilda made the following pattern during art class.**



If she colours a shape at random, what is the probability that she will colour a circle?

1 $\frac{1}{3}$ **2** $\frac{3}{10}$ **3** $\frac{3}{13}$ **4** $\frac{1}{13}$

Q: 6 **An apartment complex has 20 apartments of different sizes - 2BHK, 3BHK, 4BHK. The probability of a randomly picked apartment being a 3BHK is $\frac{2}{5}$.**

How many 3BHK apartments are in the apartment complex?

1 2 **2** 4 **3** 5 **4** 8

Q: 7 **A box contains some new and weathered cricket balls of two colours. This data is shown in the table below.**

Condition / Colour	New	Weathered
White	5	5
Red	7	3

Pratik picks a new, white ball and puts it back in the box.

If a ball is then picked randomly from the box, what is the probability that it is NOT the same variety as Pratik picked?

1 $\frac{1}{15}$ **2** $\frac{5}{20}$ **3** $\frac{5}{15}$ **4** $\frac{15}{20}$

Q: 8 **In a school, each student is assigned to one of the three houses- Honesty, Integrity and Courage. In a class of 43 students, 13 students are in Honesty house, 16 students are in Integrity house, and rest are in Courage house.**

If a student from this class is selected at random as a class representative, what is the probability that they belong to EITHER Integrity or Courage house?

1 $\frac{1}{43}$ **2** $\frac{29}{43}$ **3** $\frac{20}{43}$ **4** $\frac{30}{43}$

Free Response Questions

Q: 9 **Pritam is throwing a fair 6-sided die, with faces numbered from 1 to 6. Shown below are the outcomes of his first 4 throws:** **[1]**

Throw 1	Throw 2	Throw 3	Throw 4
6	6	6	6

Pritam says, "The probability of getting a 6 in my next throw is higher than that of getting a different number on the die."

Is Pritam's statement true or false? Give a valid reason.

Q: 10 **A pair of fair 6-sided dice with numbers 1-6 written on them are thrown.** **[1]**

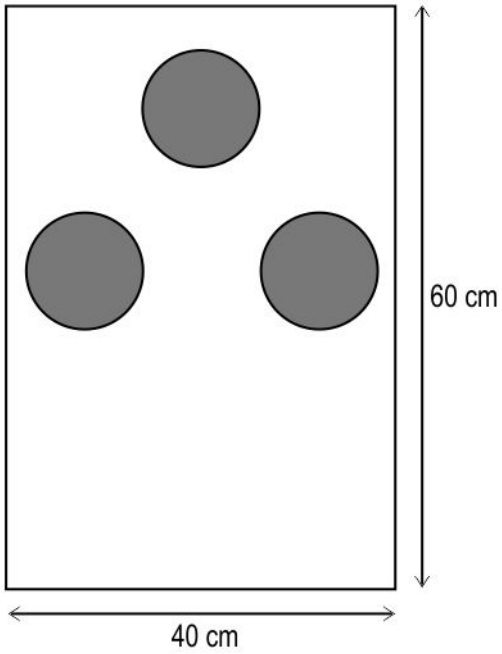
What is the probability that the sum of the numbers shown on the pair of dice is greater than 1? Justify your answer.

Q: 11 **Joel has exactly six 2-rupee coins, five 10-rupee coins and three 20-rupee coins in his pocket. He goes to the stationery store and buys a pen for Rs 19. He takes out a coin from his pocket at random.** **[2]**

i) Find the probability that the coin will be sufficient to pay for the pen.
ii) Find the probability that he will be able to give exactly Rs 19 to the shopkeeper.

Show your work.

Q: 12 **Roshni is playing a dart throwing game. In the game, players throw a dart at a wooden board from a safe distance. If the dart hits inside any one of the shaded circles, they score a point.** **[2]**



(Note: The figure is not to scale.)

The radius of each circle is 5 cm.

Roshni is randomly throwing darts at the board. If each dart Roshni throws hits the board, what is the probability of her scoring a point?

Q: 13 **Alisha had 4 orange candies, 4 mango candies, 2 cola candies and 1 strawberry candy in her bag. Neil only likes orange and cola candies. Alisha randomly takes out a candy to give to Neil.** **[2]**

i) What is the probability that she gave Neil a candy that he likes?
ii) What is the probability she gave Neil a mango candy?

Q: 14 **At an ice cream shop, there are two freezers, each containing different quantities of chocolate and vanilla flavoured ice creams as shown below.** **[2]**

Flavour of Ice cream	Freezer 1	Freezer 2
Chocolate	3	6
Vanilla	2	4

Vikram won an offer to choose an ice cream at random from one of the freezers. He wants a vanilla ice cream.

He believes that selecting from Freezer 2 is more likely to get him a vanilla ice cream because it has a higher number of them compared to Freezer 1.

Is Vikram correct? Justify your answer.

Q: 15 **In a standard deck of 52 cards, a card is drawn without replacement. It is found to be a red 7.** **[2]**

If another card is drawn, what is the probability that it is NOT a 7? Show your work.

Q: 16 **The table below shows all the possible outcomes when two fair 6-sided dice are rolled together.** **[3]**

1,1	1,2	1,3	1,4	1,5	1,6
2,1	2,2	2,3	2,4	2,5	2,6
3,1	3,2	3,3	3,4	3,5	3,6
4,1	4,2	4,3	4,4	4,5	4,6
5,1	5,2	5,3	5,4	5,5	5,6
6,1	6,2	6,3	6,4	6,5	6,6

Study the table and find the probability for the following events.
i) The numbers on both the dice are different.
ii) The second die has a number greater than the first die.
iii) The sum of both the dice is equal to 9.

Show your work.

Q: 17 **Akhila visits an indoor fishing area where an artificial pond is maintained. She randomly chooses a spot to catch fish. As she reached early, she is the only person fishing. The table below shows the population of the fish in the pond.** **[3]**

Name of Fish	Population of Fish
Indian Carp	24
Rainbow Trout	29
Tilapia	20
Largemouth Bass	30
Catfish	25
Striped Bass	22

i) Find the probability of catching a Catfish.
ii) Find the probability of catching a fish that is NOT a type of Bass.
iii) She catches 2 Rainbow Trout on her first 2 attempts. What is the probability of her catching an Indian Carp on her 3rd attempt?

Show your work.

Q: 18 **A fruit basket contains 3 oranges, 1 apple, 5 pomegranate and 6 bananas.** **[3]**

i) Anirudh picks a fruit from the basket at random to eat. What is the probability that he picks an apple?
ii) After Anirudh eats an apple, Aryan picks a fruit at random to eat. What is the probability that Aryan picks a banana?
iii) After Anirudh and Aryan eat an apple and a banana respectively, Siddharth picks a fruit at random to eat. What is the probability that Siddharth picks an apple?

Q: 19 **Anjali has a jar where she saves coins. She has collected twelve 2-rupee coins, and eighteen 10-rupee coins.** **[5]**

One day, she added four 20-rupee coins to it. If a coin is picked at random from this jar now, without looking, find the probability that it is:

i) a 1-rupee coin
ii) a 10-rupee coin
iii) an even valued coin
iv) anything EXCEPT a 5-rupee or a 20-rupee coin.

Show your work.

Q: 20 **Aisha and Ahmad are about to play a board game. To decide who starts first, they decide to throw two dice. The following was agreed upon:** **[5]**

- **Aisha goes first if the numbers on the dice are both prime numbers.**
- **Ahmad goes first if the sum of the numbers on the dice equals 6.**
- **They throw the dice repeatedly till one of these conditions is met.**

If the first throw has decided who goes first, who is more likely to start first? List all the outcomes and show your steps.

Case Study

Answer the questions based on the given information.

Sahiba conducted a survey in her school for 150 students of Class 10. She asked the students two multiple choice questions, which were "What time do you go to sleep at night?" and "What is your favourite subject?". Each student could choose only one option from the choices given.

Sahiba tabulated the results from her survey as shown below.

		Favorite Subject			
		English	Methematics	Science	Social Science
Sleep Schedule	Before 9 PM	5	7	8	7
	9 PM - 10 PM	10	12	11	9
	10 PM - 11 PM	10	12	13	13
	After 11 PM	7	8	10	8

Q: 21 **If a student is randomly selected, what is the probability that they sleep after 11 PM and that their favourite subject is NOT Social Science?** **[1]**

Q: 22 **If a student is randomly selected, what is the probability that they go to sleep after 10 PM?** **[1]**

Q: 23 **If a student is randomly selected, what is the probability that they go to sleep between 9 PM and 10 PM and that their favourite subject is Mathematics?** **[1]**

Q: 24 **If a student is randomly selected, what is the probability that their favourite subject is English?** **[1]**

Q: 25 **If a student is randomly selected, what is the probability that they go to sleep before 10 PM and that their favourite subject is either Science or Social Science?** **[1]**

Answer the questions based on the given information.

Gavin and Ishaan are playing a game using two fair dice, with faces numbered from 1-6. The rules of the game are given below:

♦ Both players take turns to throw the dice, and note the sum of the numbers on both dice as their respective scores.
♦ If a player gets the same number on both dice, they get exactly one extra turn to throw the dice again. The scores from both turns are then added to get the player's total score.
♦ Once both players have thrown the dice, the person with the higher score wins. If the scores are equal, the game ends in a draw.

Q: 26 **Gavin begins by throwing the dice.** **[2]**

What is the probability that he gets an extra turn? Show you work.

Q: 27 **In one of the games, Gavin gets a score of 13.** **[1]**

Find the probability that Ishaan wins the game if he plays only one turn. Justify your answer.

Q: 28 **If Gavin gets a score of 15 and Ishaan gets a pair of 6s on his first turn, find the probability of Ishaan winning the game on his second turn. Show your work.** **[2]**

Answer the questions based on the given information.
Shruti wrote numbers from 2 to 7 on six papers such that the number on each paper was unique. She divided the even and odd numbered papers into two groups, X and Y, respectively.

She then chose a paper from each group at random, one after the other, without looking, and used the numbers written on them to form a 2-digit number. The number chosen first is written at the tens place of the 2-digit number.

Q: 29 **Find the probability that Shruti makes an even number less than 20.** **[1]**

Q: 30 **Shruti thought she is more likely to form an even number greater than 40 as compared to an odd number less than 40.** **[2]**

Is she correct or incorrect? Justify your answer.

Q: 31 **Shruti redistributed the 6 papers evenly between two new groups, A and B, making sure each group had a mix of even and odd numbered papers.** **[2]**

Write one possible distribution of the papers in the two groups, group A and group B, such that the probability of forming an odd number is higher than that of forming an even number, if the paper from group A is chosen first. Give a valid reason.

Q.No	Correct Answers
1	3
2	3
3	3
4	2
5	3
6	4
7	4
8	4

Q.No	What to look for	Marks
9	Writes that the statement is false.	0.5
	Gives a valid reason. For example, when throwing a fair die, the probability of getting any one of the six numbers is the same.	0.5
10	Writes that all the possible sums on a pair of dice are greater than 1.	0.5
	Finds the probability of the sum of the pair of dice being greater than 1 as 1.	0.5
11	i) Identifies total number of outcomes as 6 + 5 + 3 = 14 and number of favourable outcomes as 3.	0.5
	Finds the probability that the coin will be sufficient to pay for the pen as $\frac{3}{14}$. (Award full marks if the probability is found directly without writing step 1.)	0.5
	ii) Writes that the probability that Joel will be able to give exactly Rs 19 to the shopkeeper is 0.	1
12	Finds the area of the rectangle board as 40 x 60 = 2400 cm^2.	0.5
	Finds the area of the 3 circles with radius 5 unit as $3\pi(5)^2 = 75\pi$ cm^2.	0.5
	Finds the probability of Roshni scoring a point as $\frac{75\pi}{2400} = \frac{\pi}{32}$.	1
13	i) Finds that the probability of Alisha giving Neil a candy he likes is $\frac{6}{11}$.	1
	ii) Finds that the probability of Alisha giving Neil a mango candy is $\frac{4}{11}$.	1
14	Writes that Vikram's statement is incorrect.	0.5

Q.No	What to look for	Marks
	Justifies the answer. For example, writes that the probability of randomly picking a vanilla ice cream from Freezer 1 is $\frac{2}{5}$ and the probability of randomly picking an vanilla ice cream from Freezer 2 is $\frac{4}{10}$ which is the same as $\frac{2}{5}$. Hence, the probability of picking a vanilla ice cream from Freezer 1 is the same as Freezer 2.	1.5
15	Finds the number of 7s in the remaining 51 cards as 3.	0.5
	Finds the probability of drawing a 7 as $\frac{3}{51}$ or $\frac{1}{17}$.	0.5
	Finds the probability of not drawing a 7 as 1 - $\frac{3}{51}$ = $\frac{48}{51}$ or $\frac{16}{17}$.	1
16	i) Finds the probability of getting the same number is $\frac{30}{36}$ or $\frac{5}{6}$.	1
	ii) Finds the probability of the second die having a number greater than the first die is $\frac{15}{36}$ or $\frac{5}{12}$.	1
	iii) Finds the probability of getting the sum of both die to be equal to 9 is $\frac{4}{36}$ or $\frac{1}{9}$.	1
17	i) Finds the probability of catching a Catfish as $\frac{25}{150}$ or $\frac{1}{6}$.	1
	ii) Finds the probability of not catching a type of Bass as $\frac{24+29+20+25}{150}$ = $\frac{98}{150}$ or $\frac{49}{75}$.	1
	iii) Finds that the probability of catching an Indian Carp in her 3rd attempt as $\frac{24}{148}$ or $\frac{6}{37}$.	1
18	i) Finds the probability of picking an apple as $\frac{1}{15}$.	1
	ii) Finds the probability of picking a banana after an apple has been eaten as $\frac{6}{14}$ or $\frac{3}{7}$.	1
	iii) Finds the probability of picking an apple after an apple and a banana have been eaten as 0.	1

Q.No	What to look for	Marks
19	Finds the total coins in the jar as 12 + 18 + 4 = 34.	0.5
	i) Finds the probability of picking a 1-rupee coin as 0.	1
	ii) Finds the probability of picking a 10-rupee coin as $\frac{18}{34}$ or $\frac{9}{17}$.	1
	iii) Finds the probability of picking an even valued coin as 1.	1
	iv) Finds the probability of picking a 5-rupee as 0 and a 20-rupee coin as $\frac{4}{34}$ or $\frac{2}{17}$. Thus finds the probability of picking a 5-rupee or a 20-rupee coin as $\frac{2}{17}$.	1
	Finds the probability of not picking a 5-rupee or a 20-rupee coin as: $1 - \frac{2}{17} = \frac{15}{17}$	0.5
20	Writes all the outcomes as {(1,1), (1,2), (1,3), (1,4), (1,5), (1,6), (2,1), (2,2), (2,3), (2,4), (2,5), (2,6), (3,1), (3,2), (3,3), (3,4), (3,5), (3,6), (4,1), (4,2), (4,3), (4,4), (4,5), (4,6), (5,1), (5,2), (5,3), (5,4), (5,5), (5,6), (6,1), (6,2), (6,3), (6,4), (6,5), (6,6)} and indentifies the total number of outcomes as 36.	1.5
	Writes the favourable outcomes for Aisha as {(2,2), (2,3), (2,5), (3,2), (3,3), (3,5), (5,2), (5,3), (5,5)} and identifies the total outcomes for Aisha to win as 9. Hence, finds the probability of Aisha getting both prime numbers as $\frac{9}{36}$ or $\frac{1}{4}$.	1.5
	Writes the favourable outcomes for Ahmad as {(1,5), (2,4), (3,3), (4,2), (5,1)} and writes the total outcomes for Ahmad to win as 5. Finds the probability of Ahmad getting the sum of the numbers on the dice equals 6 as $\frac{5}{36}$.	1.5
	Writes that Aisha is more likely to start first.	0.5

Q.No	What to look for	Marks
21	Finds the probability that the randomly selected student goes to sleep after 11 PM and that their favourite subject is not Social Science as $\frac{25}{150}$ or $\frac{1}{6}$.	1
22	Finds the probability that the randomly selected student goes to sleep after 10 PM as $\frac{81}{150}$ or $\frac{27}{50}$.	1
23	Finds the probability that the randomly selected student has their favourite subject as Mathematics and go to sleep between 9 PM and 10 PM as $\frac{12}{150}$ or $\frac{2}{25}$.	1
24	Finds the probability that the randomly selected student's favourite subject is English as $\frac{32}{150}$ or $\frac{16}{75}$.	1
25	If a student is randomly selected, what is the probability that they sleep before 10 PM and their favourite subject is either Science or Social Science as $\frac{35}{150}$ or $\frac{7}{30}$.	1
26	Finds the sample space of throwing two die as {(1, 1), (1, 2), (1, 3), (1, 4), (1, 5), (1, 6), (2, 1), (2, 2), (2, 3), (2, 4), (2, 5), (2, 6), (3, 1), (3, 2), (3, 3), (3, 4), (3, 5), (3, 6), (4, 1), (4, 2), (4, 3), (4, 4), (4, 5), (4, 6), (5, 1), (5, 2), (5, 3), (5, 4), (5, 5), (5, 6), (6, 1), (6, 2), (6, 3), (6, 4), (6, 5), (6, 6)} .	0.5
	Notes that Gavin will get an extra turn only when the dice show (1, 1), (2, 2), (3, 3), (4, 4), (5, 5) or (6, 6).	0.5
	Finds the probability of getting an extra turn as $\frac{6}{36}$ or $\frac{1}{6}$.	1
27	Notes that the highest score possible in a single turn is 6 + 6 = 12. Writes that there are no possible outcomes in which Ishaan gets a score higher than 13 in only one turn. Hence, the probability that Ishan wins is 0.	1
28	Finds the minimum sum required to win on the second turn as (15 - 2(6)) + 1 = (15 - 12) + 1 = 4.	0.5
	Notes that Ishan will lose only if he gets a total less than 4, that is, if he gets (1, 1), (1, 2) or (2, 1).	0.5

Q.No	What to look for	Marks
	Finds the probability of Ishaan winning on his second turn as 1 - $\frac{3}{36} = \frac{33}{36}$ or $\frac{11}{12}$.	1
29	Reasons that a number less than 20 cannot be formed as the smallest number that can be formed is 23, thus finds its probability as 0. (Award full marks if all possible outcomes are listed and then probability is found.)	1
30	Writes that Shruti is correct.	0.5
	Writes the possible 18 outcomes as: {23, 25, 27, 32, 34, 36, 43, 45, 47, 52, 54, 56, 63, 65, 67, 72, 74, 76}	0.5
	Finds the probability of the number formed being an even number more than 40 as: $\frac{1}{3}$ Finds the probability of the number formed being an odd number less than 40 as: $\frac{1}{6}$	1
31	Finds any one such rearrangement of papers as: Group A: 2, 4, 7 Group B: 3, 5, 6	1
	Reasons that this arrangement of papers satisfies the mentioned condition and as group B has more odd numbered papers than even, the probability of getting an odd number will be higher in this rule.	1

Chapter - 3
Quadratic Equations

Multiple Choice Questions

Q: 1 **Which of these quadratic equations has equal roots?**

1 $3x^2 + 9x + 3 = 0$
2 $x^2 - x + 1 = 0$
3 $x^2 + 2x + 1 = 0$
4 $4x^2 + 8x - 4 = 0$

Q: 2 **The quadratic equation $x^2 - 7x + 10 = 0$ can also be written as _____.**

1 $(x - 5)(x - 2) = 0$
2 $(x + 5)(x + 2) = 0$
3 $(x - 7)(x - 10) = 0$
4 $(x + 7)(x + 10) = 0$

Q: 3 **The quadratic equation $x^2 + 8x + h = 0$ has equal roots.**

Which of these is the value of h ?

1 8 **2** 0 **3** 4 **4** 16

Q: 4 **The sum of a number z and its reciprocal is 4.**

Which of these correctly represents the above statement?

1 $z^2 + 1 = 4$
2 $z^2 + z = 4$
3 $z^2 + 1 = 4z$
4 $z^2 + 1 = -4z$

Q: 5 **Which among the following equations can be categorized as a quadratic equation?**

1 $x(x + 2)^2 = 50$
2 $4x^2 = (2 + x)(4x - 7)$
3 $3x^2 + 5x = 9x(x - 3)$
4 $x^2 + \frac{1}{x} = 0$

Q: 6 **Look at the quadratic equation below:**

$-y^2 + 8y - 18 = 0$

Which of these can be said about the nature of roots of the above quadratic equation?

1 Real and unequal roots
2 Real and equal roots
3 No real roots
4 Cannot say

Q: 7 **Which of these equations will definitely have NO real roots, for any value of a and b other than zero?**

i) $2x^2 - bx - b^2 = 0$
ii) $a^2x - ax + 2 = 0$
iii) $x^2 + ax + b = 0$

1 only i **2** only ii **3** only iii **4** both i and ii

Q: 8 **In the quadratic equation $6x^2 - gx + 2 = 0$, the sum of the roots is equal to three times their product.**

What is the value of g ?

1 -6 **2** $\frac{-1}{6}$ **3** 1 **4** 6

Free Response Questions

Q: 9 **Given below is an equation, where p is a real number.** **[1]**

$px^2 + 4x + 4 = 0$

For what value of p will this equation not be a quadratic equation? Justify your answer.

Q: 10 **Frame a quadratic equation with roots that add up to 15 and has a product of 28.** **[1]**

Q: 11 **One of the roots of the quadratic equation $ax^2 + 4x + a = 0$ is (-2).** **[2]**

Find the value of a. Show your work.

Q: 12 **Raveena and Siya had Rs 800 together. Each of them spent Rs 100 from their respective amounts. Now the product of the amount left with them is Rs 9000.** **[2]**

Frame a quadratic equation to determine the money each one of them had initially.

Q: 13 **The sum of the squares of two consecutive even numbers is 340.** **[2]**

Express the above statement as a quadratic equation in the standard form.

Q: 14 **Find the value(s) of g for which the equation $3x^2 + 3x + gx + 3 = 0$ have real and equal roots. Show your work.** **[2]**

Q: 15 **A store sells two types of toys: standard toys and premium toys. A customer buys a total of 16 toys of both the types such that the product of the number of toys of each type is 28.** **[2]**

Frame a quadratic equation representing the above scenario. Solve it to find the number of toys of each type purchased by the customer. Show your work.

Q: 16 **A ball is thrown vertically upward from the ground. The maximum height, *h* metres, the ball reaches with respect to time, *t* seconds, is represented by the polynomial *h* (*t*) = -5 t^2 + 30 *t.*** **[2]**

How long does it take for the ball to hit the ground? Show your work.

Q: 17 **What is the maximum and minimum number of real roots a quadratic equation can have? Justify your answer.** **[2]**

Q: 18 **Write a quadratic equation with roots as 3 and 5 and coefficient of *x* as (-8). Show your work.** **[2]**

Q: 19 **The length of a rectangular garden is 6 metres more than its width. The total area of the garden is 72 m^2.** **[3]**

Find the width and length of the garden. Show your work.

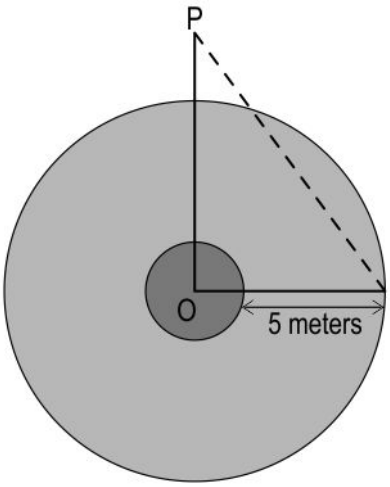
Q: 20 **The sum of the squares of two consecutive odd integers is 290.** **[3]**

Find the integers. Show your work.

Q: 21 **Gaurav saved a certain amount of money in May. He saved Rs 3540 in the month of June. He noticed that his total savings in May and June is equal to the square of his savings in May.** **[3]**

Express this situation in the form of a quadratic equation and find Gaurav's savings in May. Show your work.

Q: 22 **A circular garden has a concentric circular fountain area with centre O. The distance between the circumference of the fountain area and that of the garden is 5 meters as shown in the figure below.** **[3]**



The height of the fountain OP is 5 times the radius of the fountain area.

Find the radius of the fountain area if the shortest distance between the top of the fountain and the circumference of the garden is 17 meters. Show your work.

Q: 23 **A person needs to arrange desks in a classroom such that the number of rows is the same as the number of columns of desks. After having made such an arrangement, he found that 34 desks were still left with him. When he doubled the number of rows and columns, he found that he was short of 14 desks.** **[3]**

Find the total number of desks available with him. Show your work.

Q: 24 **i) Find the nature of roots for the quadratic equation $x^2 + 4x + 9 = 0$.** **[3]**
ii) What will be the nature of new roots if $2x$ is added to the quadratic equation given in i).

Show your work.

Q: 25 **The length of a rectangular garden is 38 m more than its width.** **[3]**

If the area of the garden is 600 m^2, find the dimensions of the garden. Show your work.

Q: 26 **The length of a rectangular park is 5 meters more than its breadth. The area of the park is 104 m^2.** **[5]**

Find the total cost of sowing the plants along the boundary of the park at the rate of Rs 150 per meter. Show your work.

Q: 27 **Shreya said, "I know a real number whose square when added to two-third of itself, gives 152."** **[5]**

Does such a number exist? If yes, find the number. If no, justify your answer.

Case Study

Answer the questions based on the information given below.

A construction company PQR pvt. ltd. signed a contract to construct a hostel building having a total of 135 rooms. The manager of company called up a meeting to decide on the design of building in an efficient way. Two employees put forward their ideas.

Employee 1 said, "the number of rooms on a floor should be 2 less than thrice the number of floors in the building."
Employee 2 said, "the number of rooms on a floor should be 3 less than double the number of floors in the building."

Q: 28 **Represent the design suggested by employee 1 in the form of a quadratic equation. Show your work.** **[1]**

Q: 29 **Represent the design suggested by employee 2 in the form of a quadratic equation. Show your work.** **[1]**

Q: 30 **Which employee suggested the practical design to construct the building? How many floors should be constructed according to that employee? Show your work and give valid reason.** **[3]**

Q.No	Correct Answers
1	3
2	1
3	4
4	3
5	3
6	3
7	2
8	4

Q.No	What to look for	Marks
9	Mentions that for $p = 0$, the equation will not be a quadratic equation.	0.5
	Reasons that as $p = 0$ will make the term with degree 2 zero, the equation will turn into a linear equation.	0.5
10	Frames a quadratic equation using $x^2 - (\alpha + \beta)x + \alpha\beta = 0$ where α and β are roots of the quadratic equation. For example, $x^2 - 15x + 28 = 0$.	1
11	Substitutes x with (-2) in the given equation as: $(-2)^2 a + 4(-2) + a = 0$ $4a - 8 + a = 0$	1
	Solves the above equation to find the value of a as $\frac{8}{5}$.	1
12	Assumes that Raveena had Rs x initially, hence Siya will have Rs $(800 - x)$. Mentions that as each spent Rs 100, money left with them will be Rs $(x - 100)$ and Rs $(700 - x)$ respectively, thus frames the quadratic equation as: $(x - 100)(700 - x) = 9000$	1
	Simplifies the above equation as: $x^2 - 800x + 79000 = 0$	1
13	Assumes one number to be $2x$ and other to be $(2x + 2)$. Frames the following quadratic equation: $(2x)^2 + (2x + 2)^2 = 340$	1
	Simplifies the above equation into the standard form as: $8x^2 + 8x - 336 = 0$ or $x^2 + x - 42 = 0$ (Award full marks if the other number is assumed to be $(2x - 2)$ instead of $(2x + 2)$, hence final equation being $x^2 - x - 42 = 0$.)	1

Q.No	What to look for	Marks
14	Mentions that for the equation to have real and equal roots, value of discriminant should be 0 and writes: $(3 + g)^2 - (4 \times 3 \times 3) = 0$	1
	Solves the above equation and finds the values of g as 3 and (-9).	1
15	Assumes the number of standard toys to be x and premium toys be $(16 - x)$. Frames the quadratic equation as: $x(16 - x) = 28$ $\Rightarrow x^2 - 16x + 28 = 0$	1
	Solves the above equation to find the value of x as 14 and 2. Concludes that the number of standard toys and premium toys are 14 and 2 respectively or vice versa.	1
16	Writes the equation for height when the ball hits the ground as: $-5t^2 + 30t = 0$	1
	Simplifies the above equation as: $t(-5t + 30) = 0$ $\Rightarrow t = 0$ or 6 seconds Writes that the ball takes 6 seconds to hit the ground.	1
17	Writes that the maximum number of real roots a quadratic equation can have is 2 and justifies the answer. For example, writes that when the value of discriminant is non negative, it has 2 real roots.	1
	Writes that the minimum number of real roots a quadratic equation can have is 0 and justifies the answer. For example, writes that when the value of discriminant is negative, it has no real roots.	1

Q.No	What to look for	Marks
18	Assumes a quadratic equation of the form $ax^2 + bx + c = 0$ and writes that: $b = -8$ $3 + 5 = \frac{-b}{a}$ $3 \times 5 = \frac{c}{a}$	1
	Solves the two equations to find the values of a and c as 1 and 15 respectively. The working may look as follows: $3 + 5 = \frac{-b}{a} = \frac{8}{a}$ $\Rightarrow a = \frac{8}{8} = 1$ $\Rightarrow 3 \times 5 = \frac{c}{a}$ $\Rightarrow c = 15$ Writes the final quadratic equation as $x^2 - 8x + 15 = 0$.	1
19	Takes the width of the rectangular garden as x m. Writes the length of the rectangular garden as $(x + 6)$ m. Equates the area of the rectangular garden to 72 m^2 as: $x(x + 6) = 72$ $\Rightarrow x^2 + 6x - 72 = 0$	1
	Solves the above quadratic equation to find the value of x as 6 and (-12).	1
	Rejects $x = (-12)$ and finds the width of garden as 6 meters. Thus finds the length of the garden as 12 meters.	1
20	Takes the pair of consecutive odd integers as x and $(x + 2)$. Uses given condition to frame the equation as: $x^2 + (x + 2)^2 = 290$ $\Rightarrow x^2 + 2x - 143 = 0$	1
	Solves the above quadratic equation to find the value of x as 11 and (-13).	1
	Considering x as 11, finds the integers as 11 and 13. Considering x as (-13), finds the integers as (-13) and (-11).	1

Q.No	What to look for	Marks
21	Assumes May's savings to be Rs x and frames the quadratic equation as: $x + 3540 = x^2$	1
	Solves the above quadratic equation to find the values of x as 60 and (-59).	1.5
	Rejects (-59) as savings cannot be negative. Finds Gaurav's savings in May as Rs 60.	0.5
22	Assumes the radius of fountain area to be r meters. Identifies that the figure forms a right angled triangle, which can be written as follows using pythagoras theorem: $(5r)^2 + (r + 5)^2 = (17)^2$ $\Rightarrow 25r^2 + r^2 + 25 + 10r = 289$ $\Rightarrow 13r^2 + 5r - 132 = 0$	1.5
	Solves the above quadratic equation to find the value of r as 3 meters and $(-\frac{44}{13})$ meters. Rejects $(-\frac{44}{13})$ as radius cannot be negative. Thus finds the radius of the fountain area as 3 meters.	1.5
23	Takes the former number of rows and columns of desks as x and finds the number of desks available as $x^2 + 34$.	0.5
	Takes the latter number of rows and columns as $2x$ and finds the number of desks available as $(2x)^2 - 14$.	0.5
	Equates the above two quadratic expressions and solves for x as: $x^2 + 34 = 4x^2 - 14$ $\Rightarrow 3x^2 = 48$ $\Rightarrow x = 4, -4$ Rejects (-4) as number of rows or columns of desks cannot be negative.	1

Q.No	What to look for	Marks
	Finds the number of desks available with the person as: **$4^2 + 34 = 50$** **or** **$(2 \times 4)^2 - 14 = 50$**	**1**
24	**i) Finds the discriminant ($b^2 - 4ac$) of the given quadratic equation where $a = 1$, $b = 4$ and $c = 9$ as:** **$b^2 - 4ac = 4^2 - 4 \times 1 \times 9 = 16 - 36 = -20$**	**1**
	States that since discriminant is negative, no real roots exists for the given quadratic equation.	**1**
	ii) Writes new value of b as 6 and finds new discriminant as: **$6^2 - 4 \times 1 \times 9 = 36 - 36 = 0$** **Concludes that since new discriminant is 0, newly formed quadratic equation will have two real and equal roots.**	**1**
25	**Assumes the width of rectangular garden to be x m. States that length of the rectangular field would be (x + 38) m.**	**0.5**
	Uses formula of area of rectangle to make the quadratic equation as x (x + 38) = 600.	**1**
	Factorises the above equation as (x - 12)(x + 50) = 0. **Finds the value of x as 12 and (-50).**	**1**
	States that since value of length cannot be negative, x = -50 is not possible. Hence, x = 12. **Concludes that width of rectangular garden is 12 m and length is 12 + 38 = 50 m.**	**0.5**
26	**Assumes breadth of the park as x m and its length as (x + 5) m.** **Frames the quadratic equation as:** **x (x + 5) = 104** **=> $x^2 + 5x - 104 = 0$**	**1**

Q.No	What to look for	Marks
	Solves the above equation to find the value of x as 8, (-13). Finds the breadth of the park as 8 m rejecting (-13) as breadth cannot be negative.	1.5
	Finds the length of the park as 8 + 5 = 13 m. Finds the length of the boundary of park as 2(8 + 13) = 42 m.	1.5
	Finds the cost of sowing plants along the boundary as Rs 150 × 42 = Rs 6300.	1
27	Assumes the number to be m. Frames the quadratic equation as: $m^2 + \frac{2}{3} m = 152$ $\Rightarrow 3m^2 + 2m - 456 = 0$	1.5
	To check if m is a real number, calculates the value of discriminant as: $(2)^2 - (4 \times 3 \times -456)$ $= 5476$ Concludes that since this value is positive, m is a real number.	1.5
	Solves the equation $3m^2 + 2m - 456 = 0$ and finds the value of m as 12 and $(-\frac{38}{3})$.	2
28	Assumes the number of floors in the building to be x. Hence, writes the number of rooms on a floor as $(3x - 2)$.	0.5
	Frames the quadratic equation as: $x(3x - 2) = 135$ $\Rightarrow 3x^2 - 2x - 135 = 0$	0.5
29	Assumes the number of floors in the building to be x. Hence, writes the number of rooms on a floor as $(2x - 3)$.	0.5

Q.No	What to look for	Marks
	Frames the quadratic equation as: $x\ (2x - 3) = 135$ $\Rightarrow 2x - 3x - 135 = 0$	**0.5**
30	**Solves the quadratic equation $2x^2 - 3x - 135 = 0$ to get the values of x as 9 and (-7.5).** **Rejects (-7.5) as number of floors cannot be negative.**	**1**
	Solves the quadratic equation $3x^2 - 2x - 135 = 0$ to get the values of x as $7\frac{1}{25}$ and $(-6\frac{19}{50})$.	**1**
	Writes that since number of floors cannot be in fraction or negative, employee 2's design is practical to construct the building. **Writes that the number of floors that should be constructed is 9.**	**1**

Chapter - 4
Some Applications of Trigonometry

Multiple Choice Questions

Q: 1 **The angle of elevation of the top of a tower from point A on the ground is 30°. The tower is 50 m high.**

Approximately how far is point A from the foot of the tower?

(Note: Take √3 as 1.73.)

1 28.90 m **2** 50 m **3** 86.50 m **4** 100 m

Q: 2 **At a particular time of the day, Shreya noticed that the length of her shadow was equal to her height.**

Which of these is the measure of the angle of elevation of the sun from her head?

1 30° **2** 45° **3** 60° **4** 90°

Q: 3 **A kite is tied to a point on the ground. The length of the string between the kite and the point on the ground is 80 m. The string makes an angle θ with the ground such that tan θ = 60°.**

What is the height of the kite above the ground?

1 20√3 m **2** 40 m **3** 40√3 m **4** 80√3 m

Q: 4 **A wheelchair ramp needs to be built from the ground to a door that is 2 m above the ground.**

If the angle of inclination for the ramp is 30 °, what should be the length of the ramp?

1 2√3 **2** 2 m **3** 4/√3 m **4** 4 m

Q: 5 **From the top of a hill, it is observed that the angle of depression of the top of a tree and its foot are 45° and 60° respectively. The height of the tree is 20 m.**

What is the height of the hill?

(Note: The base of the hill and the tree are on the same level.)

1 10(√3 + 1) m
2 20 + 20(√3 + 1) m
3 20 + 10(√3 + 1) m
4 20 - 10(√3 + 1)) m

Q: 6 **A 10 m tall pole casts a shadow of 15 m when the sun is at a certain inclination. At the same time, a nearby building casts a shadow of 25 m.**

How tall is the building?

1 16.67 m
2 20 m
3 37.5 m
4 (cannot be determined with the given information.)

Q: 7 **A pole, whose height is *h* units, is standing straight up on the ground. The top of the pole subtends an angle *β* with a specific point on the ground.**

Which of these gives the distance from the bottom of the pole to the point on the ground?

1 $h \times cos\ \beta$ **2** $\frac{h}{\tan\beta}$

3 $h \times \tan\beta$ **4** $h \times \cot\beta$

Q: 8 **A helicopter moving linearly with a uniform speed at an altitude of 600 m is observed at an angle of elevation of 45°. After 15 seconds, the angle of elevation is observed to be 30°.**

Which of these is the speed of the helicopter in metres per second?

1 $40\sqrt{3}$ **2** $40(\sqrt{3} - 1)$ **3** $40(\sqrt{3} + 1)$ **4** $600(\sqrt{3} - 1)$

Free Response Questions

Q: 9 **A car is driving up a hill inclined at 30°. It covers a distance of 500 m along the hill.** **[1]**

i) Draw a figure to represent the situation.

ii) Find the vertical height the car gained during the journey. Show your work.

Q: 10 **A ladder leans against a vertical wall. The foot of the ladder is 8 m away from the wall at an inclination of 60° from the ground.** **[1]**

Find the length of the ladder. Show your work.

Q: 11 **An Olympic shooter is aiming a gun at a target from the edge of a cliff such that the gun is 270 m above the ground. The angle of depression of the target from the gun is 30°.** **[1]**

What is the shortest distance between the gun and the target?

Q: 12 **A boy was flying a remote-controlled helicopter. The helicopter was observed at an altitude of $50\sqrt{3}$ metres when it was directly overhead the boy. The helicopter flew 50 metres horizontally making an angle of depression, θ from the boy.** **[1]**

Draw a rough diagram to represent this situation and find the value of θ. Show your work.

Q: 13 **An architect is designing two towers. One tower is 15 m taller than the other. The towers are designed such that from the top of one tower, the top of the other tower can be seen. The angle of depression of the top of the shorter tower from the top of the taller tower is 30°.** **[1]**

Find the horizontal distance between the two towers. Draw a rough image. Show your work.

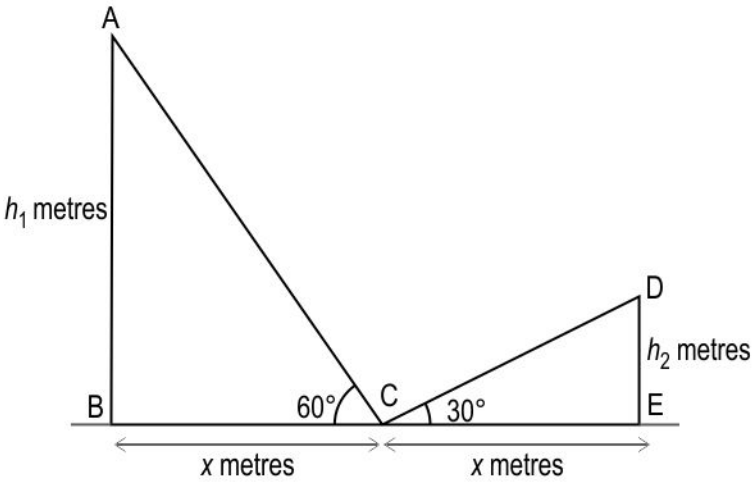
(Note: The horizontal distance is measured between the central axes.)

Q: 14 **A man of height 2 m is standing on the same level as the base of a tower and is looking at the top of the tower. The angle of elevation from his eyes to the top of the tower is 60°.** **[2]**

i) Draw a rough diagram to represent the given situation

ii) Find the height of the tower if the man is standing $30\sqrt{3}$ m away from the tower.

Q: 15 **Two poles of height h_1 metres and h_2 metres subtend angles 60° and 30° respectively at the midpoint of the line joining their feet. The distance from the point on the ground to both poles is given by x metres as shown in the figure below.** **[2]**



(Note: The figure is not to scale.)

Find the ratio $h_1 : h_2$. Show your work.

Q: 16 **Akash is ascending a vertical ladder, he is first observed from point P at an elevation angle of 45°. Upon climbing further, his elevation from the same point increases to 60°.** **[2]**

If point P is 120 m away from the base of the ladder, what is the vertical distance climbed by the man during this change in elevation? Show your steps with a diagram.

(Note: Take √3 as 1.73.)

Q: 17 **The angle of elevation of the top of the tower from a point on the ground is 60°. On moving 10 m away from the point, the angle of elevation of the top of the tower becomes 30°.** **[3]**

Find the height of the tower. Draw a rough figure and show your work.

Q: 18 **A bird was flying parallel to the ground, in an east-west direction with constant speed at a height of 100 m from the ground. Sunita standing in the middle of the park, first observed the bird in the east at an angle of elevation of 30°. After 2 minutes, she observed the bird in the west from the same position making an angle of elevation of 45°.** **[3]**

Find the speed of the bird. Draw a rough diagram to represent the given situation. Show your work.

(Note: Take √3 as 1.73.)

Q: 19 **The shadow of a tower when the angle of elevation of the sun is 30° is found to be 20 m longer than when the angle of elevation is 60°.** **[3]**

i) Find the height of the tower.

ii) Find the length of the shadow of the building when the angle of elevation of the sun was 30°.

Draw a rough figure and show your work.

Q: 20 **A helicopter was seen flying at an angle of elevation 45° from a point on the ground. In another 20 seconds, the helicopter was seen at an angle of elevation of 30° from the same point but in the opposite direction.** **[3]**
If the helicopter was flying at a constant altitude of 1000√3 m, find the average speed of the helicopter in m/s. Draw a rough diagram and show your steps.

(Note: Give your answer as a root.)

Q: 21 **At a fair, Meghna wants to estimate the height of a Ferris wheel, whose highest point is at an angle of elevation of 60° from her. She stands 25 m away from the base of the Ferris wheel.** **[3]**

If Meghna is 1.5 m tall, calculate the approximate height of the Ferris wheel. Draw a rough diagram and show your work.

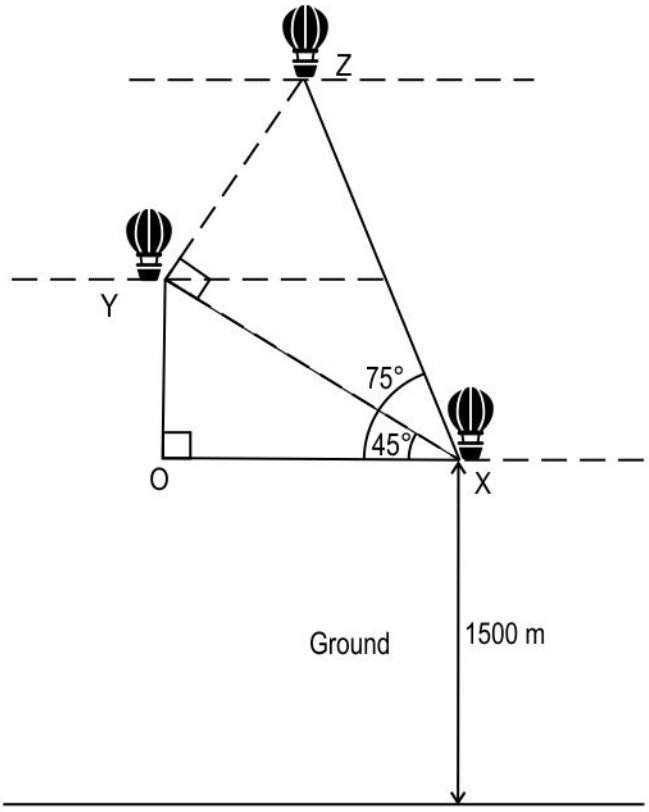
Q: 22 **A tree breaks at a point 5 m from its bottom and falls to the ground. The top of the broken tree touches the ground at a distance of 12 m from its base. The tree is at a right angle with the ground.** **[3]**

i) Find the height of the tree before it broke.

ii) If the tree had not broken, what would be the tangent ratio of the angle to the top of the tree from the same point on the ground?

Draw a rough diagram with your working.

Q: 23 **At a local fair, three hot air balloons, X, Y, Z are flying along the same plane. At a particular instant, their positions and angle between them are as shown in the diagram below.** **[5]**

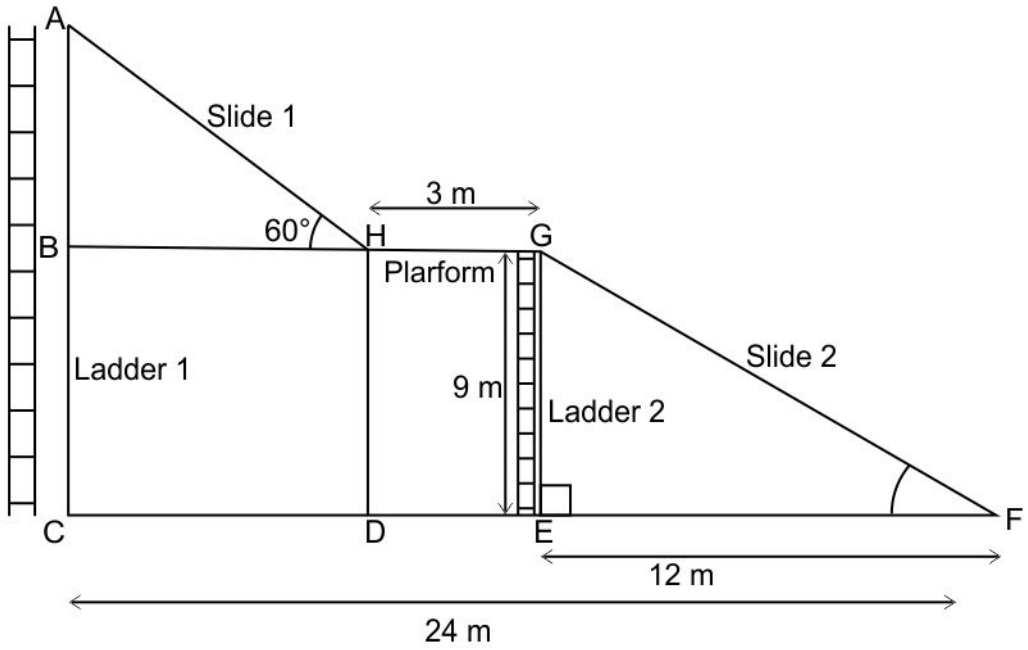


♦ The horizontal distance between balloons X and Y is equal to X's altitude.
♦ Balloons X, Y, and Z are placed such that ∠XYZ = 90°.

Find the:
i) altitude of balloon Y.
ii) shortest distance between balloons Y and Z.
iv) shortest distance between balloons X and Z.

(Note: Consider the balloons as point-sized objects; the figure is not to scale.)

Q: 24 **A large playground consists of two connected slides with a flat platform of 3 m between them. Slide 1, AH is inclined at an angle of 60° relative to the flat ground. The distance between the foot of ladder 2 and the base of the Slide 2 is 12 m. Also the height of ladder 2 is 9 m from the ground. The distance between the two ends of the two slides is 24 m as shown below.** **[5]**



(Note: The figure is not to scale.)

Find:

i) the height of the slide (AC) from the ground. (Round your answer to the nearest integer.)

ii) total distance covered by a person while sliding down from the slide.

(Note: Take √3 as 1.73 if required.)

Case Study

Answer the questions based on the given information.

Arun, Nikhil and Suman visited a park that had many recreational activities for children including slides and kites for them to enjoy. Arun found the slide interesting and he went to try it out. Nikhil and Suman went for kite flying. At a given instant, the position of Nikhil's kite and its angle of elevation from the ground is as shown assuming the string of kite forms a straight line without any snags.

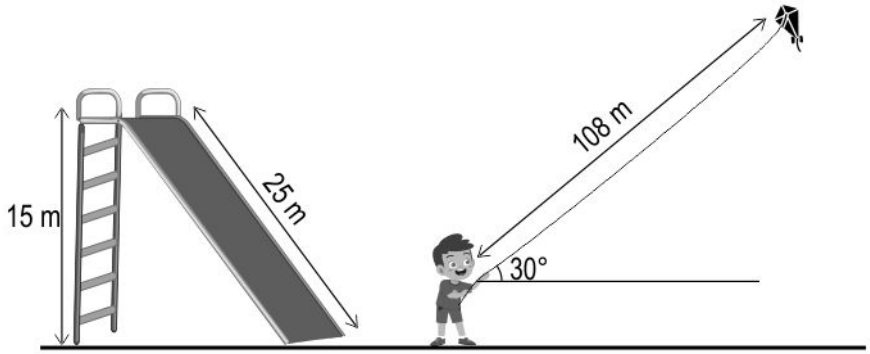


Fig (a) Fig (b)

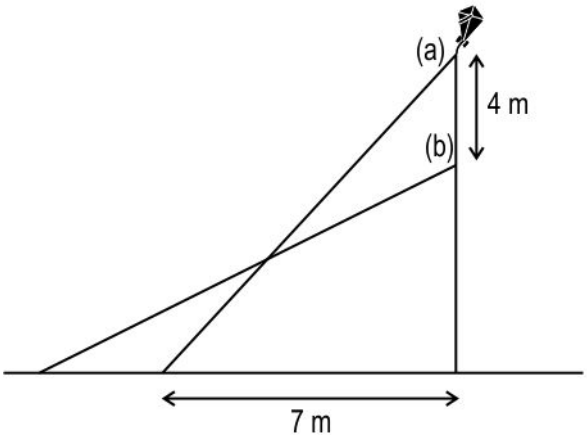
(Note: Take √2 as 1.414 and √3 as 1.732)

Q: 25 **Find the tangent of the angle of depression from the top of the slide to the ground.** **[2]**

Q: 26 **What is the height of Nikhil's kite from the ground at the given instant?** **[1]**

(*Note: Nikhil's height is to be ignored.*)

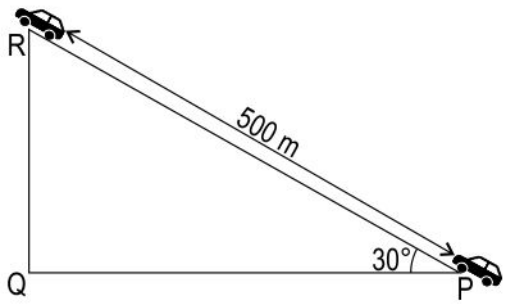
Q: 27 **Nikhil's kite got stuck on the roof of a neighbouring building. Suman saw this and used a ladder to climb up the roof. The ladder was 25 m long and was positioned 7m away from the base of the building. As Suman started to climb, the ladder slipped by 4 m from point (a) to (b) as shown below.** **[2]**

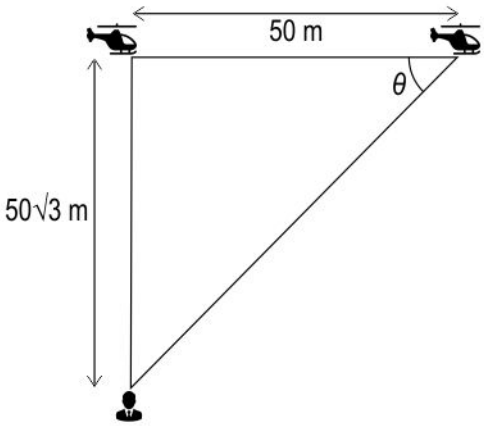


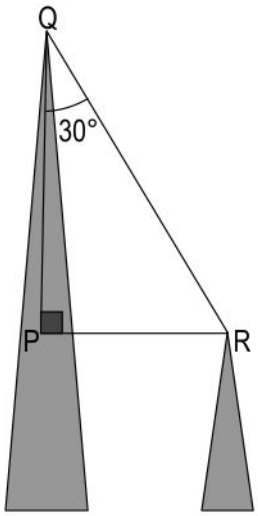
(Note: The figure is not to scale.)

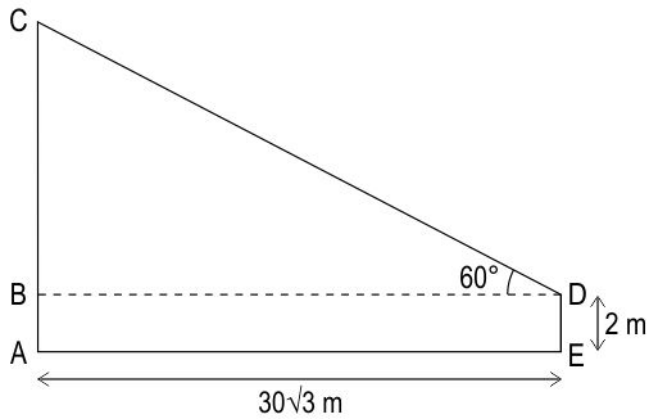
Find the distance by which the foot of the ladder slid along the ground. Show your work.

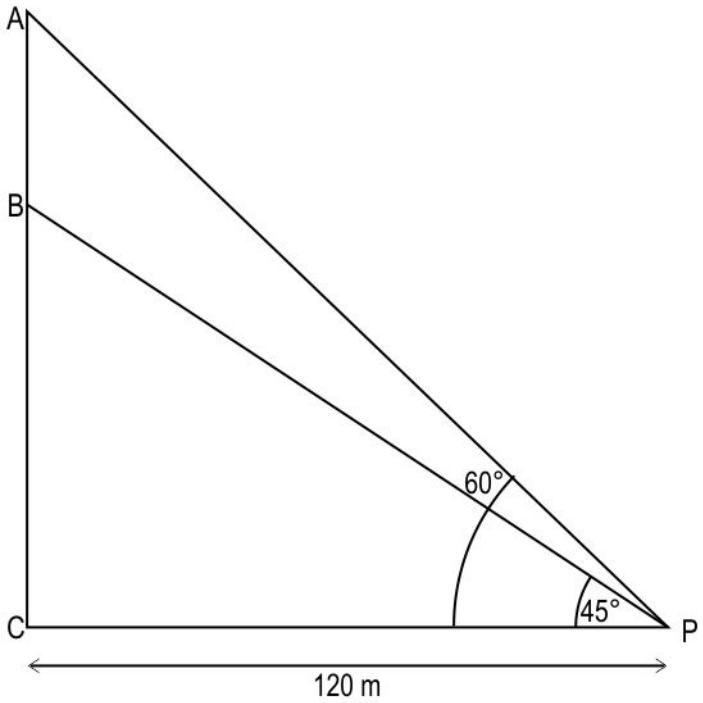
Q.No	Correct Answers
1	3
2	2
3	3
4	4
5	3
6	1
7	3
8	2

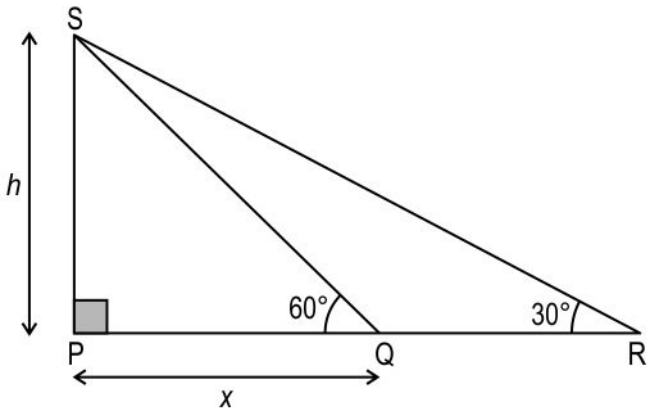
Q.No	What to look for	Marks
9	**i) Draws a figure representing the given information. The figure may look as follows:** 	**0.5**
	ii) Uses sin 30° in ΔPQR to find the vertical height of the car as $\frac{1}{2} = \frac{QR}{500}$ or 250 m.	**0.5**
10	**Uses the trigonometric ratio to write:** **cos 60° = $\frac{8}{length}$**	**0.5**
	Simplifies the above to find the length of the ladder as: **$\frac{1}{2} = \frac{8}{length}$ = 16 m**	**0.5**
11	**Uses the trigonometric ratio, sin 30°, and finds the distance between the gun and the target as $\frac{(270\times2)}{1}$ = 540 m.**	**1**

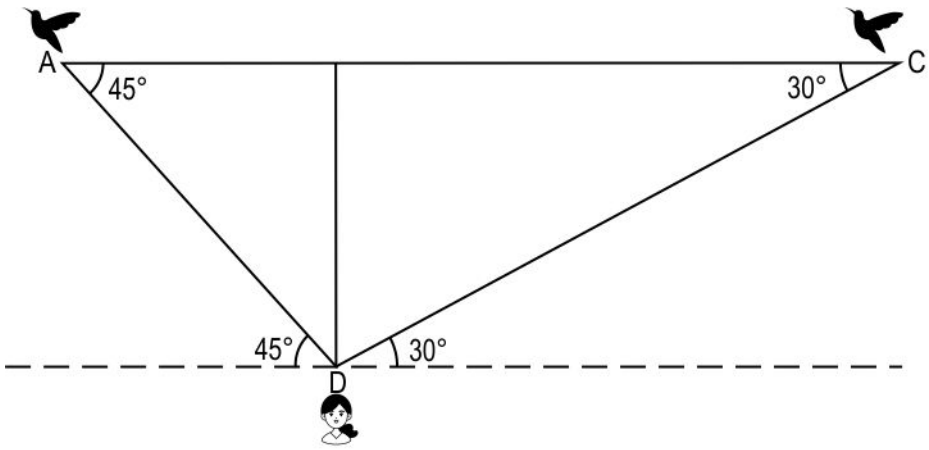
Q.No	What to look for	Marks
12	**Draws a rough diagram to represent the situation. The figure may look as follows:**  **(Note: The figure is not to scale.)**	**0.5**
	Uses the tan ratio to write : $\tan\theta = \frac{\text{altitude of the helicopter from boy}}{\text{horizontal distance covered by the helicopter}}$ $\tan\theta = \frac{50\sqrt{3}}{50} = \sqrt{3}$ **Hence finds the value of θ as 60°.**	**0.5**

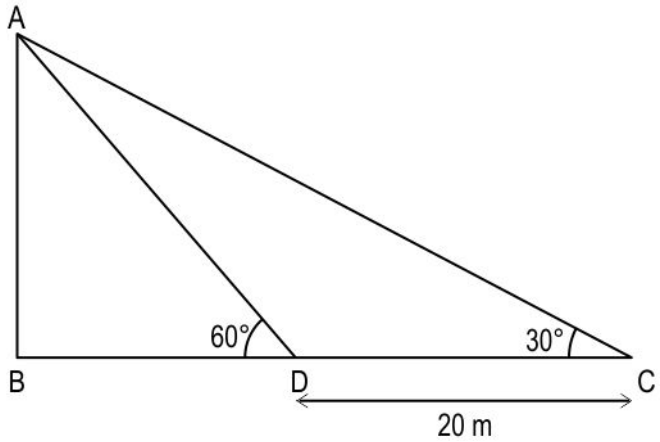
Q.No	What to look for	Marks
13	**Marks the triangle as shown**  **Writes that in ▲PQR,** **tan 30° = $\frac{PR}{PQ}$** **⇒ $\frac{1}{\sqrt{3}} = \frac{PR}{15}$**	**0.5**
	Solves the above equation and finds the horizontal distance between the towers as 5√3 m.	**0.5**

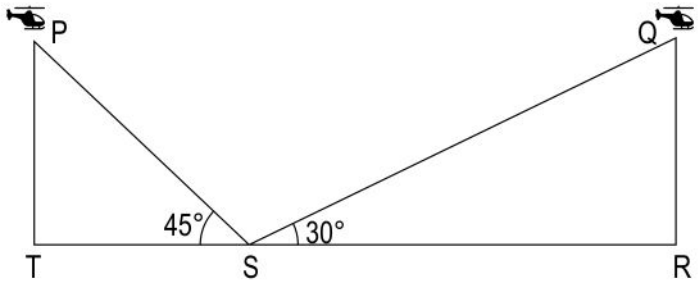
Q.No	What to look for	Marks
14	**i) Draws a diagram to represent the scenario. The diagram may look as follows:**  ***(Note: The figure is not to scale.)***	**0.5**
	ii) Uses the tangent trigonometric ratio in ΔBCD to write: **tan 60° = $\frac{BC}{BD}$** **tan 60° = $\frac{BC}{30\sqrt{3}}$ (BC = AE)** **=> BC = 90 m**	**1**
	Finds the height of the tower as: **AB + BC = 90 m + 2 m = 92 m (AB = DE)**	**0.5**
15	**Uses trigonometric ratios in ΔABC and ΔCDE to frame two equations as:** $\tan 60^\circ = \frac{AB}{BC} = \frac{h_1}{x}$ $\sqrt{3} = \frac{h_1}{x}$ – (i) $\tan 30^\circ = \frac{DE}{CE} = \frac{h_2}{x}$ $\frac{1}{\sqrt{3}} = \frac{h_2}{x}$ – (ii)	**1**

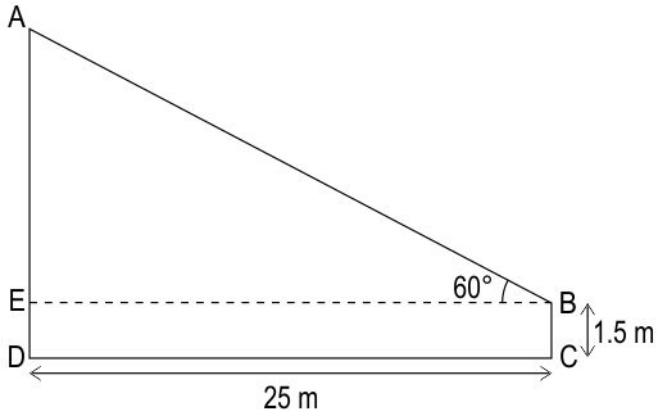
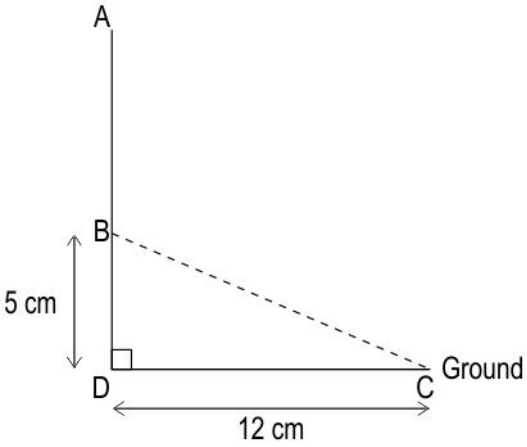
Q.No	What to look for	Marks
	Solves both the equations (i) and (ii) to write, $h_1 = \sqrt{3}\,x$ metres and $h = \frac{x}{\sqrt{3}}$ metres. **Uses the above to find the ratio as h_1 = 3:1.**	**1**
16	**Draws a rough diagram. The figure may look as follows:**  ***(Note: The figure is not to scale.)***	**0.5**
	Uses tan ratio for ΔBCP and finds the length of BC as: **$\tan 45° = \frac{BC}{120}$** **=> BC = 120 m**	**0.5**
	Uses tan ratio for ΔACP and finds the length of AC as: **$\tan 60° = \frac{AC}{120}$** **=> AC = 120√3 m**	**0.5**

Q.No	What to look for	Marks
	Finds the vertical distance covered as (120√3 - 120) = 87.6 m.	**0.5**
17	**Draws the figure according to the information given. The figure may look as follows:**  ***(Note: The figure is not to scale.)***	**0.5**
	Assumes height of tower as *h* and *x* as the horizontal distance of the tower from the initial point. **Uses tan ratio in ▲PQS to write:** **tan 60° = $\frac{PS}{PQ} = \frac{h}{x}$** **=> *h* = √3 *x* m**	**1**
	Uses tan ratio in ▲PSR to write: **tan 30° = $\frac{PS}{PR} = \frac{h}{(x+10)}$** **=> √3 *h* = *x* + 10**	**0.5**
	Substitutes *h* with √3 *x* in the above equation and solves to find PQ as: **3 *x* = *x* + 10 or *x* = 5 m**	**0.5**
	Uses the above to find the height of the tower as √3 *x* =√3 × 5 = 5√3 m.	**0.5**

Q.No	What to look for	Marks
18	**Draws a rough diagram to represent the above situation. The diagram may look as follows:**  **(Note: The figure is not to scale.)**	**1**
	Uses the tan ratio in ▲BCD to write: **tan 30° = $\frac{BD}{BC}$** **$\sqrt{3} = \frac{100}{BC}$** **=> BC = 100√3 m**	**0.5**
	Uses the tan ratio in ▲ABD to write: **tan 45° = $\frac{BD}{AB}$** **1 = $\frac{100}{AB}$** **=> AB = 100 m** **Finds total distance, AC as (100 + 100√3) = 273 m.**	**0.5**
	Finds the speed of the bird between the two observation points as $\frac{273}{2\times60}$ = 2.27 m/s.	**1**

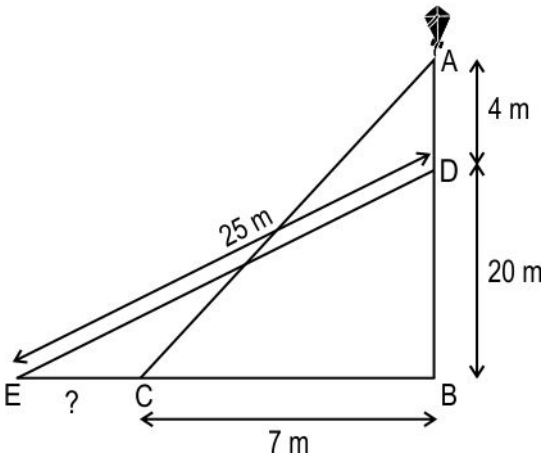
Q.No	What to look for	Marks
19	**Draws a diagram to represent the above scenario. The figure may look as follows:**  ***(Note: The figure is not to scale.)***	**0.5**
	i) Uses tan ratio in ΔABC to write: **tan 30° = $\frac{AB}{BC}$** **=> BC = √3AB m** **Uses tan ratio in ΔABD to write:** **tan 60° = $\frac{AB}{BD}$** **√3 = $\frac{AB}{(BC-DC)}$**	**1**
	Substitutes BC = √3AB and DC as 20 in the above equation and simplifies to find the height, AB of the tower as: **√3(BC - 20) = AB** **√3(√3AB - 20) = AB** **=> 2AB = 20√3** **=> AB = 10√3 m**	**1**
	Finds the length of the shadow, BC as (20 + 10√3) m.	**0.5**

Q.No	What to look for	Marks
20	**Draws a rough diagram to represent the above scenario. The figure may look as follows:**  ***(Note: The figure is not to scale.)***	**0.5**
	Uses tan ratio in ΔPST and writes: **tan 45° = $\frac{PT}{ST}$** **1 = $\frac{1000\sqrt{3}}{ST}$** **ST = 1000√3 m**	**0.5**
	Uses tan ratio in ΔQRS and finds ST as: **tan 30° = $\frac{QR}{RS}$** **$\frac{1}{\sqrt{3}} = \frac{1000\sqrt{3}}{RS}$** **=> RS = 3000 m**	**0.5**
	Uses the above equations to find RT as: **RS + ST = 3000 + 1000√3 m** **RT = 1000√3(√3 + 1) m**	**0.5**
	Finds the average speed of the helicopter in 20 seconds as: $\frac{1000\sqrt{3}\ (\sqrt{3}\ +\ 1)}{20} = 50\sqrt{3}(\sqrt{3}+1)$ m/s	**1**

Q.No	What to look for	Marks
21	**Draws a rough diagram to represent the situation. The figure may look as follows:**  ***(Note: The figure is not to scale.)***	**1**
	Writes tan 60° = $\frac{AE}{BE}$ in ΔABE and substitutes the value of BE as 25 since BE = CD. **Frames the equation as $\frac{AE}{25}$ = √3 and solves the same to find AE as 25√3 m.**	**1**
	Finds the height of the Ferris wheel as AE + ED = (25√3 + 1.5) m since BC = ED.	**1**
22	**Draws a rough diagram. The diagram may look as follows:**  ***(Note: The figure is not to scale.)***	**0.5**

Q.No	What to look for	Marks
	Uses pythagoras theorem in ▲BCD to find the length of BC as: $BC^2 = BD^2 + CD^2$ $\Rightarrow BC^2 = 5^2 + 12^2$ $\Rightarrow BC = 13$ m	1
	i) Uses the above to find the height of the tree as (BC + BD) since BC = AB = 13 + 5 = 18 m.	0.5
	ii) Finds the tangent ratio of the angle of elevation in ▲ACD as $\frac{AD}{CD} = \frac{18}{12} = \frac{3}{2}$.	1
23	i) Uses $\tan 45° = \frac{OY}{OX} = 1$ in ▲XOY to find OY = OX. Writes that OY = 1500 m.	1
	Finds balloon Y's altitude as 1500 + 1500 = 3000 m.	0.5
	ii) In ▲XOY, uses $\sin 45° = \frac{OY}{XY} = \frac{1}{\sqrt{2}}$. Substitutes the value of OY as 1500 m to find XY as $1500\sqrt{2}$ m.	1
	Finds ∠YXZ as 75° - 45° = 30°.	0.5
	In ▲XYZ, uses $\tan 30° = \frac{YZ}{XY} = \frac{1}{\sqrt{3}}$. Substitutes the value of XY as $1500\sqrt{2}$ m to find YZ as $500\sqrt{6}$ m.	1
	iii) In ▲XYZ, uses $\cos 30° = \frac{XY}{XZ} = \frac{\sqrt{3}}{2}$. Substitutes the value of XY as $1500\sqrt{2}$ to find XZ as $1000\sqrt{6}$ m.	1
24	i) Finds CD as (24 - 12 - 3) = 9 m and writes BH = CD = 9 m.	0.5
	Uses the tan 60° in ▲ ABH and writes: $\tan 60° = \frac{AB}{BH}$ $\sqrt{3} = \frac{AB}{9}$ $\Rightarrow AB = 9\sqrt{3}$ m	1

Q.No	What to look for	Marks
	Finds the height of the slide AC from the ground as (9 + 9√3) m ≅ 24.6 m ≅ 25 m.	**1**
	ii) Uses cos 60° in ΔABH and writes: **cos 60° = $\frac{BH}{AH}$** **$\frac{1}{2} = \frac{9}{AH}$** **=> AH = 18 m**	**1**
	Uses Pythagoras' theorem in ΔEFG to find GF as: $\sqrt{12^2 + 9^2} = 15$ m	**0.5**
	Total distance covered as (18 + 3 + 15) = 36 m	**1**
25	**Uses Pythagoras' theorem to find the distance between the foot of the slide and the ladder as:** $\sqrt{25^2 - 15^2} = 9$ m	**1**
	Finds the tangent of angle of depression from the top of the slide to the ground as $\frac{15}{9} = \frac{5}{3}$.	**1**
26	**Uses the sine ratio and substitutes the values to write:** **sin 30° = $\frac{height}{108}$** **$\frac{1}{2} = \frac{height}{108}$**	**0.5**
	Solves the above equation to find height of kite as 54 m.	**0.5**

Q.No	What to look for	Marks
27	**Draws a rough labelled diagram. The labelled diagram may look as follows:**  **Uses the Pythagoras' theorem in $\triangle ABC$ and finds AB as:** $\sqrt{25^2 - 7^2} = 24$ m **Uses the above to find BD as (24 - 4) = 20 m**	**1**
	Uses the Pythagoras' theorem in $\triangle BDE$ and finds BE as: $\sqrt{25^2 - 20^2} = 15$ m **Uses the above to find the distance by which the foot of the ladder slides as (15 - 7) = 8 m.**	**1**

Chapter - 5
Statistics

Multiple Choice Questions

Q: 1 **The table below shows the results of a survey conducted on 40 gamers on how many games did they play on a particular day.**

Number of games	Number of gamers
1 - 2	10
2 - 3	12
3 - 4	5
4 - 5	6
5 - 6	4
6 - 7	2
7 - 8	1

Which of the following is the modal class?

1 1 - 2 **2** 2 - 3 **3** 4 - 5 **4** 7 - 8

Q: 2 **Shreya collects the following data on the number of movies watched by her friends in the month of June.**

Names	Shailja	Nikita	Arima	Meena	Dune
No. of Movies watched	3	8	9	4	1

What is the average number of movies watched by Shreya's friends in that particular month?

1 4.16 **2** 4.20 **3** 5 **4** 9

Q: 3 **In statistics, an outlier is a data point that differs significantly from other observations of a data set.**

If an outlier is included in the following data set, which measure(s) of central tendency would change?

13, 17, 22, 43, 43, 48, 52, 51

1 only mean
2 only mean and median
3 all - mean, median, mode
4 (cannot be said without knowing the outlier)

Q: 4 **In the given number line, *p*, *q* and *r* represent the measures of central tendency of the data: 3, 4, 6, 5, 6, 10.**

Which of these is true for *p*, *q* and *r* ?

1 *p* - Mean
q - Median
r - Mode
2 *p* - Median
q - Mean
r - Mode
3 *p* - Mode
q - Median
r - Mean
4 (cannot be determined unless specific numbers on the scale is provided)

Q: 5 **The approximate relationship between the mean, mode and median can be expressed using an empirical formula.**

Shown below are the measures of central tendency of the marks obtained by Class 8 students in a test.

Mean: 5 marks
Mode: 5.3 marks

Which of the following could be the approximate median of the marks?

1 5.10 marks **2** 5.15 marks **3** 5.20 marks **4** 10.15 marks

Q: 6 **A shoe store owner is planning to stock up for the upcoming month. To make an informed decision, she reviews the sales data of various shoe sizes from the past six months.**

Which central tendency measure would help her in determining which shoe size to order the most of?

1 Mean **2** Median
3 Mode **4** Any of the above

Q: 7 **The mean of the first four data points in a dataset is 10, while the mean of the remaining sixteen data points is 20.**

What is the mean of the entire dataset?

1 1.5 **2** 12 **3** 15 **4** 18

Q: 8 **The table given below shows the literacy rate of 70 cities in a country.**

Literacy rate (in %)	Number of cities (f_i)
30 - 40	2
40 - 50	7
50 - 60	11
60 - 70	16
70 - 80	18
80 - 90	12
90 - 100	4

What is the literacy rate for maximum number of cities?

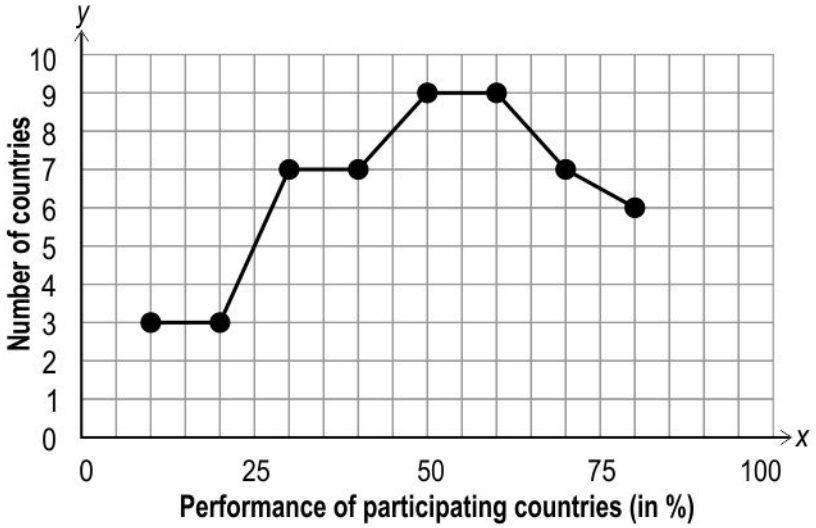
1 70.025 **2** 72.5 **3** 75 **4** 112.5

Free Response Questions

Q: 9 **A cooking oil manufacturing company sells oil in three different bottle sizes. Now, it wants to sell only one size in the market. It has data on how the three sizes perform in the market.** **[1]**

Based on which measure of central tendency should the company fix the size of the oil bottle? Justify your answer.

Q: 10 **Shown below is the frequency polygon. It represents the performance of all participating countries in a question in an international assessment, TIMSS 2011.** **[1]**



(Source of data: Page 91, https://nces.ed.gov/timss/pdf/TIMSS2011_G4_Math.pdf)

If Finland's performance was 58%, did it perform better or worse than the average performance? Show your work.

Q: 11 **Following is the data on the number of maths question attempted by a student in a week.** **[1]**

10, 15, 25, 10, 25, 15, 25

What is the mode of given data?

Q: 12 **Farhan draws less than and more than types of ogives on the same graph paper.** **[1]**

What does he obtain from the x-coordinate of the intersection of both the graphs?

Q: 13 **The number of floors in buildings of a society is given below.** **[1]**

3, 4, 3, 4, 4, 5, 3, 4, 5, 4, 4, 5, 3

Calculate the median number of floors. Show your work.

Q: 14 **Shown below is data taken from 25000 televisions in a city. The table shows the details of channel 1, its screen time and the number of viewers. Screen time refers to the duration for which the channel was viewed.** **[2]**

Screen time (in hours)	Number of Viewers
0 – 2	10000
2 – 4	5000
4 – 6	6500
6 – 8	1500
8 – 10	700
10 – 12	1300

On an average, how long does a viewer watch channel 1? Show your steps.

(Note: Round your answer to two decimal places.)

Q: 15 **In a class test, the mean score of the class is 70. Half the students of the class scored 85 marks or above in the test.** **[2]**

Sunil said, "To have a mean test score of 70 marks, the remaining students must have scored 55 marks or lower".

Is Sunil's statement correct? Justify your answer.

Q: 16 **Given below are the scores of the top 15 students of Rajat's class in a Mental Maths test.** **[2]**

20, 25, 16, 18, 14, 19, 18, 17, 14, 23, 24, 18, 14, 11, 19

Find Rajat's score if it is the median of the given data. Show your work.

Q: 17 **The number of bags sold by Sarah in the initial days of her business is given below.** **[2]**

Number of bags sold	Number of Days
0 – 5	*x*
5 – 10	4
10 – 15	15
15 – 20	5
20 – 25	8

She misplaces the data for the number of days on which less than 5 bags were sold. She knows that the median of her entire data is 12 bags.

Find the number of days on which less than 5 bags were sold. Show your steps.

Q: 18 **The mean temperature of a certain city for 30 consecutive days was found to be 34 °C. Further, the mean temperature of the first 10 days was 30 °C. The mean temperature of the next 10 days was 35 °C.** **[3]**

Find the mean temperature of the rest of the days. Show your work.

Q: 19 **The frequency distribution of daily rainfall in a town during a certain period is shown below.** **[3]**

Rainfall (in mm)	Number of Days
0 – 10	2
10 – 20	6
20 – 30	*x*
30 – 40	7
40 – 50	4

Unfortunately, due to manual errors, the information in the 20-30 mm range got deleted from the data.

If the mean daily rainfall for the period was 27 mm, find the number of days when the rainfall ranged between 20-30 mm. Show your work.

Q: 20 **A traffic police officer collects the following data for the number of cars crossing different Traffic Lights (TL) of his city in a minute.** **[3]**

Traffic Light	Number of cars crossing
TL1	15
TL2	9
TL3	16
TL4	16
TL5	14

The police officer makes an error while writing the data for TL3 and gets the average number of cars crossing traffic lights in a minute as 3 cars more than the actual average number of cars crossing traffic lights.

i) What is the actual number of cars crossing TL3 in that minute?
ii) Which Traffic Light was the busiest in that minute?

Show your work.

Q: 21 **Bowling strike rate for a bowler is defined as the average number of balls bowled per wicket taken.** **[3]**

A bowler has taken 145 wickets till last match with a strike rate of 25. In his next match, he bowled 25 balls and took 5 wickets.

What is his new strike rate? Show your work.

(Note: Round off your answer to 2 decimal places.)

Q: 22 **Akshat's father gives him following data of 31 days on the number of televisions (T.V.) sold in his shop and asks him to draw a histogram for the given data.** **[3]**

Number of T.V. sold	Number of Days
Less than 1	0
Less than 3	5
Less than 5	12
Less than 7	18
Less than 9	24
Less than 11	31

Draw the histogram. Show your work.

Q: 23 **A sports teacher records the given data about the heights (in cm) of all the students of classes 6, 7, and 8.** **[5]**

Height (in cm)	Class		
	6	7	8
120 - 130	15	13	10
130 - 140	13	15	12
140 - 150	12	18	16
150 - 160	10	5	8
160 - 170	7	8	10
170 - 180	3	2	3

Find the mean height of all the students in all three classes together, using any suitable method. Show your work and round your answer upto to two decimal places.

Q: 24 **The following data was collected on the number of potted plants in each of the 20 houses in a locality.** **[5]**

Number of plants	Number of houses
0 - 2	4
2 - 4	3
4 - 6	2
6 - 8	5
8 - 10	6

Ram and Deepak calculate the mean number of potted plants in the locality using assumed mean as 5 plants and 6 plants, respectively.

Will their results be same or different? Show your work and justify your answer.

Case Study

Answer the questions based on the given information.

Cricket is a team sport where two teams of 11 players compete to score runs and dismiss opponents. It is played using a bat and a ball. An inning in cricket is when one team bats while the other team bowls.
The table below shows the number of innings played for various ranges of overs in 50 matches of a tournament.

Number of overs	Number of innings
0-10	5
10-20	10
20-30	8
30-40	15
40-50	12

(Note: Round all calculations to two decimal places.)

Q: 25 **Draw a histogram for the given data.** **[2]**

Q: 26 **What is the average number of overs played per inning by the team in the tournament? Show your work.** **[2]**

Q: 27 **For which range of overs were the most innings played? Which measure of central tendency will definitely be found within that range?** **[1]**

Q.No	Correct Answers
1	2
2	3
3	1
4	2
5	1
6	3
7	4
8	2

<table>
<tr><th>Q.No</th><th>What to look for</th><th>Marks</th></tr>
<tr><td>9</td><td>Writes that the company should fix the size of the oil bottle based on the mode.</td><td>0.5</td></tr>
<tr><td></td><td>Writes that the mode gives the information about the size that is sold most often.</td><td>0.5</td></tr>
<tr><td>10</td><td>Finds the average performance of all countries as $\frac{(30+60+210+280+450+540+490+480)}{51} = \frac{2540}{51}$ or approximately 49.80%</td><td>0.5</td></tr>
<tr><td></td><td>Writes that Finland performed better than the average performance.</td><td>0.5</td></tr>
<tr><td>11</td><td>Concludes that 25 comes the maximum number of times hence it is the mode of the data.</td><td>1</td></tr>
<tr><td>12</td><td>States that Farhan can obtain the median of the data by intersection of less than and more than ogives.</td><td>1</td></tr>
<tr><td>13</td><td>Arranges the data in ascending order as:

3, 3, 3, 3, 4, 4, 4, 4, 4, 4, 5, 5, 5</td><td>0.5</td></tr>
<tr><td></td><td>States that n = 13, therefore, median will be $\frac{n+1}{2}$ th observation, which is 7th observation, that is 4.</td><td>0.5</td></tr>
<tr><td>14</td><td>Rewrites the data of channel 1 as:

<table>
<tr><th>Class Interval</th><th>f_i</th><th>x_i</th><th>$f_i x_i$</th></tr>
<tr><td>0 – 2</td><td>10000</td><td>1</td><td>10000</td></tr>
<tr><td>2 – 4</td><td>5000</td><td>3</td><td>15000</td></tr>
<tr><td>4 – 6</td><td>6500</td><td>5</td><td>32500</td></tr>
<tr><td>6 – 8</td><td>1500</td><td>7</td><td>10500</td></tr>
<tr><td>8 – 10</td><td>700</td><td>9</td><td>6300</td></tr>
<tr><td>10 – 12</td><td>1300</td><td>11</td><td>14300</td></tr>
<tr><td>Total</td><td>n = 25000</td><td></td><td>88600</td></tr>
</table>
</td><td>1.5</td></tr>
</table>

<table>
<tr><th>Q.No</th><th>What to look for</th><th>Marks</th></tr>
<tr><td></td><td>Writes that, on an average, a viewer watches channel 1 for $\frac{88600}{25000}$ = 3.54 hours.</td><td>0.5</td></tr>
<tr><td>15</td><td>Writes that Sunil's statement is not correct.</td><td>0.5</td></tr>
<tr><td></td><td>Provides a valid example where the mean score of some students is 70 marks, half of them scored 85 marks or above, but the rest have not scored 55 marks or lower.

For example, considers 4 students in a class with scores, 89, 85, 56 and 50 and shows that the condition specified by Sunil's statement is not satisfied.</td><td>1.5</td></tr>
<tr><td>16</td><td>Arranges the given data in ascending order as 11, 14, 14, 14, 16, 17, 18, 18, 18, 19, 19, 20, 23, 24, 25.</td><td>0.5</td></tr>
<tr><td></td><td>States that the number of scores is 15 (odd), and hence, the $\frac{15+1}{2}$ th or 8th observation will be the median.</td><td>1</td></tr>
<tr><td></td><td>States that the median of given data will be 18. Hence, Rajat's score is 18.</td><td>0.5</td></tr>
<tr><td>17</td><td>Creates cumulative frequency distribution for the given data as:

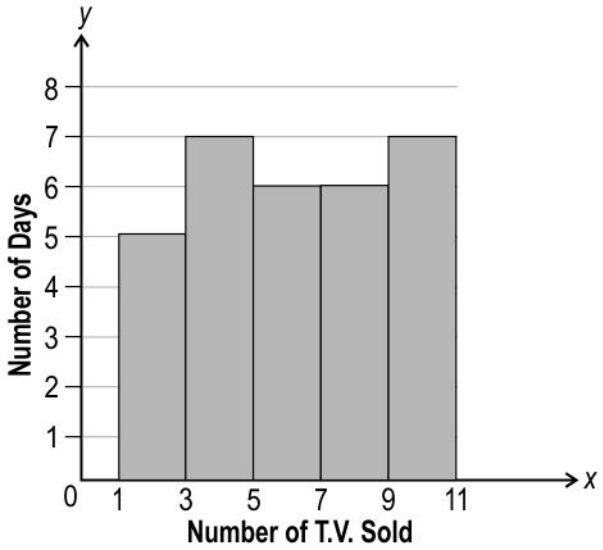
<table><tr><th>Number of bags sold</th><th>Number of Days</th><th>Cumulative Frequency</th></tr><tr><td>0 – 5</td><td>x</td><td>x</td></tr><tr><td>5 – 10</td><td>4</td><td>$x + 4$</td></tr><tr><td>10 – 15</td><td>15</td><td>$x + 19$</td></tr><tr><td>15 – 20</td><td>5</td><td>$x + 24$</td></tr><tr><td>20 – 25</td><td>8</td><td>$x + 32$</td></tr></table></td><td>1</td></tr>
<tr><td></td><td>Writes that since 12 lies in the range 10 - 15, 10 - 15 is the median class. Applies the median formula for the grouped data and solves for x as:

$12 = 10 + \frac{5[\frac{x+32}{2} - (x+4)]}{15}$
$\Rightarrow x = 12$</td><td>1</td></tr>
<tr><td>18</td><td>Finds the number of days remaining as 30 - 10 - 10 = 10.</td><td>0.5</td></tr>
</table>

<table>
<tr><th>Q.No</th><th>What to look for</th><th>Marks</th></tr>
<tr><td></td><td>Finds the sum of the temperatures of all the 30 days as 34 °C × 30 = 1020 °C.</td><td>0.5</td></tr>
<tr><td></td><td>Finds the sum of the temperatures of first 10 days as 30 °C × 10 = 300 °C.</td><td>0.5</td></tr>
<tr><td></td><td>Finds the sum of the temperatures of next 10 days as 35 °C × 10 = 350 °C.</td><td>0.5</td></tr>
<tr><td></td><td>Finds the sum of the temperatures of last 10 days as 1020 °C - 300 °C - 350 °C = 370 °C.</td><td>0.5</td></tr>
<tr><td></td><td>Finds the mean temperature of the last 10 days as $\frac{370}{10}$ = 37 °C.</td><td>0.5</td></tr>
<tr><td>19</td><td>Completes the frequency distribution table as:
<table><tr><th>Rainfall (in mm)</th><th>Frequency (f_i)</th><th>Class mark (x_i)</th><th>$f_i x_i$</th></tr><tr><td>0 – 10</td><td>2</td><td>5</td><td>10</td></tr><tr><td>10 – 20</td><td>6</td><td>15</td><td>90</td></tr><tr><td>20 – 30</td><td>x</td><td>25</td><td>25x</td></tr><tr><td>30 – 40</td><td>7</td><td>35</td><td>245</td></tr><tr><td>40 – 50</td><td>4</td><td>45</td><td>180</td></tr><tr><td>Total</td><td>19 + x</td><td></td><td>525 + 25x</td></tr></table></td><td>1.5</td></tr>
<tr><td></td><td>Writes the equation for mean as:
$\frac{(525+25x)}{19+x}$ = 27</td><td>0.5</td></tr>
<tr><td></td><td>Solves the above equation to find the value of x as 6. Hence, writes that the rainfall ranged between 20-30 mm for 6 days.</td><td>1</td></tr>
<tr><td>20</td><td>i) Calculates the current average of the number of cars crossing traffic light as $\frac{15+9+16+16+14}{5} = \frac{70}{5}$ = 14 cars per traffic light.</td><td>0.5</td></tr>
<tr><td></td><td>Calculates actual average number of cars crossing traffic light as 14 - 3 = 11 cars.</td><td>0.5</td></tr>
</table>

<table>
<tr><th>Q.No</th><th>What to look for</th><th>Marks</th></tr>
<tr><td></td><td>Calculate the actual sum of number of all the cars passing through each traffic lights of the city as 11 x 5 = 55 cars.</td><td>0.5</td></tr>
<tr><td></td><td>Calculate the actual number of cars crossing TL3 as 16 - (70 - 5) = 16 - 15 = 1 car.</td><td>0.5</td></tr>
<tr><td></td><td>ii) Finds the mode of the data which is 16 cars. Hence, states that according to the data, traffic light TL4 was the busiest in that minute.</td><td>1</td></tr>
<tr><td>21</td><td>Finds the total number of balls bowled by the bowler so far as 145 × 25 = 3625.</td><td>1</td></tr>
<tr><td></td><td>Finds the total number of balls bowled after the latest match as 3625 + 25 = 3650 and total number of wickets taken after the latest match as 145 + 5 = 150.</td><td>1</td></tr>
<tr><td></td><td>Finds the new strike rate of the bowler as $\frac{3650}{150}$ = 24.33.</td><td>1</td></tr>
<tr><td>22</td><td>Creates a frequency table for the given data. It may look as follows:

<table><tr><th>Number of T.V. sold</th><th>Number of Days</th></tr><tr><td>1 - 3</td><td>5</td></tr><tr><td>3 - 5</td><td>7</td></tr><tr><td>5 - 7</td><td>6</td></tr><tr><td>7 - 9</td><td>6</td></tr><tr><td>9 - 11</td><td>7</td></tr></table></td><td>1</td></tr>
</table>

Q.No	What to look for	Marks
	Uses the given frequency table to create a histogram as follows:  	**2**
23	**(Note: Here, Step Deviation method is used. Give full marks for any other method used and solved correctly.)** **Creates following table to calculate the mean of all the grades using Step Deviation method.** Height (in cm) / Number of students 120 - 130 / 38 130 - 140 / 40 140 - 150 / 46 150 - 160 / 23 160 - 170 / 25 170 - 180 / 8 Total / 180	**1**

<table>
<tr><th>Q.No</th><th>What to look for</th><th>Marks</th></tr>
<tr><td></td><td>Takes class size h as 10 and considers a value for assumed mean (a). For example, a = 145 cm.</td><td>0.5</td></tr>
<tr><td></td><td>Creates following table to calculate mean:

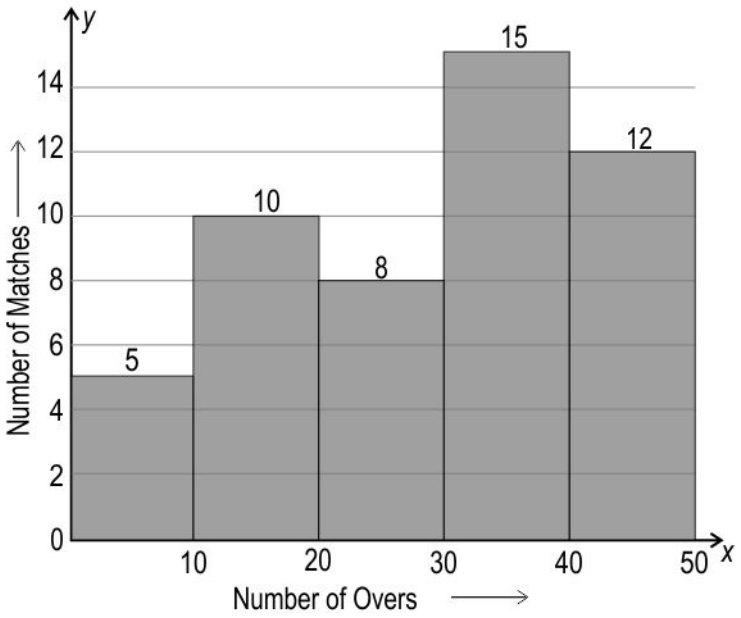
<table>
<tr><th>Class Interval</th><th>Frequency (f_i)</th><th>Class Mark (x_i)</th><th>$d_i = x_i - a$</th><th>$u_i = d_i / h$</th><th>$f_i u_i$</th></tr>
<tr><td>120-130</td><td>38</td><td>125</td><td>-20</td><td>-2</td><td>-76</td></tr>
<tr><td>130-140</td><td>40</td><td>135</td><td>-10</td><td>-1</td><td>-40</td></tr>
<tr><td>140-150</td><td>46</td><td>145</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>150-160</td><td>23</td><td>155</td><td>10</td><td>1</td><td>23</td></tr>
<tr><td>160-170</td><td>25</td><td>165</td><td>20</td><td>2</td><td>50</td></tr>
<tr><td>170-180</td><td>8</td><td>175</td><td>30</td><td>3</td><td>24</td></tr>
<tr><td>Total</td><td>180</td><td></td><td></td><td></td><td>-19</td></tr>
</table></td><td>2</td></tr>
<tr><td></td><td>Calculates mean using the Step Deviation formula as:
$\overline{x} = 145 + 10 \times \frac{(-19)}{180} = 145 - \frac{190}{180} = 145 - 1.06 = 143.94$ cm

(Note: Award 0.5 marks if the student has only written the formula correctly.)</td><td>1.5</td></tr>
<tr><td>24</td><td>Takes assumed mean, a = 5 plants and creates following table:

<table>
<tr><th>Class Interval</th><th>Frequency (f_i)</th><th>Class Mark (x_i)</th><th>$d_i = x_i - a$</th><th>$f_i d_i$</th></tr>
<tr><td>0 - 2</td><td>4</td><td>1</td><td>–4</td><td>–16</td></tr>
<tr><td>2 - 4</td><td>3</td><td>3</td><td>–2</td><td>–6</td></tr>
<tr><td>4 - 6</td><td>2</td><td>5</td><td>0</td><td>0</td></tr>
<tr><td>6 - 8</td><td>5</td><td>7</td><td>2</td><td>10</td></tr>
<tr><td>8 - 10</td><td>6</td><td>9</td><td>4</td><td>24</td></tr>
<tr><td>Total</td><td>20</td><td></td><td></td><td>12</td></tr>
</table></td><td>1</td></tr>
</table>

<table>
<tr><th>Q.No</th><th>What to look for</th><th>Marks</th></tr>
<tr><td></td><td>Calculates mean using assumed mean formula,
$\bar{x} = a + \frac{\sum f_i d_i}{\sum f_i} = 5 + \frac{12}{20} = 5.6$ potted plants</td><td>1</td></tr>
<tr><td></td><td>Takes assumed mean, a = 6 plants and creates following table:

<table>
<tr><th>Class Interval</th><th>Frequency (f_i)</th><th>Class Mark (x_i)</th><th>$d_i = x_i - a$</th><th>$f_i d_i$</th></tr>
<tr><td>0 - 2</td><td>4</td><td>1</td><td>–5</td><td>–20</td></tr>
<tr><td>2 - 4</td><td>3</td><td>3</td><td>–3</td><td>–9</td></tr>
<tr><td>4 - 6</td><td>2</td><td>5</td><td>–1</td><td>–2</td></tr>
<tr><td>6 - 8</td><td>5</td><td>7</td><td>1</td><td>5</td></tr>
<tr><td>8 - 10</td><td>6</td><td>9</td><td>3</td><td>18</td></tr>
<tr><td>Total</td><td>20</td><td></td><td></td><td>–8</td></tr>
</table></td><td>1</td></tr>
<tr><td></td><td>Calculates mean using assumed mean formula,
$\bar{x} = a + \frac{\sum f_i d_i}{\sum f_i} = 6 + \frac{-8}{20} = 6 - \frac{2}{5} = 5.6$ potted plants</td><td>1</td></tr>
<tr><td></td><td>Concludes that their result will be same.</td><td>1</td></tr>
</table>

Q.No	What to look for	Marks
25	**Interprets the data and draws correct histogram as given:**  	**2**
26	**(Note: Here, Step Deviation method is used. Give full marks for any other method used and solved correctly.)** **Takes class size *h* as 10 and considers a value for assumed mean (*a*). For example, *a* = 25 overs.** **1**

Class Interval	Frequency (f_i)	Class Mark (x_i)	$d_i = x_i - a$	$u_i = d_i / h$	$f_i u_i$
0 - 10	5	5	–20	–2	–10
10 - 20	10	15	–10	–1	–10
20 - 30	8	25	0	0	0
30 - 40	15	35	10	1	15
40 - 50	12	45	20	2	24
Total	50				19

Calculates mean, $\overline{x} = a + h \times \frac{\sum f_i u_i}{\sum f_i}$ **1**

$= 25 + 10 \times \frac{19}{50} = 25 + \frac{19}{5} = 25 + 3.8 = 28.8$ overs

Q.No	What to look for	Marks
27	States that most innings were played for 30-40 overs.	0.5
	Writes that 30-40 overs is the modal class and hence, the mode will definitely be found within this range.	0.5

Chapter - 6

Surface areas and volumes

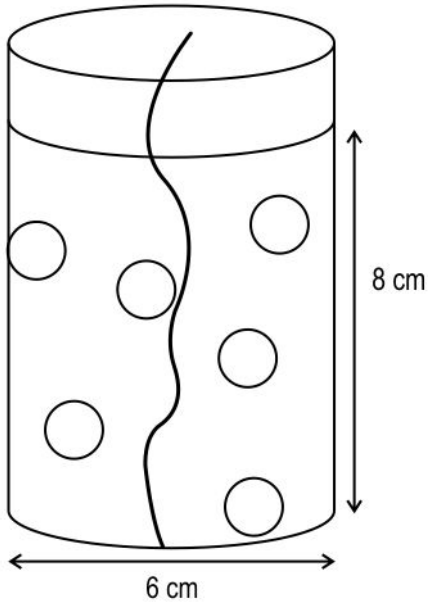
Multiple Choice Questions

Q: 1 **A solid iron cylinder is melted to form rods of the same height. The radius of the iron rods is $\frac{1}{4}$ of the radius of the cylinder.**

How many rods were made?

1 4
2 16
3 64
4 (depends on the volume of the cylinder)

Q: 2 **6 spherical glitter balls with diameter 1 cm are present in a cylindrical candle made with transparent wax as shown in the figure below.**



(Note: The figure is not to scale.)

Find the volume of wax used to make the candle.

1 $70\pi\ cm^3$
2 $71\pi\ cm^3$
3 $72\pi\ cm^3$
4 $73\pi\ cm^3$

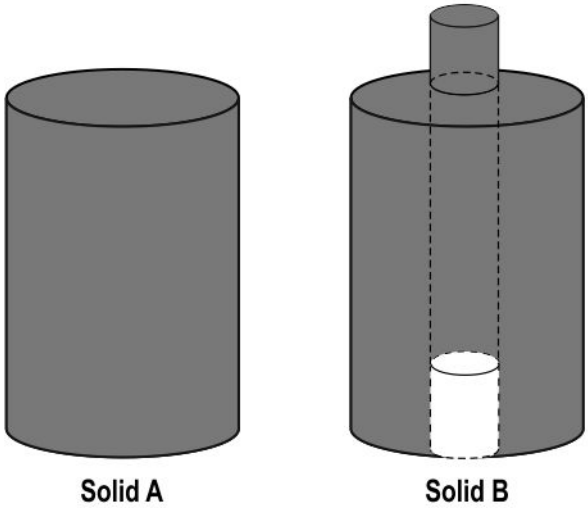
Q: 3 **Bipin is making iced tea in 2.2 litre jar. He adds some ice spherical balls of diameter 2 cm into the jar, followed by 1.32 litre of tea until it's full.**

How many ice spheres does he add to the cup?

(Note: 1 ml = 1 cm ^{3} **and take π as** $\frac{22}{7}$ **.)**

1 26.25
2 210
3 315
4 1050

Q: 4 **Solid B is made using Solid A by cutting a smaller cylinder through the centre which is then pushed from below such that it protrudes from the top as shown below.**



(Note: The figure is not to scale.)

Which of these is true about the volume and surface area of the two solids?

1 Both the volume and the surface area of the solids are different.
2 Both the volume and the surface area of the solids are the same.
3 The volume of the solids is different but the surface area of the solids is the same.
4 The volume of the solids is the same but the surface area of the solids is different.

Q: 5 **Ajit makes a hemispherical clay pot with inner radius 12 cm and 3 cm uniform thickness.**

Find the volume of clay used to make the pot.

1 $243\pi\ cm^3$
2 $1098\pi\ cm^3$
3 $1152\pi\ cm^3$
4 $2250\pi\ cm^3$

Q: 6 **Two identical solid cubes are joined by a side to form a cuboid.**

What fraction of the surface area of the 2 cubes is the surface area of the cuboid?

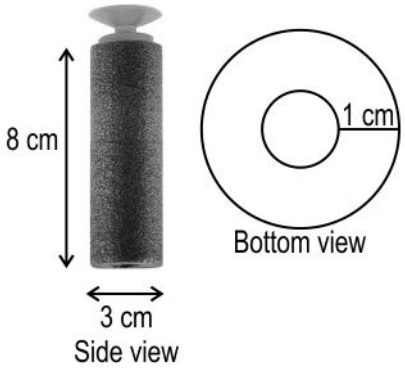
1 $\frac{5}{6}$
2 $\frac{11}{12}$
3 1
4 (cannot be determined without the exact dimensions)

Q: 7 **A solid hemisphere with radius 20 cm is melted to form 8 cones of the height 20 cm.**

Which of these is the radius of the cones?

1 5 cm **2** $2\sqrt{10}$ cm **3** 10 cm **4** $10\sqrt{2}$ cm

Q: 8 **A toy company manufactures hollow foam bullets with plastic tops for their toy guns, the dimensions of which are shown in the figure below.**



(Note: The figure is not to scale.)

What is the volume of the foam used to make a set of 10 bullets?

1 $80\pi\ cm^3$ **2** $160\pi\ cm^3$
3 $180\pi\ cm^3$ **4** $240\pi\ cm^3$

Free Response Questions

Q: 9 **Find the radius of the solid cylinder with height equal to its radius and total surface area of $144\pi\ cm^2$. Show your work.** **[1]**

Q: 10 **A cone and a sphere have the same radius and volume.** **[1]**

Find the ratio of the radius of the cone to its height.

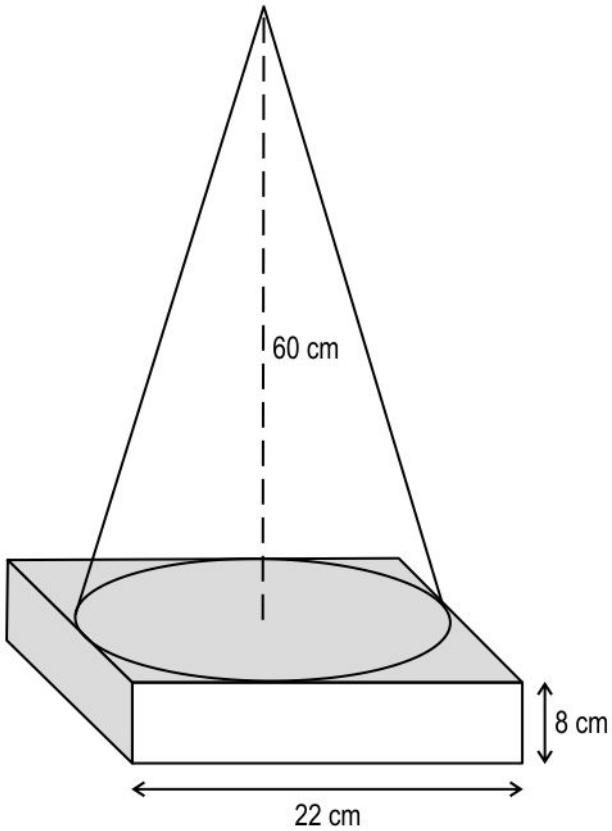
Q: 11 **What is the length of the side of a cube if its volume and surface area are numerically equal? Show your work.** **[1]**

Q: 12 **14 identical cylindrical cups of radius 2 cm completely fills a cubical container of side 10 cm.** **[1]**

What is the height of the cups? Show your work.

(*Note: Round your answers to 2 decimal places.* Take π as $\frac{22}{7}$.)

Q: 13 **Shown below is a solid marker cone mounted on a cuboidal base, the exterior of which, excluding the bottom, is to be painted with red colour. The dimensions can be observed in the figure provided.** **[2]**

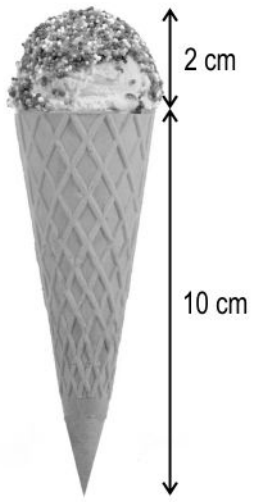


(*Note: The figure is not to scale.*)

What is the surface area of the traffic cone that is painted red? Show your work.

(*Note: Take π = 3.14*)

Q: 14 **Yash and his younger brother, Swapnil buy a cone of ice cream to share equally. The ice cream is filled till the top of the cone and an hemispherical scoop is added on the top as shown below.** **[2]**

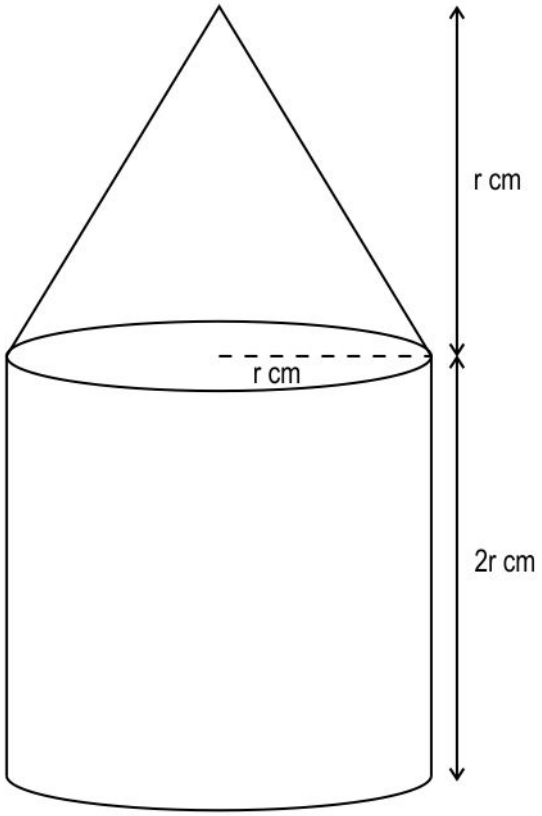


(Note: The figure is not to scale.)

Yash eats his share of the ice cream and gives the remaining to Swapnil. When Yash gives the cone to Swapnil, the volume of the ice cream in the cone is $\frac{28\pi}{3}$ cm^3.

Did Swapnil get an equal share?

Q: 15 **The volume of the solid shown below is 198 cm^3.** **[2]**



(Note: The figure is not to scale.)

Find the radius of the solid. Show your work.

(Note: Take π as $\frac{22}{7}$.)

Q: 16 **A wooden paper weight is made such that the top is a hemisphere and the bottom is a cube where the diameter of the hemisphere is equal to the side of the cube. The entire surface area of the paper weight is to be polished.** **[2]**

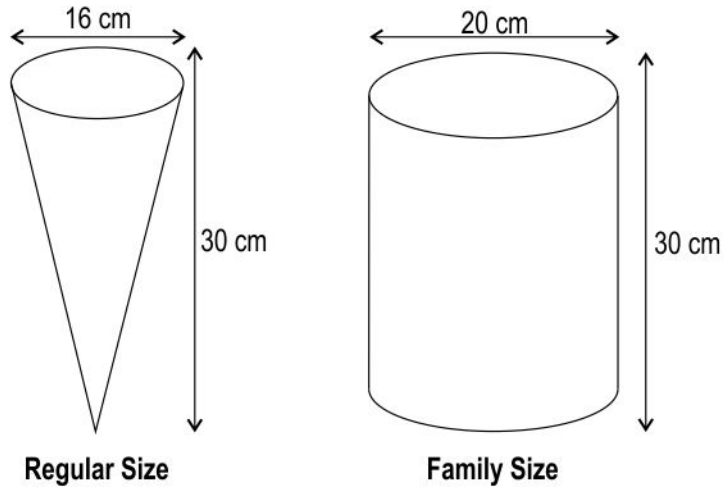
If the side of the cube is 4 cm, find the surface area of the paperweight that is to be polished? Show your work.

(Note: Take π as 3.14)

Q: 17 **Determine the ratio of the volume of a cube to the right circular cone that fits exactly inside the cube. Show your steps.** **[3]**

(Note: Take π as $\frac{22}{7}$.)

Q: 18 **A theatre offers 2 popcorn sizes - regular and family size as shown in the figure below.** **[3]**

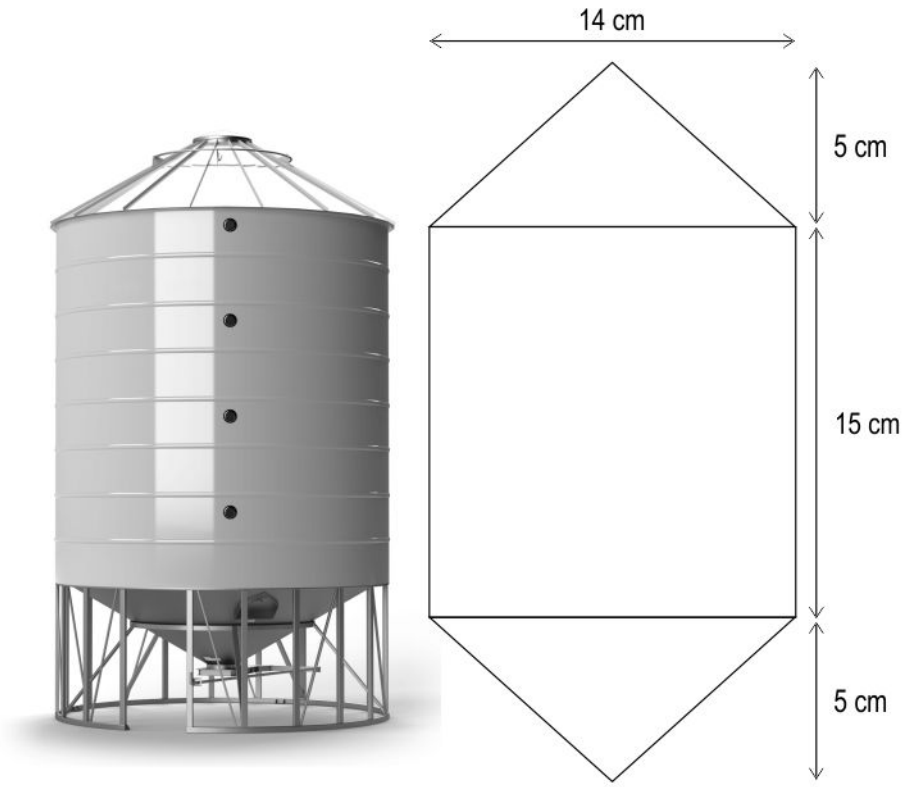


(Note: The figure is not to scale.)

Yamir and his friends have the choice of buying either 5 regular portions or 1 family size portion, both priced the same.

Which option should they choose to get the most popcorn? Show your work.

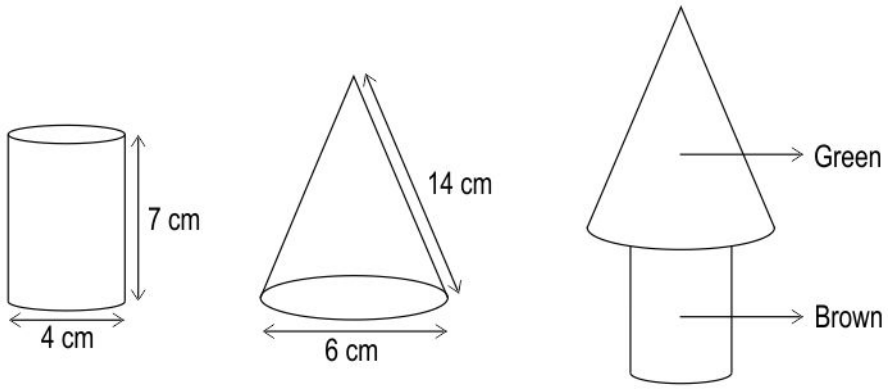
Q: 19 **A silo is used to store grains. It can be observed as a cylinder with 2 cones on its circular bases as shown in the figure below.** **[3]**



(Note: The figure is not to scale.)

If the height of the grains in the silo is 20 m, what fraction of the silo's volume is filled with grains? Show your work.

Q: 20 **Deepika takes a solid cylinder and attaches it to a solid cone to make the figure of a tree as shown in the figure below.** **[3]**

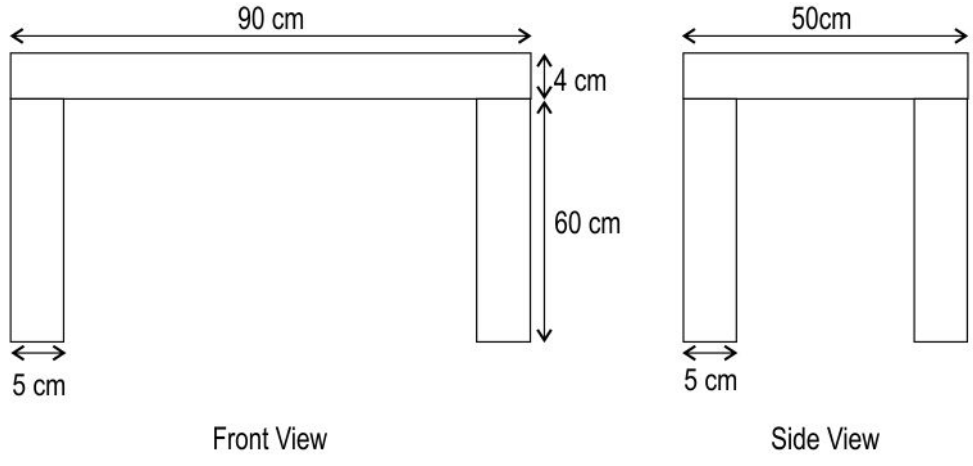


(Note: The figure is not to scale.)

She wants the conical part including its base to be painted green and the cylindrical part including its base to be painted brown to resemble a tree.

i) Find the area to be painted green.
ii) Find the area to be painted brown.
(Note: Round the answers to 2 decimal places. Take π as $\frac{22}{7}$.)

Q: 21 **A carpenter makes a wooden table with four legs. His sketch of the design is also shown in the figure below.** **[3]**

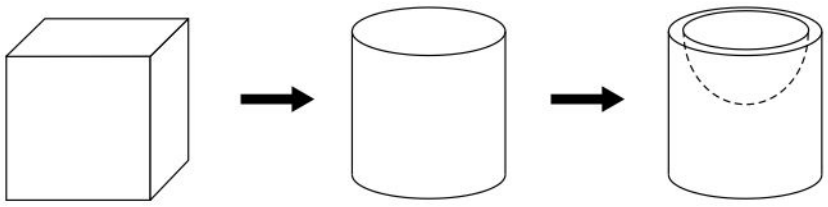


(Note: The figure is not to scale.)

Once the table is assembled entire table is to be laminated except the part where it touches the floor.

Find the area of the table that is to be laminated.

Q: 22 **Aparna takes a wood carving class during her summer camp. She attempts to make a bird feeder. She takes a piece of wood in the shape of a cube and carves it to make a cylinder with height and diameter equal to the side of the cube. She then carves a hemisphere into the circular base of the cylinder with radius equal to $\frac{4}{5}$ th of the radius of the cylinder. After this, she sands the wood to make it smooth.** **[5]**



(Note: The figure is not to scale.)

What percentage of the original cube has been used to make the bird feeder? Show your work.

(*Note: Take π as 3.14. Round your answer to the nearest integer.*)

Q: 23 **A toy company designs a soft toy of a cube-shaped regular die. The numbers on the side of the die are represented by the number of hemispherical indents on each side, that is, a total of 21 hemispherical indents. The radius of each hemispherical indent is 4 cm and the edge of the toy is 30 cm long. The toy is to be covered with a cloth costing Rs 0.01 per cm^2 and is to be stuffed with cotton costing Rs 0.02 per cm^3.** **[5]**

(Note: The figure is not to scale.)

i) How much cloth is required to make the soft toy?
ii) What is the volume of cotton required to stuff the toy?
iii) What is the cost of the cloth and cotton requires to make one toy?

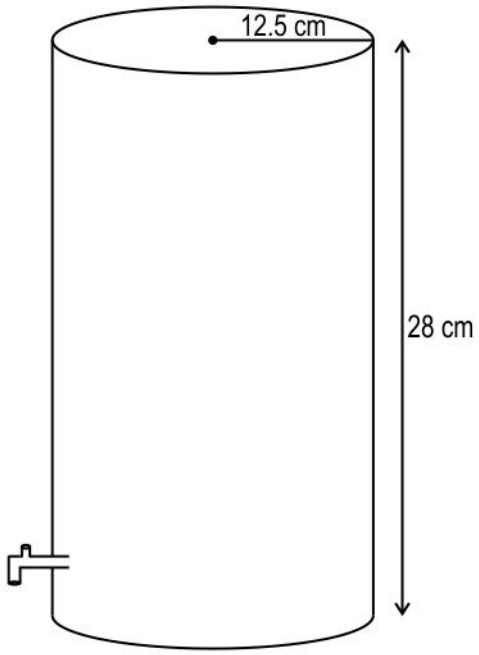
Show your work.

(Note: Take π as $\frac{22}{7}$. The toy retains its shape after the cotton is stuffed.)

Case Study

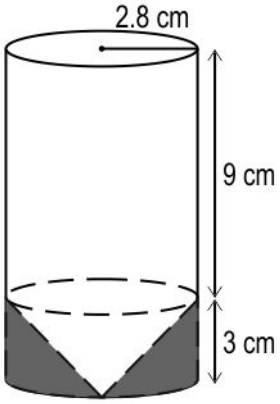
Answer the questions based on the information given.

Kinjal is running a lemonade stand in her apartment complex's Diwali fair. Her mother gave her a cylindrical container to store the lemonade as shown by the figure below. She uses cylindrical paper cups of height 10 cm and radius 2.8 cm to serve the lemonade. To avoid spillage, she fills the cups only up to 75% of their height. She sells each cup for Rs 10.



(Note: The figure is not to scale. *)*

While selling the lemonade, Kinjal runs out of cups. She goes to the store and buys the first set of paper cups she finds. The dimensions and the shape of the new paper cup is shown in the figure below. She continues to fill the cups up to 75% of their height.



(Note: The figure is not to scale.)

(Note: Take π *as* $\frac{22}{7}$*.)*

Q: 24 Find the capacity of the cylindrical container. Show your work. **[1]**

Q: 25 **She fills 10 litres of lemonade in the container.** **[2]**

What is the maximum amount she would make if all the 10 litres of lemonade were to be sold in the original set of cups. Show your work.

(Note: 1 litre = 1000 cm^3)

Q: 26 **Find the amount of lemonade she fills in a single new cup. Show your work.** **[2]**

Q.No	Correct Answers
1	2
2	2
3	2
4	4
5	2
6	1
7	3
8	2

Q.No	What to look for	Marks
9	Takes height as h and radius as r. Writes $h = r$ Writes $2\pi rh + 2\pi r^2 = 144\pi \text{ cm}^2$ Writes $4\pi r^2 = 144\pi \text{ cm}^2$	0.5
	Solves $4\pi r^2 = 144\pi \text{ cm}^2$ to get $r = 6$ cm.	0.5
10	Equates the volumes of the cone and the sphere as: $\frac{1}{3}\pi r^2 h = \frac{4}{3}\pi r^3$	0.5
	Simplifies the equation in the above step to find the required ratio as $\frac{r}{h} = \frac{1}{4}$.	0.5
11	Writes $s^3 = 6s^2$, where s is the side length of the cube.	0.5
	Solves the above equation to get $s = 6$ units.	0.5
12	Writes that 14 × Volume of 1 cylindrical cup = Volume of cubical container. $\Rightarrow 14 \times (\pi \times 2^2 \times h) = 10^3$ where, h is the height of the cups.	0.5
	Solves the above equation to get h as 5.68 cm.	0.5
13	Finds the slant length of conical part using pythagoras theorem as 61 cm.	0.5
	Finds the CSA of the conical part as: $(\pi \times 11 \times 61) = 671\pi \text{ cm}^2$.	0.5
	Finds exposed area of the cuboidal part as: $[2 \times (22 \times 22 + 22 \times 8 + 22 \times 8)] - (\pi \times 11^2) = (1672 - 121\pi) \text{ cm}^2$.	0.5

Q.No	What to look for	Marks
	Finds total surface area to be painted red as: **$(671\pi + 1672 - 121\pi) = (1672 + 550\pi)\ cm^2 = 3399\ cm^2$.**	**0.5**
14	**Finds the volume of the hemispherical scoop on the top as $(\frac{2}{3} \times \pi \times 2^3) = \frac{16\pi}{3}\ cm^3$.**	**0.5**
	Finds the volume of the cone as $(\frac{1}{3} \times \pi \times 2^2 \times 10) = \frac{40\pi}{3}\ cm^3$.	**0.5**
	Finds the total volume of the ice cream as Volume of the hemispherical scoop + Volume of the cone = $\frac{56\pi}{3}\ cm^3$. **Finds that an equal share of the ice cream is $\frac{28\pi}{3}\ cm^3$.**	**0.5**
	Concludes that Swapnil got an equal share of the ice cream.	**0.5**
15	**Finds the volume of the conical part as:** $(\frac{1}{3} \times \pi \times r^2 \times r) = \frac{\pi r^3}{3}$	**0.5**
	Finds the volume of the cylindrical part: **as:** $(\pi \times r^2 \times 2r) = 2\pi r^3$	**0.5**
	Finds the total volume of the solid as: $(\frac{\pi r^3}{3} + 2\pi r^3) = \frac{7\pi r^3}{3}$	**0.5**
	Writes $\frac{7\pi r^3}{3} = 198$ **Solves the equation to get r = 3 cm.**	**0.5**
16	**Finds the surface area of the cube as $(6 \times 4^2) = 96\ cm^2$.**	**0.5**
	Finds curved surface area of the hemisphere as $(2 \times \pi \times 2^2) = 8\pi\ cm^2$.	**0.5**

Q.No	What to look for	Marks
	Finds the surface area of the circular base of the hemisphere to be subtracted from the surface area of the cube as $(\pi \times 2^2) = 4\pi$ cm^2.	0.5
	Finds the total surface area of the paper weight to be polished as $(96 + 8\pi - 4\pi) = (96 + 4\pi)$ cm^2 = 108.56 cm^2.	0.5
17	Assumes the radius of the cone as r units, and hence, writes the length of edge of the cube as 2 r units and the height of the cone as 2 r units.	0.5
	Finds the volume of the cube as $(2r)^3 = 8r^3$.	1
	Finds the volume of the cone as $(\frac{1}{3} \times \pi \times r^2 \times 2r) = \frac{2}{3}\pi r^3$.	1
	Uses the above step to find the ratio as 42 : 11.	0.5
18	Finds the volume of the regular size container as $(\frac{1}{3} \times \pi \times 8^2 \times 30) = 640\pi$ cm^3.	1
	Finds the volume of 5 regular size portions as $(5 \times 640\pi) = 3200\pi$ cm^3.	0.5
	Finds the volume of the family size container as $(\pi \times 10^2 \times 30) = 3000\pi$ cm^3.	1
	Mentions that Yamir and his friends should get 5 regular size portions.	0.5
19	Finds the volume of the cone as: $(\frac{1}{3} \times \pi \times 7^2 \times 5) = \frac{245\pi}{3}$ m^3.	0.5
	Finds volume of the cylinder as: $(\pi \times 7^2 \times 15) = 735\pi$ m^3.	0.5
	Finds the volume of the silo as: $(2 \times \frac{245\pi}{3} + 735\pi) = \frac{2695\pi}{3}$ m^3.	0.5

Q.No	What to look for	Marks
	Finds the volume of grains in the silo as: Volume of cone + Volume of cylinder $\Rightarrow \left(\frac{245\pi}{3} + 735\pi\right) = \frac{2450\pi}{3}\ m^3$. (Award full marks for this step if volume of grains is directly calculated.)	1
	Finds the fraction of silo that is filled with grains as (Volume of grains/Volume of silo) $= \frac{10}{11}$.	0.5
20	i) Finds the CSA of the cone as $(\pi \times 3 \times 14) = 42\pi\ cm^2$.	0.5
	Finds the surface area of the circular base of the cone as $(\pi \times 3^2) = 9\pi\ cm^2$.	0.5
	Finds the surface area of the circular base of the cylinder as $(\pi \times 2^2) = 4\pi\ cm^2$.	0.5
	Finds the area to be painted green as $(42\pi + 9\pi - 4\pi) = 47\pi = 147.71\ cm^2$.	0.5
	ii) Finds the CSA of the cylinder as $(2 \times \pi \times 2 \times 7) = 28\pi\ cm^2$.	0.5
	Finds the area to be painted brown as $(28\pi + 4\pi) = 32\pi = 100.57\ cm^2$.	0.5
21	Finds the total surface area of the cuboidal table top as: $2 \times (90 \times 4 + 90 \times 50 + 4 \times 50) = 10120\ cm^2$	1
	Finds the lateral surface area of 4 wooden legs as: $4 \times (5 \times 60 + 5 \times 60) = 2400\ cm^2$	1
	Finds the area of the base of the wooden legs where they connect with the table top as: $4 \times (5 \times 5) = 100\ cm^2$	0.5
	Finds the total surface area of the table to be laminated as: $(10120 - 100 + 2400) = 12420\ cm^2$	0.5

Q.No	What to look for	Marks
22	**Finds the volume of the wooden cube to be s^3 cm^3, where s is the length of the side of the cube.**	**0.5**
	Finds the volume of cylinder as: $\left\{\pi \times \left(\frac{s}{2}\right)^2 \times s\right\} = \left(\frac{\pi s^3}{4}\right) cm^3$	**0.5**
	Finds the radius of of the hemisphere as $\frac{1}{2} \times \frac{4}{5} \times s = \frac{2}{5} s$.	**0.5**
	Finds the volume of the hemisphere carved out of the cylinder as: $\{\frac{2}{3} \times \pi \times (\frac{2s}{5})^3\} = (\frac{16s^3\pi}{375})\ cm^3$	**1**
	Finds total volume of the bird feeder as: $(\frac{s^3\pi}{4} - \frac{16s^3\pi}{375}) = (\frac{311s^3\pi}{1500})\ cm^3$	**1**
	Mentions percentage of wooden cube left as: $\frac{\text{Volume of bird feeder}}{\text{Volume of wooden cube}} \times 100$	**0.5**
	Simplifies the fraction in the above step to get percentage of wooden cube left as 65%.	**1**
23	**i) Finds the surface area of the cube as (6 × 302) = 5400 cm^2.**	**0.5**
	Finds the CSA of the 21 hemispherical dents as (21 × 2 × π × 4^2) = 2112 cm^2.	**0.5**
	Finds the surface area of the bases of the hemispherical dents to subtract from the surface area of the cube as (21 × π × 4^2) = 1056 cm^2.	**0.5**
	Finds total surface area of the plush toy, i.e., cloth required to make the plush toy as (5400 + 2112 - 1056) = 6456 cm^2.	**1**

Q.No	What to look for	Marks
	ii) Finds the volume of the cube as $30^3 = 27000\ cm^3$.	0.5
	Finds the volume of the 21 hemispherical dents as $(21 \times \frac{2}{3} \times \pi \times 4^3) = 2816\ cm^3$.	0.5
	Finds the total volume of the plush toy, i.e., the volume of cotton required to stuff the plush toy as $27000 - 2816 = 24184\ cm^3$.	1
	iii) Finds the cost of the cloth and cotton required to make the plush toy as $(0.01 \times 6456 + 0.02 \times 24184) = Rs\ 548.24$.	0.5
24	Calculates the volume of the cylindrical container as $\pi r^2 h = (\frac{22}{7})(12.5)^2(28) = 13750\ cm^3$.	1
25	Finds the height till which lemonade is poured in the cup as 75% of 10 cm = 7.5 cm. Finds the amount of lemonade in the container as $10 \times 1000 = 10000\ cm^3$.	0.5
	Calculates the volume of lemonade poured in the cylindrical paper cup as: Volume of lemonade poured in the cup = $\pi r^2 h = \frac{22}{7} \times (2.8)^2 \times 7.5 = 184.8\ cm^3$.	0.5
	Writes the maximum amount of cups sold by her as $\frac{\text{Total}}{\text{volume of lemonade/Volume of 1 cup of lemonade)}} = \frac{10000}{184.8}$.	0.5
	Solves the equation in the previous step to get 54.11 and rounds it to 54 cups. Calculates the maximum amount made by Kinjal as 54 x 10 = Rs. 540.	0.5
26	Writes new height of cup = 75% of 12 cm = 9 cm. Hence, the height of cylindrical part is 6 cm and the height of conic part is 3 cm.	0.5
	Calculates the volume of lemonade filled in the cup as: Volume of Cylinder + Volume of cone = $\pi r^2 H + \frac{1}{3}\pi r^2 h$ $= \frac{22}{7} \times (2.8)^2 \times 6 + \frac{1}{3} \times \frac{22}{7} \times (2.8)^2 \times 3 = 172.48\ cm^3$.	1.5

Chapter - 7
Triangles

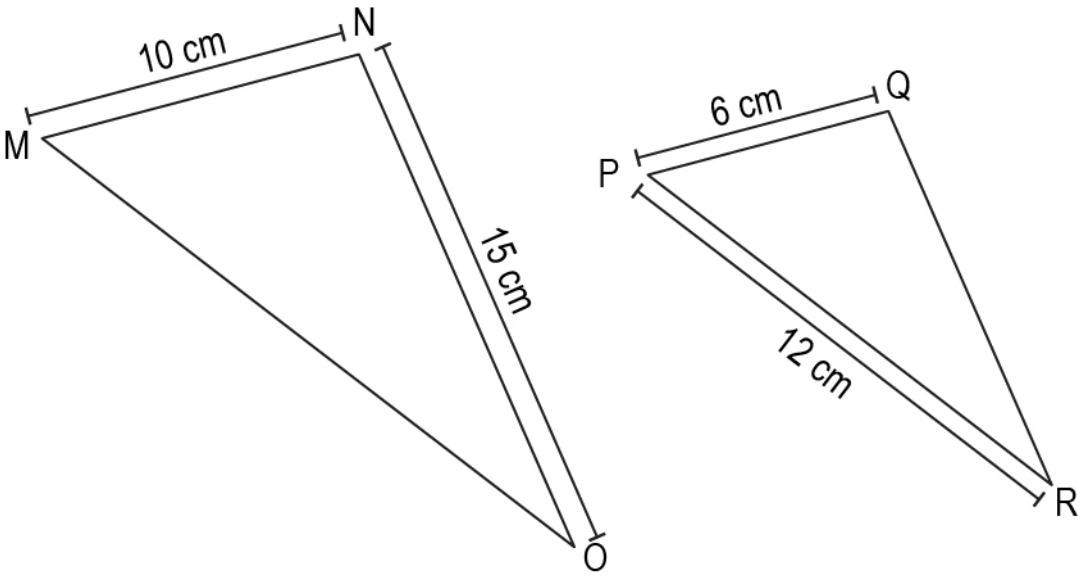
Multiple Choice Questions

Q: 1 **Which of the following may NOT be similar to each other?**

i) any two circles
ii) any two rhombuses
iii) any two regular hexagons

1 only ii)
2 only i) and ii)
3 only i) and iii)
4 all - i), ii) and iii)

Q: 2 **Shown below are two triangles ΔMNO and ΔPQR. Dimensions of their two sides are marked in the figure.**

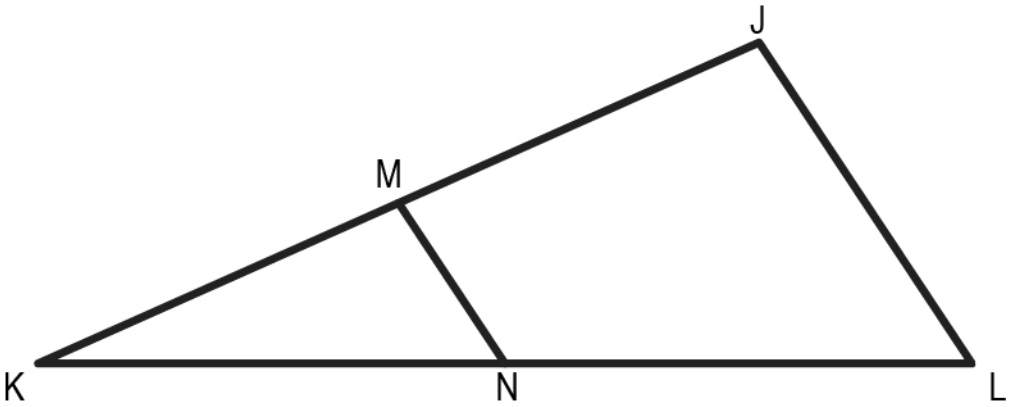


(Note: The figures are not to scale.)

What should be the value of QR if ΔMNO is similar to ΔPQR?

1 9 cm **2** 11 cm **3** 15 cm **4** 25 cm

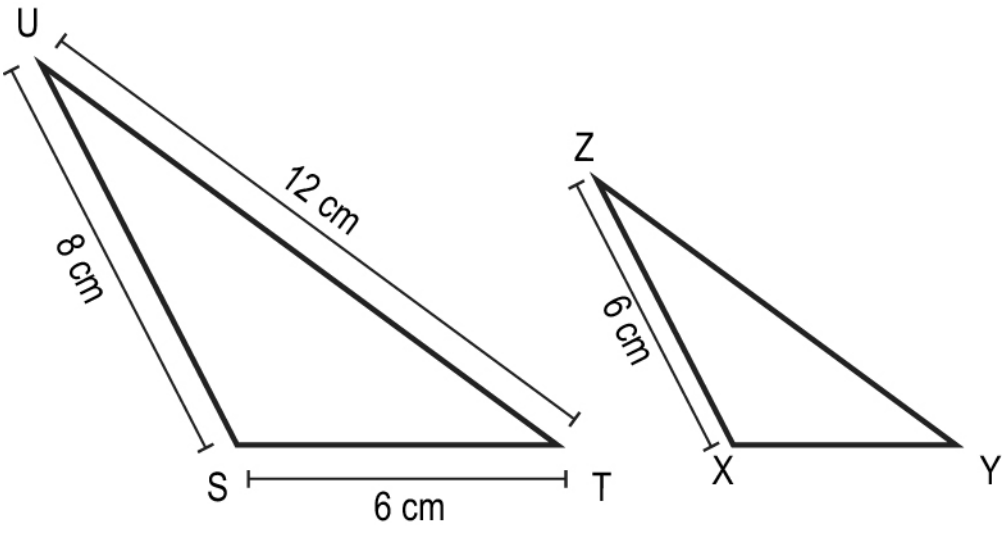
Q: 3 **In the following figure, MN is drawn such that M and N are mid-points on JK and KL, respectively.**



Which of these criteria CANNOT be used to prove that △JKL is similar to △MKN?

1 SSS similarity criterion
2 SAS similarity criterion
3 AAA similarity criterion
4 (All of the similarity criteria can be used.)

Q: 4 **In the figures given below, △STU and △XYZ are similar.**

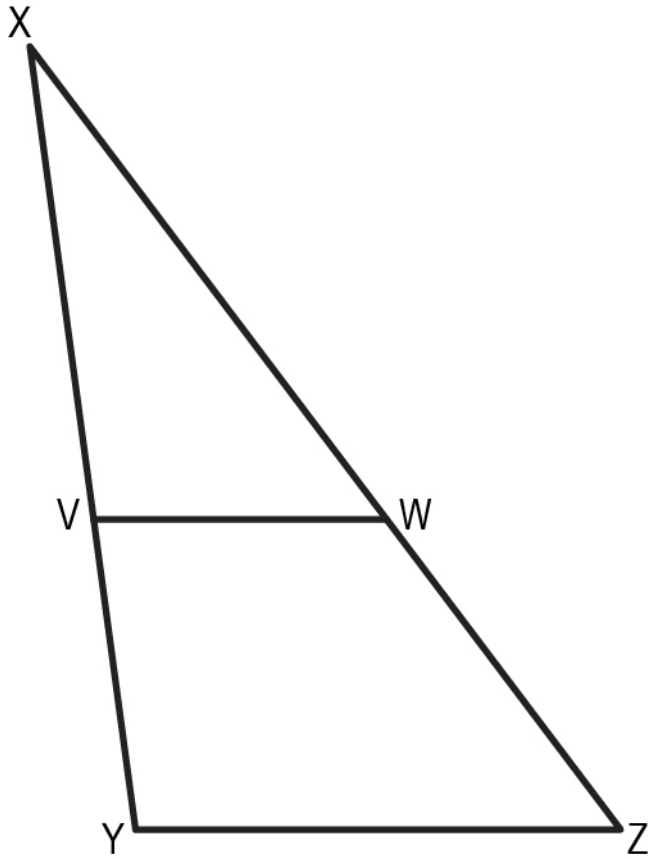


(*Note: The figures are not to scale.*)

What is the perimeter of △XYZ?

1 19.5 cm **2** 20 cm **3** 26 cm **4** 34.67 cm

Q: 5 **In the △XYZ given below, VW || YZ. VY = 6 cm, XY = 14 cm, XW = 12 cm.**



(Note: The figure is not to scale.)

What is the length of XZ?

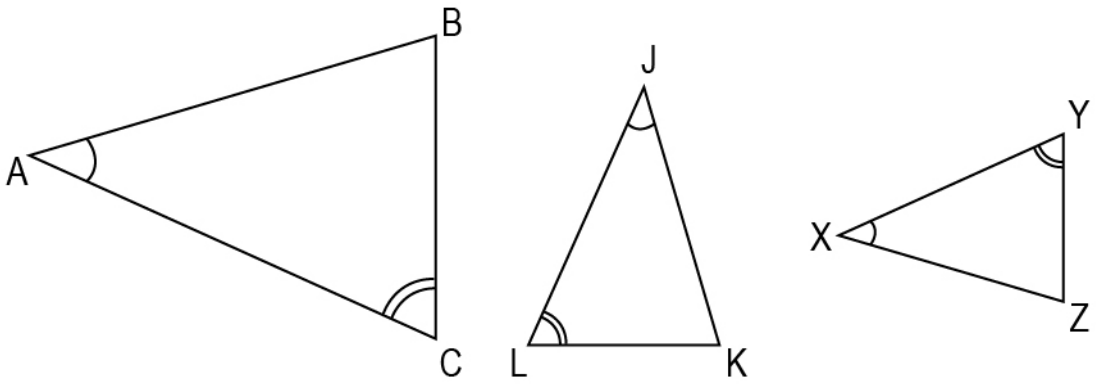
1 14 cm **2** 21 cm **3** 26 cm **4** 28 cm

Q: 6 **Danish created an equilateral triangle-shaped rangoli pattern in his room with an area of 10 square units. He replicated the same rangoli pattern in the lobby of his apartment building, where each side of the triangle was 2.5 times the length of the one in his room.**

What was the area of rangoli made in the lobby?

1 25 square units
2 62.5 square units
3 156.25 square units
4 (cannot be determined as exact dimensions of the design are required)

Q: 7 **Equal angles have been marked in the triangles below.**



(Note: The figures are not to scale.)

Which of these is NOT always true?

1 ΔABC ~ ΔJKL
2 ΔABC ~ ΔXYZ
3 ΔABC ~ ΔXZY
4 (All three triangles are similar.)

Q: 8 **The triangles ▲JKL and ▲MNO are similar such that their corresponding sides are in the ratio,**

$\frac{LJ}{OM} = \frac{5}{7}$

What is the ratio of the areas of ▲JKL and ▲MNO?

1 $\frac{49}{25}$ **2** $\frac{7}{5}$ **3** $\frac{5}{7}$ **4** $\frac{25}{49}$

Q: 9 **▲DEF and ▲XYZ are two triangles right angled at point E and Y, respectively. Also,** $\frac{DE}{XY} = \frac{EF}{YZ}$ **.**

Based on the above information, two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Read the statements carefully and choose the option that correctly describes statements (A) and (R).

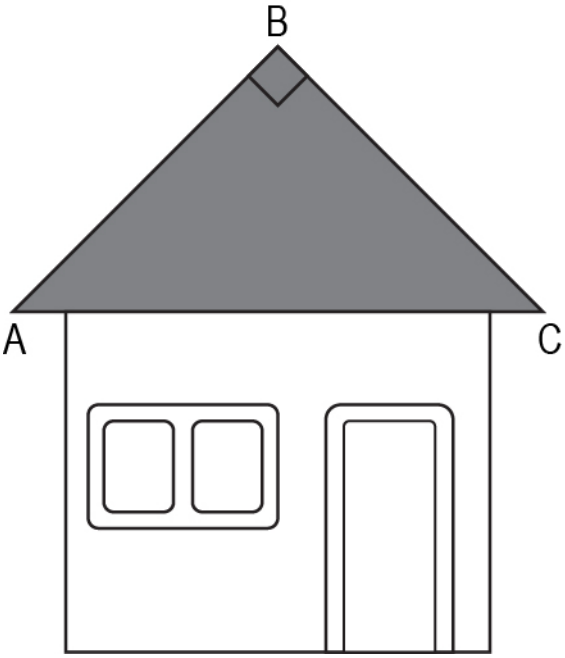
Assertion(A): ▲DEF is similar to ▲XYZ.

Reason(R): All right angled triangles are similar to each other.

1 Both (A) and (R) are true and (R) is the correct explanation for (A).
2 Both (A) and (R) are true and (R) is not the correct explanation for (A).
3 (A) is false but (R) is true.
4 (A) is true but (R) is false.

Free Response Questions

Q: 10 **Anuradha painted the front of the roof of her house, shown by the isosceles right-angled △ABC in the figure below. The area painted by her is 18 m^2.** **[1]**

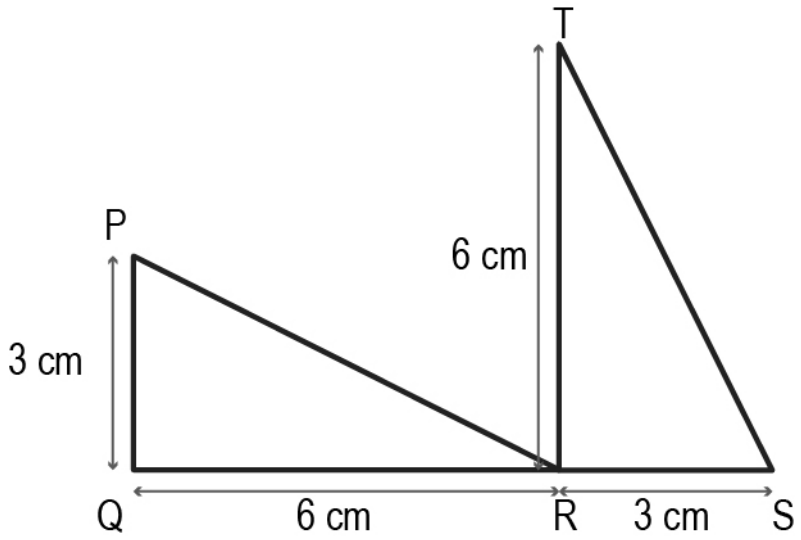


(Note: The figure is not to scale.)

She wants to hang string lights in a straight line along AC, for decoration.

Find the length of string lights Anuradha will need. Show your work.

Q: 11 **A graffiti artist wants to create a design on a wall using two triangles. He draws a miniature version of the artwork in his notebook, as shown below.** **[1]**



(Note: The figure is not to scale.)

△PQR is similar to △SRT. To find the dimensions of the larger image for the wall, he found the ratio of the corresponding sides of the two triangles as:

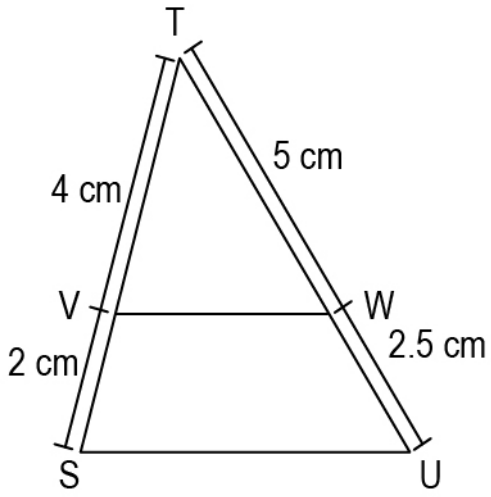
$\frac{PQ}{RT} = \frac{SR}{QR} = \frac{1}{2}$

Is the above ratio of sides correct? Give a valid reason.

Q: 12 **In a △KLM, N and O are points on KM and LM, respectively, such that NO || KL.** **[1]**

If KN:KM = 3:5 and OM = 12 cm, find the length of LM. Show your work.

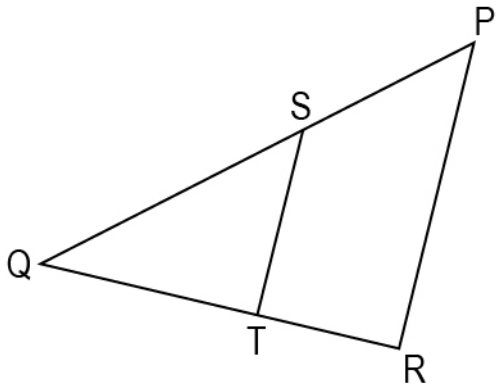
Q: 13 **Shown below is a figure.** **[1]**



(Note: The figure is not to scale.)

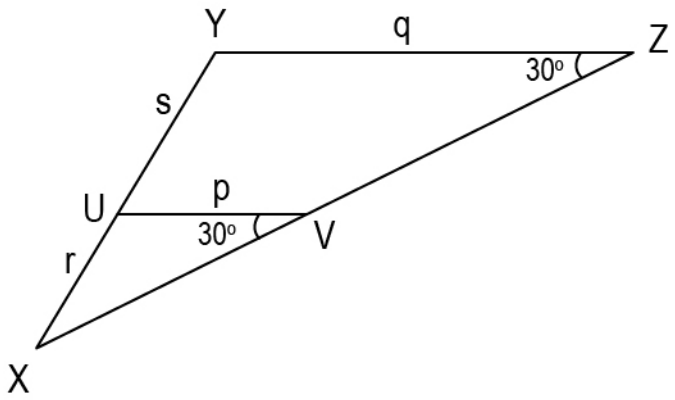
Show that ∠TUS = ∠TWV.

Q: 14 **In the following figure, S is a point on PQ and T is a point on QR such that ST || PR.** **[2]**



Prove that ΔPQR is similar to ΔSQT.

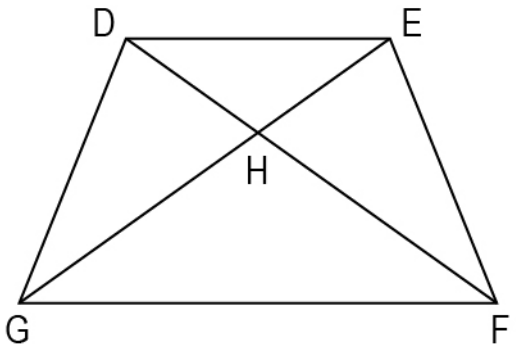
Q: 15 **Shown below are △XYZ and △XUV. All measurements are in cm.** **[2]**



(Note: The figure is not to scale.)

Show that $p = \frac{qr}{r+s}$.

Q: 16 **Shown below is a trapezium DEFG with DE || GF. The diagonals, DF and EG intersect at point H.** **[2]**



Prove that △DHE is similar to △FHG.

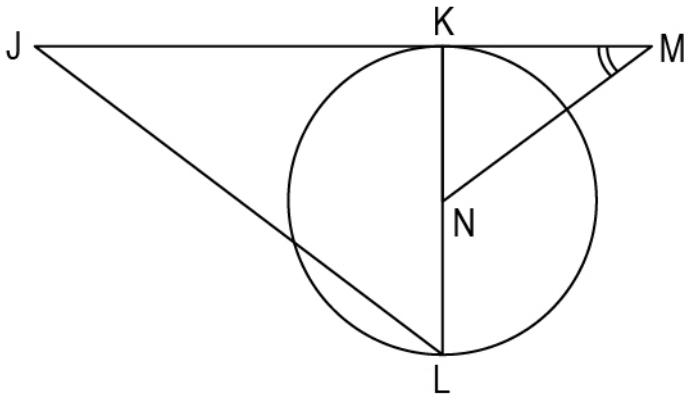
Q: 17 **Tanya cut a square piece of paper along its diagonal to get two right-angled triangles. He claimed that both these triangles are equilateral triangles.** **[2]**

Is his claim correct? Justify your answer.

Q: 18 **Sarthak notices that his 24 cm water bottle casts a shadow of 30 cm at a particular time of the day.** **[2]**

If Sarthak is 150 cm tall, what is the length of the shadow he casts at the same time? Show your work and give valid reasons.

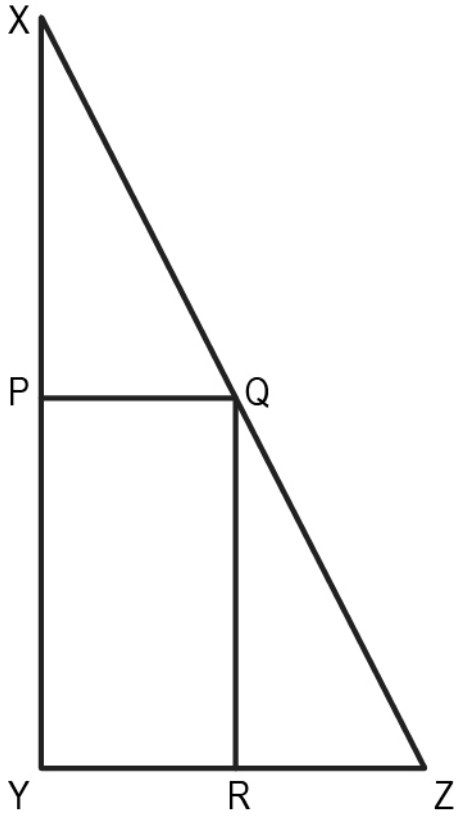
Q: 19 **In the figure below, JM is tangent to the circle which has its centre at point N and ∠LJK = ∠NMK.** **[2]**



(Note: The figure is not to scale.)

If JL = 15 cm, find the length of MN. Show your work.

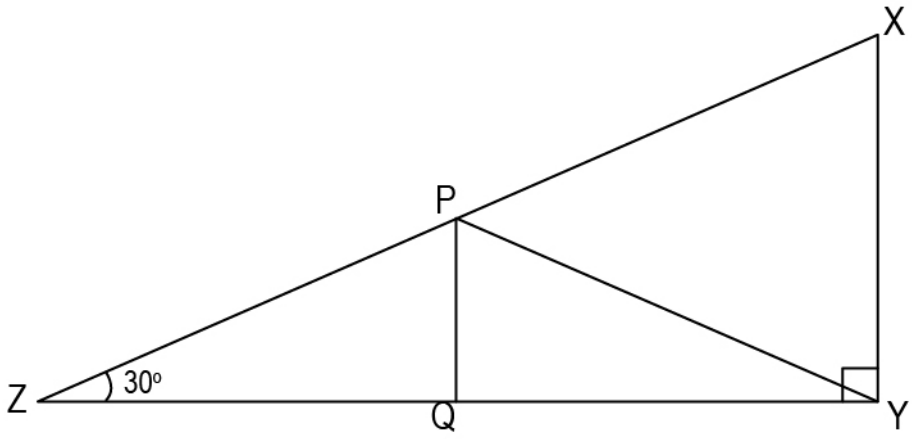
Q: 20 **In the figure below, QX = 10 cm, QZ = 8 cm, RZ = *b* cm, RY = (*b* + 1) cm and XY || QR.** **[3]**



(Note: The figure is not to scale.)

i) Find the length of YZ. Show your work.
ii) If PQ || YZ, show that $\frac{PX}{PY} = \frac{RY}{RZ}$.

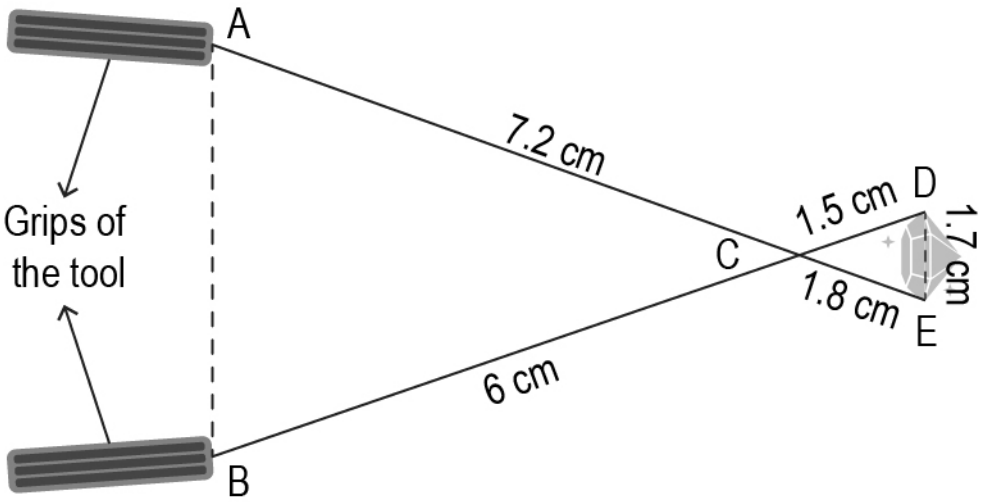
Q: 21 **In the figure below, PQ is drawn such that ZQ = QY and ZP = PX.** **[3]**



(Note: The figure is not to scale.)

i) Show that ▲PQZ ~ ▲XYZ.
ii) Find ∠PYQ. Show your work.

Q: 22 **Ritika's grandfather is a jeweller who needs to pick up a newly cut sapphire and place it in a necklace. To do so he uses a tool that is pictured in the figure below. The tool must be held in a specific manner as to not damage the sapphire.** **[3]**



(Note: The figure is not to scale.)

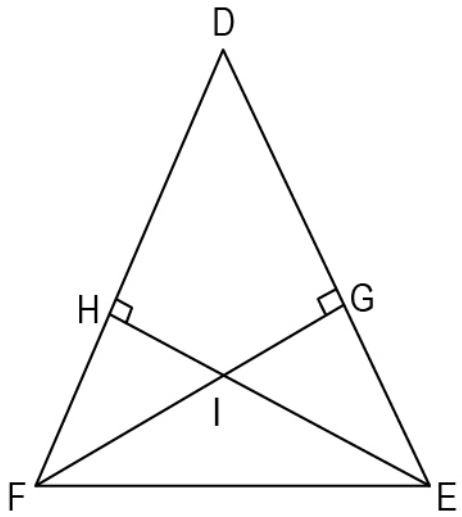
Ritika tells her grandfather tells her grandfather the width at which he needs to hold the tool.

i) How does Ritika know how wide apart the grips of the tool are to be held?
ii) Find the width at which Ritika's grandfather must hold the tool to safely place the sapphire in the necklace. Show your work.

Q: 23 **In a ▲UVW, X and Y are points on UV and UW, respectively such that the points divide the respective sides in the ratio of 2:1.** **[3]**

If XY = 7 units, find the length of VW. Show your work.

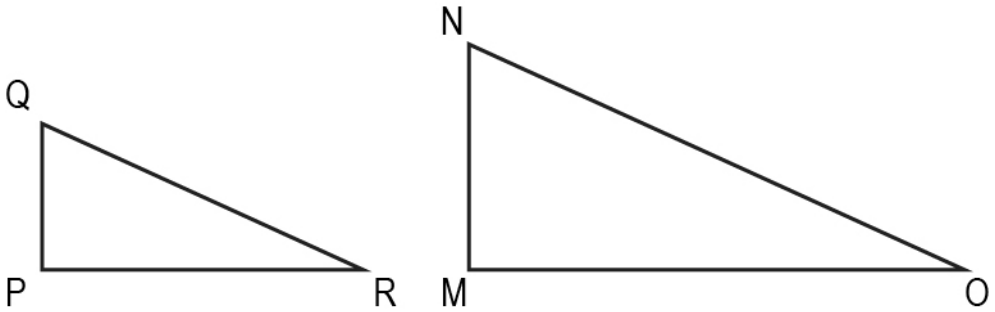
Q: 24 **In △DEF, altitudes EH and FG are altitudes intersecting at point I as shown below.** **[3]**



(Note: The figure is not to scale.)

i) Prove △DGF ~ △DHE.
ii) Prove △IHF ~ △IGE.

Q: 25 **All the corresponding sides of △PQR and △MNO shown below are in the ratio 5:7.** **[5]**



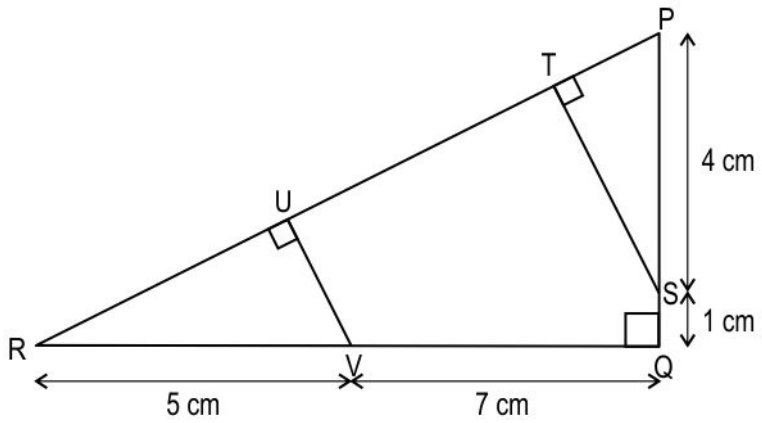
i) Shahnawaz claims, "△PQR is similar to △MNO as per the SSS similarity criterion." Dhruv claims, "△PQR is NOT similar to △MNO as per the AAA similarity criterion as ∠P ≠ ∠O."

Who is correct and incorrect?

ii) Abhiniti said that the ratio of the perimeter of △PQR and △MNO must be 5:7. Is she correct?

Explain your answers.

Q: 26 **Shown below is a figure.** **[5]**



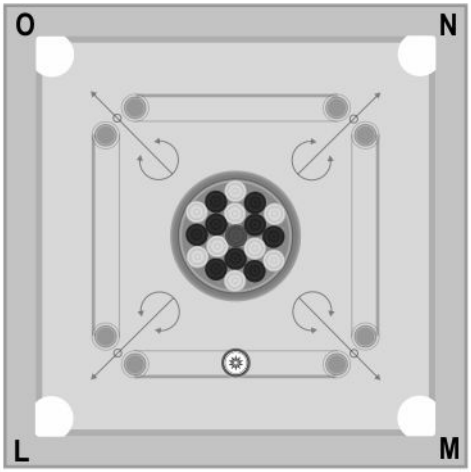
(Note: The figure is not to scale.)

Find the length of UT. Show your work.

Case Study

Answer the questions based on the given information.

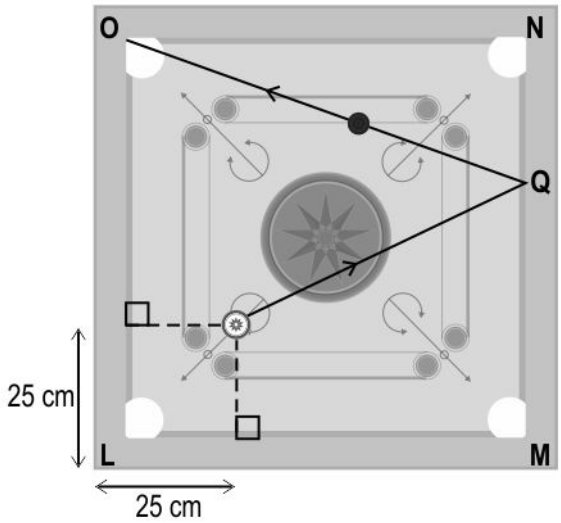
The carrom board has a 75 cm square playing top with four corner pockets. When coins hit the sides, they bounce off at the same angle. There are four types of coins: 9 white, 9 black, a red (the queen), and a larger and heavier striker. The striker is flicked to push these coins across the board to the pockets. See the carrom board below.



(Note: The figure is not to scale.)

Aryan and Sai got bored while playing the game and are now placing the striker and coins at random spots of the board and taking shots.

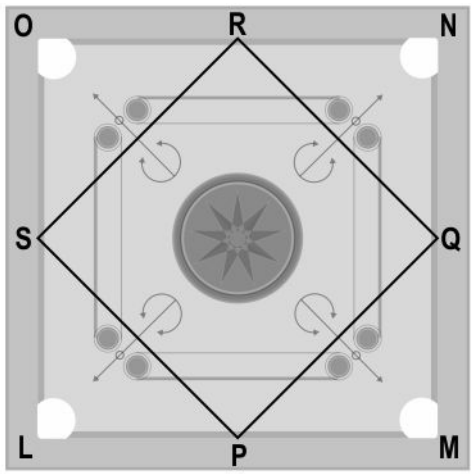
Q: 27 **Shown below is the path when Aryan strikes a white coin into pocket O.** **[3]**



(Note: The figure is not to scale.)

Find the distance QN. Draw a diagram, show your work and give valid reasons.

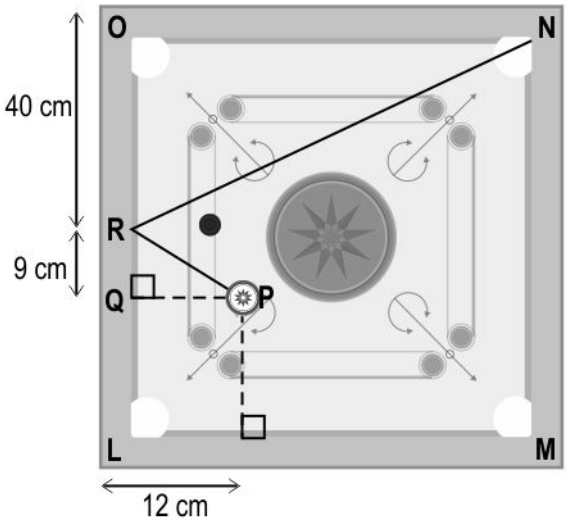
Q: 28 **Sai places the striker at the midpoint of LM. He flicks it in such a way that it hits the midpoints of all the sides and stops at the starting point. The rough sketch of the path of the striker is shown below.** **[1]**



(Note: The figure is not to scale.)

Are there any similar triangles formed? Give a valid reason for your answer.

Q: 29 **Sai flicks the striker in an attempt to hit a coin. He misses the coin and his striker ends up in pocket N. The rough sketch of the path of the striker is shown below.** **[1]**



(Note: The figure is not to scale.)

Find the distance travelled by the striker.

Q.No	Correct Answers
1	1
2	1
3	4
4	1
5	2
6	2
7	2
8	4
9	4

Q.No	What to look for	Marks
10	Assumes AB = BC as p and writes the equation for the area of the triangle as: $\frac{1}{2} \times p^2 = 18$ Using the above equation, finds p as 6 m.	0.5
	Uses the Pythagoras theorem to find the length of string lights required (length of AC) as: $\sqrt{(p^2 + p^2)}$ $= \sqrt{(6^2 + 6^2)}$ $= 6\sqrt{2}$ m	0.5
11	Writes that the the given ratio of sides is not correct.	0.5
	Gives a valid reason. For example, the corresponding sides of $\triangle PQR$ and $\triangle SRT$ are QR and RT respectively. Hence, the ratio of the corresponding sides is 1.	0.5
12	Uses the basic proportionality theorem to write: $\frac{2}{5} = \frac{12}{LM}$	0.5
	Solves the above equation to find the length of LM as 30 cm.	0.5
13	Writes $\frac{TU}{TW} = \frac{TS}{TV}$. Uses the converse of basic proportionality theorem to write VW || SU.	0.5
	Writes that $\angle TUS = \angle TWV$ as they are corresponding angles in parallel lines. (Award full marks if proved using similarity.)	0.5
14	Writes that for $\triangle PQR$ and $\triangle SQT$: i) $\angle PQR = \angle SQT$ (common) ii) $\frac{PQ}{SQ} = \frac{QR}{QT}$ (using basic proportionality theorem)	1
	Hence, concludes that $\triangle PQR \sim \triangle SQT$ by SAS similarity criterion.	1

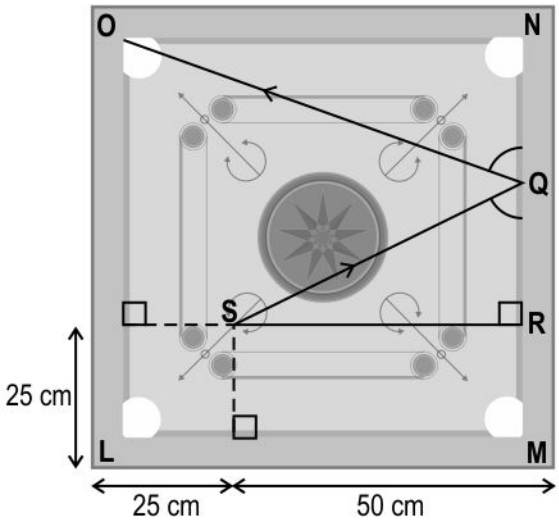
Q.No	What to look for	Marks
15	Writes that in △XYZ and △XUV, i) ∠YXZ = ∠UXV (common) ii) ∠YZX = ∠UVX = 30° (given) Hence, concludes that △XYZ ~ △XUV by AA similarity criterion.	1
	Uses similarity of triangles to write the relation of sides as: $\frac{XY}{XU} = \frac{YZ}{UV}$ Hence, concludes that $p = \frac{qr}{r+s}$.	1
16	Writes any two for △DHE and △FHG: i) ∠DHE = ∠FHG (Vertically opposite angles are equal.) ii) ∠HDE = ∠HFG (Alternate interior angles are equal.) iii) ∠HED = ∠HGF (Alternate interior angles are equal.)	1.5
	Writes that △DHE and △FHG are similar using AAA similarity criterion. (Award full marks if AA similarity criterion is correctly used.)	0.5
17	Assumes the length of each side of the square to be p units, where p is a real number. Uses Pythagoras's theorem to find the length of the hypotenuse as: $\sqrt{(p^2 + p^2)} = p\sqrt{2}$ units. Writes that the length of the hypotenuse does not equal to p.	1.5
	Concludes that the triangle is not an equilateral right-angled triangle and his claim is incorrect.	0.5
18	Mentions that the bottle and its shadow and Sarthak and his shadow form similar triangles.	0.5

Q.No	What to look for	Marks
	Identifies the corresponding sides of similar triangles and writes: $\frac{\text{Height of water bottle}}{\text{Length of the shadow of water bottle}} = \frac{\text{Height of Sarthak}}{\text{Length of the shadow of Sarthak}}$ $\Rightarrow \frac{24}{30} = \frac{150}{\text{Length of the shadow of Sarthak}}$	**1**
	Solves the equation in Step 2 to find the length of Sarthak's shadow as $\frac{375}{2}$ cm or 187.5 cm.	**0.5**
19	**Writes that in ΔJKL and ΔMKN,** **i) ∠LJK = ∠NMK (given)** **ii) ∠JKL = ∠MKN (tangents to a circle are perpendicular at the point of contact)** **Hence, concludes that ΔJKL ~ ΔMKN by AA similarity criterion.**	**1**
	Finds the ratio of the corresponding sides of ΔJKL and ΔMKN as $\frac{KL}{KN} = \frac{2}{1}$ as KN is the radius and KL is the diameter.	**0.5**
	Uses the ratio of corresponding sides of similar triangles writes $\frac{JL}{MN} = \frac{2}{1}$ to get MN as 7.5 cm.	**0.5**
20	**i) Uses basic proportionality theorem to write:** $\frac{QX}{QZ} = \frac{RY}{RZ}$ $\Rightarrow \frac{10}{8} = \frac{b+1}{b}$	**1**
	Solves the above equation to find the value of *b* as 4 cm.	**0.5**
	Uses the value of *b* and finds the length of YZ as 9 cm.	**0.5**
	ii) Uses basic proportionality theorem to write $\frac{PX}{PY} = \frac{QX}{QZ}$.	**0.5**
	Uses steps 1 and 4 to show that $\frac{PX}{PY} = \frac{RY}{RZ}$.	**0.5**

Q.No	What to look for	Marks
21	i) Mentions $\frac{ZQ}{QY} = \frac{ZP}{PX}$ and finds PQ || XY using converse of basic proportionality theorem. (Award full marks if another appropriate method is correctly used.)	0.5
	Writes that in ▲PQZ and ▲XYZ, ♦ ∠PQZ = ∠XYZ = 90° (corresponding angles as PQ || XY) ♦ ∠PZQ = ∠XZY (common) Hence, ▲PQZ ~ ▲XYZ using AA similarity criterion.	1
	ii) Gives proof for either similarity or congruency of ▲PQY and ▲PQZ. For Example, ♦ $\frac{PQ}{PQ} = \frac{QY}{QZ} = 1$ ♦ ∠PQY = ∠PQZ = 90° Hence, ▲PQY ~ ▲PQZ using SAS similarity criterion.	1
	Finds ∠PYQ = ∠PZQ = 30° as ▲PQY is similar to ▲PQZ.	0.5
22	i) Writes that she can know the width by using the properties of similar triangles.	0.5
	ii) Proves that ▲EDC and ▲ABC are similar. For example, i) ∠DCE = ∠ACB ii) $\frac{CE}{AC} = \frac{CD}{BD}$ Hence, using SAS similarity criterion, ▲EDC and ▲ABC are similar.	1.5
	Uses the above step to get the following equation, $\frac{CE}{AC} = \frac{CD}{BD} = \frac{DE}{AB} = \frac{1}{4}$ Solves it to find the width, AB = 6.8 cm.	1
23	Writes that in ▲UXY and ▲UVW: i) $\frac{UX}{UV} = \frac{UY}{UW} = \frac{2}{3}$ (given) ii) ∠XUY = ∠VUW (common angle) Hence, by SAS similarity criterion, ▲UXY and ▲UVW are similar.	1.5

Q.No	What to look for	Marks
	Uses the ratio of the corresponding sides of similar triangles to write: $\frac{UX}{UV} = \frac{XY}{VW}$ $\Rightarrow \frac{2}{3} = \frac{7}{VW}$	1
	Solves the above equation to find the length of VW as 10.5 units.	0.5
24	i) Writes that for $\triangle DGF$ and $\triangle DHE$, ♦ $\angle DGF = \angle DHE = 90°$ ♦ $\angle FDG = \angle EDH$ (Common)	1
	Uses AA similarity criterion to prove that $\triangle DGF \sim \triangle DHE$.	0.5
	ii) Writes that for $\triangle IHF$ and $\triangle IGE$, ♦ $\angle IHF = \angle IGE = 90°$ ♦ $\angle HFI = \angle GEI$ (Corresponding angles of similar triangles, $\triangle DGF$ and $\triangle DHE$)	1
	Uses AA similarity criterion to prove $\triangle IHF \sim \triangle IGE$.	0.5
25	i) Mentions that Shahnawaz is correct.	0.5
	Mentions that as per the SSS similarity criterion, the ratio of corresponding sides must be the same, which is true in this case.	0.5
	Mentions that Dhruv is incorrect.	0.5
	Mentions that as per the AAA similarity criterion, the corresponding angles must be equal. In PQR and $\triangle MNO$, $\angle P$ and $\angle O$ are not corresponding angles. Hence, AAA similarity criterion cannot be used.	1
	ii) Mentions that Abhiniti is correct.	0.5
	Uses the information from part i), $\triangle PQR$ is similar to $\triangle MNO$ to write: PQ = $\frac{5}{7}$ MN, QR = $\frac{5}{7}$ NO and RP = $\frac{5}{7}$ OM.	1

Q.No	What to look for	Marks
	Writes the following, $\frac{\text{Perimeter of } \Delta PQR}{\text{Perimeter of } \Delta MNO} = \frac{PQ + QR + RP}{MN + NO + OM}$ **Simplifies the expression to find the ratio of the perimeter of ▲PQR and ▲MNO as $\frac{5}{7}$.**	**1**
26	**Uses Pythagoras theorem in ▲PQR to find the length of PR as:** $PR^2 = 5^2 + 12^2$ **=> PR = 13**	**1**
	Writes in ▲VUR and ▲PQR: **♦ ∠VUR = ∠PQR (Right angle)** **♦ ∠VRU = ∠PRQ (Common angle)** **Hence, by AA similarity criterion, ▲VUR ~ ▲PQR.**	**1**
	Writes that in ▲PTS and ▲PQR: **♦ ∠PTS = ∠PQR (Right angle)** **♦ ∠TPS = ∠RPQ (Common angle)** **Hence, by AA similarity criterion, ▲PTS ~ ▲PQR.**	**1**
	Uses properties of similar triangles to write: **i) $\frac{UR}{QR} = \frac{VR}{PR}$** **ii) $\frac{PT}{PQ} = \frac{PS}{PR}$** **Evaluates equation i) to find UR = $\frac{60}{13}$ cm and equation ii) to find PT = $\frac{20}{13}$ cm.**	**1.5**
	Finds the length of UT as 13 - $\frac{60}{13}$ - $\frac{20}{13}$ = $\frac{89}{13}$ cm or 6 $\frac{11}{13}$ cm.	**0.5**

Q.No	What to look for	Marks
27	**Draws a rough diagram. The figure may look as follows,** 	**0.5**
	Shows that ▲QRS and ▲QNO are similar. For example, **i) ∠OQN = ∠SQR (mentioned in the question)** **ii) ∠QRS = ∠ QNO = 90°**	**1**
	Uses the above step to conclude that ▲QRS and ▲QNO are similar by the AAA similarity criterion.	**0.5**
	Finds $\frac{QR}{NQ} = \frac{SR}{ON} = \frac{2}{3}$ as ▲QRS and ▲QNO are similar.	**0.5**
	Solves QR + NQ + 25 = 75 to get NQ = 30cm.	**0.5**
28	**Writes the following for ▲SLP, ▲PMQ, ▲QNR and ▲ROS:** **∠SLP = ∠PMQ = ∠QNR = ∠ROS (Right angles)** **All the non-hypotenuse sides of the triangles are equal. (P, Q, R and S are midpoints of the sides of a square.)**	**0.5**

Q.No	What to look for	Marks
	Writes that $\triangle SLP \sim \triangle PMQ \sim \triangle QNR \sim \triangle ROS$ by SAS congruency criterion. Hence, concludes that all the triangles are similar triangles as they are congruent. (Award full marks if proved using suitable alternative method.)	0.5
29	Uses Pythagoras theorem to come up with the following equations, i) $PQ^2 + QR^2 = PR^2$ ii) $NO^2 + OR^2 = NR^2$ Solves the two equations to find PR = 15 cm and NR = 85 cm and distance travelled by the striker as 100 cm.	1

8. Annexure
Correct Answer Explanation

Chapter Name	Q. no	Correct Answer	Correct Answer Explanation
Polynomials	1	A	On substituting the given values into the polynomial, if the value of p(x) is 0, then the graph of the polynomial intersects the x-axis at the point (x, 0). $p(x) = -2x + 8x^2 - 1 = 8x^2 - 2x - 1$ Thus, $p(1/2) = 8.(1/2)^2 - 2.(1/2) - 1$ Thus, $p(1/2) = 2 - 1 - 1 = 0$ Thus, $p(1/4) = 8.(1/4)^2 - 2.(1/4) - 1$ Thus, $p(1/4) = 1/2 - 1/2 - 1 = -1$ Since, only $p(1/2) = 0$, only 1/2 will intersect the positive x-axis. Hence, option A is the correct answer.
	7	A	Degree of a polynomial is the highest power of the variable in the polynomial. Here among the 4 options the highest power of x is in option A which is 7. Hence option A is the correct answer.
Probability	6	D	As the probability of randomly picking a 3BHK apartment is 2/5, the number of 3BHK apartments can be found as $(2/5) \times 20 = 8$ apartments. Hence, option D is the correct answer.
Quadratic Equations	5	C	$3x^2 + 5x = 9x(x - 3)$; $6x^2 - 32x = 0$. The highest power of the equation is 2, hence it is a quadratic equation. Hence, option C is the correct answer.
	7	B	The value of discriminant of equation with no real roots is negative. The discriminant of equation ii) is given by: $a^2 - (4 \times a^2 \times 2) = -7a^2$, which will always be negative irrespective of the values of a and b. Hence, option B is the correct answer.

Some applications of trigonometry	6	A	The tangent of the angle of inclination of the sun can be represented as the ratio of the height to the shadow length in both cases. Therefore, we have: tan theta = Height of pole/Height of shadow of pole Also, tan theta = Height of building/Height of shadow of building. Since both expressions are equal to the tangent of the same angle, we can set them equal to each other and after substituting the values, Let x be height of building, Then, 10/15 = x/25 Therefore, x = 16.67 m
	7	C	A right-angled triangle is formed by the pole, the ground, and the line of sight to the top of the pole. The top of the pole will make an angle of (90 - beta) with the ground. tan (90 - beta) = h / base length That gives, cot beta = h / base length Thus, base length = h/cot beta Thus, base length = h * tan beta Hence, option C is the correct answer.
Statistics	4	B	For the given data - Mean - 5.67 Median - 5.5 Mode - 6 Hence, correct sequence of measures of central tendency when arranged in ascending order is - Median

	7	D	Sum of the first four data points = 40 Sum of the remaining 16 data points = 320 Sum of all the data points = 360 Mean of all the data points = 360/20 = 18 Hence, option D is the correct answer.
Surface areas and volumes	4	D	As Solid B is formed after modifying Solid A without adding or removing any parts, the volume of Solid B remains the same. The surface area of Solid B is greater than the surface area of Solid A by 2 x (CSA of the protruding cylindrical part) Hence, option D is the correct answer.
	6	A	The surface area of the one of the identical cubes = 6 × Area of a face of the cube The surface area of both the identical cubes = 12 × Area of one face of the cube The cubes are joined to form a cuboid by joining two faces of the cubes together. The surface area of the cuboid = 10 × Area of one face of the cube The fraction of the surface area of the 2 cubes is the surface area of the cuboid = 10/12 = 5/6 Hence, option A is the correct answer.
Triangles	1	A	All circles are similar as the only factor that differentiates them is their size. Any two rhombuses may not always be similar as corresponding angles may not necessarily be equal. All regular hexagons are similar as the corresponding angles are always equal. Hence, option A is the correct answer.

	6	B	As done replicates the same triangle, both the triangles must be similar. The area of the triangle-shaped rangoli made in his room can be found as (1/2) × b × h = 10 square units, where b = base of the triangle-shaped rangoli in his room and height = h of the triangle-shaped rangoli made in his room. The area of the triangle-shaped rangoli made in the lobby of his apartment building can be found as (1/2) × (2.5)b × (2.5)h = $(2.5)^2$ × [(1/2) × b × h] = $(2.5)^2$ × (10) = 62.5 square units. Hence, option B is the correct answer.
	7	B	When writing naming similar shapes, the order of the vertices is of the utmost importance. This is to represent the relationship between the corresponding parts of the shapes. ∠CAB = ∠YXZ and ∠BCA = ∠ZYX. Therefore, ΔABC ~ ΔXZY, but the it cannot be confirmed if ΔABC and ΔXYZ are similar. Hence, option B is the correct answer.

Central Board of Secondary Education
Shiksha Sadan, 17, Rouse Avenue,
New Delhi-110002

Competency Focused Practice Questions

Mathematics (Volume 3) | Grade 10

Co-created by

CBSE Centre for Excellence in Assessment

and

Educational Initiatives

Preface

Assessments are an important tool that help gauge learning. They provide valuable feedback about the effectiveness of instructional methods; about what students have actually understood and also provide actionable insights. The National Education Policy, 2020 has outlined the importance of competency-based assessments in classrooms as a means to reform curriculum and pedagogical methodologies. The policy emphasizes on the development of higher order skills such as analysis, critical thinking and problem solving through classroom instructions and aligned assessments.

Central Board of Secondary Education (CBSE) has been collaborating with Educational Initiatives (Ei) in the area of assessment. Through resources like the Essential Concepts document and A- Question-A-Day (AQAD), high quality questions and concepts critical to learning have been shared with schools and teachers.

Continuing with the vision to ensure that every student is learning with understanding, Question Booklets have been created for subjects for Grade 10th and 12th. These booklets contain competency-based items, designed specifically to test conceptual understanding and application of concepts.

Process of creating competency-based items

All items in these booklets are aligned to the NCERT curriculum and have been created keeping in mind the learning outcomes that are important for students to understand and master. Items are a mix of Free Response Questions (FRQs) and Multiple-Choice Questions (MCQs). In case of MCQs, the options (correct answer and distractors) are specifically created to test for understanding and capturing specific errors/misconceptions that students may harbour. Each incorrect option can thereby inform teachers on specific gaps that may exist in student learning. In case of subjective questions, each question also has a detailed scoring rubric to guide evaluation of students' responses.

Each item has been reviewed by experts, to check for appropriateness of the item, validity of the item, conceptual correctness, language accuracy and other nuances.

How can these item booklets be used?

There are 195 questions in this booklet.

The purpose of these item booklets is to provide samples of high-quality competency-based items to teachers. The items can be used to–

- get an understanding of what good competency-based questions could look like
- give exposure to students to competency-based items
- assist in classroom teaching and learning
- get inspiration to create more such competency-based items

Students can also use this document to understand different kinds of questions and practice specific concepts and competencies. There will be further additions in the future to provide competency focused questions on all chapters.

The item booklets are aligned with the 2022-23 curriculum. However, a few questions from topic which got rationalized in 2023-24 syllabus are also there in the booklet which may be used as a reference for teachers and students.

Please write back to us to give your feedback.

Team CBSE

Table of Contents

Chapter - 1
Real Numbers

Multiple Choice Questions

Q: 1 **Which of the following is an irrational number?**

1 $\sqrt{5}$ **2** 3.14159265359 **3** $\frac{\sqrt{4}}{3}$ **4** $0.\overline{23517}$

Q: 2 **Which of the following is an irrational number?**

1 5√4 **2** $\frac{\sqrt{2}}{\sqrt{8}}$ **3** 6 + √5 **4** √64 - √4

Q: 3 $\frac{63}{p}$ **has a terminating decimal expansion.**

Which of these CANNOT be a factor of *p* ?

1 2 **2** 5 **3** 13 **4** 20

Q: 4 **Which of the following have a terminating decimal expansion?**

(Note: You need not evaluate the decimals.)

1 $\frac{1}{3}$ **2** $\frac{1}{60}$ **3** $\frac{1}{90}$ **4** $\frac{1}{625}$

Q: 5 **Which of these is the HCF of 1260 and 1680?**

1 210 **2** 420 **3** 630 **4** 5040

Q: 6 **Which of these is the LCM of 720 and 900?**

1 180 **2** 1800 **3** 3600 **4** 648000

Q: 7 Which of the following is the rationalised form of $\frac{\sqrt{5}}{\sqrt{3}+\sqrt{2}}$?

1 5 **2** $\frac{\sqrt{3}+\sqrt{2}}{\sqrt{5}}$ **3** $\sqrt{15}-\sqrt{2}$ **4** $\sqrt{15}-\sqrt{10}$

Q: 8 **Which of the following fractions has a terminating decimal expansion?**

1 $\frac{33}{343}$ **2** $\frac{19}{49}$
3 $\frac{71}{99}$ **4** $\frac{237}{625}$

Q: 9 **Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Read the statements carefully and choose the option that correctly describes statements (A) and (R).**

Assertion (A): Product of HCF and LCM of THREE numbers is equal to the product of those numbers.

Reason (R): Product of HCF and LCM of TWO numbers is equal to the product of those numbers.

1 Both (A) and (R) are true and (R) is the correct explanation for (A).
2 Both (A) and (R) are true and (R) is not the correct explanation for (A).
3 (A) is false but (R) is true.
4 Both (A) and (R) are false.

Free Response Questions

Q: 10 **The prime factorisation of a natural number p is $(5 \times 7 \times t)$ where $t \neq 2, 3$.** **[1]**

What is the prime factorisation of $42p^2$?

Q: 11 **$\sqrt{4} + \sqrt{5}$ is a rational number.** **[1]**

Write true or false and justify your answer.

Q: 12 **Ramesh has two rectangular fields of the same length but different widths. He wants to plant 76 trees in the smaller field and 190 trees in the larger field. In both fields, the trees will be planted in the same number of columns but in different numbers of rows.** **[1]**

What is the most number of columns that can be planted in this arrangement? Show your work.

Q: 13 **Use Euclid's Division Algorithm to find the HCF of 175, 225 and 465. Show your work.** **[2]**

Q: 14 **Given that $\sqrt{3}$ is irrational, show by contradiction that the sum of $\sqrt{3}$ and 2 is irrational. Show your steps.** **[2]**

Q: 15 **M and N are positive integers such that $M = p^5 q^3 r^2$ and $N = p^7 q^5 r$, where p, q, r are prime numbers.** **[2]**
Find LCM(M, N) and HCF(M, N).

Q: 16 **√5 is an irrational number. Meera was asked to prove that (3 + √5) is an irrational number.** **[2]**

Shown below are the steps of Meera's proof:

Step 1	Let (3 + √5) be a rational number. Then (3 + √5) can be written as $\frac{p}{q}$, where p and q ($q \neq 0$) are co-primes.
Step 2	Hence, √5 = ($\frac{p}{q}$ - 3).
Step 3	Since p and q are integers, ($\frac{p}{q}$ - 3) is also an integer.
Step 4	Since ($\frac{p}{q}$ - 3) is an integer and every integer is a rational number, ($\frac{p}{q}$ - 3) is a rational number. It implies that √5 is a rational number.
Step 5	But this contradicts the fact that √5 is an irrational number. Hence, (3 + √5) is an irrational number.

She made an error in one step due to which her subsequent steps were incorrect too.

In which step did she make that error? Justify your answer.

Q: 17 **Ajay has a box of length 3.2 m, breadth 2.4 m, and height 1.6 m.** **[2]**
What is the length of the longest ruler that can exactly measure the three dimensions of the box? Show your steps and give valid reasons.

Q: 18 ***m* is a positive integer. HCF of *m* and 450 is 25. HCF of *m* and 490 is 35.** **[2]**

Find the HCF of *m*, 450 and 490. Show your steps.

Q: 19 **Prove that √7 is irrational.** **[3]**

Q: 20 **Prove that $\frac{1}{\sqrt{2}}$ is irrational.** **[3]**

Q: 21 **Show that any positive even integer is of the form (8 *m*), (8 *m* + 2), (8 *m* + 4) or (8 *m* + 6), for some positive integer *m*. Show your work.** **[3]**

Q: 22 **Write two rational numbers each between the following pair:** **[3]**

i) √3 and √10
ii) 7 and √64
iii) √15 and 6

Q: 23 **The number 3837425721 is divided by a number between 5621 and 5912.** **[3]**

State true or false for the below statements about the remainder and justify your answer.

i) The remainder can be more than 5912.
ii) The remainder cannot be less than 5621.
iii) The remainder is always between 5621 and 5912.

Q: 24 **On the two real numbers $a = 2 + \sqrt{5}$ and $b = 3 - \sqrt{7}$, perform the following operations:** **[5]**

i) Calculate the sum ($a + b$).
ii) Calculate the product (ab).
iii) Find the additive inverse of a.
iv) Rationalise $\frac{1}{b}$.
v) Verify whether the numbers a and b are rational or irrational. Provide a valid reason for your answer.

Q: 25 **i) Find the LCM and HCF of 78, 91, and 195.** **[5]**
ii) Check whether LCM(a, b, c) × HCF(a, b, c) = $a \times b \times c$ where a, b and c are natural numbers.

Show your work.

Case Study

Answer the questions based on the given information.

For the screening of an informational documentary, three schools were selected by the district administration.

Name of the school	No. of students
C.A.V. Public School	78
Bal Vidya Bhawan	117
Bombay Public School	130

♦ During the screening, multiple rooms are used simultaneously, and each room can accommodate an equal number of students.
♦ All students in a particular room belong to the same school.
♦ As a token of appreciation, the district administration has provided an equal number of chocolates to each school.
♦ When distributing these chocolates, each school distributes chocolates equally among its students, ensuring fairness and consistency.

Q: 26 **Find the maximum number of students that can be seated in one room. Show your work.** **[2]**

Q: 27 **What is the minimum number of rooms required? Show your work.** **[2]**

Q: 28 **What is the minimum number of chocolates provided to each school? Show your work.** **[1]**

Q.No	Correct Answers
1	1
2	3
3	3
4	4
5	2
6	3
7	4
8	4
9	3

Q.No	What to look for	Marks
10	Writes the prime factorisation of 42 p^2 as ($2 \times 3 \times 5^2 \times 7^3 \times t^2$).	1
11	Writes False.	0.5
	Justifies the answer. For example, states that √5 is irrational as it is the square root of a prime number and sum of a rational and irrational is irrational.	0.5
12	Identifies that the number of columns for the two fields must be HCF of 76 & 190, and applies an appropriate method to find the HCF as 38.	1
13	Finds the HCF of 175, 225 and 465 using Euclid's Division Algorithm as follows: 225 = 175 × 1 + 50 175 = 50 × 3 + 25 50 = 25 × 2 + 0 Finds the HCF of 175 and 225 as 25.	1
	465 = 25 × 18 + 15 25 = 15 × 1 + 10 15 = 10 × 1 + 5 10 = 5 × 2 + 0 Finds the HCF of 465 and 25 as 5. Concludes that the HCF of 175, 225 and 465 is 5.	1
14	Assumes that (2 + √3) is rational and writes $2 + \sqrt{3} = \frac{p}{q}$, where p and q are co-prime integers and $q \neq 0$.	0.5
	Simplifies the above as $\frac{p}{q} - 2 = \sqrt{3}$.	0.5
	Writes that since p and q ($q \neq 0$) are integers and 2 is a rational, ($\frac{p}{q} - 2$) is also rational.	0.5
	Writes that since √3 is irrational, hence proves by contradiction that the sum of √3 and 2 is irrational.	0.5

Q.No	What to look for	Marks
15	Finds LCM(M, N) as $p^7 q^5 r^2$.	1
	Finds HCF(M, N) as $p^5 q^3 r$.	1
16	Identifies that Meera makes an error in step 3.	1
	Writes that if p and q are integers, $(\frac{p}{q} - 3)$ cannot be an integer since p and q are co-primes.	1
17	Identifies and reasons that the length of the longest ruler should be equal to the HCF of the three lengths.	0.5
	Finds the HCF of the three numbers as Prime factorization of 32 = 2^5 Prime factorization of 24 = 3×2^3 Prime factorization of 16 = 2^4 Highest Common factor, HCF = 2^3 Mentions the length of the longest ruler as 80 cm or 0.8 m. (Award 0.5 marks if the length is correct but the unit is incorrect).	1.5
18	Writes that the HCF of m, 450 and 490 is nothing but the HCF of 25 and 35 and finds the same as: 35 = (25 × 1) + 10 25 = (10 × 2) + 5 10 = (5 × 2) + 0.	1
	Concludes that HCF of m, 450 and 490 is 5.	1
19	Assumes $\sqrt{7} = \frac{a}{b}$ where $b \neq 0$, a and b are co-primes.	0.5
	Writes $b\sqrt{7} = a$ and squares both the sides to get $7b^2 = a^2$.	0.25
	Concludes that a is divisible by 7 as a^2 is divisible by 7 because 7 is a prime number.	0.5

Q.No	What to look for	Marks
	Writes $a = 7c$ and squares both the sides to get $a^2 = 49c^2$.	0.25
	Replaces a^2 with $7b^2$ from step 2 to get $7b^2 = 49c^2$ and solves it to get $b^2 = 7c^2$.	0.5
	Concludes that b is divisible by 7 as b^2 is divisible by 7 because 7 is a prime number.	0.5
	Mentions that 7 divides both a and b which contradicts the assumption that a and b are both co-prime and hence $\sqrt{7}$ is irrational.	0.5
20	Assumes $\frac{1}{\sqrt{2}} = \frac{a}{b}$ where $b \neq 0$, a and b are co-primes.	0.5
	Writes $b = a\sqrt{2}$ and squares both the sides to get $b^2 = 2a^2$.	0.25
	Concludes that b is divisible by 2 as b^2 is divisible by 2 because 2 is a prime number.	0.5
	Writes $b = 2c$ and squares to get $b^2 = 4c^2$.	0.25
	Replaces b^2 with $2a^2$ from step 2 to get $2a^2 = 4c^2$ and solves it to get $a^2 = 2c^2$.	0.5
	Concludes that a is divisible by 2 as a^2 is divisible by 2 because 2 is a prime number.	0.5
	Mentions that 2 divides both a and b which contradicts the assumption that a and b are both co-primes and hence $\frac{1}{\sqrt{2}}$ is irrational.	0.5
21	Writes Euclid's Division Lemma for $a = bm + n$, $0 \leq n < b$, where a is a positive integer and substitutes $b = 8$ to get $a = 8m + n$, $0 \leq n < 8$.	0.5
	Mentions that the possible values of n for $a = 8m + n$ are 0, 1, 2, 3, 4, 5, 6, 7.	1
	Writes that a can be $(8m)$, $(8m + 1)$, $(8m + 2)$, $(8m + 3)$, $(8m + 4)$, $(8m + 5)$, $(8m + 6)$ or $(8m + 7)$ where m is the quotient.	0.5

Q.No	What to look for	Marks
	Writes that out of the above expressions only (8 *m*), (8 *m* + 2), (8 *m* + 4) and (8 *m* + 6) are even and concludes that any positive even integer is of the form (8 *m*), (8 *m* + 2), (8 *m* + 4) or (8 *m* + 6).	1
22	i) Writes any 2 rational numbers between √3 and √10. For example, 2 and 2.1.	1
	ii) Writes any 2 rational numbers between 7 and √64. For example, 7.22 and 7.5.	1
	iii) Writes any 2 rational numbers between √15 and 6. For example, 4 and 5.	1
23	i) Writes false and justifies the answer. For example, writes that Euclid's Division Lemma states that the remainder is always less than the divisor and all the divisors are less than 5912.	1
	ii) Writes false and justifies the answer. For example, the remainder is always less than the divisor and the numbers from 0 to the divisor are all possible remainders.	1
	iii) Writes false and justifies the answer. For example, writes that Euclid's Division Lemma states that the remainder always lies between 0 and the divisor.	1
24	i) Calculates the sum correctly as 5 + √5 - √7.	1
	ii) Calculates the product correctly as 6 - 2√7 + 3√5 - √35.	1
	iii) Calculates the additive inverse of *a* correctly as (-2 - √5).	1
	iv) Calculates the rationalised form of $\frac{1}{b}$ correctly as $\frac{(3+\sqrt{7})}{2}$.	1
	v) Verifies both *a* and *b* are irrational because they are the sum of rational and irrational numbers.	1

Q.No	What to look for	Marks
25	**i) Finds the LCM and HCF of 78, 91, and 195 as 2730 and 13 respectively. The working may look as follows:** **Prime factorization of:** **$78 = 2^1 \times 3^1 \times 13^1$** **$91 = 7^1 \times 13^1$** **$195 = 3^1 \times 5^1 \times 13^1$** **LCM = 2 x 3 x 5 x 7 x 13 = 2730** **HCF = 13**	**3**
	ii) Considers a, b and c as 78, 91 and 195 respectively. **Finds LCM(a, b, c) × HCF(a, b, c) as 2730 × 13 = 35,490.**	**1**
	Finds the product of a, b, and c as 78 × 91 × 195 = 13,84,110. **Concludes that LCM(a, b, c) × HCF(a, b, c) ≠ $a \times b \times c$.**	**1**
26	**Identifies that to find the required number, HCF of 78, 117, and 130 is needed and finds the HCF of 78, 117, and 130 as:** **Prime factorization of 78, 117, and 130-** **$78 = 2^1 \times 3^1 \times 13^1$** **$117 = 3^2 \times 13^1$** **$130 = 2^1 \times 5^1 \times 13^1$** **Concludes that the maximum number of students to be seated in a room = HCF(78, 117, 130) = 13.**	**2**
27	**Finds the total number of students as 78 + 117 + 130 = 325.**	**1**
	Divides the total number of students by 13 to obtain the minimum number of rooms required as 25.	**1**
28	**Identifies that LCM of 78, 117, and 130 is the minimum number of chocolates received by each school and uses the prime factorization used earlier to find the LCM of 78, 117, and 130 as:** **LCM = 2 × 3 × 3 × 5 × 13 = 1170.** ***(Note: Award full marks if the student performs prime factorization.)***	**1**

Chapter - 2
Arithmetic Progressions

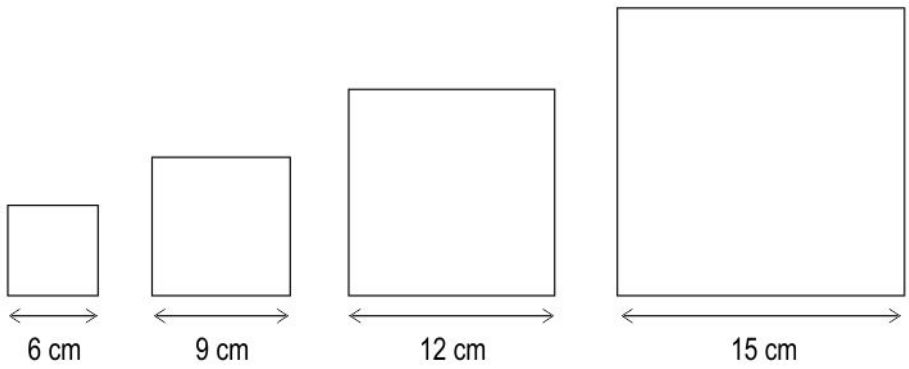
Multiple Choice Questions

Q: 1 **In a game, a player must gather 20 flags positioned 5 meters apart in a straight line. The starting point is 10 meters away from the first flag. The player starts from the starting point, collects the 20 flags and comes back to the starting point to complete one round.**

What will be the total distance covered by a player upon completing one round?

1 105 m **2** 210 m **3** 220 m **4** 1150 m

Q: 2 **Shown below are some squares whose sides form an arithmetic progression (AP).**



(Note: The figures are not to scale.)

Which of these are also in AP?

i) The areas of these squares.

ii) The perimeters of these squares.

iii) The length of the diagonals of these squares.

1 only ii)
2 only i) and ii)
3 only ii) and iii)
4 all - i), ii) and iii)

Q: 3 **Given below is an arithmetic progression. X and Y are unknown.**

$4\frac{1}{4}$, $6\frac{3}{4}$, X, $11\frac{3}{4}$, Y, $16\frac{3}{4}$

Which of these are X and Y?

1 X = $8\frac{3}{4}$, Y = $13\frac{3}{4}$
2 X = $8\frac{3}{4}$, Y = $14\frac{1}{4}$
3 X = $9\frac{1}{4}$, Y = $14\frac{1}{4}$
4 X = $9\frac{1}{4}$, Y = $13\frac{3}{4}$

Q: 4 **Which of the following are in Arithmetic progression?**

i) 2, 12, 22, 32, 42, ...
ii) 1, 2, 4, 7, 11, 16, ...
iii) 7, 6.5, 6, 5.5, 5, ...

1 only i)
2 only i) and ii)
3 only i) and iii)
4 all - i), ii) and iii)

Q: 5 **Given below is a pattern.**

$-\frac{3}{4}, -\frac{5}{8}, -\frac{1}{2}, -\frac{3}{8}, -\frac{1}{4}, \ldots$

If the pattern is extended, what would be the 41st term?

1 $\frac{-223}{4}$ **2** $\frac{23}{4}$ **3** $\frac{17}{4}$ **4** $\frac{35}{8}$

Q: 6 **Vanshika decided to plant a certain number of seeds every month as a part of a gardening project. In the first month, she planted 5 flower seeds, and in the final month, she planted 50 flower seeds. Every month, she planted 3 more seeds than the previous month.**

How many flower seeds did Vanshika plant in total?

1 50 **2** 103 **3** 390 **4** 440

Q: 7 **A construction company is working on construction of new floors in an old building which already had 6 floors. During the first week, they completed 5 floors. Each subsequent week, they completed 3 more floors.**

If this progression continues for 12 weeks, how many floors will the building have in total?

1 38 **2** 44 **3** 47 **4** 258

Q: 8 **Which term of the arithmetic progression (AP) 21, 18, 15, ... is 0?**

1 6th term
2 7th term
3 8th term
4 (the AP does not have 0 as any term)

Free Response Questions

Q: 9 **Write the first four terms of an Arithmetic Progression, whose first term is 3.75, and the common difference is (-1.5).** **[1]**

Q: 10 **If the first term of an arithmetic progression (AP) is 5 and the common difference is (-3), then the *n* th term of the progression is given by $T_n = 5n - 3$.** **[1]**

Is the above statement true or false? Justify your answer.

Q: 11 **In a library, the arrangement of bookshelves follows a pattern where the number of books on each successive shelf increases by 10 books. The first shelf has 30 books, and the last shelf has 160 books.** **[2]**

i) How many shelves are there in the library?
ii) How many total books are there in the library?

Show your work.

Q: 12 **The common difference of an arithmetic progression is $\frac{5}{2}$. The 9th term is 17.** **[2]**

i) Find the first term.
ii) Find the 101th term.

Show your work.

Q: 13 **Sameer is saving up to buy a bike, which costs Rs 46,000. He plans to save money each month. In the first month, he saves Rs 1,000 and every subsequent month, he saves Rs 250 more than the previous month.** **[2]**

After how many months will he be able to buy the bike? Show your work.

Q: 14 **The n th term of an arithmetic progression (AP) is $T_n = (2n + 1)^2 - 3$.** **[2]**

Determine the sum of the first 10 terms of the AP. Show your work.

Q: 15 **John is renovating his house. He began by painting one wall, which took him 2 hours on the first day. Each subsequent day, he spends an additional 30 min on the renovation project.** **[2]**

On which day will he spend 12 hours of his day on the renovation? Show your work.

Q: 16 **How many terms of the arithmetic progression 5, 7 $\frac{1}{2}$, ... add up to 50? Show your work.** **[2]**

Q: 17 **Given below are 2 arithmetic progressions (AP):** **[2]**

AP_1 : 5, 9, 13, 17,...
AP_2 : 30, 40, 50, 60,...

The x th term of AP_1 is the same as the y th term of AP_2.

Find the relationship between x and y. Show your work.

Q: 18 **A theatre charges Rs 350 for the first ticket and Rs 20 less for every subsequent ticket. The offer is valid for 12 tickets only.** **[3]**

i) Find the discounted price for the first four tickets.

ii) How much would someone pay for 8 tickets?

iii) What would be the discounted price of the 12th ticket?

Show your work.

Q: 19 **How many three-digit numbers are smaller than 200 and divisible by 8? Find sum of these numbers. Show your work.** **[3]**

Q: 20 **In an arithmetic progression, the sum of the first n terms is given by $S_n = 2n^2 - 5n$.** **[3]**

Determine the first term and the common difference of this arithmetic progression. Show your work.

Q: 21 **In a new school, student enrolments occured over a period of 30 days, with 5 students joining each day than the previous day. The first day started with an enrolment of 12 students.** **[3]**

i) After how many days did the school have a total of 110 students?
ii) How many students were enrolled in the 30 days?

Show your work.

Q: 22 **In a construction project of making chairs, the team adds 3 chairs every day. On the first day, they added 4 chairs.** **[3]**

i) After how many days will the office have a total of 40 chairs?
ii) Calculate the total number of chairs after 30 days.
iii) If they added 5 chairs instead of 3 chairs each day, find the minimum number of days after which there will be more than 150 chairs.

Show your work.

Q: 23 **A librarian wanted to add more books to a library that had a current collection of 150 books. He added 5 books every week.** **[3]**

i) How many books were there in the library after 11 weeks?

ii) Determine the total number of new books added in the 11 weeks.

iii) If the library has a maximum capacity of 300 books, after how many weeks would the library reach its limit?

Show your work.

Q: 24 **The difference between the 5th and 10th terms of an arithmetic progression (AP) is 15.** **[3]**

If the first term is 4, find the common difference and the 15th term of the AP. Show your work.

Q: 25 **The difference between the 2^{nd} and 4^{th} term of an arithmetic progression (AP) is 6.** **[3]**

Find the common difference of the AP. Show your work.

Q: 26 **[5]**

The cannon fires every 2 minutes, with the first shot occurring 10 minutes after the start of the fight. Additionally, the weight of each cannonball increases by 0.5 kg with each successive shot, starting with the first ball weighing 0.5 kg.

i) How many balls are fired after the first 30 minutes of fight?
ii) What is the ball's weight when the 12th ball is fired?
iii) After how much time will the ball of 10 kg be fired?

Show your work.

Q: 27 **A car covers 55 km in the first hour and increases its speed by 10 km/hr every hour.** **[5]**

i) Find the total distance covered in 6 hours.
ii) How long will the car take to cover 1000 km?
iii) Find the speed of the car in the 9th hour.

Show your work.

Case Study

Answer the questions based on the given information.

Isha is planning to grow her orchard. She wants to plant rows of fruit trees in a way that each row has more trees than the one before, following a specific pattern. Given below are the details of her plan:

i) The first row will have 5 trees.

ii) Each new row will have 3 more trees than the one before.

iii) There will be a total of 10 rows of trees.

Q: 28 **Calculate the number of trees in the 10th row of the orchard. Show your work.** **[1]**

Q: 29 **What will be the total number of trees in the orchard after all 10 rows are planted? Show your work.** **[2]**

Q: 30 **Isha changed her plan by not planting in rows 5 and 6 to create a pathway for walking, without altering the pattern for the rows. All rows will have the same number of trees as before.** **[3]**

Calculate the number of trees now. Show your work.

Q.No	Correct Answers
1	2
2	3
3	3
4	3
5	3
6	4
7	2
8	3

Q.No	What to look for	Marks
9	Writes the first four terms as: 3.75, 2.25, 0.75, -0.75	1
10	Writes false and justifies the answer. For example, writes that: The n th term of an AP is: $T_n = 5 + (-3)(n - 1) = 8 - 3n$	1
11	i) Assumes the the total number of shelves in the bookshelf as n and writes the equation as: $160 = 30 + 10(n - 1)$	0.5
	Solves the above equation to find the value of n as 14.	0.5
	ii) Finds the total number of books in the shelf as: $\frac{14}{2} \times (30 + 160) = 1330$	1
12	i) Assumes the first term of the arithmetic progression to be a and forms the equation: $17 = a + (9 - 1) \times \frac{5}{2}$ Solves the above equation to find the value of a as (-3).	1
	ii) Finds the 101th term as: $(-3) + (101 - 1) \times \frac{5}{2} = 247$	1
13	Assumes the number of months to be n and writes the equation: $46000 = \frac{n}{2})\} [(2 \times 1000) + (n - 1) \times 250]$	1
	Solves the above equation to get n as 16 or -23. Writes that the number of months cannot be negative and hence after 16 months, he will be able to buy the bike.	1

Q.No	What to look for	Marks
14	Finds the 1st term of the AP as: $(2 \times 1 + 1)^2 - 3 = 6$	0.5
	Finds the 10th term of the AP as: $(2 \times 10 + 1)^2 - 3 = 438$	0.5
	Finds the sum of first 10 terms of the AP as: $\frac{10}{2}(6 + 438) = 2220$	1
15	Finds the first term of the progression as $2 \times 60 = 120$ min and writes the common difference as 30 min.	0.5
	Finds the time spent on the n th day as $12 \times 60 = 720$ min.	0.5
	Writes the equation for the n th day as: $720 = 120 + (n - 1) \times 30$ Solves the above equation to find that John will spend 12 hours of his day on the 21st day.	1
16	Writes the equation for the sum of n terms of an arithmetic progression as: $50 = \frac{n}{2}[2 \times 5 + (n - 1) \times 2\frac{1}{2}]$	0.5
	Solves the above equation to get the values of n as 5 or (-8). Writes that the number of terms cannot be negative and hence $n = 5$.	1.5
17	Writes the equation for the x th term of AP_1 as: $5 + (x - 1) \times 4$	0.5
	Writes the equation for the x th term of AP_2 as: $30 + (y - 1) \times 10$	0.5

Q.No	What to look for	Marks
	Equates the above two equations and writes: $5 + (x - 1) \times 4 = 30 + (y - 1) \times 10$ $\Rightarrow 4x - 10y = 19$	1
18	i) Finds the price for first ticket as Rs 350 and the subsequent 3 tickets as Rs 330, Rs 310, and Rs 290.	1
	ii) Writes the equation for the price of 8 tickets as: $\frac{8}{2} \times [(2 \times 350) + (7 \times (-20))]$	0.5
	Solves the above equation to get total price of 8 tickets as Rs 2240.	0.5
	iii) Finds the discounted price of 12th ticket as: $350 + 11 \times (-20) =$ Rs 130	1
19	Writes the sequence of 3-digit numbers less than 200 divisible by 8 as 104, 112, 120, ..., 192 and mentions that it forms an arithmetic progression (AP).	0.5
	Assumes that the AP has n terms and writes the equation for the last term as: $192 = 104 + (n - 1)8$	0.5
	Solves the above equation to find the total number of terms in the AP as 12.	1
	Finds the sum of all terms of the AP as: $\frac{12}{2}(104 + 192) = 1776$	1
20	Finds the first term (T_1) of the arithmetic progression as: $S_1 = 2(1)^2 - 5(1) = (-3)$	1
	Finds the second term (T_2) of the arithmetic progression as: $T_1 + T_2 = S_2 = 2(2)^2 - 5(2) = (-2)$ $\Rightarrow T_2 = (-2) - (-3) = 1$	1.5

Q.No	What to look for	Marks
	Finds the common difference as: **$T_2 - T_1 = 1 - (-3) = 4$**	**0.5**
21	**i) Writes that the first term of the arithmetic progression (AP) is 12, common difference is 5. Assumes the required number of days as *n* and writes the equation for 110 students as:** **$110 = \frac{n}{2} \times (24 + (n - 1) \times 5)$**	**0.5**
	Solves the above equation to find the values of *n* as 5 or (-8.8). **Writes that after 5 days, the school had a total of 110 students.**	**1**
	ii) Finds the total number of students enrolled in 30 days as: **$\frac{30}{2} \times (24 + (30 - 1) \times 5) = 2535$**	**1.5**
22	**i) Finds the first term (*a*) as 4 and common difference (*d*) as 3. Using the formula to determine the number of days (*n*),** **$40 = 4 + (n - 1) \times 3$** **$\Rightarrow n = 13$** **Concludes that after 13 days, there would be total of 40 chairs in office.**	**1**
	ii) Finds the total number of chairs after 30 days as: **$4 + (30 - 1) \times 3 = 91$**	**1**
	iii) Finds the new common difference to be 5. **Assumes the minimum number of days as *n* and writes the equation for the number of days after which there will be more than 150 chairs as:** **$4 + (n - 1) \times 5 > 150$** **$\Rightarrow n > 30.2 \cong 31$** **After 31 days there will be more than 150 chairs.**	**1**

Q.No	What to look for	Marks
23	i) Writes that the number of books added forms an arithmetic progression with first term 150 and common difference 5. Finds the number of books in the library after 11 weeks as: $150 + (11 - 1) \times 5 = 200$	1
	ii) Finds the total number of new books added in the 11 weeks as 200 - 150 = 50.	0.5
	iii) Assumes that after n weeks, there were 300 books. Writes the equation as: $300 = 150 + (n - 1) \times 5$	1
	Solves the above equation for n and finds the required number of weeks as 31.	0.5
24	Writes the 5th and 10th term of the arithmetic progression as ($a + 4d$) and ($a + 9d$), where a is the first term and d is the common difference of the AP.	0.5
	Writes the difference of both the terms as 5 d or (-5 d) and equates it with 15 to get the common difference as (3) or (-3).	0.5
	Finds the 15th term of the AP as 46 or (-38). The working may look as follows: case i) when $a = 4$, $n = 15$ and $d = 3$: $T_{15} = 4 + (15 - 1) \times 3 = 46$ case ii) when $a = 4$, $n = 15$ and $d = -3$: $T_{15} = 4 - (15 - 1) \times 3 = -38$	2
25	Represents the 2 nd and 4 th term of the AP as ($a + d$) and ($a + 3d$) with the first term as a and common difference as d.	1
	Finds the difference of 2 nd and 4 th term as ($a + 3d$) - ($a + d$) = 2 d or ($a + d$) - ($a + 3d$) = (-2 d).	1
	Concludes that the common difference can either be 3 or (-3).	1

Q.No	What to look for	Marks
26	**i) Finds the first term (a) = 10 and common difference (d) = 2.** **Assumes *n* as the number of balls fired.** **$30 = 10 + (n - 1) \times 2$** **Finds the value of *n* as 11 and hence 11 balls have been fired after the first 30 minutes of fight.**	**1**
	ii) Finds the first term (a) = 0.5 and common difference (d) = 0.5. **Required weight = $0.5 + (12 - 1) \times 0.5$** **Thus concludes weight of the 12th ball fired is 6 kg.**	**1.5**
	iii) Assumes that after *n* th ball, the 10 kg ball is fired and writes the equation as: **$10 = 0.5 + (n - 1) \times 0.5$** **Solves the equation to find *n* as 20 and hence after the 20th ball, the ball would weigh 10 kg.**	**1**
	Uses the above *n* to evaluate the time as: **$10 + (20 - 1) \times 2$** **Concludes that after 48 mins of the fight starting, 10 kg ball will be fired.**	**1.5**
27	**i) States that speed of car forms an arithmetic progression with common difference, *d* = 10 and first term, *a* = 55.**	**1**
	Finds the total distance covered after 6 hours as 480 km. The working may look as follows: **$\frac{6}{2}\{2 \times 55 + (6 - 1) \times 10\} = 480$ km**	**1**

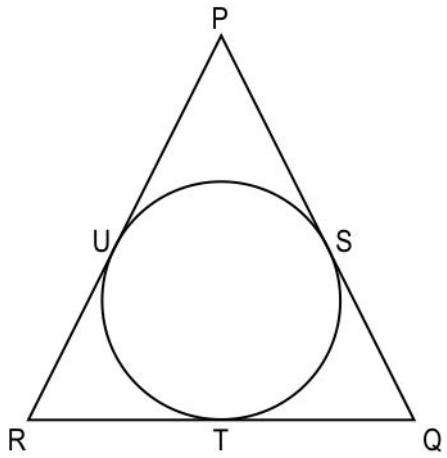
Q.No	What to look for	Marks
	ii) Uses the equation of sum of first *n* terms of an arithmetic progression and finds that the car will cover the distance of 1000 km in 11 hours. The working may look as follows: $1000 = \frac{n}{2}\{2 \times 55 + (n - 1) \times 10\}$ $\Rightarrow n^2 + 10n - 200 = 0$ $\Rightarrow n = 10$ or (-20) **Concludes that $n = 10$ since negative value of time is not possible.**	**2**
	iii) Uses the equation of *n* th terms of an AP to find the 9th term and states that the speed will be 135 km/h. The working may look as follows: $T_9 = 55 + (9 - 1) \times 10 = 135$ km/h	**1**
28	**Writes that the first row contains 5 trees, and each subsequent row has 3 more trees than the previous row.** **Concludes that the given pattern is in AP, and identifies *a* as 5 and *d* as 3.**	**0.5**
	Finds the number of trees in the 10th row as: $5 + (10 - 1) \times 3 = 32$	**0.5**
29	**Uses the sum of an arithmetic series formula and writes:** $\frac{10}{2} \times (2 \times 5 + (10 - 1) \times 3)$ **Solves the above equation to get the total number of trees in the orchard after all 10 rows are planted as 185.**	**2**
30	**Forms two APs such as :** AP_1 : 1 st, 2 nd, 3 rd, 4 th row. AP_2 : 7 th, 8 th, 9 th, 10 th row.	**0.5**
	Finds the total number of trees in AP_1 as: $\frac{4}{2} \times (2 \times 5 + (4 - 1) \times 3) = 38$	**0.5**

Q.No	What to look for	Marks
	Calculates the number of trees in the 7 th row as: **$5 + (7 - 1) \times 3 = 23$**	**0.5**
	Finds total number of trees in AP_2 as : **$\frac{4}{2} \times (2 \times 23 + (4 - 1) \times 3) = 110$**	**1**
	Finds the total number of trees as 38 + 110 = 148 trees. **(Award full marks if students calculate total number of trees and subtract number of trees in Row 5 and 6.)**	**0.5**

Chapter - 3
Circles

Multiple Choice Questions

Q: 1 **In the figure below, ▲PQR is an isosceles triangle with PQ = PR, and the lengths of PU and UR are 5 units and 3 units respectively.**

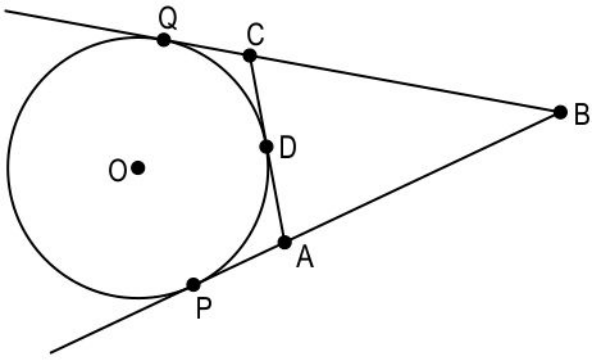


(Note: The figure is not to scale.)

Which of the following is TRUE?

1 PS = 3 units **2** SQ = 5 units **3** QT = 3 units **4** QR = 8 units

Q: 2 **In the figure below, ▲ABC is formed using three tangents to a circle centred at O.**



(Note: The figure is not to scale.)

Based on the construction, which of the following statements is true?

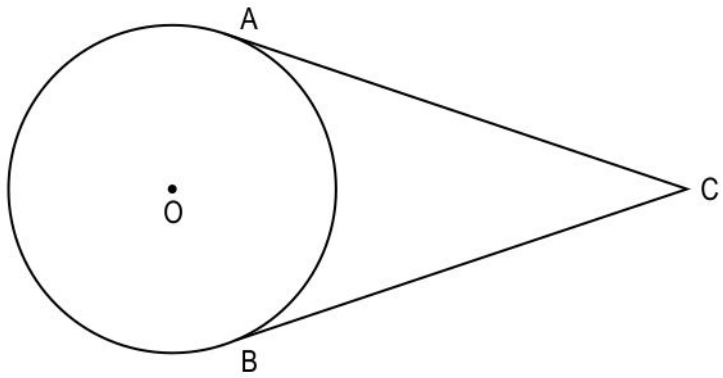
1 The sum of the length of BP and BQ less than the perimeter of ΔABC.
2 The sum of the length of BP and BQ is same as the perimeter of ΔABC.
3 The sum of the length of BP and BQ is greater than the perimeter of ΔABC.
4 Length of the tangents should be known to compare it to the perimeter of ΔABC.

Q: 3 **Four tangents of a circle are extended from both the sides to intersect each other until a quadrilateral is formed.**

Which of these quadrilateral is NOT possible to be formed?

1 Square **2** Rhombus **3** Rectangle **4** Trapezium

Q: 4 **A circle with center O is shown below, where CA and CB are tangents to the circle.**

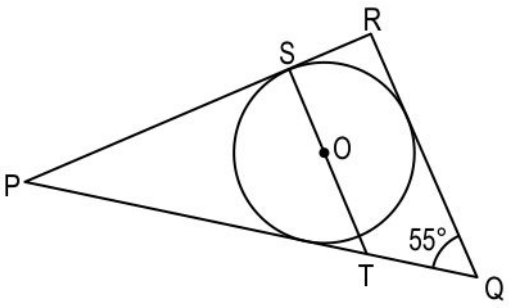


(Note: Figure is not to scale)

If measure of ∠ACB = 50°, find the measure of ∠AOB.

1 40° **2** 50° **3** 130° **4** 140°

Q: 5 **In the following figure, O is the center of the circle. PQ, QR and RP are tangents of the circle. TS is parallel to QR.**



(Note: The figure is not to scale.) **Which of these is the measure of ∠RPQ?**

1 35° **2** 55° **3** 62.5° **4** 70°

Q: 6 **How many tangents can be drawn from an external point to a circle?**

1 Only 1 **2** Only 2 **3** Only 3 **4** Infinitely many

Q: 7 **Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Read the statements carefully and choose the option that correctly describes statements (A) and (R).**

Assertion (A): All angles formed by a chord on the same side of the circumference of a circle are equal to each other.

Reason (R): The sum of any two angles formed by a chord on the opposite sides of the circumference of a circle is 180°.

1 Both (A) and (R) are true and (R) is the correct explanation for (A).
2 Both (A) and (R) are true and (R) is not the correct explanation for (A).
3 (A) is false but (R) is true.
4 Both (A) and (R) are false.

Q: 8 **Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Read the statements carefully and choose the option that correctly describes statements (A) and (R).**

Assertion (A): At the point of contact, a tangent to a circle is always perpendicular to the radius.

Reason (R): The point where a tangent touches a circle is the only point of contact between the tangent and the circle.

1 Both (A) and (R) are true and (R) is the correct explanation for (A).
2 Both (A) and (R) are true and (R) is not the correct explanation for (A).
3 (A) is false but (R) is true.
4 (A) is true but (R) is false.

Q: 9 **Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Read the statements carefully and choose the option that correctly describes statements (A) and (R).**

Assertion (A): Area of minor sector formed by an arc is always half the area of the major sector formed by it.

Reason (R): The angle subtended by an arc at the center is double the angle subtended by it at any point on the circumference of the circle.

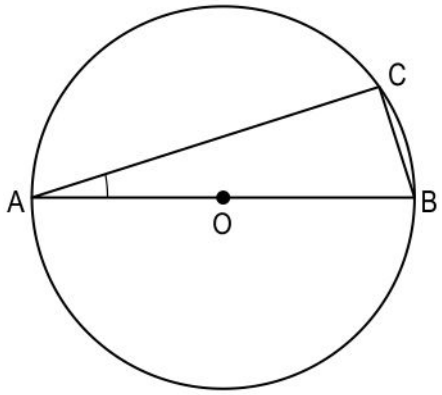
1 Both (A) and (R) are true and (R) is the correct explanation for (A).
2 Both (A) and (R) are true and (R) is not the correct explanation for (A).
3 (A) is true but (R) is false.
4 (A) is false but (R) is true.

Free Response Questions

Q: 10 **AC is a chord to a circle, the length of which is double the radius of the circle.** **[1]**

If B is a point on the circumference of the circle, what is the measure of ∠ABC? Give reason.

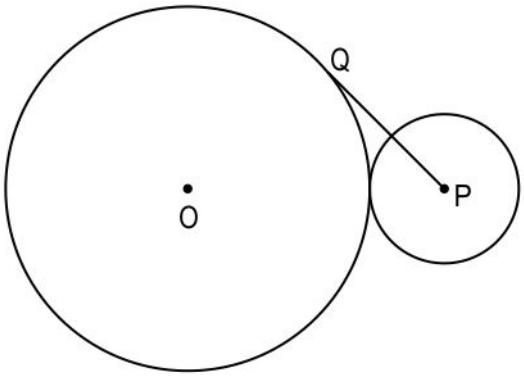
Q: 11 **In the figure below, AB is the diameter of the circle and C is a point on the circumference of the circle with centre O.** **[1]**



(Note: The figure is not to scale.)

If ∠ABC = 50°, what is the measure of ∠BAC? Justify your answer.

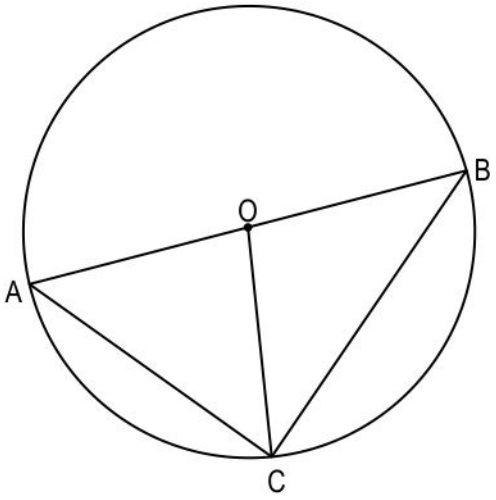
Q: 12 **In the figure below, circles with centres O and P touch each other and their radii are 12 units and 3 units respectively. PQ is a tangent to the circle with centre O.** **[1]**



(Note: The figure is not to scale.)

What is the length of the tangent PQ?

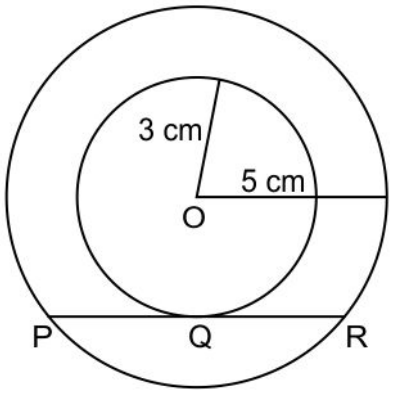
Q: 13 **In the figure below, AB is the diameter of the circle and ∠ABC is 33° where C is the point on circle.** **[1]**



(*Note: The figure is not to scale.*)

If OC is the bisector of ∠ACB, find the measure of ∠BOC. Show your work with valid reasons.

Q: 14 **Shown below are two concentric circles having center O. The radius of the smaller circle is 3 cm and that of the larger circle is 5 cm.** **[2]**



(Note: The figure is not to scale.)

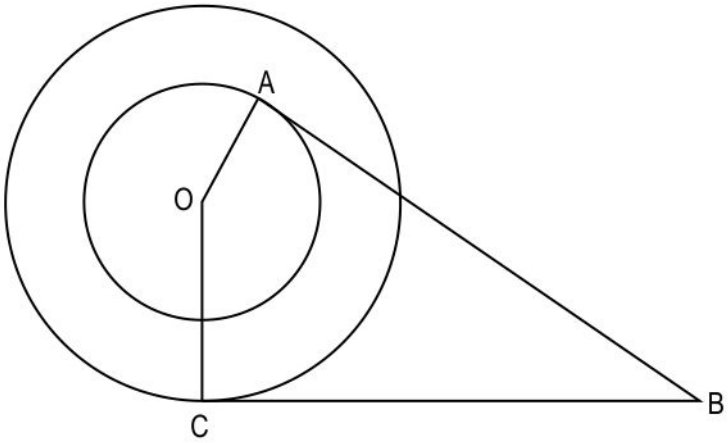
PR is a chord of the larger circle which is also a tangent to the smaller circle at point Q. What is the length of PR?

Show your work and give valid reason.

Q: 15 **i) Construct two tangents to a circle of your choice from an external point. Draw the radii at the points of tangency of both the tangents to form a quadrilateral.** **[2]**
ii) Prove that the line segment joining the external point and the center of the circle divides the quadrilateral into two triangles with equal area.

Show your work.

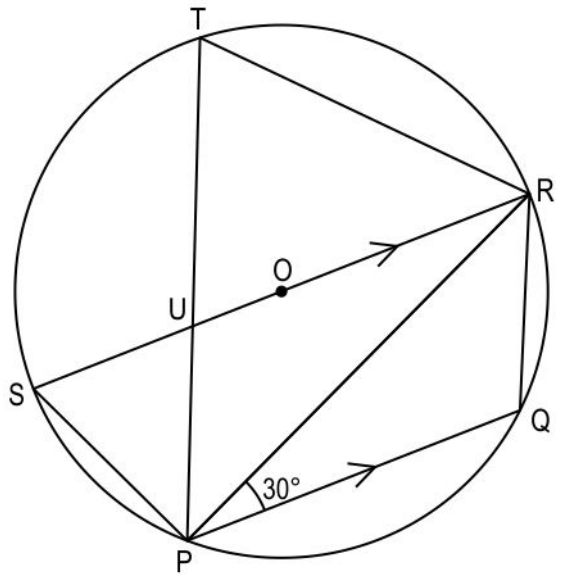
Q: 16 **In the figure below, O is the centre of two concentric circles of radii OA and OC. From point B, tangent BC is drawn to outer circle and tangent BA is drawn to inner circle.** **[2]**



(*Note: The figure is not to scale.*)

If ∠ABC = 43°, find the measure of ∠AOC. Show your work.

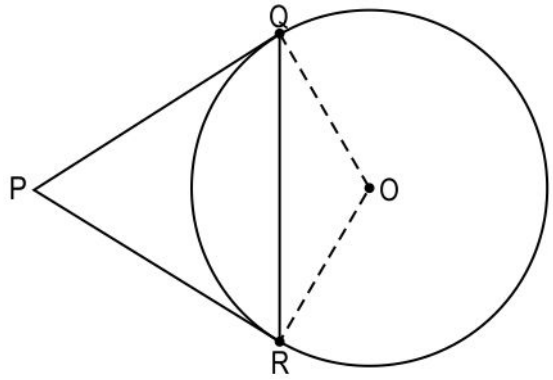
Q: 17 **Shown below is a circle with centre O, ∠RPQ = 30° and RS || PQ.** **[2]**



(Note: The figure is not to scale.)

What is the measure of ∠PTR?

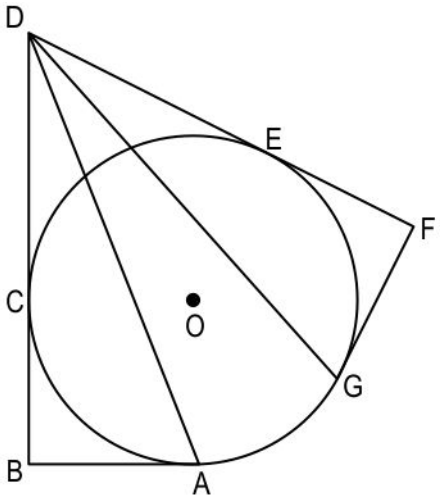
Q: 18 **Shown below is a circle with centre O having radius of 3 units and PQ and PR are the tangents from external points P. The length of PQ is 4 units.** **[3]**



(*Note: The figure is not to scale.*)

Find area of quadrilateral PQOR. Show your steps.

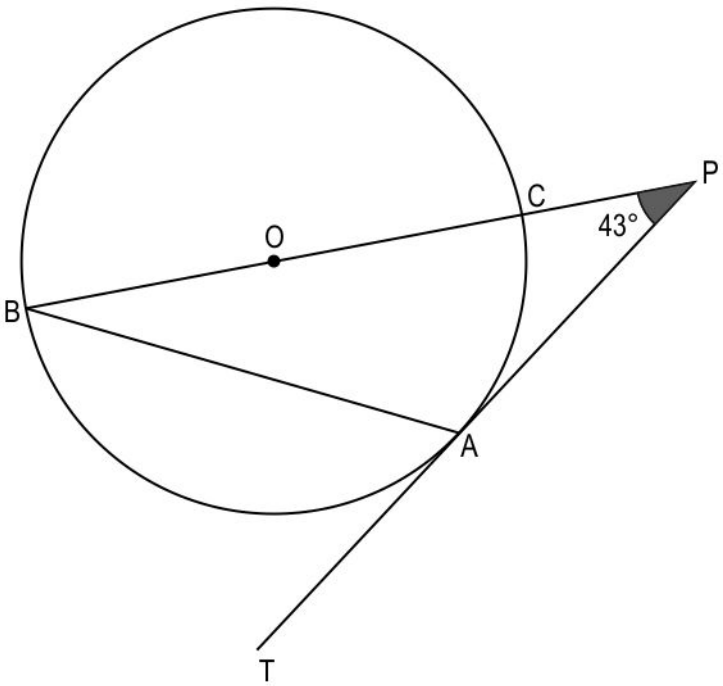
Q: 19 **Shown below is a circle with centre O. AB = GF = 5 cm, DC = 7 cm. A, C, E, and G are the points of tangency with ∠ABC = ∠EFG = 90°.** **[3]**



(Note: The figure is not to scale)

Find the length of (AD + DG). Show your work with valid reasons.

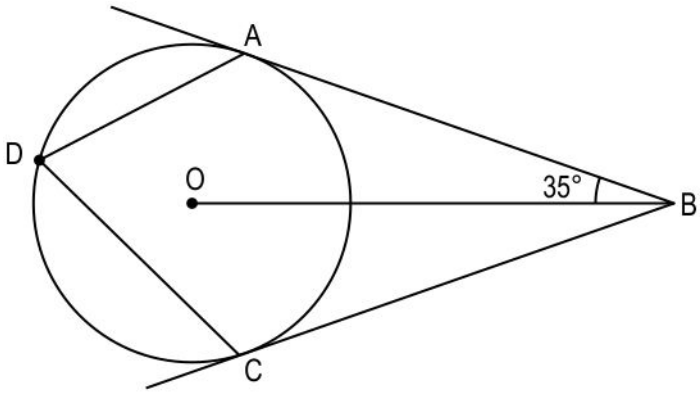
Q: 20 **In the figure given below, BC is a diameter of the circle with center O. PT is tangent to the circle at point A and ∠BPA = 43°.** **[3]**



(Note: The figure is not to scale.)

Find the measure of ∠PAB. Show your work with a rough figure and give valid reasons.

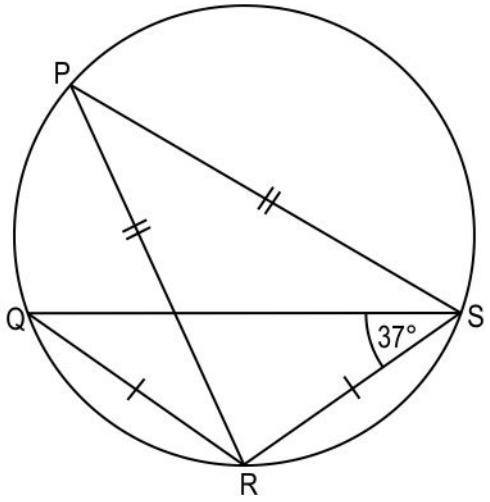
Q: 21 **Given below is a circle with centre O. AB and BC are tangents to the circle from an external point B such that ∠OBA = 35°. D is a point on the circle such that it is NOT on the same line as OB.** **[3]**



(Note: The figure is not to scale.)

Find the measure of ∠ADC. Show your work.

Q: 22 **The points P, Q, R and S lie on the circumference of the circle. SR = RQ , PR = PQ and ∠SQR = 37°.** **[3]**



(Note: The figure is not to scale.)

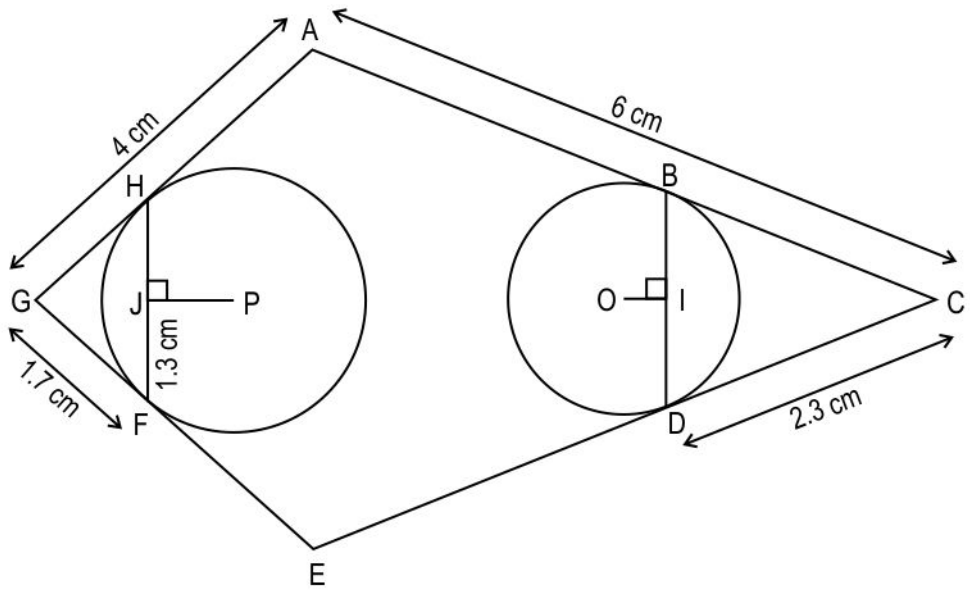
Find ∠PRS. Show your work with valid reasons.

Q: 23 **A circle with centre O and radius 13 units has PM and PN as its two tangents from an external point P. The length of chord MN is 24 units.** **[5]**

Use the properties of tangent to a circle to find the length of (PM + PN). Draw a rough figure and show your work.

Q: 24 **Sahid is learning thread embroidery and draws following pattern with two circles inscribed inside a kite on a piece of cloth. A kite is a quadrilateral with two distinct pairs of adjacent sides that are of equal length. Here, AG = EG and AC = EC.** **[5]**

Chord BD and HF are of equal length.



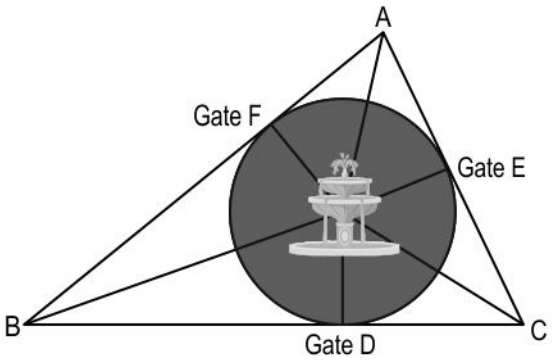
(*Note: The figure is not to scale.*)

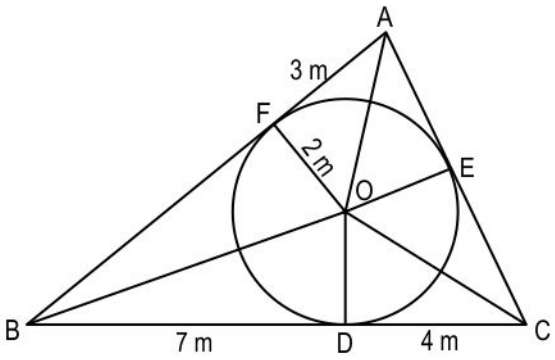
If he wants to enclose hexagon ABDEFH with a red coloured thread, what length of red coloured thread will he need? Show your steps with valid reasons.

Case Study

Answer the questions based on the given information.

A Municipal Corporation wants to build an old-age home on a triangular piece of land. The plan is to build a circular building along the triangular boundary with a water fountain at the centre and utilize the remaining space for gardening. Also, there are six paths that radiate from the fountain towards the boundary of the triangular land. The blueprint along with the dimensions is shown below.





(Note: The figures are not to scale.)

The distance between Gate F and point A is 3 metres. The distance of Gate D from points B and C is 7 metres and 4 metres, respectively. The water fountain is at a distance of 2 meters from gate F.

Q: 25 **The Municipal Corporation needs to pass an underground electric wire from point A to D along the paths AO and OD.** **[2]**

If the cost of laying wire is Rs. 500 per meter, then find the total cost of laying the main electric wire.

Show your work and give your answer correct to nearest hundreds.

Q: 26 **A compound wall along with three solid gates, both of height 2 m is to be built for fencing the entire triangular area.** **[2]**

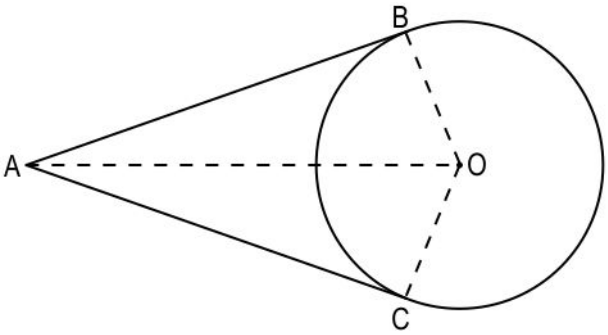
If 1 liter of paint is required to paint 4 m^2 of the internal surface area of the wall and the gates, find the quantity of paint required to paint the entire internal surface of the boundary. Show your work.

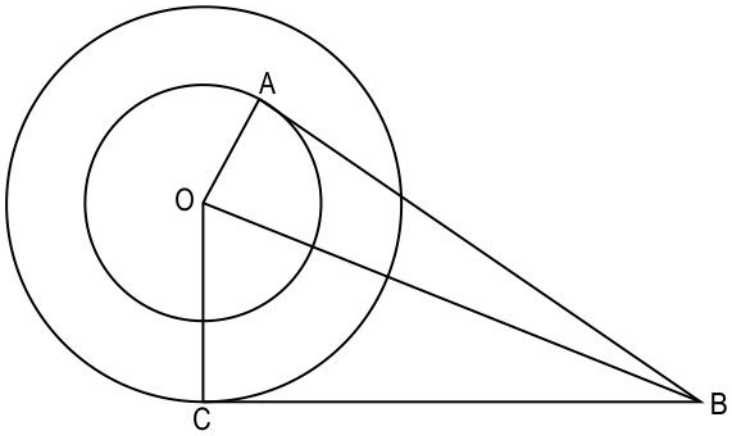
Q: 27 **A person standing somewhere in between point B and gate D wants to go to the fountain at the center. She starts walking towards gate D and takes a turn at gate D.** **[1]**

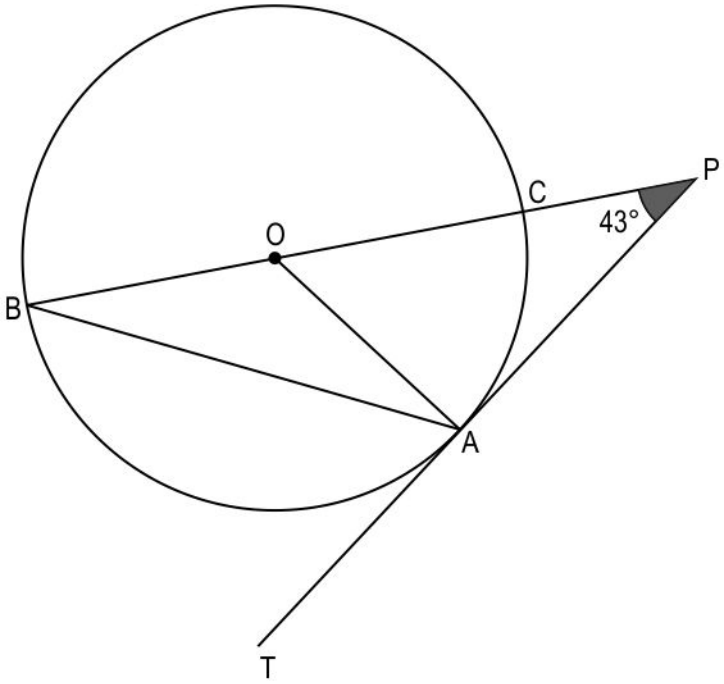
At what angle should she turn at gate D to reach fountain at the center? Support your answer with suitable reason.

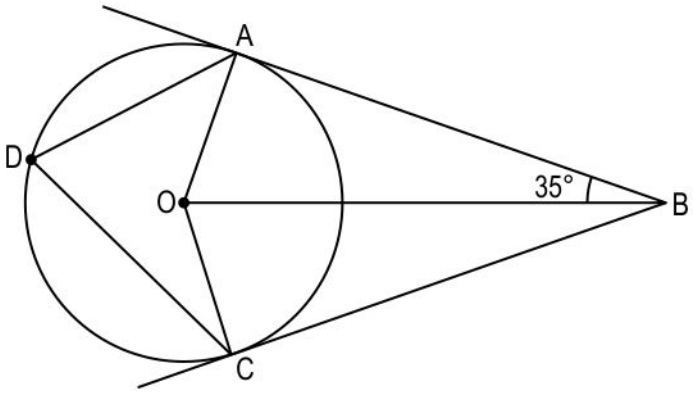
Q.No	Correct Answers
1	3
2	2
3	3
4	1
5	2
6	2
7	2
8	4

Q.No	What to look for	Marks
10	**Writes that the measure of ∠ABC is 90°.**	**0.5**
	States that AC is the diameter of the circle and the angle subtended by diameter on the circumference of the circle is 90°.	**0.5**
11	**States that since diameter subtends right angle on the circumference of circle, ΔABC is a right angled triangle with right angle at point C.**	**0.5**
	States that ∠ABC + ∠CAB = 90°. Therefore, ∠CAB = 40°.	**0.5**
12	Finds the length of PQ as, $\sqrt{OP^2 - OQ^2} = \sqrt{(12+3)^2 - 9^2}$ $= \sqrt{15^2 - 9^2} = \sqrt{225 - 81} = \sqrt{144} = 12$ units.	**1**
13	**States that the angle subtended by a diameter of a circle on it's circumference is 90°. Hence, measure of ∠OCB is 45°.**	**0.5**
	Uses angle sum property of triangle in ΔBCO to find the measure of ∠BOC = 180° - 45° - 33° = 102°.	**0.5**
14	**States that tangent of a circle is perpendicular to its radius.**	**1**
	Uses pythagoras theorem to find the length of QR as, $QR = \sqrt{OR^2 - OQ^2} = \sqrt{5^2 - 3^2} = 4$ cm.	**0.5**
	Finds PR = 2 x QR = 2 x 4 = 8 cm	**0.5**

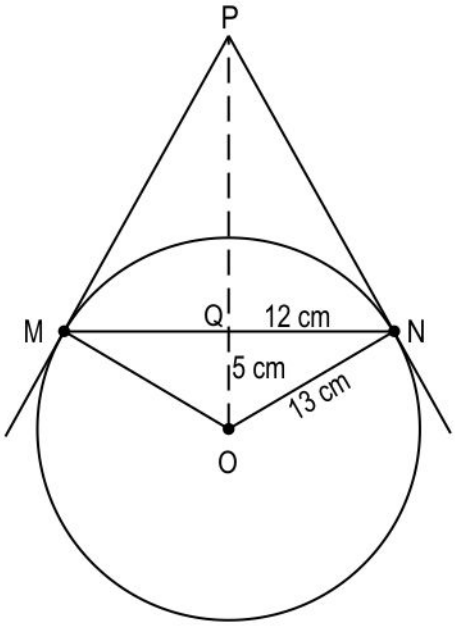
Q.No	What to look for	Marks
15	**i) Draws a circle with centre O and two tangents AB and AC. Joins OA, OB and OC. The figure may look as follows:**  	**0.5**
	ii) Writes that, in ▲OAB and ▲OAC, **OA is common,** **OB = OC (radii of the same circle)** **∠OBA = ∠OCA = 90°** **Concludes that, ▲OAB is congruent to ▲OAC by RHS congruence criteria. Hence, writes that line segment AO joining the external point and the center of the circle, divides the quadrilateral made by both the tangents and the radius of the circle into two equal parts.** **(Award full marks if any other correct method is used. For example, this can also be proved by showing that the heights of two triangles are the same.)**	**1.5**
16	**States that in a circle angle made between radius and tangent at the point of contact of tangent is 90°.**	**0.5**

Q.No	What to look for	Marks
	Joins line segment OB as shown in image below.  **Finds measure of ∠AOB = 180° - 90° - ∠ABO = 90° - ∠ABO.** **Similarly, ∠COB = 180° - 90° - ∠CBO = 90° - ∠CBO.**	**0.5**
	Finds ∠AOC = ∠AOB + ∠COB = 180° - ∠ABO - ∠CBO = 180° - ∠ABC = 180° - 43° = 137° **(Award full marks if any other correct method is used.)**	**1**
17	**Writes that in ▲RPS:** **∠PRS = 30° (alternate interior ∠'s since RS||PQ)** **∠SPR = 90° (Angle subtended in semi-circle is of 90°)** **∠PSR = (180° - 90° - 30°) = 60° (Angle sum property of triangle.)**	**1.5**
	Writes that ∠PSR = ∠PTR (angles in the same segment on chord PR) **Hence, measure of ∠PTR = 60°**	**0.5**
18	**Writes that tangents from external points are equal in length.** **Hence, PQ = PR = 4 units.**	**1**
	States that since PQ and PR are tangents to the circle, ∠PRO and ∠PQO are right angles. **Hence, ▲PQO and ▲PRO are right angled triangle.**	**0.5**

Q.No	What to look for	Marks
	Finds area of $\triangle PQO = \frac{1}{2} \times OQ \times PQ = \frac{1}{2} \times 3 \times 4 = 6$ sq units. Similarly, area of $\triangle PRO = 6$ sq units.	1
	Finds the area of quadrilateral PQOR = area of $\triangle PQO$ + area of $\triangle PRO$ = 12 sq units.	0.5
19	Uses the property that length of tangents drawn from an external point to a circle are equal and writes that AB = BC = GF = EF = 5 cm and CD = DE = 7 cm.	1
	Finds the length of BD = CD + BC = 7 + 5 = 12 cm and BD = DF = 12 cm.	1
	Using pythagoras theorem, in $\triangle ABD$, $AD^2 = BD^2 + AB^2$, we have AD = 13 cm.	0.5
	Finds AD + DG = 13 + 13 = 26 cm.	0.5
20	Draws OA. The figure may look as follow: 	0.5

Q.No	What to look for	Marks
	Writes that the tangent to a circle is perpendicular to the radius of the circle at the point of contact and hence ∠OAP = 90°.	**0.5**
	Uses the exterior angle property of triangles in ▲OAP as: **∠AOB = ∠OAP + ∠APO** **=> ∠AOB = 90° + 43° = 133°.**	**0.5**
	Writes that ▲OAB is an isoceles triangle as OA = OB and hence ∠OAB = ∠OBA.	**0.5**
	Uses the angle sum property of a triangle in ▲OAB and gets: **$\angle OAB = \angle OBA = \frac{180-133}{2} = 23.5°$.**	**0.5**
	Finds the measure of ∠PAB as 90° + 23.5° = 113.5°. **(Award full marks if any other correct method is used.)**	**0.5**
21	**Joins OA and OC as follows:**  **Mentions that in ▲OBA and ▲OBC:** **i) OA = OC (radii of the circle)** **ii) AB = CB (tangents from an external point)** **iii) ∠OAB = ∠OCB = 90° (AB and BC are tangents)**	**1**

Q.No	What to look for	Marks
	Uses the above step to conclude that ▲OBA ≅ ▲OBC by RHS congruency.	0.5
	Writes that ∠OBA = ∠OBC since the corresponding angles of congruent triangles are equal.	0.5
	In ABCO, finds ∠AOC as 360° - (90° + 90° + 70°) = 110°.	0.5
	Writes that angle made by the chord AC at the circumference is half of the angle made at the centre and hence finds the measure of ∠CDA as $\frac{110^\circ}{2}$ = 55°.	0.5
22	States that in ▲QRS, ∠RQS = ∠RSQ = 37° giving reason that angles on the equal sides of a triangle are equal in measure.	1
	States that angles in the same segment of a circle are equal. Hence, ∠RQS = ∠RPS = 37°.	1
	Finds that in ▲PRS, ∠PRS = $\frac{180-37}{2}$ = 71.5° since ∠PRS = ∠RSP as they are angles on the equal sides of the triangle.	1

Q.No	What to look for	Marks
23	**Joins OP so that it intersects MN at point Q. Then, ▲MPN is isosceles and PO is the angle bisector of ∠MPN.** **So, OP ⊥ MN and therefore, OP bisects MN which gives NQ = QM = 12 cm.** **Also, OQ = √ (ON^2 - NQ^2) = √ (13^2 - 12^2) cm = 5 cm.** **Draws a rough image similar to the image given below -** 	**2**
	States that since, OP ⊥ MN, ▲PQN is right angled triangle with ∠PQN = 90°. **Now, ∠PNQ + ∠QNO = 90° = ∠PNQ + ∠NPQ** **So, ∠QNO = ∠NPQ**	**1**
	Therefore, By AA similarity, ▲PQN ~ ▲NQO. **Hence, $\frac{PN}{NO} = \frac{QN}{QO}$** **Substitutes the value of NO, QN and QO, and finds $\frac{PN}{13} = \frac{12}{5}$** **=> PN = $\frac{156}{5}$ cm**	**1**

Q.No	What to look for	Marks
	States that, since, PM amd PN are tangents to the circle from an external point, PM = PN. Hence, PM + PN = $2\times \frac{156}{5}$ cm = $\frac{312}{5}$ cm (Provide full marks for any other correct methods used.)	1
24	Writes that tangents from an external point to a circle are equal in length. Hence finds GF = GH = 1.7 cm and CD = BC = 2.3 cm.	1
	Finds AH as 4 - 1.7 = 2.3 cm and AB as 6 - 2.3 = 3.7 cm.	1
	Writes that the perpendicular from the centre to a chord bisects the chord. Thus finds BD = HF = 2 × 1.3 = 2.6 cm.	1
	Writes that distinct pair of adjacent sides in a kite are equal and states with reference from question that AG = EG and AC = EC. Finds AG = EG = 4 cm and AC = EC = 6 cm. Thus finds FE = 4 - 1.7 = 2.3 cm and ED = 6 - 2.3 = 3.7 cm.	1
	Finds the perimeter of the hexagon ABDEFH as: 3.7+ 2.6 + 3.7+ 2.3 + 2.6 + 2.3 = 17.2 cm Concludes that Sahid will need 17.2 cm of red coloured thread.	1
25	States that the tangent to a circle is perpendicular to the radius of the circle, therefore, ▲AOF is right angled triangle.	0.5
	By using Pythagoras theorem, $AO^2 = OF^2 + AF^2$, Finds AO as √13 m. Finds AD as: AD = AO + OD = (√13 + 2) m	1

Q.No	What to look for	Marks
	Finds the total cost of laying wire correct to nearest hundreds as (√13 + 2) × 500 = 500√13 + 1000 = Rs 2800.	0.5
26	States that the length of tangents drawn from an external point to the circle are same and concludes BF = BD = 7 m, AE = AF = 3 m and CD = CE = 4 m.	1
	Finds perimeter of △ABC as 28 m. Calculates area to be painted as $2 \times 28\ m^2 = 56\ m^2$. Concludes that $56 \times \frac{1}{4} = 14$ liters of paint is required to cover the entire internal surface area of the wall and gates.	1
27	States the reason that angle between tangent and radius to the circle at the point of contact of tangent to the circle is 90°. Hence, concludes that the person must turn by a measure of 90°.	1

Chapter - 4
Coordinate Geometry

Multiple Choice Questions

Q: 1 **What is the distance between the points (-1, 3) and (2, -5)?**

1 √5 **2** √55 **3** √65 **4** √73

Q: 2 **A circle of radius 5 units has its centre at (-2, 2). The point (-6, *y*) lies on the circle.**

Which of these could be the value of *y* ?

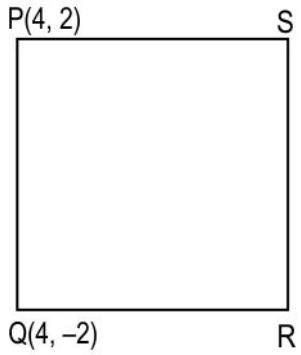
1 -3 **2** 1 **3** 5 **4** 6

Q: 3 **P(1, 7), Q(-3, 2) and R(6, 1) are the coordinates of the vertices of a triangle.**

Which of the following types of triangle is △PQR?

1 Scalene triangle
2 Equilateral triangle
3 Isosceles right-angled triangle
4 Isosceles acute-angled triangle

Q: 4 **In the SQUARE given below, the coordinates of two adjacent vertices P and Q are given.**



What are the coordinates of vertex R?

1 (-4, -2) **2** (8, 2) **3** (8, -2) **4** (-4, 2)

Q: 5 **△PQR is a triangle such that PQ:PR = 1:2. Point P lies on the *x* -axis and the coordinates of Q and R are known.**

Which of the following formula can DEFINITELY be used to find the coordinates of P?

i) Section formula
ii) Distance formula

1 only i) **2** only ii) **3** both i) and ii) **4** neither i) or ii)

Q: 6 **Which one of these is the relation between *x* and *y* if (*x, y*) is equidistant from (-1, 4) and (2, 5)?**

1 $3x - y = 6$ **2** $6x + 2y = -9$
3 $3x + y = 6$ **4** $3x - y = 3$

Q: 7 **What is the distance of (7, -3) from the origin?**

1 7 units **2** √40 units **3** √21 units **4** √58 units

Q: 8 **Which of the following points is the mid-point of the line segment joining P(5, 2) and Q(7, 6)?**

1 (1, 2) **2** (6, 4) **3** (2, 4) **4** (4, 4)

Free Response Questions

Q: 9 **The point (*x, y*) is equidistant from (-4, 0) and (5, 3).** **[1]**

Write an equation relating *x* and *y*. Show your steps.

Q: 10 **In what ratio does the origin divides line segment joining A(-5, 0) and B(3, 0)? Show your work.** **[1]**

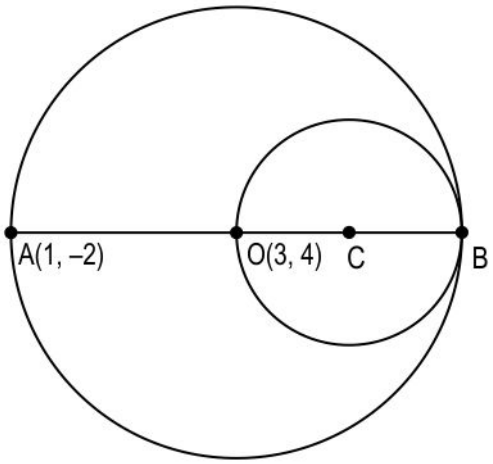
Q: 11 **A(6, 8), B(3, 7) and C(4, 4) are the vertices of a right-angled triangle, where ∠B = 90°.** **[2]**

Find the area of the triangle. Show your work.

Q: 12 **F lies on the line segment joining E(-3, 2) and G(4, 5). F divides EG in the ratio 2:1.** **[2]**

Find the coordinates of F. Show your work.

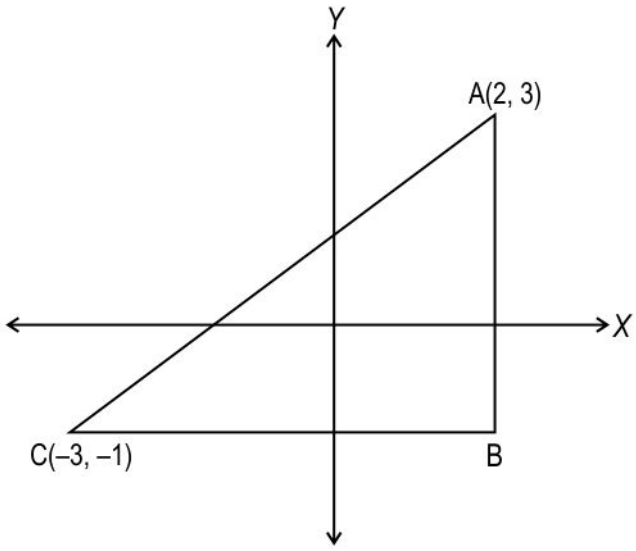
Q: 13 **In the figure given below, AB is the diameter of the circle with centre O and OB is the diameter of the circle with centre C.** **[2]**



(Note: The figure is not to scale)

Find the coordinates of point C. Show your steps.

Q: 14 **Shown below is a right triangle ABC.** **[2]**



Find the value of cos C. Show your work.

Q: 15 **Find the ratio in which O(4, 3) divides the line segment joining A(2, 1) and B(7, 6). Show your work.** **[2]**

Q: 16 **Find the length of the longest side of the triangle formed by the points of intersection of line 8 x + 6 y = 48 with the coordinate axes. Show your work.** **[2]**

Q: 17 **A square is inscribed in a circle of radius 2 cm with center O at the origin. All 4 vertices of the square lie on the coordinate axes.** **[2]**

Use the distance formula to find the length of the side of the square. Show your work.

Q: 18 **Check whether the points A(0, 5), B(2, 3), C(4, 5) and D(2, 7) are the vertices of a square. Show your work.** **[3]**

Q: 19 **Atul plotted the seating plan of his classroom on a cartesian plane such that, Abdul is seated at (3, 7), and Vaibhav is seated at (-2, -1). Prashant is seated somewhere on the line that connects Abdul and Vaibhav. It is given that the distance between Prashant and Vaibhav is half of the distance between Abdul and Prashant.** **[3]**

What are the coordinates of Prashant's seat? Show your work.

Q: 20 **P(-6, 4) and Q(2, 10) are the two end-points of the diameter of the circle with centre O(x, y).** **[3]**

i) Find the radius.
ii) Prove that $4x + 3y - 13 = 0$.

Show your steps.

Q: 21 **Find the ratio in which the x-axis divides the line segment joining the points A(4, 9) and B(3, -5). Show your work.** **[3]**

Q: 22 **The three vertices of a rhombus ABCD are A(-3, 2), B(-5, -5) and C(2, -3).** **[3]**

i) Find the coordinates of the point where both the diagonals AC and BD intersect.
ii) Find the coordinates of the fourth vertex D.

Show your steps and give valid reasons.

Q: 23 **Prove that A(-1, 1), B(1, 2) and C(3, 3) are collinear.** **[3]**

Q: 24 **Points C and D divide the line segment AB into 3 equal parts where the coordinates of points A and D are (4,2) and (8,10) respectively.** **[3]**

What are the coordinates of point B? Show your work.

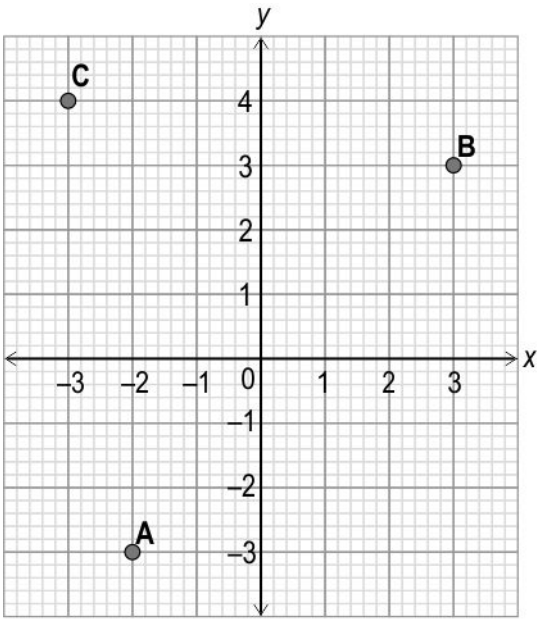
Q: 25 **A circle passes through the following points:** **[5]**

P(-1, 5), Q(-4, 6) and R(-2, 2)

i) Find the coordinates of the centre of the circle.
ii) Find the radius of the circle.

Show your work.

Q: 26 **Shown below is a coordinate grid with points A, B, and C plotted on it.** **[5]**



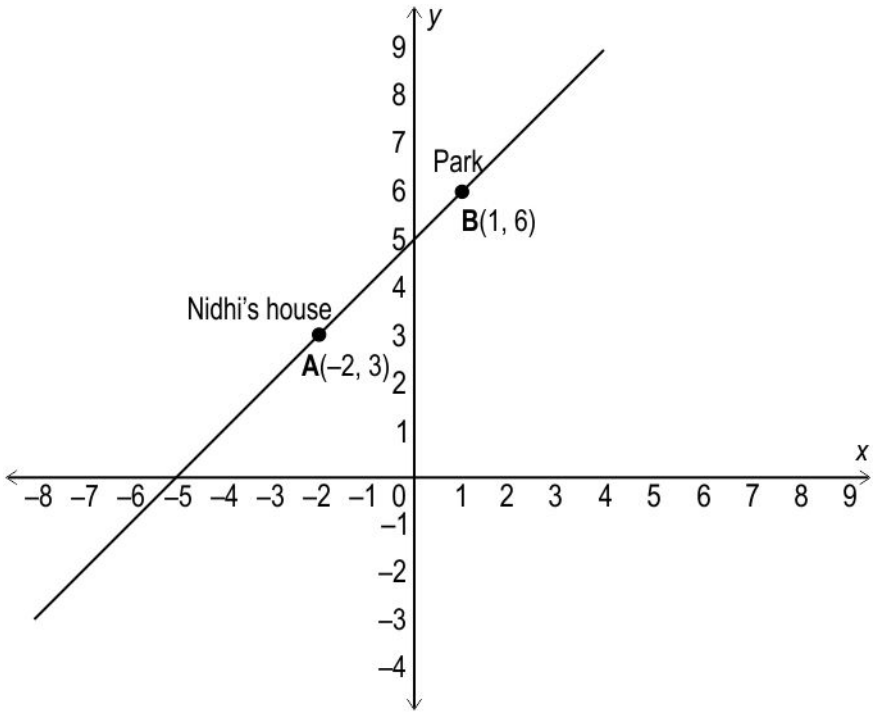
(i) Find the length of all the sides of the triangle formed by A, B, and C.
(ii) Find the area of triangle ABC.

Show your work.

Case Study

Answer the questions based on the given information.

Nidhi and Shikha have planned to meet at a park. Nidhi's house is at point A, and the park is at point B as shown in the below figure. Shikha's house is at point C, the coordinates of which are unknown.



Points A, B, and C lie on a straight line. The park divides the line connecting their houses such that AB:BC = 3:2.

Q: 27 **Find the coordinates of Shikha's house.** **[3]**

Q: 28 **Find the distance between Nidhi's house and the Park.** **[1]**

Q: 29 **Find the distance between Nidhi's house and Shikha's house.** **[1]**

Q.No	Correct Answers
1	4
2	3
3	1
4	3
5	2
6	3
7	4
8	2

Q.No	What to look for	Marks
9	Applies the distance formula correctly to write $\sqrt{\{(x+4)^2 + y^2\}} = \sqrt{\{(x-5)^2 + (y-3)^2\}}$	0.5
	Writes the relation as $3x + y = 3$.	0.5
10	Writes the distance of A from the origin is 5 units and that of B from the origin is 3 units. Hence, the ratio in which the origin divides the line segment AB is 5:3 (Award full marks if student uses any other method using calculation.)	1
11	Identifies height of triangle = AB and base of triangle = BC.	0.5
	Finds height = AB = $\sqrt{\{(-3)^2 + (-1)^2\}} = \sqrt{10}$ units and base = BC = $\sqrt{\{(1^2 + (-3)^2)\}} = \sqrt{10}$ units.	1
	Finds area of triangle = $\frac{1}{2}$ × base × height = $\frac{1}{2} \times \sqrt{10} \times \sqrt{10} = 5$ square units.	0.5
12	Uses the section formula to find the coordinates of the point F as follows: $\left(\frac{2(4)+1(-3)}{2+1}, \frac{2(5)+1(2)}{2+1}\right)$	1
	Simplifies the above expression and finds the coordinates of point F as $(\frac{5}{3}, 4)$.	1
13	Finds the coordinates of B using the mid-point formula as B(5, 10). Working may look like: Let co-ordinates of B be (x, y) O(3, 4) = $(\frac{(x+1)}{2}, \frac{(y-2)}{2})$ => $x = 5$, $y = 10$	1.5
	Finds the coordinates of C using the mid-point formula as C(4, 7). Working may look like: Let co-ordinates of C be (m, n) C(m, n) = $(\frac{(3+5)}{2}, \frac{(4+10)}{2})$ => $m = 4$, $n = 7$	0.5

Q.No	What to look for	Marks
14	Finds the coordinates of B as (2, -1).	0.5
	Uses the distance formula and finds AC = $\sqrt{(5^2 + 4^2)} = \sqrt{41}$ units and BC = $\sqrt{(5)^2}$ = 5 units.	1
	Mentions cos C = $\frac{BC}{AC}$ and finds the value as $\frac{5}{\sqrt{41}}$.	0.5
15	Finds the distances using the distance formula: AO = $\sqrt{8} = 2\sqrt{2}$ units BO = $\sqrt{18} = 3\sqrt{2}$ units	1
	Finds the ratio $\frac{AO}{BO} = \frac{2}{3}$. Hence, the ratio in which O(4, 3) divides the line segment AB is 2:3. (Award full marks if the student correctly solves the same using the Section Formula.)	1
16	Substitutes x and y as 0 in the given equation $8x + 6y = 48$ to find the coordinates of the points of intersection as (0, 8) and (6, 0) respectively.	1
	Uses the distance formula to find the length of the longest side of the triangle as $\sqrt{\{(0 - 6)^2 + (8 - 0)^2\}} = 10$ units.	1
17	Writes that the coordinates of the vertices of the circle would be (2, 0), (0, -2), (-2, 0), (0, 2).	1
	Uses the distance formula and any 2 adjacent coordinates of the vertices of the square to find the length of the side of the square as $2\sqrt{2}$ cm.	1
18	Finds the measure of AB as $\sqrt{\{(2)^2 + (-2)^2\}} = \sqrt{8} = 2\sqrt{2}$ units. Finds the measure of BC as $\sqrt{\{2^2 + 2^2\}} = \sqrt{8} = 2\sqrt{2}$ units.	1
	Finds the measure of CD as $\sqrt{\{(-2)^2 + 2^2\}} = \sqrt{8} = 2\sqrt{2}$ units. Finds the measure of DA as $\sqrt{\{(-2)^2 + (-2)^2\}} = \sqrt{8} = 2\sqrt{2}$ units.	1

Q.No	What to look for	Marks
	Finds the diagonals of ABCD as: **AC = √{(4 - 0)^2 + (5 - 5)^2 } = √16 = 4 units.** **BD = √{(2 - 2)^2 + (7 - 3)^2 } = √16 = 4 units.**	**0.5**
	Concludes AB = BC = CD = DA and, AC = BD. Hence, A, B, C, and D are vertices of a square. **(Award full marks if the student uses any other method to prove this).**	**0.5**
19	**Represents the given situation mathematically as:** **Let the positions of Abdul, Prashant and Vaibhav be as points A, P and V on the seating plan.** **Here, PV = $\frac{1}{2}$ AP** **=> $\frac{AP}{PV} = \frac{2}{1}$** **=> AP:PV = 2:1**	**1**
	Uses section formula for the coordinates of P such that it divides AV in the ratio of 2:1 as: $\left(\frac{1(3)+2(-2)}{2+1}, \frac{1(7)+2(-1)}{2+1}\right)$	**1**
	Simplifies the above expression to find the coordinates of Prashant's seat as ($\frac{-1}{3}$, $\frac{5}{3}$).	**1**
20	**i) Finds the diameter, PQ as √{(2 + 6)^2 + (10 - 4)^2 } = 10 units.**	**1**
	Finds the radius as $\frac{10}{2}$ = 5 units.	**0.5**
	ii) Uses the distance formula and writes the following relation: **(x + 6)^2 + (y - 4)^2 = (x - 2)^2 + (y - 10)^2**	**0.5**
	Simplifies the above equation and concludes that 4 x + 3 y - 13 = 0.	**1**

Q.No	What to look for	Marks
21	Assumes that the ratio as $p:q$ and mentions that the coordinates of the point at which the line intersects the x -axis can be taken as (x, 0).	1
	Uses the section formula to write the equation as: $(x, 0) = \left(\frac{3p+4q}{p+q}, \frac{-5p+9q}{p+q}\right)$	1
	Equates $\frac{-5p+9q}{p+q}$ to 0 as: $\frac{-5p+9q}{p+q} = 0$ $\Rightarrow 5p = 9q$ $\Rightarrow p : q = 9:5$	1
22	i) Writes that the diagonals of a rhombus bisect each other.	0.5
	Finds the point of intersection of both the diagonals by finding the mid-point of A(-3, 2) and C(2, -3) as $\left(\frac{-1}{2}, \frac{-1}{2}\right)$.	0.5
	ii) Finds the mid-point of B(-5, -5) and D(x, y) as $\left(\frac{x-5}{2}, \frac{y-5}{2}\right)$, where x and y are the coordinates of the fourth vertex D.	0.5
	Uses the above steps and equates the respective coordinates of the mid-points to get the following relationships: $\frac{-1}{2} = \frac{x-5}{2}$ $\frac{-1}{2} = \frac{y-5}{2}$	0.5
	Solves the above two equations to find the values of x and y as 4 and 4 respectively. Concludes that the coordinates of the fourth vertex D are (4, 4).	1
23	Assumes that A, B and C are collinear and hence AB + BC = AC. Finds the distance AB, BC and AC as: $AB = \sqrt{(2^2 + 1^2)} = \sqrt{5}$ units $BC = \sqrt{(2^2 + 1^2)} = \sqrt{5}$ units $AC = \sqrt{(4^2 + 2^2)} = \sqrt{20} = 2\sqrt{5}$ units	2

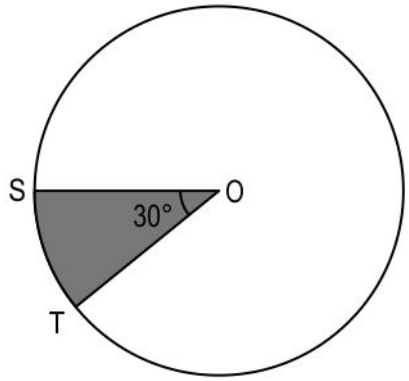
Q.No	What to look for	Marks
	Writes that since AB + BC = AC, A, B and C are collinear. (Award full marks if the student proves the same using the area of the triangle method.)	1
24	Assumes the coordinate of point B as (x, y). States that since points C and D divide line segment AB into 3 equal parts, point D will divide AB in the ratio of 1:2 or 2:1.	1
	Uses section formula to find the values of (x, y) as (16,26) when D divides AB in ratio 1:2. The working may look as follows: $(8,10) = \left(\frac{x+8}{3}, \frac{y+4}{3}\right)$	1
	Uses section formula to find the values of (x, y) as (10,14) when D divides AB in ratio 2:1. The working may look as follows: $(8,10) = \left(\frac{2x+4}{3}, \frac{2y+2}{3}\right)$	1
25	i) Assumes the centre of the circle as any point, say O(x, y) and uses the distance formula to find OP, OQ and OR. $OP = \sqrt{[(x+1)^2 + (y-5)^2]} = \sqrt{(x^2 + 2x + y^2 - 10y + 26)}$ $OQ = \sqrt{[(x+4)^2 + (y-6)^2]} = \sqrt{(x^2 + 8x + y^2 - 12y + 52)}$ $OR = \sqrt{[(x+2)^2 + (y-2)^2]} = \sqrt{(x^2 + 4x + y^2 - 4y + 8)}$	1.5
	Uses OP = OQ to get $3x - y + 13 = 0$. Uses OP = OR to get $x + 3y - 9 = 0$. Uses OQ = OR to get $x - 2y + 11 = 0$. (Award full marks if any 2 of the 3 equations are formed.)	1
	Solves any 2 of the 3 equations mentioned in step 2 to get $x = -3$ and $y = 4$. Concludes that the centre of the circle is O(-3, 4).	1.5
	ii) Substitutes the value of x and y in any one of the equations in step 1 to find the radius of the circle as: $OP = \sqrt{(9 - 6 + 16 - 40 + 26)} = \sqrt{5}$ units	1
26	(i) Identifies points as A(-2, -3), B(3, 3) and C(-3, 4).	1

Q.No	What to look for	Marks
	Finds the distance AB = $\sqrt{(5^2 + 6^2)} = \sqrt{61}$ units.	**1**
	Finds the distance BC = $\sqrt{(6^2 + 1^2)} = \sqrt{37}$ units.	**1**
	Finds the distance AC = $\sqrt{((-1)^2 + 7^2)} = \sqrt{50}$ units.	**1**
	(ii) Finds the area of ΔABC as: Area of $\Delta ABC = \frac{1}{2}\|x_1(y_2 - y_3) + x_2(y_3 - y_1) + x_3(y_1 - y_2)\|$ Area of $\Delta ABC = \frac{1}{2}\|(-2)(3-4) + 3(4+3) + (-3)(-3-3)\|$ Area of $\Delta ABC = \frac{41}{2}$ sq units	**1**
27	**Uses the section formula by considering C(*m*, *n*) and dividing line AC such that AB:BC = 3:2 to write:** $B(1, 6) = (\frac{3\times m+2\times(-2)}{3+2}, \frac{3\times n+2\times 3}{3+2})$	**1**
	Simplifies the expressions obtained above to form pairs of equations as $\frac{3m}{}$ - 4/5)} = 1 and $\frac{3n}{}$ + 6/5)} = 6.	**1**
	Solves the above system of equations to obtain 3 *m* = 9 and 3 *n* = 24 to find *m* = 3 and *n* = 8. **Hence obtains the coordinates of Shikha's house as C(3, 8).**	**1**
28	**Uses the distance formula to find the distance between Nidhi's house and the park as:** **$\sqrt{(1 - (-2))^2 + (6 - 3)^2} = \sqrt{18} = 3\sqrt{2}$ units**	**1**
29	**Writes coordinates of Nidhi's house as A(-2, 3) and Shikha's house as C(3, 8).** **Uses the distance formula to find the distance between their houses as $\sqrt{(3 - (-2))^2 + (8 - 3)^2} = \sqrt{50}$ units = $5\sqrt{2}$ units.**	**1**

Chapter - 5
Areas related to circles

Multiple Choice Questions

Q: 1 **Shown below is a circle with centre O. The area of the minor sector SOT is 7 cm^2.**



(Note: The figure is not to scale.)

What is the area of the circle?

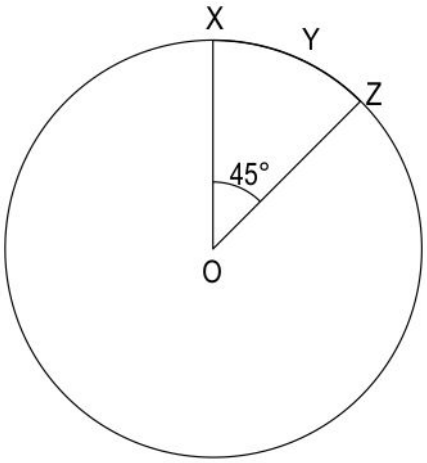
1 $84\pi\ cm^2$

2 $\frac{84}{11}\ cm^2$

3 $84\ cm^2$

4 $\frac{\sqrt{84}}{\sqrt{\pi}}\ cm^2$

Q: 2 **In the figure given below, O is the centre of the circle. XYZ is an arc on the circle subtending an angle of 45° at the centre.**

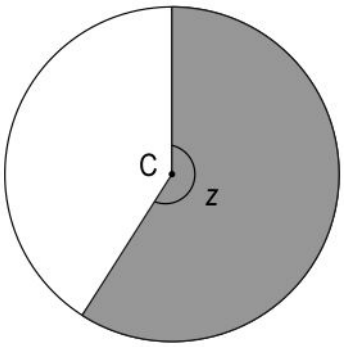


(Note: The figure is not to scale.)

If the radius of the circle is 32 cm, then what is the length of the arc XYZ?

1 4π cm **2** 8π cm **3** 64π cm **4** 128π cm

Q: 3 **In the figure shown below, C is the centre of the circle. The area of the shaded sector is $\frac{5}{8}$ of the area of the circle.**

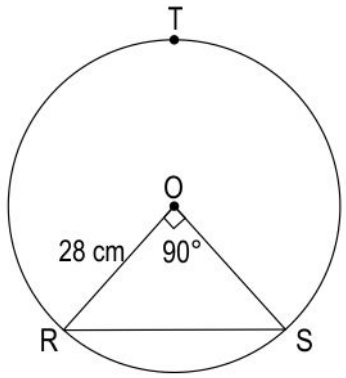


(Note: The figure is not to scale.)

What is the measure of angle *z* ?

1 135°
2 200°
3 225°
4 (cannot be determined as the radius of circle is not given)

Q: 4 **Shown below is a circle with centre O and radius 28 cm. Chord RS subtends an angle of 90° at O.**



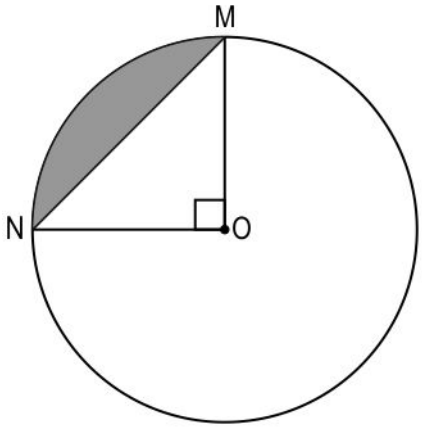
(Note: The figure is not to scale.)

What is the area of the segment RTS?

(Note: Take π as $\frac{22}{7}$.)

1 224 cm^2 **2** 616 cm^2
3 1848 cm^2 **4** 2240 cm^2

Q: 5 **In the circle shown below, O is the centre. MN is a chord which subtends an angle of 90° at the centre. The area of the shaded region is 72 cm^2.**



What is the radius of the circle?

(Note: Take π as $\frac{22}{7}$.)

1 6√7 cm **2** 6√28 cm **3** 84 cm **4** 252 cm

Q: 6 **A circular pond needs to be fenced along its circumference. One-fourth of the fencing is already done, which cost Rs 750 at the rate of Rs 50 per metre.**

How many metres of the pond still need to be fenced?

1 15 **2** 20 **3** 45 **4** 60

Q: 7 **Which of the following information is NOT sufficient to differentiate between minor and major sector of a circle?**

1 the angle subtended at the centre
2 the radius of the circle
3 the area of the sector
4 the length of the arc

Free Response Questions

Q: 8 **In a circular agricultural field, a sector subtending an angle of 120° at the centre is dedicated to growing sugarcane.** **[1]**

If the radius of the circular field is 30 meters, what is the area of the land used for growing sugarcane? Show your work.

(Note: Take π as 3.14.)

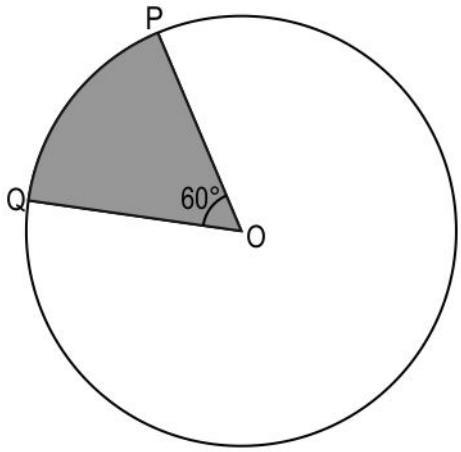
Q: 9 **Anjali got the following question in her class test.** **[1]**

"*A 13 cm chord of a circle subtends an angle of 60° at the centre. Find the area of the minor segment.*"

After the test, she went to the teacher and said, "The question cannot be answered as it doesn't mention the radius of the circle".

Is Anjali right or wrong? Give a valid reason for your answer.

Q: 10 **Shown below is a circle with centre O. The area of the shaded region is 294π cm^2.** **[1]**



(Note: The figure is not to scale.)

What is the area of the circle? Show your work.

Q: 11 **Find the length of an arc which subtends an angle of 80° at the centre of a circle with radius 63 cm. Show your work.** **[1]**

(Note: Take π as $\frac{22}{7}$.)

Q: 12 **The length of an arc of a circle is 22 cm and its radius is 21 cm.** **[2]**

What is the area of the sector formed by the arc? Show your work.

(Note: Use π as $\frac{22}{7}$.)

Q: 13 **Find the perimeter of a sector with a radius of 18 cm subtending an angle of 70° at the centre. Show your work.** **[2]**

(Note: Use π as $\frac{22}{7}$.)

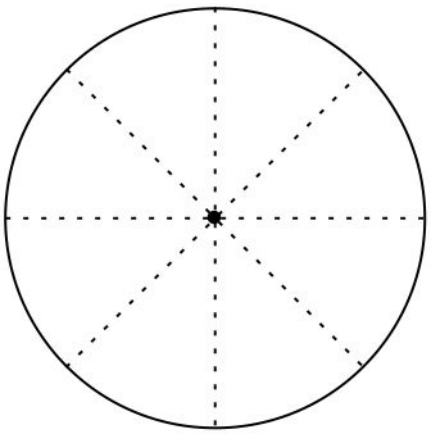
Q: 14 **A sector of a circle with radius 6 cm subtends an angle of 30° at the centre.** **[2]**

Find:
i) the length of the arc.
ii) the area of the corresponding major sector.

Show your work.

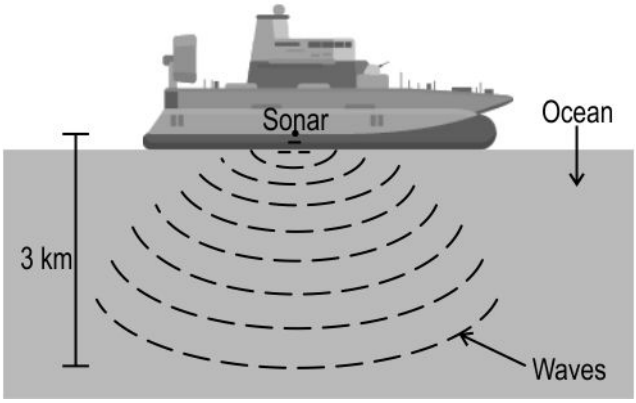
(Note: Take π as $\frac{22}{7}$.)

Q: 15 **A circular sheet of paper with a diameter of 16 inches is divided into 8 equal pieces as shown below.** **[2]**



What is the area of each piece of the paper in terms of π? Show your work.

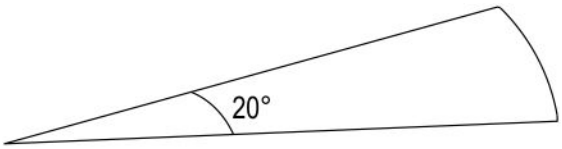
Q: 16 **A SONAR system is deployed in a maritime environment to detect and alert submarines about potential underwater obstacles. The SONAR covers a sector with a central angle of 120° and has a maximum detection range of 3 kilometres under water.** **[2]**



Approximately, how much area is covered by the SONAR during the monitoring period? Show your work.

(Note: Take π as 3.14 if required.)

Q: 17 **The arc length of the sector below is 11 cm.** **[3]**

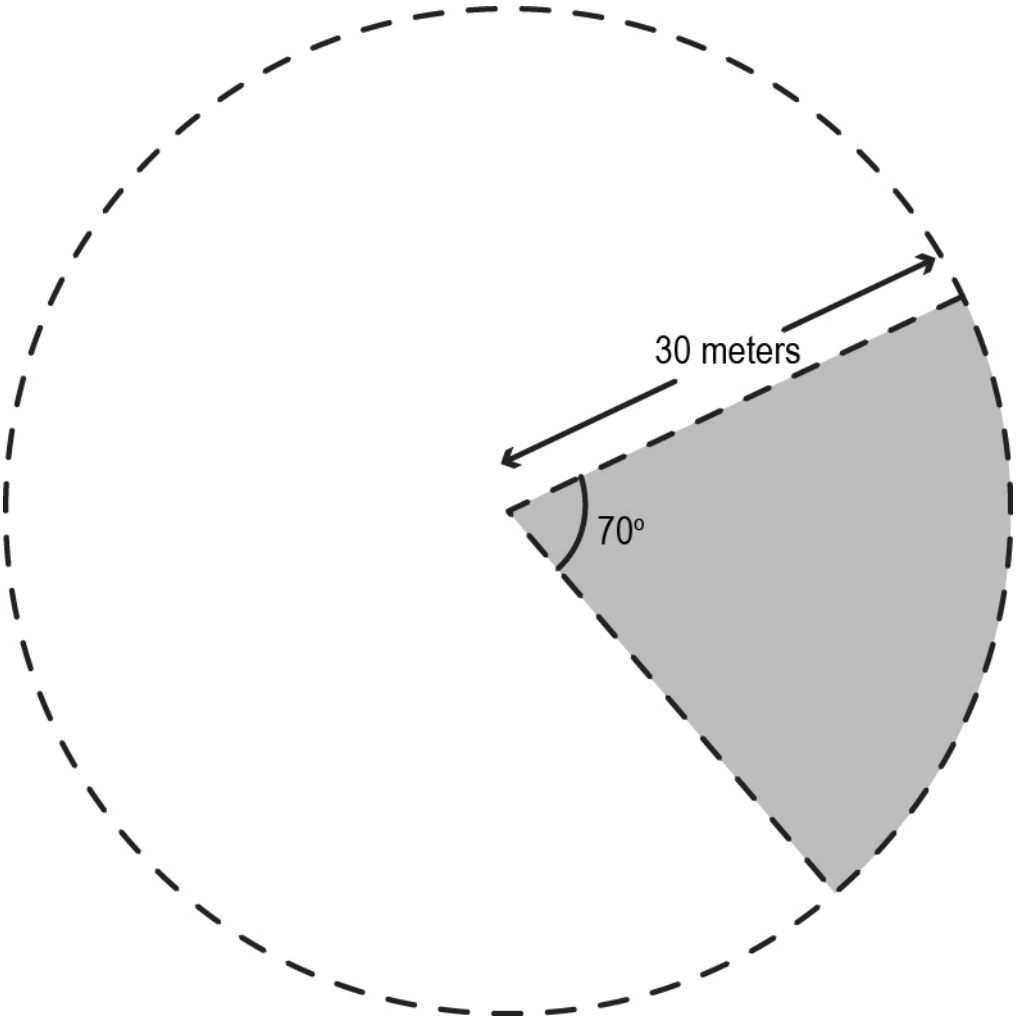


(Note: The figure is not to scale.)

Find the area of the sector. Show your work.

(Note: Take π as $\frac{22}{7}$.)

Q: 18 **Raju is a farmer who owns a portion of land in the shape of a sector. He wishes to install a new irrigation system on his land. The radius of his sector of land is 30 metres, it subtends an angle of 70° at the centre as shown below.** **[3]**



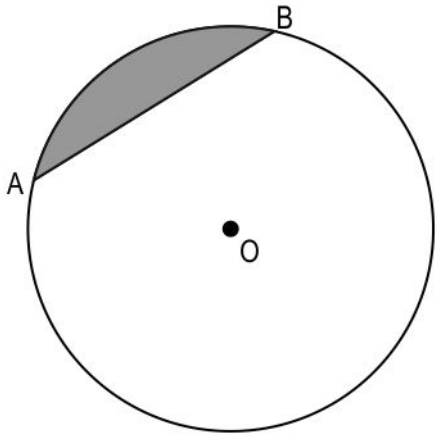
(Note: The figure is not to scale.)

The cost of installing the new irrigation system is Rs 250 per m^2. Raju has kept aside a budget of Rs 1,20,000 for it.

Will Raju be able to install the new irrigation system with his budget? Explain your answer with proper working.

(Note: Take π as $\frac{22}{7}$.)

Q: 19 **Shown below is a circle with centre O. The area of the circle is 154 cm^2. The length of chord AB is $7\sqrt{2}$ cm and it subtends an angle of 90° at the centre.** **[3]**

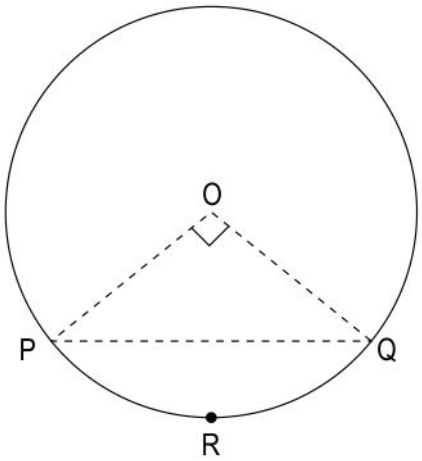


(Note: The figure is not to scale.)

Find the area of the shaded segment. Show your work.

(Note: Take π as $\frac{22}{7}$.)

Q: 20 **Given below is a circle with centre O. The length of arc PRQ is 22 cm and it subtends an angle of 90° at the centre. A triangle POQ is cut along the dotted lines as shown below.** **[3]**



(Note: The figure is not to scale.)

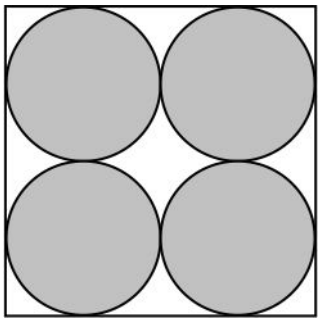
Find the area of the remaining circle after the triangle is cut. Show your work.

(Note: Take π as $\frac{22}{7}$.)

Q: 21 **A chord of length 18 cm subtends an angle of 60° at the centre of a circle.** **[3]**

Find the area of the corresponding major segment in terms of π and roots. Show your work.

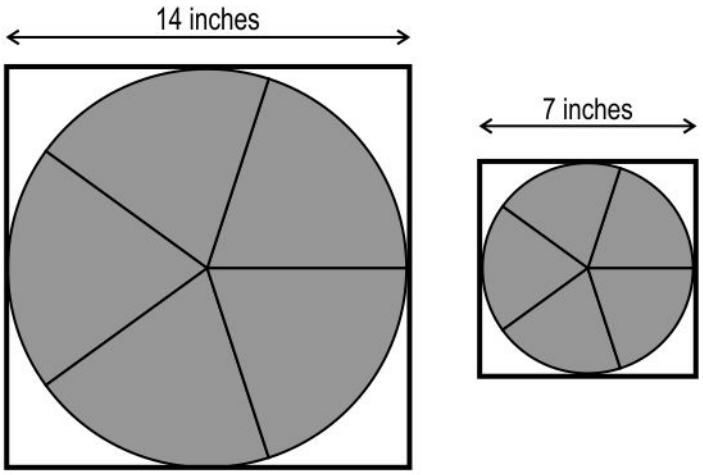
Q: 22 **On a white sheet of square paper, 4 identical yellow circles are drawn such that the circles inside the square touch the boundaries of two other circles and the two sides of the square as shown below:** **[3]**



If the area of the square sheet is 576 cm^2, what is the area that is NOT covered by the circles? Show your work.

(Note: Take π as 3.14.)

Q: 23 **Sameer and Madhur drew two circles circumscribed by squares of side 14 and 7 inches respectively. Both the circles are divided into 5 equal sectors as shown below.** **[5]**



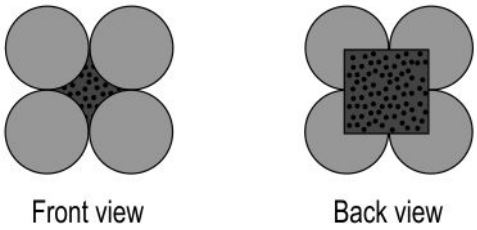
i) Determine the area occupied by one sector of the larger circle.

ii) Sameer says, "The area occupied by 2 sectors of the larger circle is equal to the area occupied by 4 sectors of the smaller circle, as the side of the larger square is twice of the smaller square."

Do you agree with the statement? Justify your answer.

(Note: Take π as $\frac{22}{7}$ if required.)

Q: 24 **Pragati made a flower using 4 identical circles and a dotted square. The front view and back view of the flower is as shown below.** **[5]**



The diameter of each circle is the same as the length of the side of the square, 42 mm.

i) Find the perimeter of the flower. Show your work.

ii) Find the area of the dotted region from the front view. Show your work.

iii) Is the area of the flower the same from the front and back views? Justify your answer with proper working.

(Note: Take π as $\frac{22}{7}$.)

Case Study

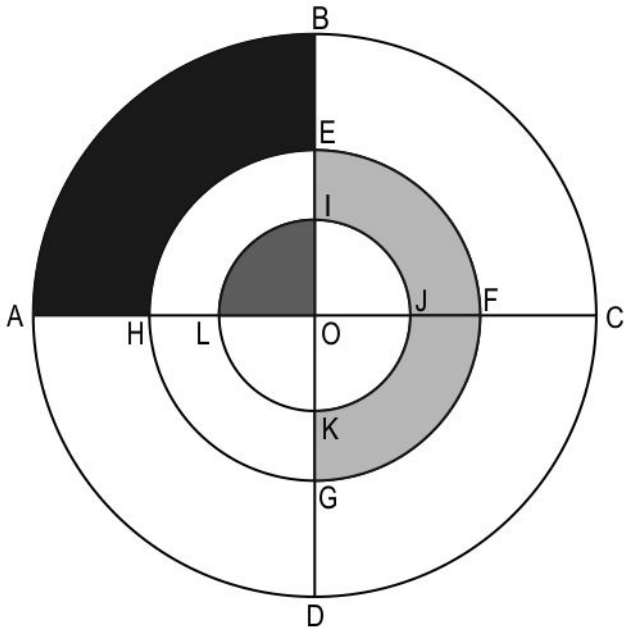
Answer the questions based on the given information.

An archery target board consists of three concentric circles with centre O as shown below. The innermost circle has a radius of 7 cm, the middle circle has a radius of 14 cm, and the outer circle has a radius of 28 cm. The target board is divided into four equal parts by AC and BD, which are the diameters of the outermost circles. The scoring system for the game is as follows:

Area LIO: 10 points

Area KJIEFG: 7 points

Area ABEH: 4 points



(Note: Take π as $\frac{22}{7}$ if required.)

Q: 25 **Find the area of the sector in which 10 points can be scored. Show your work.** **[1]**

Q: 26 **If the target lands on the boundary of the 4 points scoring area, a deduction of 1 point occurs, resulting in a score of 3 points.** **[2]**

Find the length of the boundary in which 3 points can be scored. Show your work.

Q: 27 **Find the area KJIEFG. Show your work.** **[2]**

Q.No	Correct Answers
1	3
2	2
3	3
4	4
5	1
6	3
7	2

Q.No	What to look for	Marks
8	Finds the area of the sector used for growing sugarcane as: $\frac{120°}{360°} \times 3.14 \times 30 \times 30 = 942\ m^2$	1
9	Writes that Anjali is wrong and gives a reason. For example, since the chord extends an angle of 60° at the centre, it forms an equilateral triangle with the radii and hence, the radius is 13 cm.	1
10	Identifies that the shaded sector occupies $\frac{1}{6}$ th of the area of circle. Hence, finds the area of the circle as: $294\pi \times 6 = 1764\pi\ cm^2$ (Award full marks if radius is calculated first and then the area of the circle.)	1
11	Finds the length of the arc as $\frac{80°}{360°} \times 2 \times \frac{22}{7} \times 63 = 88$ cm.	1
12	Assumes the angle of the sector as θ and writes the equation as: $22 = \frac{\theta}{360} \times 2 \times \frac{22}{7} \times 21$ $\Rightarrow \theta = 60°$	1
	Finds the area of the sector as: $\frac{60}{360} \times \frac{22}{7} \times 21 \times 21 = 231\ cm^2$	1
13	Finds the length of the arc of the sector as: $\frac{70°}{360°} \times 2 \times \frac{22}{7} \times 18 = 22$ cm	1
	Finds the perimeter of the sector as 22 + 18 + 18 = 58 cm.	1
14	i) Finds the length of the arc as: $\frac{30°}{360°} \times 2 \times \frac{22}{7} \times 6 = \frac{22}{7}$ cm	1

Q.No	What to look for	Marks
	ii) Finds the area of the major sector as: $\frac{330°}{360°} \times \frac{22}{7} \times (6)^2 = \frac{726}{7}\ cm^2$ **(Award full marks if the area of major sector is found by subtracting the area of minor sector from the area of circle.)**	**1**
15	**Identifies that 8 equal pieces mean each sector will have a central angle of** $\frac{360°}{8} = 45°$	**1**
	Uses the above to find the area of each sector as: $\frac{45°}{360°} \times \pi \times 8 \times 8 = 8\pi\ in^2$	**1**
16	**Expresses the underwater sector's area covered by SONAR as:** $\frac{120°}{360°} \times 3.14 \times 3 \times 3$	**1**
	Solves the above expression and finds the area covered as 9.42 km^2**.**	**1**
17	**Assumes the radius of the sector as** r **cm and writes the equation for the arc length as:** $\frac{20°}{360°} \times 2 \times \frac{22}{7} \times r = 11$	**1**
	Solves the above equation to find the value of r **as** $\frac{63}{2}$ **cm.**	**0.5**
	Writes the expression for the area of the sector as: $\frac{20°}{360°} \times \frac{22}{7} \times (\frac{63}{2})^2$	**1**
	Evaluates the above expression to find the area of the sector as $\frac{693}{4}\ cm^2$**.**	**0.5**
18	**Writes the expression to find the area of the sector as:** $\frac{70°}{360°} \times \frac{22}{7} \times 30 \times 30$	**1**

Q.No	What to look for	Marks
	Solves and finds the area of the sector as 550 m^2.	1
	Finds the cost of installing the irrigation system as 550 × 250 = Rs 1,37,500.	0.5
	Concludes that Raju will not be able to install the new irrigation system as the cost which is Rs 1,37,500 exceeds his budget of Rs 1,20,000.	0.5
19	Finds the area of the minor sector AOB as $\frac{1}{4} \times 154 = 38.5\ cm^2$.	0.5
	Finds radius (r) of the circle by applying pythagoras theorem in △AOB as: $r^2 + r^2 = (7\sqrt{2})^2$ $\Rightarrow r = 7$ cm (Award full marks if the radius is found correctly using area of the circle.)	1
	Identifies that △AOB has base = 7 cm and height = 7 cm. Finds the area of △AOB as $\frac{1}{2} \times 7 \times 7 = 24.5\ cm^2$.	1
	Finds the area of the shaded segment as 38.5 - 24.5 = 14 cm^2.	0.5
20	Finds the radius of the circle by using the equation for arc length as: $\frac{90°}{360°} \times 2 \times \frac{22}{7} \times r = 22$ $\Rightarrow r = 14$ cm	1
	Finds the area of △POQ as: $\frac{1}{2} \times 14 \times 14 = 98\ cm^2$	1
	Finds the area of circle as $\frac{22}{7} \times 14^2 = 616\ cm^2$.	0.5
	Subtracts area of triangle from area of circle to get the remaining area as: 616 - 98 = 518 cm^2	0.5

Q.No	What to look for	Marks
21	Identifies that the triangle formed will be an equilateral triangle. Finds the area of triangle as $\frac{\sqrt{3}}{4} \times 18^2 = 81\sqrt{3}$ cm^2.	1
	Finds the area of the minor sector as $\frac{60°}{360°} \times \pi \times 18 \times 18 = 54\pi$ cm^2.	1
	Finds the area of the circle as $\pi \times 18^2 = 324\pi$ cm^2.	0.5
	Finds the area of the corresponding major segment as $324\pi - (54\pi - 81\sqrt{3}) = 270\pi + 81\sqrt{3}$ cm^2.	0.5
22	Writes that if the area of square sheet is 576 cm^2, then the side of square is $\sqrt{576} = 24$ cm.	1
	Finds the radius of each circle as $\frac{24}{4} = 6$ cm.	0.5
	Finds the area of the circles as $= 3.14 \times 6 \times 6 = 113.04$ cm^2.	0.5
	Finds the area of the square sheet not covered by the circles as: $576 - (4 \times 113.04) = 123.84$ cm^2	1
23	i) Identifies that the radius of the larger circle will be $\frac{14}{2} = 7$ inches as the circle is circumscribed in the square of 14 inches.	0.5
	Writes the following or an equivalent expression to get the area of a sector of the larger circle: $\frac{1}{5} \times \frac{22}{7} \times 7 \times 7 = \frac{154}{5}$ or 30.8 sq inches	1.5
	ii) Calculates the area of 2 sectors of the larger circle as: $2 \times 30.8 = 61.6$ sq inches	1
	Identifies that radius of the smaller circle is $\frac{7}{2}$ inches. Writes the following expression to get the area of 4 sectors: $\frac{4}{5} \times \frac{22}{7} \times \frac{7}{2} \times \frac{7}{2} = \frac{154}{5}$ or 30.8 sq inches	1.5

Q.No	What to look for	Marks
	Concludes that Sameer's statement is wrong, as area of 2 sectors of larger circle (61.6 sq inches) is more than 4 sectors of smaller circle (30.8 sq inches). **(Award full marks only if areas of both are calculated and given as justification for the statement being wrong.)**	**0.5**
24	**i) Finds the perimeter of flower as:** $(4 \times 2\pi r) - (4 \times \frac{1}{4} \times 2\pi r) = 6\pi r$ $6 \times \frac{22}{7} \times 21 = 396$ mm	**1**
	ii) Finds the area of the dotted region from the front as: $(42)^2 - (\frac{22}{7} \times (21)^2) = 378$ mm^2	**1**
	iii) Finds the area of the flower from the front view as: $378 + (4 \times \frac{22}{7} \times 21^2) = 5922$ mm^2	**1**
	Finds the area of the flower from the back view as: $(42)^2 + (4 \times \frac{3}{4} \times \frac{22}{7} \times 21^2) = 5922$ mm^2	**1**
	Compares the area of the front and back views and concludes that the area remains the same.	**1**
25	**Uses the expression for the area of a sector to find the area of the part LIO as:** $\frac{1}{4} \times \frac{22}{7} \times 7 \times 7 = \frac{77}{2}$ **or** 38.5 cm^2	**1**
26	**Finds the length of arc of middle circle as:** $\frac{1}{4} \times 2 \times \frac{22}{7} \times 14 = 22$ cm	**0.5**
	Finds the length of arc of outer circle as: $\frac{1}{4} \times 2 \times \frac{22}{7} \times 28 = 44$ cm	**0.5**

Q.No	What to look for	Marks
	Finds the length of boundary in which 3 points can be scored as: **44 + 22 + 2(28 - 14) = 94 cm**	**1**
27	**Finds the area of the semicircle in the middle region as:** $\frac{1}{2} \times \frac{22}{7} \times 14 \times 14 = 308\ cm^2$	**0.5**
	Finds the area of the innermost semicircle as: $\frac{1}{2} \times \frac{22}{7} \times 7 \times 7 = 77\ cm^2$	**0.5**
	Finds the area KJIEFG as (308 - 77) = 231 cm^2.	**1**

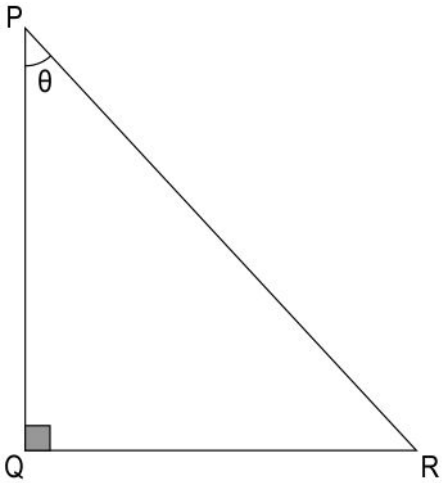
Chapter - 6
Introduction to Trigonometry

Multiple Choice Questions

Q: 1 **Given, cot θ = 3, what is the value of cos θ?**

1 $\frac{1}{3}$
2 $\frac{1}{\sqrt{10}}$
3 $\frac{3}{\sqrt{10}}$
4 (cannot be determined using given information)

Q: 2 **Given below is △PQR, right-angled at Q.**



(Note: The figure is not to scale.)

What is the value of tan θ?

1 $\frac{PQ}{QR}$ **2** $\frac{QR}{PQ}$ **3** $\frac{PQ}{RP}$ **4** $\frac{QR}{RP}$

Q: 3 **Given that $\cos^2\theta - \sin^2\theta = \frac{3}{4}$, what is the value of cos θ?**

1 $\frac{7}{8}$ **2** $\frac{\sqrt{7}}{2\sqrt{2}}$ **3** 1 **4** $\frac{\sqrt{7}}{2}$

Q: 4 **If cot 81° = tan θ, what is the value of sec 5θ?**

(Note: 0 ° ≤ 5θ ≤ 90 °)

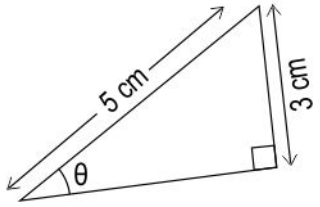
1 $\frac{1}{\sqrt{2}}$
2 1
3 √2
4 (5θ will always be greater than 90°)

Q: 5 **Any relation which is ALWAYS true is an identity. Which of the following is a trigonometric identity?**

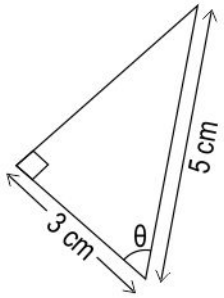
i) $\cot\theta = \frac{\cos\theta}{\sin\theta}$
ii) $\sec^2\theta + \text{cosec}^2\theta = 1$
iii) $\frac{1-\cos^2\theta}{\cos^2\theta} = \tan^2\theta$
iv) $\frac{\sin^2\theta}{1-\sin^2\theta} = \cot^2\theta$

1 only i) and ii)
2 only i) and iii)
3 only i), ii) and iii)
4 only i), iii) and iv)

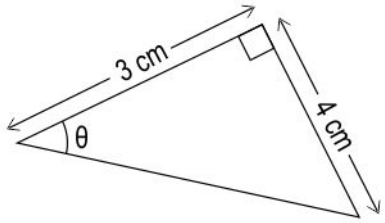
Q: 6 **Which of these triangles have sin θ = $\frac{4}{5}$?**



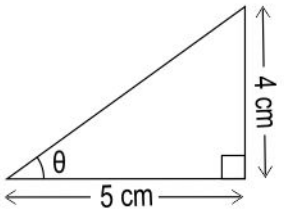
P



Q



R



S

(Note: The figures are not to scale.)

1 only Q and R
2 only Q and S
3 only Q, R and S
4 all - P, Q, R and S

Q: 7 Which of these is equal to $\sqrt{\frac{1+\sin\theta}{1-\sin\theta}}$?

1 sec θ + tan θ
2 sec θ - tan θ
3 $\sec^2\theta + \tan^2\theta$
4 $(\sec\theta + \tan\theta)^2$

Q: 8 **If cos θ = $\frac{12}{13}$, what is the value of 5cosec θ - 4tan θ?**

1 $\frac{10}{39}$
2 $\frac{131}{60}$
3 $\frac{31}{3}$
4 $\frac{34}{3}$

Answer the questions based on the given information.

A TRIG-QUIZ is organized in a school, which consists of 3 rounds in order to get a winner. 4 Teams participated in the quiz - Team 1, Team 2, Team 3 and Team 4.
In each round, the same question was asked to all the teams and one team was eliminated after every round.

Following three questions were asked in 3 rounds to the teams.

Round 1	Round 2	Round 3
Give a correct statement related to trigonometric ratio of an angle Θ.	If $\cos^2\Theta - \sin^2\Theta = 3/4$, $0° < \Theta < 90°$, use appropriate identities to find the values of $\cos\Theta$ and $\tan\Theta$.	In a right angled triangle ABC, B is at right angle and $\sin A = 1/4$. Find the value of: $\cos^2A + 2\sin^2A + 2\sin^2C + 2\cos^2C$

Q: 9 **Which team gets eliminated in Round 1 if the following are the statements made by the teams:**

Team 1: $\cos\theta = -1$, for some angle θ.
Team 2: $\tan\theta = 2$, for some angle θ.
Team 3: $\sin\theta = 2$, for some angle θ.
Team 4: $\tan\theta = 10$, for some angle θ.

1 Team 1 **2** Team 2 **3** Team 3 **4** Team 4

Q: 10 **What answers should the teams give to enter Round 3. Show your work.** **[2]**

Q: 11 **The remaining teams were asked the Round 3 question.** **[2]**

What answer should a team give to win the Quiz? Show your work.

Free Response Questions

Q: 12 **If $\tan x - \cot y = 0$, find the value of $x + y$.** **[1]**

Show your steps.

(Note: $0° \le x, y \le 90°$.)

Q: 13 **Prove that:** **[1]**

$\sin^2 70° - \sin^2 10° = \cos^2 10° - \cos^2 70°$

Q: 14 **Write true or false for the given statement and give a valid reason.** **[1]**
In $\triangle ABC$, right-angled at B, cosec A can be less than 1.

Q: 15 **What is the value of $\sin^2\theta + \sec^2\theta + \cos^2\theta - \tan^2\theta$ where θ is an acute angle? Show your work.** **[1]**

Q: 16 **Find the value of θ for which the below statement is true. θ is acute angle.** **[2]**
$\sqrt{3}\tan\theta - \cot 45° = 0$

Show your work.

Q: 17 **In $\triangle ABC$, AC = 25 cm and $\sin C = \frac{4}{5}$.** **[2]**

Find the length of BC. Show your work.

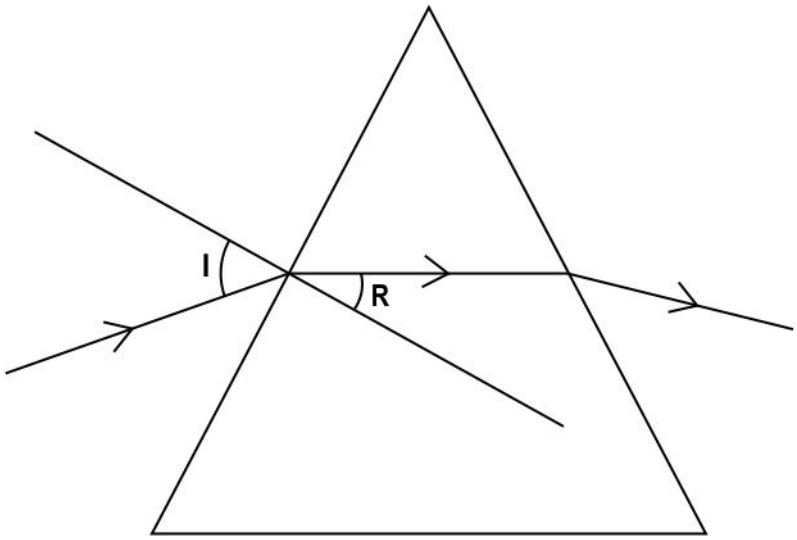
Q: 18 **$\sin(A + B) = \frac{\sqrt{3}}{2}$ and $\sin(A - B) = \frac{1}{2}$ where A and B are acute angles.** **[2]**

Find the values of A and B. Show your steps.

Q: 19 **$2\sin 3A = \sqrt{3}$ where 3A is an acute angle.** **[2]**

Find the value of A. Show your steps.

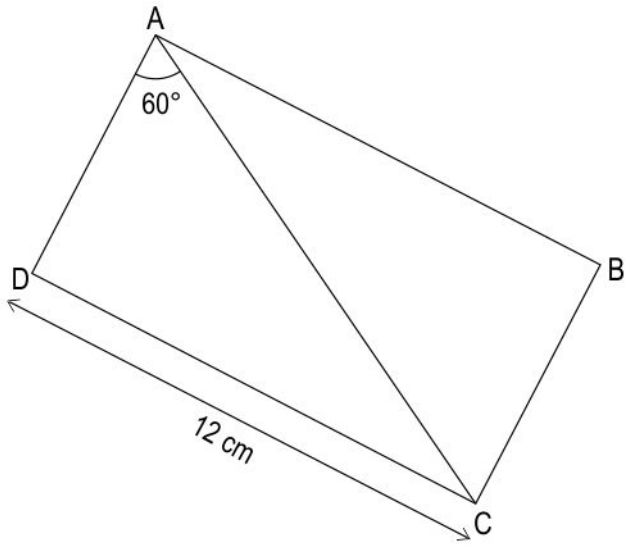
Q: 20 **Shown below is a glass prism. When a ray of light enters the prism, it refracts inside the prism as shown.** **[2]**



If the refractive index (RI) of the above prism is sec 45° and the angle of refraction (R) is 30°, find the angle of incidence (I). Show your work.

(*Note* : *Refractive Index* = $\frac{\sin I}{\sin R}$.)

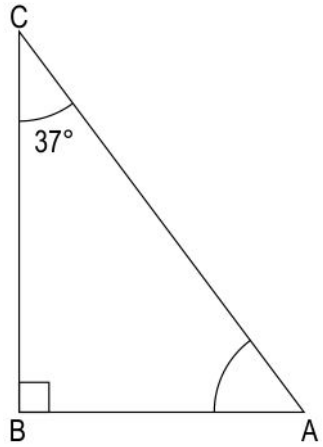
Q: 21 **In the figure below, ABCD is a rectangle.** **[2]**



(Note: The figure is not to scale.)

Find the length of BC and AC. Show your work.

Q: 22 **In a △ABC, ∠C is 37° and CB = 20 cm as shown below.** **[3]**



(Note: The figure is not to scale.)

Find
i) Length of AB.
ii) sin 37°

Show your work.

(Note: Take cos 37° as 0.8.)

Q: 23 **Prove that:** **[3]**

$$\sqrt{\frac{sec\ \theta\ -\ 1}{sec\ \theta\ +\ 1}} = cosec\ \theta - cot\ \theta$$

Q: 24 **A △PQR is right angled at Q. If tan *P* = √5 - 2, show that sin *P* × cos *P* = $\frac{1}{2\sqrt{5}}$. Show your work.** **[3]**

Q: 25 **Prove:** **[3]**

$$\frac{tan\ \theta}{1\ -\ cot\ \theta} + \frac{cot\ \theta}{1\ -\ tan\ \theta} = 1\ +\ sec\ \theta\ cosec\ \theta$$

Show your work.

Q: 26 **Prove that:** **[5]**

$$\frac{tan\ \theta\ +\ sec\ \theta\ -\ 1}{tan\ \theta\ -\ sec\ \theta\ +\ 1} = \frac{1\ +\ sin\ \theta}{cos\ \theta}$$

Q: 27 **Solve the following:** **[5]**

i) Given tan A = $\frac{5}{12}$, find sin A, cos A, cot A, sec A, cosec A.

ii) Given 4 $\cos^2$ A + 8 $\sin^2$ A = 5, show that cot A = √3.

Show your work.

Q.No	Correct Answers
1	3
2	2
3	2
4	3
5	2
6	1
7	1
8	4
9	3

Q.No	What to look for	Marks
10	Uses identity $\cos^2\theta + \sin^2\theta = 1$ and writes: $2\cos^2\theta - 1 = \frac{3}{4}$	1
	Simplifies the above and finds the values as: $\cos\theta = \frac{\sqrt{7}}{\sqrt{8}}$ $\tan\theta = \frac{1}{\sqrt{7}}$	1
11	Uses the given equation $\sin A = \frac{1}{4}$ to find other ratios as: $\cos A = \frac{\sqrt{15}}{4}$ $\sin C = \frac{\sqrt{15}}{4}$ $\cos C = \frac{1}{4}$	1
	Substitutes the above values in the given expression, $\cos^2A + 2\sin^2A + 2\sin^2C + 2\cos^2C$ and simplifies it to get $\frac{49}{16}$.	1
12	Rewrites that the given equation as $\tan x = \cot y$.	0.5
	Concludes that this is only possible for a pair of complementary angles. Hence, $x + y = 90°$	0.5
13	Proceeds with LHS as, $= \sin^2 70° - \sin^2 10°$ Uses identity $\sin^2\theta = 1 - \cos^2\theta$ to get $= (1 - \cos^2 70°) - (1 - \cos^2 10°)$ $= 1 - \cos^2 70° - 1 + \cos^2 10°$ $= \cos^2 10° - \cos^2 70° = RHS$	1
14	Writes False.	0.5

Q.No	What to look for	Marks
	Gives a reason. For example, writes that as, in a right-angled triangle, cosec A is always greater than or equal to 1, as it represents the reciprocal of the sine function, and the sine of an acute angle is always less than or equal to 1.	0.5
15	Rearranges the given expression and uses identities to evaluate as: $(\sin^2\theta + \cos^2\theta) + (\sec^2\theta - \tan^2\theta)$ $= 1 + 1 = 2$	1
16	Simplifies the given equation as $\tan\theta = \frac{1}{\sqrt{3}}$.	1
	Finds the value of θ for which $\tan\theta$ is $\frac{1}{\sqrt{3}}$ as 30°.	1
17	Writes: $\sin C = \frac{AB}{AC} = \frac{4}{5}$.	0.5
	Substitutes the value of AC as 25 in the above equation and simplifies it to find the value of AB as 20 cm.	0.5
	Uses Pythagoras theorem to find the length of BC as: $\sqrt{(25)^2 - (20)^2} = 15$ cm.	1
18	Writes that, since $\sin(A + B) = \frac{\sqrt{3}}{2}$, $A + B = 60°$.	0.5
	Writes that, since $\sin(A - B) = \frac{1}{2}$, $A - B = 30°$.	0.5
	Solves the equations in steps 1 and 2 to find A as 45° and B as 15°.	1
19	Rewrites the above equation as: $\sin 3A = \frac{\sqrt{3}}{2}$	0.5
	From the above step finds 3A as: $\sin 3A = \frac{\sqrt{3}}{2}$ $\Rightarrow \sin 3A = \sin 60°$ $\Rightarrow 3A = 60°$	1

Q.No	What to look for	Marks
	Thus finds the value of A as $\frac{60}{3}$ = 20°.	**0.5**
20	**Writes the equation for the refractive index as:** $\text{Refractive Index} = \frac{\sin I}{\sin R}$ $\Rightarrow \sec 45^\circ = \frac{\sin I}{\sin 30^\circ}$ $\Rightarrow \sqrt{2} = \frac{\sin I}{0.5}$ $\Rightarrow \sin I = \frac{1}{\sqrt{2}}$	**1**
	Finds the value of I for which sin I is $\frac{1}{\sqrt{2}}$, that is 45°.	**1**
21	**Writes that in ΔADC,** **tan 60° = $\frac{12}{AD}$** **=> AD = 4√3 cm** **Finds BC = AD = 4√3 cm.**	**1**
	Uses Pythagoras theorem in ΔADC to find AC as $\sqrt{[12^2 + (4\sqrt{3})^2]}$ = 8√3 cm. **(Award full marks if the AC is found using other trigonometric ratios.)**	**1**
22	**i) Writes, in the ΔABC:** **cos C = $\frac{CB}{CA}$** **=> cos 37° = $\frac{20}{CA}$** **=> CA = $\frac{20}{0.8}$ = 25 cm**	**1**
	Uses Pythogorus theorem to find AB as: **AB = $\sqrt{(25^2 - 20^2)}$ = 15 cm**	**1**
	ii) Finds sin 37° as: **=> sin C = $\frac{AB}{AC}$** **=> sin 37° = $\frac{15}{25}$ = 0.6** **(Award equal marks if a student uses an alternative method.)**	**1**

Q.No	What to look for	Marks
23	**Multiplies both numerator and denominator with √(sec *θ* - 1) as:** $\sqrt{\frac{(sec\ \theta\ -\ 1)\times(sec\ \theta\ -\ 1)}{(sec\ \theta\ +\ 1)\times(sec\ \theta\ -\ 1)}}$	**1**
	Uses the identity sec^2 *θ* - 1 = tan^2 *θ* in the above expression as: $= \sqrt{\frac{(sec\ \theta\ -\ 1)^2}{(sec^2\ \theta\ -\ 1)}}$ $= \sqrt{\frac{(sec\ \theta\ -\ 1)^2}{tan^2\ \theta}}$ $= \frac{(sec\ \theta\ -\ 1)}{tan\theta}$	**1.5**
	Further simplifies the above expression as: $= \frac{sec\ \theta}{tan\ \theta} - \frac{1}{tan\ \theta}$ $= cosec\ \theta - \cot\ \theta$ **Hence, proves the given statement.**	**0.5**
24	**Finds the hypotenuse as:** $\sqrt{(\sqrt{5}-2)^2 + 1^2} = \sqrt{10-4\sqrt{5}}$ units	**1**
	Finds the value of sin *P* and cos *P* as $\frac{\sqrt{5}-2}{\sqrt{(10-4\sqrt{5})}}$ and $\frac{1}{\sqrt{(10-4\sqrt{5})}}$ respectively.	**1**
	Calculates the value of sin *P* × cos *P* as $\frac{\sqrt{5}-2}{10-4\sqrt{5}}$ and simplifies it further as $\frac{1}{2\sqrt{5}}$.	**1**

Q.No	What to look for	Marks
25	**Rewrites the LHS of the above equation as:** $\frac{\frac{\sin\theta}{\cos\theta}}{1-\frac{\cos\theta}{\sin\theta}} + \frac{\frac{\cos\theta}{\sin\theta}}{1-\frac{\sin\theta}{\cos\theta}}$ **Simplifies the above expression as:** $\frac{1}{\sin\theta - \cos\theta}\left[\frac{\sin^3\theta - \cos^3\theta}{\sin\theta\cos\theta}\right]$	1
	Uses the formula ($a^3 - b^3$) = ($a - b$)($a^2 + ab + b^2$) in the above expression and simplifies it as: $\frac{\sin^2\theta + \cos^2\theta + \sin\theta\cos\theta}{\sin\theta\cos\theta}$	1
	Further simplifies the above expression as: $\frac{1 + \sin\theta\cos\theta}{\sin\theta\cos\theta}$ **Replaces $\frac{1}{\sin\theta}$ with cosec θ and $\frac{1}{\cos\theta}$ with sec θ in the above expression and simplifies it as:** $1 + \sec\theta\,\mathrm{cosec}\,\theta$ **Hence, proves the given statement.**	1
26	**Uses identity $\sec^2\theta - \tan^2\theta = 1$ in LHS of the above equation and rewrites it as:** $\frac{(\tan\theta + \sec\theta) - (\sec^2\theta - \tan^2\theta)}{\tan\theta - \sec\theta + 1}$	1
	Rewrites the above equation as: $\frac{(\tan\theta + \sec\theta) - (\sec\theta + \tan\theta)\times(\sec\theta - \tan\theta)}{\tan\theta - \sec\theta + 1}$	1

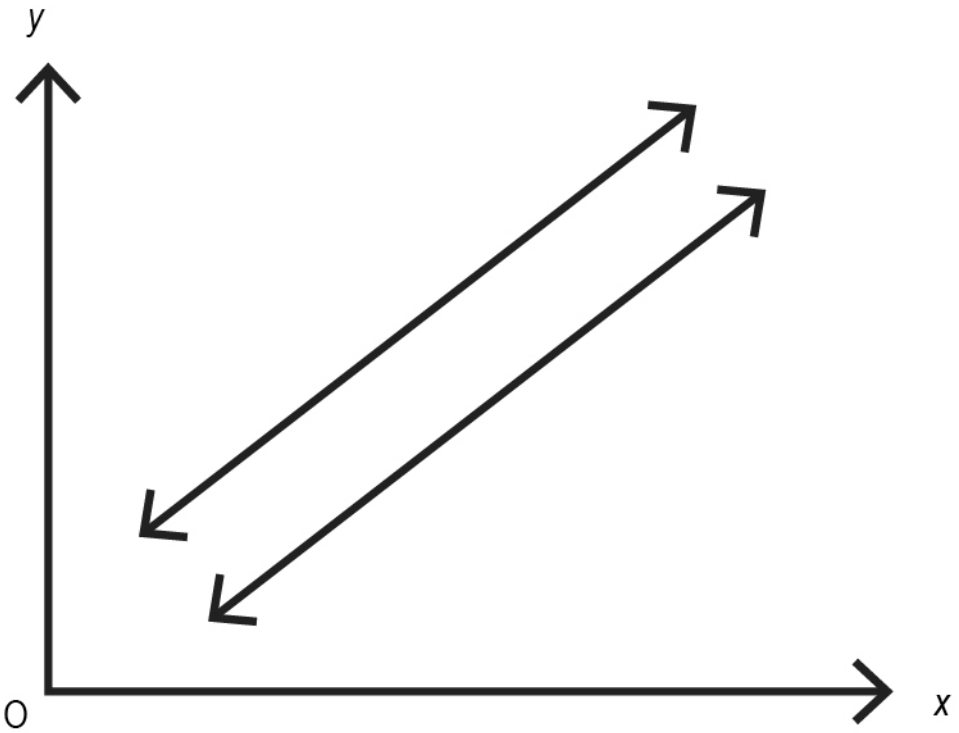
Q.No	What to look for	Marks
	Takes (tan θ + sec θ) common in the numerator as: $\frac{(tan\ \theta + sec\ \theta) \times (1 - sec\ \theta + tan\ \theta)}{tan\ \theta - sec\ \theta + 1}$	**1**
	Rearrange the numerator and simplifies the above expression as: $\frac{(tan\ \theta + sec\ \theta)\times(tan\ \theta - sec\ \theta + 1)}{(tan\ \theta - sec\ \theta + 1)}$ $= tan\ \theta + sec\ \theta$ $= \frac{sin\ \theta}{cos\ \theta} + \frac{1}{cos\ \theta}$	**1**
	Further simplifies the above expression and proves: $\frac{1+sin\ \theta}{cos\ \theta}$ = RHS	**1**
27	**i) Uses the pythagoras theorem and finds the hypotenuse as √(144 + 25) = 13 units.**	**1**
	Determines the other ratios as: **sin A = $\frac{5}{13}$** **cos A = $\frac{12}{13}$** **cot A = $\frac{12}{5}$** **sec A = $\frac{13}{12}$** **cosec A = $\frac{13}{5}$**	**2**
	ii) Divides the given equation with $\sin^2 A$ to get: **$4\cot^2 A + 8 = 5\ \text{cosec}^2 A$.**	**1**

Q.No	What to look for	Marks
	Uses identity, $\text{cosec}^2\theta = 1 + \cot^2\theta$ in RHS to get: **$4\cot^2 A + 8 = 5(1 + \cot^2 A)$** **Simplifies the above to get $\cot A = \sqrt{3}$** **Thus shows that, $\cot A = \sqrt{3}$.**	**1**

Chapter - 7
Pair of linear equations in two variables

Multiple Choice Questions

Q: 1 **Given below is a graph showing two lines that never intersect. These are represented by two linear equations.**



Which of these can be said about the number of solution(s) of the above pair of linear equations?

1 They have infinitely many solutions.
2 They have a unique solution.
3 They do not have a solution.
4 Nothing can be said about the number of solutions unless the algebraic form of these equations are known.

Q: 2 **Given below is a pair of linear equations in two variables.**

$4x + 2y = 18$
$3x - 6y = 6$

Which of the following pairs of equations have the same number of solution(s) as the given pair?

1 $3a + 3b = 18$; $a + b = 6$
2 $a - b = 4$; $b - a = 4$
3 $6a - 2b = 10$; $3a + b = 5$
4 $7a + 9b = 27$; $28a + 36b = 76$

Q: 3 **If a pair of linear equations given by $l_1 x + m_1 y + n_1 = 0$ and $l_2 x + m_2 y + n_2 = 0$ has infinitely many solutions, then which of the following is DEFINITELY true?**

1 $\frac{l_1}{l_2} = \frac{n_2}{n_1}$ **2** $l_1 l_2 \neq m_1 m_2$ **3** $\frac{l_1}{l_2} \neq \frac{m_1}{m_2}$ **4** $l_1 m_2 = l_2 m_1$

Q: 4 **A gardener bought a mix of 100 flower and vegetable seeds for a total of Rs 1350. Each flower seed costs Rs 12, and each vegetable seed costs Rs 11.**

Which of the following pairs of linear equations can be used to determine *f*, the number of flower seeds purchased, and *v*, the number of vegetable seeds purchased?

1 $f + v = 100$; $11 f + 12 v = 1350$
2 $f + v = 1350$; $12 f + 11 v = 1350$
3 $f + v = 100$; $12 f + 11 v = 1350$
4 $f + v = 23$; $12 f + 11 v = 1350$

Q: 5 **Sara collected a total of Rs 1800 in a fundraising event. She knew that the event had a mix of Rs 10 and Rs 50 notes, but not sure how many of each. She counted the total number of notes as 60.**

Which of the following pairs of linear equations can be used to find the number of 10-rupee and 50-rupee notes?

***(Note: x represents the number of 10-rupee note and y represents the number of* 50-rupee note.)**

1 $x + y = 60$; $x - y = 40$
2 $x + y = 1800$; $10 x + 50 y = 60$
3 $x + y = 60$; $10 y + 50 x = 1800$
4 $x + y = 60$; $10 x + 50 y = 1800$

Q: 6 **Tanisha and Aditya have some chocolates with them such that:**

♦ if Tanisha were to give 6 chocolates to Aditya, the new quantity of chocolates with each of them would be equal.

♦ instead, if Aditya were to give 3 chocolates to Tanisha, then Tanisha would have four times as many chocolates as Aditya initially had.

Which of these pairs of equations would help us find the number of chocolates that they have?

(Note: Assume the initial number of chocolates with Tanisha as 'x' and that with Aditya as 'y'.)

1 $x - 6 = y + 6$; $x + 3 = 4(y - 3)$
2 $x - 6 = y + 6$; $x + 3 = 4 y$
3 $x + 6 = y - 6$; $x - 3 = 4 y$
4 $x - y = 6$; $x = y$

Q: 7 **For the given pair of linear equations, two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Read the statements carefully and choose the option that correctly describes statements (A) and (R).**

$x - 2y + 3 = 0$
$3x + 4y - 11 = 0$

Assertion (A) **: The pair of linear equations has a unique solution.**

Reason (R) **: The pair of linear equations represents a pair of coincident lines.**

1 Both (A) and (R) are true and (R) is the correct explanation of the (A).
2 Both (A) and (R) are true but (R) is not the correct explanation of the (A).
3 (A) is true but (B) is false.
4 (A) is false but (B) is true.

Free Response Questions

Q: 8 **Given below is a pair of linear equations in two variables:** **[1]**

$6y + 7z = 12$; $12y - 12z = 24$

Which variable's coefficient can be changed such that the given pair has infinitely many solutions? What should it be changed to? Show your work.

Q: 9 **On a specific day, a budget-friendly restaurant managed to sell 1000 vegetarian meals. These vegetarian meals were priced at Rs 85 per adult and Rs 45 per child. A total of Rs 73000 was collected from these sales.** **[1]**

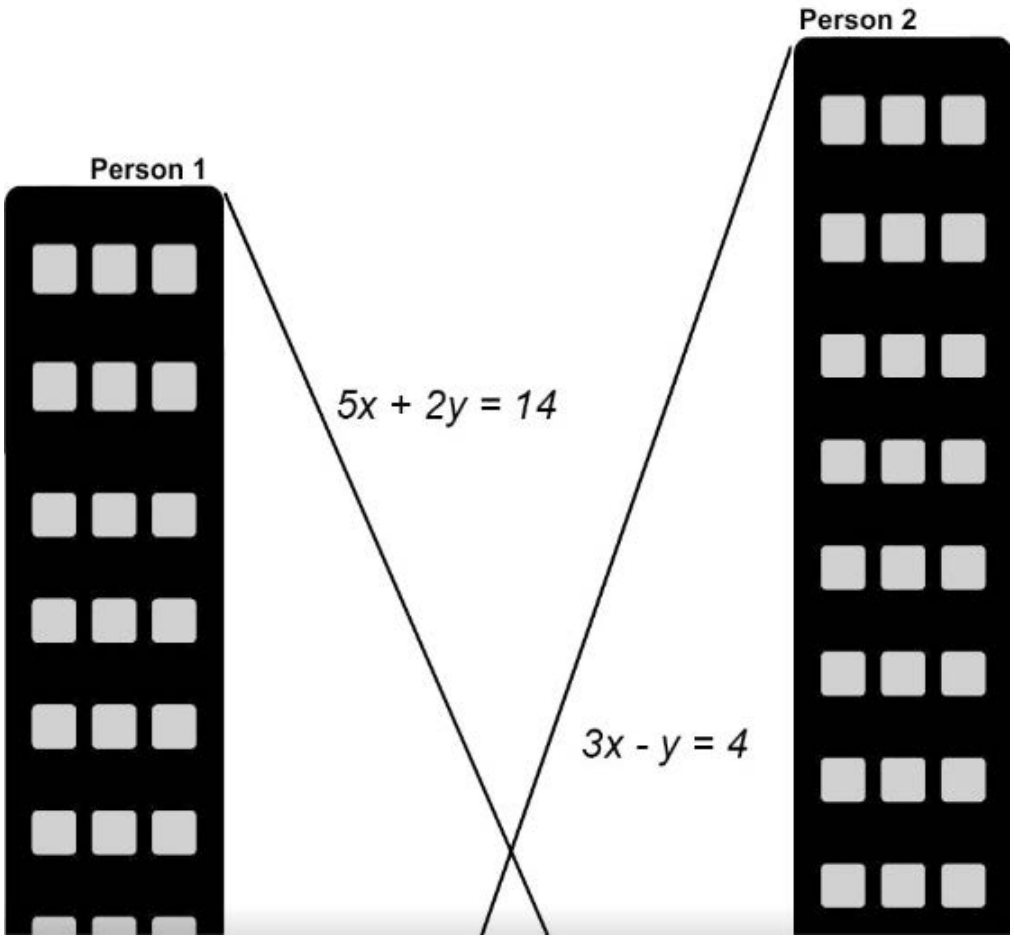
If p represents the number of adult veg meals sold and q represents the number of child veg meals sold, write a pair of equations to find out how many meals of each kind were sold.

Q: 10 **A pair of linear equations is shown below, where b is an integer.** **[1]**

$2x - y = b + 1$
$x + (b - 1)y = 3b$

For any given value of b, how many solution(s) does this pair of equations have? Justify your answer.

Q: 11 **Shown below is an image where the lines represent the paths of sight of two people standing at different heights and looking at the bottom level of the buildings. Both lines of sight can be represented by the corresponding linear equations.** **[2]**



(Note: The figure is not to scale.)

Find the ordered pair that will represent the intersecting point of their lines of sight. Show your work.

Q: 12 **Nisha and Samarth are preparing a cup of coffee each by mixing two ingredients, milk and brewed coffee in different quantities satisfying the following conditions:** **[2]**

♦ The quantity of milk in Nisha's cup is twice the quantity of brewed coffee in her cup.
♦ The quantity of milk in Samarth's cup is four times the quantity of brewed coffee in his cup.
♦ The quantity of milk in Nisha's cup is 40 ml less than what is found in Samarth's cup.
♦ The quantity of brewed coffee in Nisha's cup exceeds Samarth's by 30 ml.

Represent the above situation in the form of a pair of linear equations in two variables. Show your work.

Q: 13 **The delivery fees of a delivery service company consists of a fixed fee in addition to a fee based on the distance travelled. For a delivery covering 20 kms, the total fee (fixed + variable fee) is Rs 300, and for a delivery spanning 25 kms, the total fee is Rs 350.** **[2]**

How much total amount would a customer need to pay for a delivery that covers a distance of 49 kms? Show your work.

Q: 14 **Different shades of purple are obtained by mixing different quantities of red and blue colours.** **[2]**

An artist combined 5 litres of red paint with 7 litres of blue paint to achieve a shade of purple, incurring a cost of Rs 5000. To achieve a different shade of purple, she mixed 7 litres of red paint and 5 litres of blue paint, incurring a cost of Rs 4600.

Calculate the price of red and blue paint per litre. Show your work.

Q: 15 **In a chemistry lab, scientists are studying a chemical reaction between two substances, Substance A and Substance B. The following was known:** **[2]**

♦ The total mass of the substances before the reaction was 9 grams.
♦ The difference in mass between Substance A and Substance B before the reaction was 6 grams. Determine the mass of Substances A and B before the reaction. Show your work.

Q: 16 **Tanvi and her friend Vanshika both made purchases from a local fruit seller on a specific day. Tanvi bought 3 kgs of grapes and 4 kgs of oranges, spending a total of Rs 680. Meanwhile, Vanshika bought 4 kgs of grapes and 2 kgs of oranges from the same fruit seller, spending a total of Rs 640.** **[2]**

What is the price of grapes and oranges per kg? Show your work.

Q: 17 **A two-digit number is such that the sum of its digits is 11. When the digits are reversed, the resulting number increases by 27.** **[3]**

Determine the original two-digit number. Show your work.

Q: 18 **Two real numbers *c* and *d* satisfy the following equations:** **[3]**

$2c - 3d = 7$
$4c + d = 1$

Find the product of *c* and *d*. Show your work.

Q: 19 **Solve the following pair of linear equations in two variables graphically.** **[3]**

$x + 3y = 6$
$2x - 3y = 12$

Identify the shape resulting from the intersection of the pair of equations with the *y*-axis and write its vertex coordinates.

Q: 20 **The length of a rectangle is 3 cm less than five times the width. The sum of six times the length and two times the width is equal to 46 cm.** **[3]**

What is the width of the rectangle? Show your work.

Q: 21 **In the competitive world of smartphone data plans, two leading telecom companies, TechConnect and SwiftLink offer distinct pricing structures. TechConnect charges a base monthly fee of Rs 300, along with an additional Rs 15 for each gigabyte (GB) of data used beyond the initial 5 GB included in the plan. In contrast, SwiftLink offers a different pricing model with a flat monthly fee of Rs 600 for unlimited data usage.** **[3]**

i) Express the data plan structure for TechConnect in the form of linear equation. Use *c* as the total cost (in Rs) and *d* as the data usage (in GB).

ii) At what point of data usage the cost of a data plan with TechConnect becomes equal to the cost of the data plan with SwiftLink?

Show your steps.

Q: 22 **Rahul rode his bike initially at an average speed of 40 km/h. Upon noticing a road sign indicating a speed limit of 35 km/h, he slowed down and rode at an average speed of 35 km/h for the remainder of his journey. He covered a total of 190 km in 5 hours.** **[3]**

For how long did Rahul maintain an average speed of 40 km/h? Show your work.

Q: 23 **A geometric shape is formed by the equation $2y + x = 8$ and the coordinate axes. For the resulting shape,** **[5]**

i) Identify the shape and find its vertices.
ii) Find the perimeter and area of the shape.

Solve graphically.

Q: 24 **Muskan lives 12 km away from her college. She walks to the metro station and takes a metro to college everyday. If she goes to the nearest metro station, she needs to walk for 2 km and cover the rest by metro. This takes her 1 hour. If she walks to a metro station farther away, she needs to walk for 4 km and cover the rest by metro. This takes her 1.5 hours.** **[5]**

Find the average speeds of Muskan's walking and the metro. Show your work.

Case Study

Answer the questions based on the given information.

Reena and Sonia went to a mall on 14th November 2022. On the occasion of Children's Day, the mall was offering movie tickets and bowling alley tickets at discounted prices. The cost of a movie ticket was Rs 70 more than twice the cost of a bowling alley ticket. Sonia purchased five bowling alley tickets and three movie tickets for a total of Rs 870.

Q: 25 **Represent the given situation with a pair of linear equations.** **[1]**

Q: 26 **Find the price of a movie ticket and a bowling alley ticket. Show your work.** **[2]**

Q: 27 **On the next day, Reena took her siblings to the mall. She observed that prices of the movie ticket and the bowling alley ticket had come back to their standard rates of Rs 220 and Rs 90, respectively. She bought a total of 10 tickets, costing her Rs 1420.** **[2]**

Find the number of movie tickets and bowling alley tickets she bought. Show your work.

Q.No	Correct Answers
1	3
2	3
3	4
4	3
5	4
6	2
7	3

Q.No	What to look for	Marks
8	Identifies that either of the coefficients of z can be changed.	0.5
	Changes either 7 to (-6) in first equation or (-12) to 14 in second equation so that all ratios are equal to $\frac{1}{2}$, making it a pair with infinitely many solutions.	0.5
9	Expresses equations in this or any equivalent form: $p + q = 1000$ $85p + 45q = 73000$	1
10	Identifies that for any integer b : $\frac{2}{1} \neq \frac{-1}{b-1}$ This satisfies the condition for intersecting lines, hence there is a unique solution.	1
11	Solves the following pair of linear equations to get $x = 2$ and $y = 2$: $5x + 2y = 14$ $3x - y = 4$	1.5
	Writes that (2, 2) represents the intersecting point of both lines of sight.	0.5
12	Writes that if quantity of brewed coffee = x ml for Nisha, then quantity of milk = $2x$ ml for Nisha. Writes that if quantity of brewed coffee = y ml for Samarth, then quantity of milk = $4y$ ml for Samarth.	1
	Represents both the equations in this or an equivalent form: $4y - 2x = 40$ $x - y = 30$	1
13	Assumes the fixed fee as Rs x and the variable fee as Rs y, then formulates the following pair of linear equations: $x + 20y = 300$ $x + 25y = 350$	1

Q.No	What to look for	Marks
	Solves the pair of linear equations to find the value of x as Rs 100 and y as Rs 10.	**0.5**
	Finds the final total amount as: **100 + (10 × 49) = Rs 590**	**0.5**
14	**Translates the given information to frame a pair of linear equations in two variables as:** $5x + 7y = 5000$ $7x + 5y = 4600$ **where x = price of red paint per litre; y = price of blue paint per litre**	**1**
	Solves the pair of equations obtained in the above step to find the price of red and blue paints per litre as Rs 300 and Rs 500 respectively.	**1**
15	**Assumes the mass of Substance A as x grams and that of Substance B as y grams. Represents the given situation in linear equations as:** $x + y = 9$ $x - y = 6$	**1**
	Solves the above pair of equations and finds the mass of Substance A as $\frac{15}{2}$ grams and that of Substance B as $\frac{3}{2}$ grams. **(Award full marks if the mass of Substance A is $\frac{3}{2}$ grams and that of Substance B is $\frac{15}{2}$ grams.)**	**1**
16	**Assumes the price of grapes per kg as Rs x and that of oranges as Rs y. Formulates the following pair of linear equations:** $3x + 4y = 680$ $4x + 2y = 640$	**1**
	Solves the above pair of linear equations to find the price of grapes and oranges per kg as Rs 120 and Rs 80 respectively.	**1**

<table>
<tr><th>Q.No</th><th>What to look for</th><th>Marks</th></tr>
<tr><td rowspan="3">17</td><td>Assumes the digit at the tens place and ones place as x and y respectively.

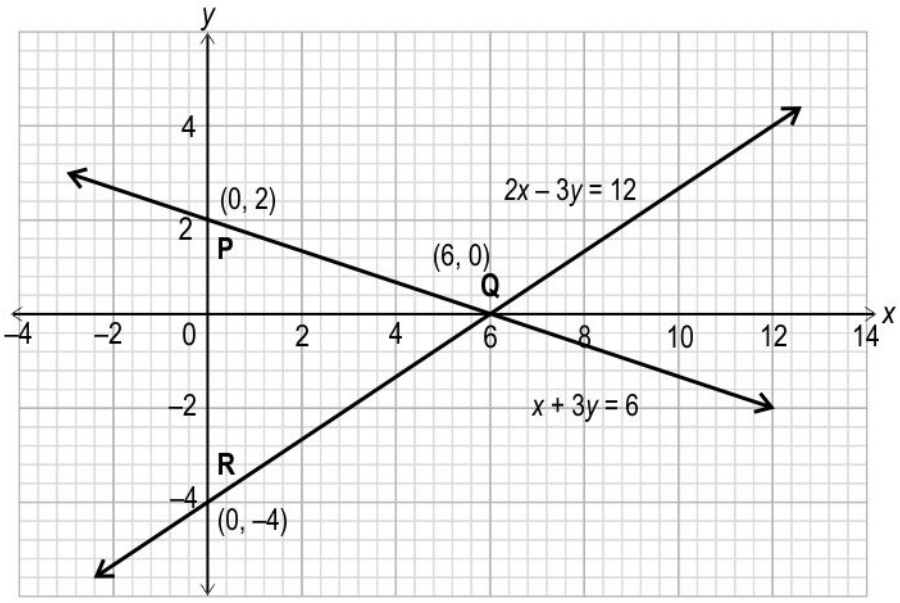
Writes the equation as:

$x + y = 11$
$10y + x = 10x + y + 27$</td><td>1</td></tr>
<tr><td>Solves the above equations correctly to find the values of x and y as 4 and 7 respectively.</td><td>1</td></tr>
<tr><td>Finds the original two-digit number as 47.</td><td>1</td></tr>
<tr><td rowspan="2">18</td><td>Solves the given pair of linear equation to find the values of c and d as $\frac{5}{7}$ and $\frac{-13}{7}$ respectively.</td><td>2</td></tr>
<tr><td>Finds the product of c and d as:

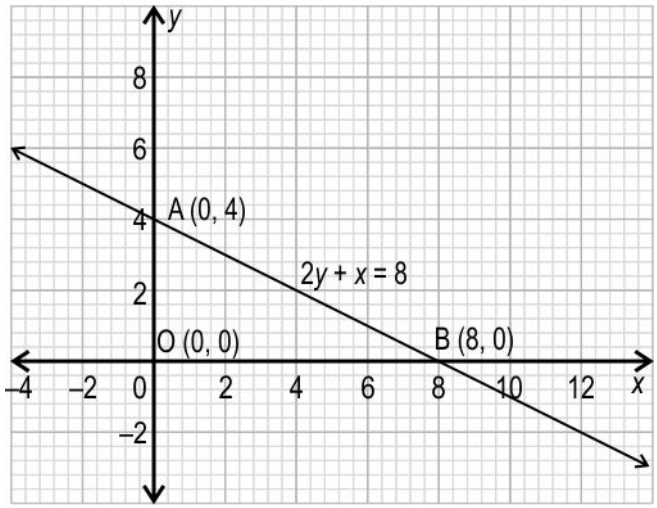
$\frac{5}{7} \times \frac{-13}{7} = \frac{-65}{49}$</td><td>1</td></tr>
<tr><td>19</td><td>Finds at least two points that satisfy the linear equation, $x + 3y = 6$. For example,

<table><tr><td>x</td><td>0</td><td>6</td></tr><tr><td>y</td><td>2</td><td>0</td></tr></table>
Finds at least two points that satisfy the linear equation, $2x - 3y = 12$. For example,

<table><tr><td>x</td><td>0</td><td>6</td></tr><tr><td>y</td><td>-4</td><td>0</td></tr></table></td><td>1.5</td></tr>
</table>

Q.No	What to look for	Marks
	Draws the graph for each equation using the coordinates found in the above two steps and thus finds the solution as $x = 6$ and $y = 0$. The graph may look as follows: 	**1**
	Identifies the shape as a triangle and write its vertices as (0, 2), (6, 0) and (0, -4).	**0.5**
20	**Assumes the width and length of the rectangle as w and x respectively. Expresses the above statement as a pair of linear equations:** **$x = 5w - 3$** **$6x + 2w = 46$**	**1**
	Solves the above pair of linear equations to find the width of the rectangle as 2 cm.	**2**
21	**i) Expresses the data plan structure for TechConnect in the form of an equation as:** **$c = 300 + 15(d - 5)$** **$\Rightarrow c = 15d + 225$** **(Award full marks if any other correct variation of the equation is written.)**	**1**

Q.No	What to look for	Marks
	ii) Identifies that the cost of both plans will become equal when *c* becomes 600: **600 = 15 *d* + 225**	**1**
	Solves the above equation and concludes that at data usage of 25 GB, the cost for both the plans will become equal.	**1**
22	**Assumes the time duration for which Rahul rode his bike at an average speed of 40 km/h to be *x* and at 35 km/h to be *y*.** **Frames the pair of linear equations in two variables as:** ***x* + *y* = 5** **40 *x* + 35 *y* = 190**	**1**
	Solves the above pair of linear equations to find *x* = 3 and *y* = 2.	**1.5**
	Writes that Rahul rode his bike at an average speed of 40 km/h for 3 hours.	**0.5**

Q.No	What to look for	Marks
23	**Finds at least two points that satisfy the linear equation, 2 y + x = 8. For example,** x 0 8 y 4 0 **Draws the graph for the equation using the coordinates found above. The graph may look as follows:**  	2
	i) Identifies the shape as a triangle and writes the vertices as (0, 4), (0, 0) and (8, 0).	1
	ii) Finds the perimeter of triangle using pythagoras theorem as 4 + 8 + $\sqrt{(4^2 + 8^2)}$ = 12 + 4$\sqrt{5}$ units.	1
	Finds the area of the triangle as $\frac{1}{2}$ × 4 × 8 = 16 sq units.	1
24	**Takes average speed while walking and average speed of the metro as x km/h and y km/h respectively.**	0.5
	Uses speed = $\frac{\text{distance}}{\text{time}}$ to frame equations $\frac{2}{x} + \frac{10}{y} = 1$ and $\frac{4}{x} + \frac{8}{y} = 1.5$ respectively.	1.5

Q.No	What to look for	Marks
	Substitutes $\frac{1}{x} = m$ and $\frac{1}{y} = n$, where m and n are also variables. Rewrites the equations as: **$2m + 10n = 1$** **$4m + 8n = 1.5$**	**1**
	Solves the above equations to find the values of m and n as $\frac{7}{24}$ and $\frac{1}{24}$ respectively. **Expresses the average speed of Muskan as $x = \frac{24}{7}$ km/h and average speed of the metro as $y = 24$ km/h.**	**2**
25	**Assumes the price of one bowling alley ticket as Rs x and price of one movie ticket as Rs y.** **Frames the pair of linear equations as:** **$y - 2x = 70$** **$5x + 3y = 870$**	**1**
26	**Solves the equations simultaneously to find the price of a movie ticket as Rs 190 and a bowling alley ticket as Rs 60.**	**2**
27	**Assumes the number of movie tickets and bowling alley tickets to be m and b respectively.** **Frames the pair of linear equations as:** **$m + b = 10$** **$220m + 90b = 1420$**	**1**
	Solves the equations to find the number of movie tickets (m) and bowling alley tickets (b) to be 4 and 6 respectively.	**1**

8. Annexure
Correct Answer Explanation

Chapter Name	Q. No	Correct Answer	Correct Answer Explanation
Real numbers	1	A	The square root of numbers which are not a perfect square of any number is an irrational number. All the other three options are either terminated decimal or square root of perfect squares, or non-terminating non-repeating decimal expansion. Hence only option A here is an irrational number.
	3	C	In the fraction 63/p, p can only be of the form $2^m \times 5^n$ to make the fraction a terminating decimal expansion. All the other 3 options are of the form $2^m \times 5^n$, so p cannot be equal to 13.
Arithmetic Progressions	4	C	In i), the common difference is 10, hence it is in AP. In iii), the common difference is (-0.5), hence it is in AP. In ii), there is no common difference and it's a random pattern, with random intervals between the numbers. So, it is not in AP. Hence, only i) and iii) are in Arithmetic progression.
	7	B	The construction progress follows an AP where the first term (a) is 5 (floors completed in the first week), and the common difference (d) is 3 (floors completed each subsequent week). The formula to find the nth term = a + (n−1) × d, where n = 12 => 5 + (12 − 1) × 3 = 38. Given, 6 floors were already there. So total number of floors = 38 + 6 = 44. Hence, option B is the correct answer.
Circles	2	B	Tangents drawn to the circle from an external point is of the same length. So, PA=DA and QC=DC (tangents to the circle from the external point A and C) Thus, AP + AB = AD + AB and CQ + BC = CD + BC Thus, BP = AD + AB and BQ = CD + BC Thus, BP + BQ = AD + AB + CD + BC Thus, BP + BQ = perimeter of ΔABC

			Hence, option B is the correct answer.
	3	C	If rectangle is drawn, the measure of length and breadth of rectangle will be same as the length of the diameter of the circle. Which will in turn make the rectangle into square.
	5	A	A right angle is formed between the radius and the tangent to the circle. Given that TS is parallel to QR. Thus, ∠PRQ = ∠PSO = 90° (corresponding angles) By angle sum property of triangle in ΔPQR, ∠RPQ = 180° - (90° + 55°) = 180° - 145° = 35°. Hence, option A is the right answer.
Coordinate Geometry	4	C	In a square all sides are of the same length and it must be noticed in the figure that P and Q has same x-coordinate and different y co-ordinate with a difference of 4 units.
	6	C	To find the relation, the distance formula is to be used and the two sides are to be equated as: $(x + 1)^2 + (y - 4)^2 = (x - 2)^2 + (y - 5)^2$ $\Rightarrow x^2 + 2x + 1 + y^2 - 8y + 16 = x^2 - 4x + 4 + y^2 - 10y + 25$ $\Rightarrow 6x + 2y = 12$ $\Rightarrow 3x + y = 6.$
Areas related to circles	7	B	The radius will remain same for both minor and major sectors of a circle. But the angle subtended at the centre, the area of the sector and the length of the arc, all three will be larger for the major sector and smaller for the minor sector. Hence, option B is the answer.
	3	C	Angle z can be found by framing and solving for this equation: $(5/8)\pi(r)^2 = (z/360)\pi(r)^2$ $\Rightarrow z = 225°.$ Hence, option C is the correct answer.
Introduction to Trigonometry	3	B	$\cos^2 \text{theta} - \sin^2 \text{theta} = 3/4$ $\Rightarrow 2\cos^2 \text{theta} - 1 = 3/4$

			=> $\cos^2$ theta = 7/8 => cos theta = sqrt(7/8)
	7	A	Multiplying and dividing the equation by sqrt (1 + sin theta) We get, sqrt [(1 + sin theta)^2/ (1 - $\sin^2$ theta)] sqrt [(1 + sin theta)^2/ ($\cos^2$ theta)] (1 + sin theta) / cos theta (1 / cos theta) + (sin theta/cos theta) sec theta + tan theta Hence, option A is the correct answer.
Pair of Linear Equations in Two Variables	6	B	If Tanisha gives 6 chocolates to Aditya, that means 6 should be subtracted from Tanisha's and added to Aditya's chocolates, which turns out to be equal: x - 6 = y + 6. If Aditya gives 3 chocolates to Tanisha, then 3 should be added to Tanisha's; Aditya's initial chocolates should be multiplied by 4 to make them equal: x + 3 = 4y. Hence, option B is the correct answer.
	7	C	As (1/3) ≠ (-1/2) => (a1/a2) ≠ (b1/b2), the pair of equations has a unique solution and it represents a pair of intersecting lines. That means the assertion is correct but the reasoning is not. Hence, option C is the correct answer.

Central Board of Secondary Education
Shiksha Sadan, 17, Rouse Avenue,
New Delhi-110002

Competency Focused Practice Questions

Mathematics (Volume 4) | Grade 10

Co-created by

CBSE Centre for Excellence in Assessment

and

Educational Initiatives

Preface

Assessments are an important tool that help gauge learning. They provide valuable feedback about the effectiveness of instructional methods; about what students have actually understood and also provide actionable insights. The National Education Policy, 2020 has outlined the importance of competency-based assessments in classrooms as a means to reform curriculum and pedagogical methodologies. The policy emphasizes on the development of higher order skills such as analysis, critical thinking and problem solving through classroom instructions and aligned assessments.

Central Board of Secondary Education (CBSE) has been collaborating with Educational Initiatives (Ei) in the area of assessment. Through resources like the Essential Concepts document and A- Question-A-Day (AQAD), high quality questions and concepts critical to learning have been shared with schools and teachers.

Continuing with the vision to ensure that every student is learning with understanding, Question Booklets have been created for subjects for Grade 10th and 12th. These booklets contain competency-based items, designed specifically to test conceptual understanding and application of concepts.

Process of creating competency-based items

All items in these booklets are aligned to the NCERT curriculum and have been created keeping in mind the learning outcomes that are important for students to understand and master. Items are a mix of Free Response Questions (FRQs) and Multiple-Choice Questions (MCQs). In case of MCQs, the options (correct answer and distractors) are specifically created to test for understanding and capturing specific errors/misconceptions that students may harbour. Each incorrect option can thereby inform teachers on specific gaps that may exist in student learning. In case of subjective questions, each question also has a detailed scoring rubric to guide evaluation of students' responses.

Each item has been reviewed by experts, to check for appropriateness of the item, validity of the item, conceptual correctness, language accuracy and other nuances.

How can these item booklets be used?

There are 121 questions in this booklet.

The purpose of these item booklets is to provide samples of high-quality competency-based items to teachers. The items can be used to–

- get an understanding of what good competency-based questions could look like
- give exposure to students to competency-based items
- assist in classroom teaching and learning
- get inspiration to create more such competency-based items

Students can also use this document to understand different kinds of questions and practice specific concepts and competencies. There will be further additions in the future to provide competency focused questions on all chapters.

The item booklets are aligned with the 2022-23 curriculum. However, a few questions from topic which got rationalized in 2023-24 syllabus are also there in the booklet which may be used as a reference for teachers and students.

Please write back to us to give your feedback.

Team CBSE

Table of Contents

Chapter - 1
Real Numbers

Free Response Questions

Q: 1 **Nidaa performed the division of $\frac{53}{83}$ on a calculator whose result is shown below. Even though the quotient has more digits, the calculator didn't display it all due to the limited display area.** **[1]**

Is the output of the division rational or irrational? Explain your answer.

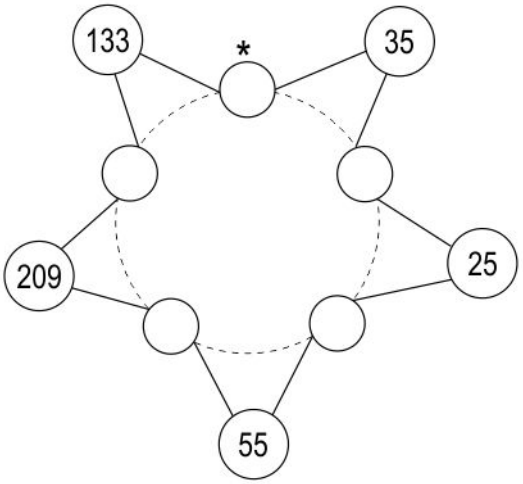
Q: 2 **2^n is not divisible by 6 where n is a positive integer.** **[1]**

Is the above statement true or false? If true, give a valid reason and if false, give an example.

Q: 3 **The prime factorisation of a natural number k is $(3 \times 5 \times p)$ where $p \neq 2$.** **[1]**

What is the prime factorisation of $10k^2$?

Q: 4 **In the figure below, the inner circles are filled with the prime factors of the numbers given in the outer circles. Each number from 1-26 corresponds to the letter in its position in the alphabet, A-Z. For instance, 1 is A, 2 is B, and so on.** **[3]**



Starting clockwise from *, find the word formed by the numbers in the inner circle. Show your work.

Q: 5 **For a positive integer n, m is a prime factor of n.** **[3]**

Show that m is not a factor of (n + 1).

Q: 6 **A rectangular arrangement of pens has rows and columns. Rohan takes away 3 rows of pens and then Sarah takes away 2 columns of pens from the remaining pens. The remaining pens are rearranged in p rows and q columns where p is a prime number.** **[3]**

If Rohan takes 24 pens and Sarah takes 18 pens, find all possible value(s) of p. Show your work.

Case Study

Answer the following questions based on the information given.

Sakshara International School organised a combined exhibition for grade 10 students of its three branches. 345 students from Mumbai branch, 405 students from Pune branch and 270 students from Nagpur branch participated in it. The following were planned for the exhibition:

1. Group projects: The students of each of the three branches were divided in groups for making various group projects such that each group had equal number of students and the number of groups was minimum.

2. Individual project: Each of total 1020 students had to submit an individual project. A fixed number of topics were allotted such that each topic had equal number of students.

3. Inter-state model making competition: A few equal number of students were selected from each branch to participate in the competition. Each branch was supposed to submit between 3 to 7 models.

Q: 7 **Use Euclid's Division Algorithm to find the number of different groups for the group projects. Show your work.** **[2]**

Q: 8 **A maths teacher asked his students to solve the below puzzle regarding the individual project.** **[2]**

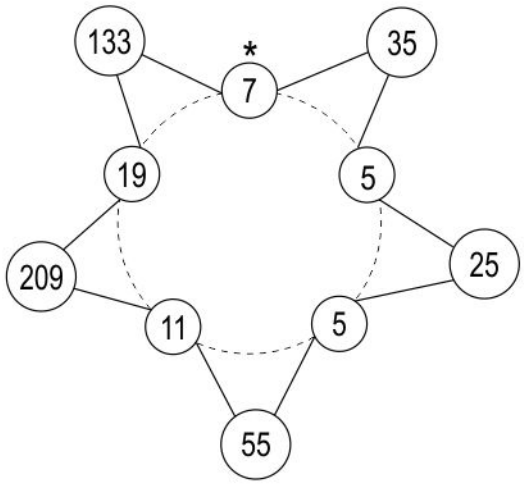
The number of students who got the same topic can be represented as $(2^n \times 5)$ where *n* is a positive integer having the maximum possible value.

Find *n* and the number of topics allotted. Show your work.

Q: 9 **Mumbai branch divided the students selected for inter-state model making competition into the groups of 12 students, Pune into the groups of 10 students and Nagpur into the groups of 15 students.** **[2]**

i) How many students were selected from each branch?
ii) How many models were submitted by individual branches and all the branches together?

Show your work.

Q.No	What to look for	Marks
1	**Writes that output is a rational number.**	**0.5**
	Explains the answer. For example, since the output $\frac{53}{83}$ can be represented in the form $\frac{p}{q}$, where $q \neq 0$, it is a rational number.	**0.5**
2	**Writes that the given statement is true and gives a reason. For example, writes that $2^n = 2 \times 2 \times 2 \times 2 \times \ldots$ n times and hence its only prime factor is 2 whereas prime factors of 6 are 2 and 3.**	**1**
3	**Writes the prime factorisation of $10k^2$ as $(2 \times 3^2 \times 5^3 \times p^2)$.**	**1**
4	**Redraws the factor tree diagram with the prime factors. The tree may look as follows:** 	**2**
	Uses the number to letter mapping and finds the word as GEEKS.	**1**
5	**Uses Euclid's division lemma and writes the equation for some positive integer p as:** $n = mp$ $\Rightarrow p = \frac{n}{m}$	**0.5**

Q.No	What to look for	Marks
	Assumes that *m* is a factor of (*n* + 1), uses Euclid's division lemma and writes the equation for some positive integer *q* as: $n + 1 = mq$	**0.5**
	Rearranges the above equation as: $q = \frac{n}{m} + \frac{1}{m}$	**0.5**
	Writes that *q* is a positive integer, $\frac{n}{m}$ is a positive integer but $\frac{1}{m}$ is not an integer and hence the above equation cannot be true.	**1**
	Hence, uses contradiction to conclude that *m* is not a factor of (*n* + 1).	**0.5**
6	**Writes that in the original rectangular arrangement, there are 8 pens in each row and 12 pens in each column.**	**1**
	Finds the remaining number of pens as 9 rows and 6 columns or 54 pens.	**0.5**
	Writes the prime factorisation of 54 as 2×3^3.	**1**
	Writes all the possible values of *p* as 2 or 3.	**0.5**
7	**Finds HCF of 345, 405 and 270 using Euclid's Division Algorithm as follows:** $405 = 345 \times 1 + 60$ $345 = 60 \times 5 + 45$ $60 = 45 \times 1 + 15$ $45 = 15 \times 3 + 0$ **Finds HCF of 405 and 345 as 15.**	**1**
	Finds HCF of 270 and 15 as follows: $270 = 15 \times 18 + 0$ **Concludes that HCF of 345, 405 and 240 is 15, hence there were 15 students in each group.**	**0.5**

Q.No	What to look for	Marks
	Finds the number of different groups for the group projects as: $\frac{345}{15} + \frac{405}{15} + \frac{270}{15} = 23 + 27 + 18 = 68$	**0.5**
8	**Factorises 1020 as: $2^2 \times 3 \times 5 \times 17$.** **From the above factorisation concludes that $2^n \times 5 = 2^2 \times 5$ and hence finds the maximum possible value of *n* as 2.**	**1**
	Finds the number of topics allotted as the remaining factors of 1020 as: **$3 \times 17 = 51$**	**1**
9	**i) Finds LCM of 12, 10 and 15 using prime factorisation as:** **$12 = 2 \times 2 \times 3$** **$10 = 2 \times 5$** **$15 = 3 \times 5$** **LCM $= 2^2 \times 3 \times 5 = 60$** **Concludes that 60 students were selected from each branch for the inter-state model making competition.**	**1**
	ii) Finds the number of models submitted by each branch as: **Mumbai $= \frac{60}{12} = 5$** **Pune $= \frac{60}{10} = 6$** **Nagpur $= \frac{60}{15} = 4$** **Finds the total number of models submitted as 15.**	**1**

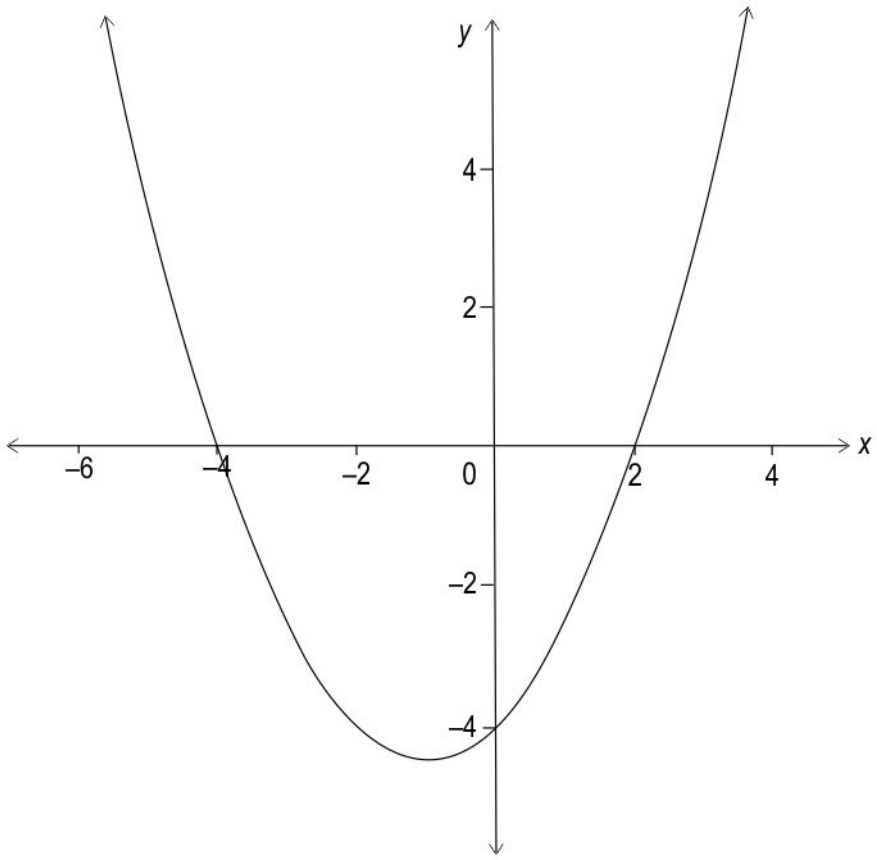
Chapter - 2
Polynomials

Multiple Choice Questions

Q: 1 **At which point will the graph of the polynomial $p(x) = (-x + 6x^2 - 1)$ intersects the negative x -axis?**

1 only $\frac{-1}{3}$
2 only $\frac{-1}{2}$
3 both $\frac{-1}{3}$ and $\frac{-1}{2}$
4 (none, it never intersects negative x -axis)

Q: 2 **Shown below is the graph of a quadratic polynomial.**



Which of these is the polynomial graphed above?

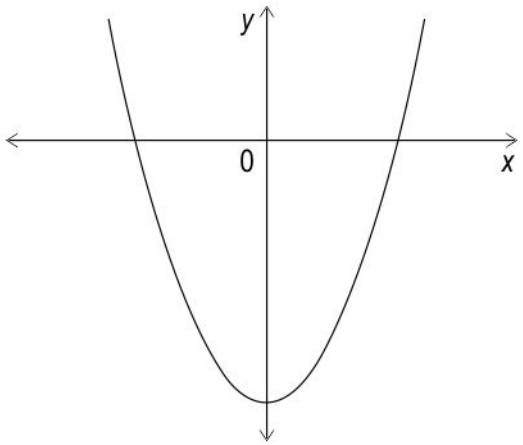
1 $(x - 2)(x + 4)$
2 $(x - 4)(x + 2)$
3 $\frac{1}{2}(x - 2)(x + 4)$
4 $\frac{1}{2}(x - 4)(x + 2)$

Free Response Questions

Q: 3 **State whether the following statement is true of false. Justify your answer.** **[1]**

If the graph of a polynomial has EXACTLY 2 zeroes, then the polynomial must be quadratic.

Q: 4 **A quadratic polynomial $f(x)$ has two real zeroes that are equal. Adah drew the graph of $f(x)$ as shown below.** **[1]**



Is Adah's graph correct? Explain your answer.

Q: 5 **Aasira multiplied a variable with 4, subtracted 12 and added the square of the original variable. She expressed the final expression as a product of 2 factors.** **[3]**

Her friend, Rishi, said that the factors will always have a difference of 8.

Is Rishi right? Show your work.

Q: 6 **$g(x) = px^2 + qx + 152$ is a polynomial where p and q are real numbers. The zeroes of $g(x)$ are distinct prime numbers. Find the:** **[5]**

i) zeroes of $g(x)$.

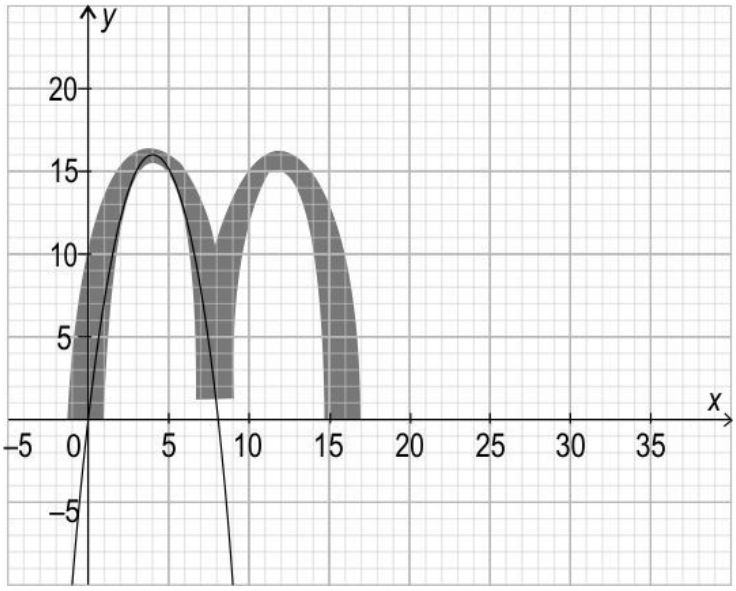
ii) values of p and q.

Show your work and give valid reasons.

Case-Based Questions

Answer the questions based on the given information.

Shown below is a logo that is made up of two intersecting golden arches, which are parabolic in shape. One such parabola, coinciding with the first arch in the logo, is shown in the graph below.



Q: 7 **Write an equation to represent the parabola shown in the graph.** **[2]**

Show your work and give valid reasons.

Q: 8 **State whether the following statements are true or false.** **[3]**

i) If the zeroes of the parabola, $ax^2 + bx + c = 0$, coinciding with the second arch in the logo are given by σ and 2σ, then *c* will be negative.

ii) If the logo is shifted so that it is symmetrical about the *y* -axis, then the constant term in the equation of the parabola made by the first arch will be positive.

Justify your answers.

Q.No	Correct Answers
1	1
2	4

Q.No	What to look for	Marks
3	Writes that the statement is false.	0.5
	Gives reason that while a quadratic polynomial must have a maximum of 2 zeroes, a graph with exactly 2 zeroes need not be that of a quadratic polynomial. For example: The graph of a cubic polynomial of the form $(x - a)(x - b)^2$ will have only two zeroes, a and b.	0.5
4	Writes that the graph Adah has drawn is incorrect.	0.5
	Gives a valid reason. For example, since $f (x)$ has real and equal zeroes, the graph of $f (x)$ intersects the x -axis at a unique point.	0.5
5	Assumes the original variable as x and frames the expression as $4 x - 12 + x^2$.	1
	Factorises the above expression as $(x - 2)(x + 6)$.	1
	Concludes that Rishi was right as the above factors have a difference of 8.	1
6	i) Writes the equation for the product of zeroes as: product of zeroes = $\frac{152}{p}$	1
	Writes the prime factorisation of 152 as $2^3 \times 19$.	0.5
	Writes that since the zeroes are distinct prime numbers, finds the zeroes of $g (x)$ as 2 and 19.	1
	Finds the value of p as $\frac{152}{38} = 4$.	0.5
	ii) Writes the equation for the sum of zeroes as: $2 + 19 = \frac{-q}{4}$	1
	Solves the above equation to find the value of q as (-84).	1

Q.No	What to look for	Marks
7	Identifies zeroes of the quadratic equation as 0 and 8. Identifies that the coefficient of x^2 must be negative, since the given parabola is facing downward.	1
	Takes $\alpha + \beta = \frac{-b}{a} = 8$ and $\alpha\beta = \frac{c}{a} = 0$, where α and β are the zeroes of the parabola, and a, b and c represent the coefficient of x^2, the coefficient of x and the constant respectively.	0.5
	Finds one equation representing the parabola, by picking a value for a and, accordingly choosing values for b and c. For example, when $a = (-1)$, the required equation is $-x^2 + 8x = 0$.	0.5
8	i) Writes that the statement is true.	0.5
	Justifies with a reason. For example, $\frac{c}{a} = 2\sigma^2$, which cannot be negative. a is negative as the parabola is facing downward. Since a is negative, c must also be negative.	1
	ii) Writes that the statement is false.	0.5
	Justifies with a reason. For example, When the parabola is shifted, the new zeroes of the first arch will be (-8) and 0. As 0 is a zero of the arch, $c = 0$. This is because $\alpha\beta = \frac{c}{a} = 0$, where α, β are zeroes of the polynomial.	1

Chapter - 3
Pair of Linear Equations in Two Variables

Free Response Questions

Q: 1 **Anjali solved the following equations for the value of x.** **[1]**

(i) $5x - 2y = 4$
(ii) $3x - y = 8$

Her solution is given below.

Step 1: Multiplied equation (ii) by 2 on both sides.

$6x - 2y = 16$.....(iii)

Step 2: Solved equations (i) and (iii) to get $x = (-20)$.

$$\begin{array}{r} 5x - 2y = 4 \\ -6x + 2y = 16 \\ \hline -x \quad\quad = 20 \end{array}$$

Anjali made a mistake while solving this. What was her mistake? Also, find the correct value of x.

Q: 2 **State true or false for the below statement and justify your answer** **[1]**

A pair of linear equations represented by intersecting lines can have two solutions.

Q: 3 **A pair of linear equations is shown below.** **[1]**

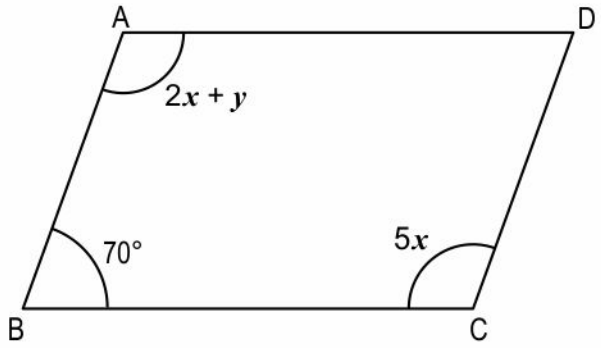
$(k - 1)x + y = k + 1$
$(k^2 - 1)x + (k + 1)y = 1 - k^2$

If $k > 1$, then how many solutions does this pair of equations have?

Q: 4 **The equations of the lines l_1, l_2, and l_3 are given by $5x + 3y = 2p$, $35x + 21y = pq$, and $100x + 4qy = 240$, respectively, where p and q are real numbers.** **[2]**

(i) For what values of p and q does the line l_3 coincide with l_1? Show your steps.
(ii) For the values of p and q found in question (i), are the lines l_1 and l_2 parallel? Justify your answer.

Q: 5 **Shown below is a parallelogram with ∠ABC = 70°.** **[2]**



(Note: The figure is not to scale.)

Find the values of *x* and *y*. Show your steps.

Q: 6 **Anisha lives 15 km away from her school. She walks to the bus stop and takes a bus to school everyday.** **[5]**

If she goes to the nearest bus stop, she needs to walk for 3 km and cover the rest by bus. This takes her 1.5 hours. If she walks to a bus stop further away, she needs to walk for 5 km and cover the rest by bus. This takes her 2 hours.

Frame equations and solve them to find the average speed Anisha walks at, as well as the average speed of the bus. Show your steps.

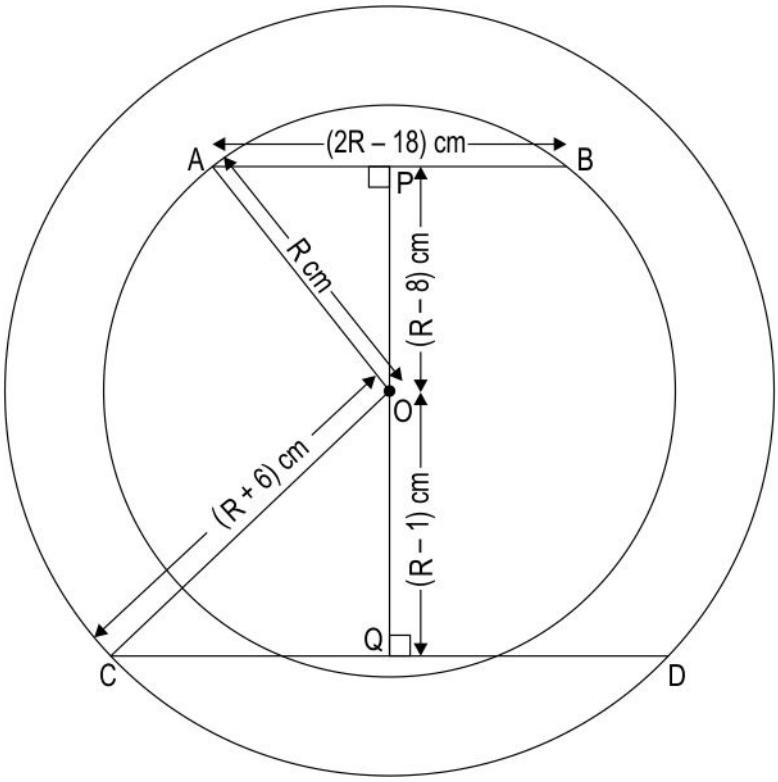
Q.No	What to look for	Marks
1	**Identifies that Anjali made a mistake in step 2 and 16 on the right hand side should be (-16).**	**0.5**
	Solves correctly to find (- *x*) = (- 12) or *x* = 12 as follows: $5x - 2y = 4$ $-6x + 2y = -16$ $-x = -12$	**0.5**
2	**States that the statement is false.**	**0.5**
	Gives the reason that a pair of linear equations represented by intersecting lines have only one point of intersection on the lines, which is a unique solution.	**0.5**
3	**Finds the ratio of the coefficients and concludes that there is no solution.** **For example, finds the ratio of coefficients as $\frac{1}{k+1} = \frac{1}{k+1} \neq \frac{1}{1-k}$, for *k* > 1.**	**1**
4	**i) Uses the condition for coincident lines for l_1 and l_3 as shown below:** $\frac{a_1}{a_3} = \frac{b_1}{b_3} = \frac{c_1}{c_3}$ **Finds *p* = 6 and *q* = 15.**	**1**
	ii) Checks if $l_1 \parallel l_2$ using the following relation: $\frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$ **Finds that $\frac{5}{35} = \frac{3}{21} \neq \frac{12}{90}$.** **Hence concludes that $l_1 \parallel l_2$.**	**1**

Q.No	What to look for	Marks
5	**Uses the properties of parallelograms to make the following equations:** **(i) 2 *x* + *y* = 5 *x*** **(ii) 5 *x* + 70° = 180°**	**1**
	Solves equation (ii) to get *x* = 22°.	**0.5**
	Substitutes *x* = 22° in equation (i) to get *y* = 66°.	**0.5**
6	**Takes average speed while walking and average speed of bus as *x* km/h and *y km/h* respectively.**	**0.5**
	Uses speed = $\frac{\text{distance}}{\text{time}}$ to frame equations $\frac{3}{x} + \frac{12}{y} = \frac{3}{2}$ and $\frac{5}{x} + \frac{10}{y} = 2$ respectively.	**1**
	Substitutes $\frac{1}{x} = m$ and $\frac{1}{y} = n$, where *m* and *n* are also variables.	**0.5**
	Solves equations *3m* + *12n* = 1.5 and *5m* + *10n* = 2 to find the values of *m* and *n* as $\frac{3}{10}$ and $\frac{1}{20}$ respectively.	**2**
	Finds the average speed of Anisha as *x* = $\frac{10}{3}$ km/h and average speed of bus as *y* = 20 km/h.	**1**

Chapter - 4
Quadratic Equations

Free Response Questions

Q: 1 **In the figure below, two concentric circles have centre O. Their radii are R and (R + 6) cm respectively.** **[5]**



(Note: The figure is not to scale.)

Find the lengths of the chords AB and CD. Show your work.

Q: 2 **Vitthal went on a long cycling round trip from his home to a nearby hill and back. The journey to the hill started with a 40 km flat road and then a 25 km uphill slope.** **[5]**

While going uphill, his average speed reduced by 10 km/hr compared to the flat road leading to an extra half-hour of travel time. However, he maintained the same average speed on the flat road in both directions.

i) Find the time taken by Vitthal to reach the end of 65 km stretch in the uphill direction.

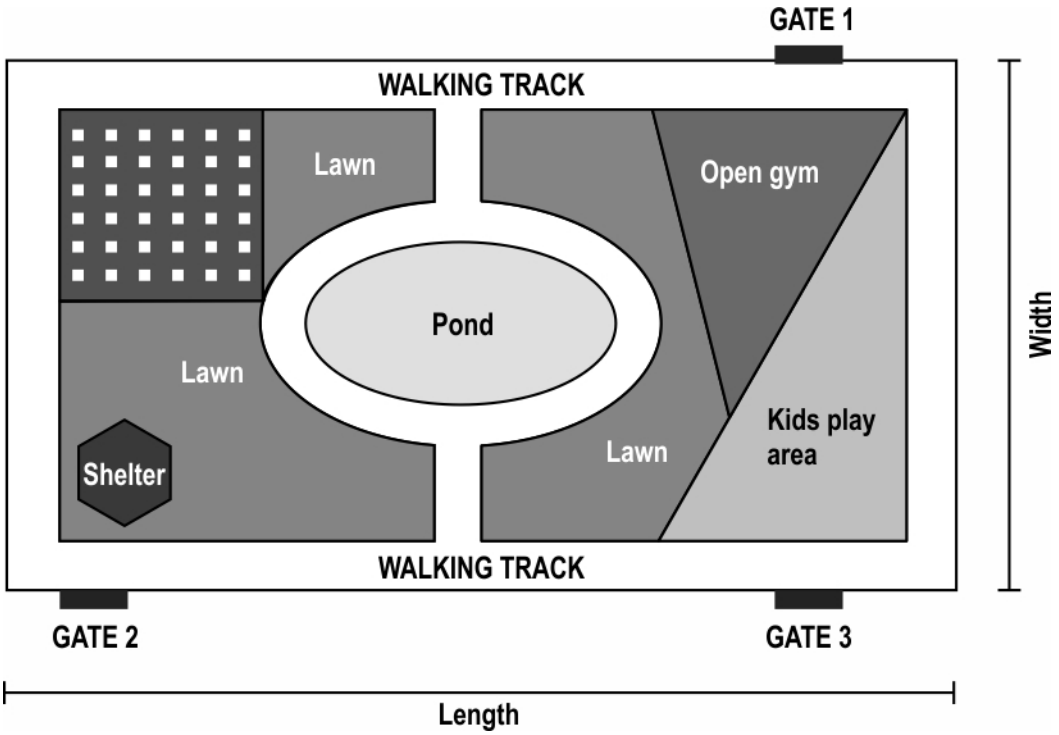
ii) If he took $2\frac{1}{2}$ hrs to reach home from the hill, find his average speed on the slope while descending.

Show your work.

Case Study

Study the given information and answer the questions that follow.

Bangalore city corporation is building parks in residential areas across the city. Shown below is one such park. The rectangular park consists of various components like walking track, kids play area, open gym, pond etc.



(Note: The image is not to scale.)

Q: 3 **Gate 3 has been placed exactly opposite to gate 1 on the boundary of the park. The distance between gate 3 and gate 2 is 1 m more than the distance between gate 3 and gate 2.** **[2]**

The shortest distance between gates 1 and 2 is 29 m, find the width of the park. Show your work.

Q: 4 **The caretaker of the park is attempting to plant saplings in the form of a square. That is, number of rows of saplings is the same as the number of columns of saplings. On arranging the saplings, he found that 24 saplings were still left with him. When he increased the number of rows and columns by 1, he found that he was short of 25 saplings.** **[2]**

Find the number of saplings available with him. Show your work.

Q: 5 **The city corporation is planning to install a rectangular sand table as shown below, for the kids in the play area. The carpenter is asked to design a rectangular table whose length is thrice its width and the area is 108 sq m.** **[1]**

(Note: The image is not to scale.)

Determine whether such a table can be made. Show your steps.

Q.No	What to look for	Marks
1	**Writes that a perpendicular from the centre to a chord bisects the chord, hence:** **AP = $\frac{1}{2}$ × AB = (R - 9) cm**	**0.5**
	Uses the pythagoras theorem in ΔAOP and writes the equation: **$(R)^2 = (R - 8)^2 + (R - 9)^2$**	**0.5**
	Solves the above equation to find the value of R as 5 cm and 29 cm.	**1.5**
	Replaces the values obtained of R in (2R - 18) cm and discards the value 5 cm because it gives negative value of AB. **Finds AB = 40 cm considering R = 29 cm.**	**1**
	Finds OQ = (29 - 1) = 28 cm and OC = (29 + 6) = 35 cm.	**0.5**
	Uses the pythagoras theorem in ΔCOQ and writes the equation for CQ as: **CQ = $\sqrt{[(35)^2 - (28)^2]}$ = 21 cm** **Finds the value of CD as 21 × 2 = 42 cm using the same logic as step 1.**	**1**
2	**i) Assumes Vitthal's average speed on the 40 km flat road to be *s* km/hr and the time taken by him to cover it as *t* hrs.** **Thus, finds the speed on the 25 km slope uphill as (*s* - 10) km/hr and the time taken to cover it as ($t + \frac{1}{2}$) hrs.** **Frames the equations:** **$s = \frac{40}{t}$ and** **(s - 10) = 25 ÷ ($t + \frac{1}{2}$)**	**1**
	Substitutes the value of *s* from the first equation into the second equation as: **$\frac{40}{t}$ - 10 = 25 ÷ ($t + \frac{1}{2}$)** **Simplifies the above equation to frame quadratic equation in *t* as:** **$t^2 - t - 2 = 0$**	**1.5**

Q.No	What to look for	Marks
	Factorises and solves the above equation to find the value of *t* as (-1) and 2. **Rejects (-1) and thus finds *t* as 2 hrs and ($t + \frac{1}{2}$) as $2\frac{1}{2}$ hrs.**	**1**
	Finds the time taken by Vitthal to reach the end of 65 km stretch in the uphill direction as: $2 + 2\frac{1}{2} = 4\frac{1}{2}$ **hrs.**	**0.5**
	ii) Writes that, Vitthal took 2 hrs to cover cover the flat road and hence finds the time taken to descend the 25 km slope as: $2\frac{1}{2} - 2 = \frac{1}{2}$ **hrs**	**0.5**
	Finds the speed on the slope while descending as: $25 \div \frac{1}{2} = 50$ **km/hr**	**0.5**
3	**Takes the distance between gates 1 and 3 as '*x*' m. Writes that the distance between gates 2 and 3 is (*x* + 1) m.** **Applies Pythagoras theorem to the triangle formed by gates 1, 2 and 3 and frames a quadratic equation as:** $x^2 + (x + 1)^2 = 29^2$ **or** $x^2 + x - 420 = 0$	**1**
	Solves the above quadratic equation and finds the value of *x* as 20m. **Concludes that the width of the park is 20m.**	**1**
4	**Takes the former number of rows and columns of saplings as *x* and finds the number of saplings available as** $x^2 + 24$.	**0.5**
	Takes the latter number of rows and columns of saplings as (*x* + 1) and finds the number of saplings available as $(x + 1)^2 - 25$.	**0.5**
	Equates the above two quadratic expressions and solves for *x* as: $x^2 + 24 = x^2 + 1 + 2x - 25$ $\Rightarrow x = 24$	**0.5**

Q.No	What to look for	Marks
	Finds the number of saplings available with the caretaker as $24^2 + 24 = 600$.	**0.5**
5	**Assumes the width as x, length as $3x$ and uses the given area to write the quadratic equation as:** **$3x^2 = 108$ or $x^2 - 36 = 0$**	**0.5**
	Finds the discriminant as $0^2 - (4)(1)(-36) = 144 > 0$ and concludes that it is possible to make such a table. **(Award full marks if the equation is solved to obtain $x = 6$ m instead of using the concept of discriminant.)**	**0.5**

Chapter - 5
Arithmetic Progressions

Multiple Choice Questions

Q: 1 **If a_n is the n^{th} term of an arithmetic progression whose common difference is d, then which of the following statements is valid?**

1. $a_{24} = a_1 + 24\,d$
2. $a_{25} = a_2 + 24\,d$
3. $a_{26} = a_2 + 24\,d$
4. None of these

Q: 2 **Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Read the statements carefully and choose the option that correctly describes statements (A) and (R).**

Assertion (A) **: The difference between any two consecutive terms in the sequence of numbers √6, √24, √54, √96, ... is 3√6.**

Reason (R) **: The sequence of numbers √6, √24, √54, √96, ... form an arithmetic progression.**

1. Both (A) and (R) are true and (R) is the correct explanation for (A).
2. Both (A) and (R) are true but (R) is not the correct explanation for (A).
3. (A) is false but (R) is true.
4. Both (A) and (R) are false.

Free Response Questions

Q: 3 **Determine whether the following sequence is an arithmetic progression or not.** **[1]**

(-12 + 12 *a*), (-11 + 11 *a*), (-10 + 10 *a*),... where *a* is any rational number.

Show your work.

Q: 4 **Amit makes the following statement:** **[1]**

"The sequence of positive integers divisible by 2 but not by 6 form an arithmetic progression."

Check if Amit's statement is true. Give reason for your answer.

Q: 5 **The 3 rd and the 14 th terms of an arithmetic progression are (-9) and (35) respectively.** **[5]**
Which term of this arithmetic progression is five times the 6 th term? Show your work.

Q.No	Correct Answers
1	3
2	3

Q.No	What to look for	Marks
3	Identifies the two sets of consecutive terms and finds the difference between the terms in each set by subtracting a term from its next term. For example, Second term - First term $=(-11 + 11a) - (-12 + 12a)$ $= -11 + 11a + 12 - 12a$ $= (1 - a)$ Third term - Second term $= (-10 + 10a) - (-11 + 11a)$ $= -10 + 10a + 11 - 11a$ $= (1 - a)$	0.5
	Compares the difference and concludes that the given sequence is an arithmetic progression.	0.5
4	Lists the sequence of positive integers divisible by 2 but not by 6 as 2, 4, 8, 10, ...	0.5
	Identifies that the difference between the 2 nd and the 3 rd terms is not equal to the previous difference. $(4 - 2) = 2 \neq (8 - 4) = 4$ Concludes that Amit's statement is false.	0.5
5	Writes the 3 rd and the 14 th terms of the AP as: $a + 2d = -9$ $a + 13d = 35$ where a is the first term and d is the common difference of the AP.	1
	Solves the above pair of linear equations to obtain the values of a and d as (-17) and 4 respectively.	1.5
	Formulates the equation to find the n th term which is five times the 6 th term as: $a + (n - 1)d = 5(a + 5d)$	1

Q.No	What to look for	Marks
	Substitutes the values of *a* and *d* in the above equation and solves it as follows. **-17 + 4(*n* - 1) = 5(-17 + 20)** **=> -17 + 4(*n* - 1) = 15** **=> 4(*n* - 1) = 32** **=> (*n* - 1) = 8** **=> *n* = 9** **Concludes that the required term is the 9 th term.**	**1.5**

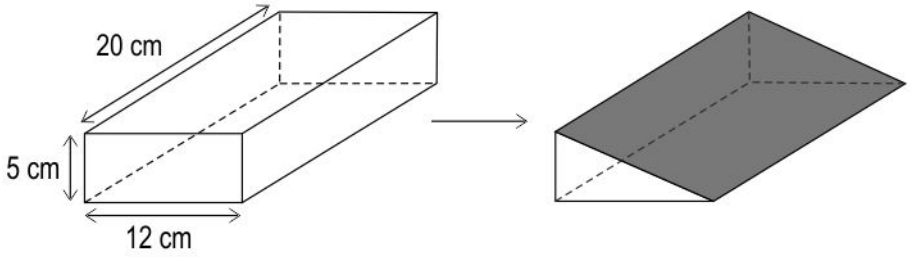
Chapter - 6
Triangles

Free Response Questions

Q: 1 **Give an example each for when two rectangles are:** **[1]**

i) similar.
ii) not similar.

Q: 2 **A painted cuboid, Solid P, is cut along a plane to get two identical solids. One of the identical solids, Solid Q, is shown below.** **[1]**

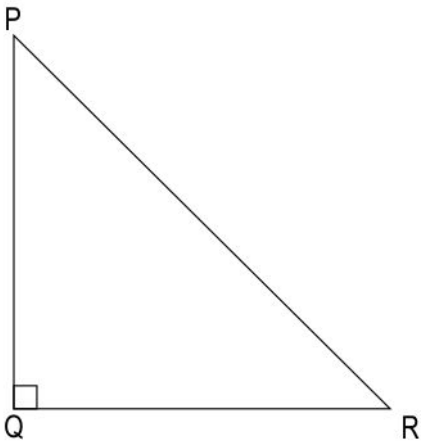


Solid P Solid Q

(Note: The figures are not to scale.)

What is the area of the face of Solid Q that is not painted? Show your work.

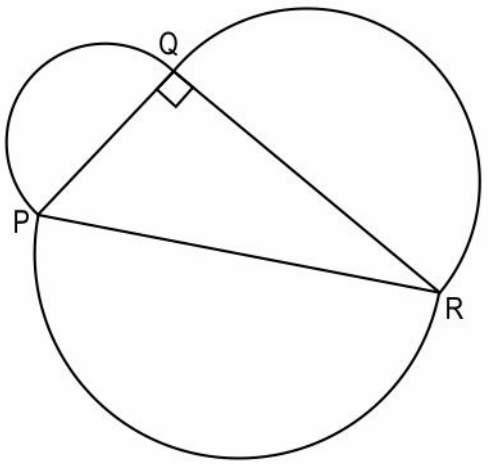
Q: 3 **Shown below is an isosceles right-angled ▲PQR. The area of ▲PQR is 18 cm^2.** **[1]**



(Note: The figure is not to scale.)

Find the length of PR. Show your work.

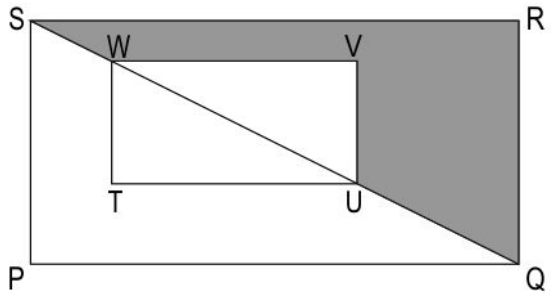
Q: 4 **Shown below is a figure. ▲PQR is a right-angled triangle. There are 3 semicircles with diameters as sides of ▲PQR. All length measurements are in cm.** **[3]**



(Note: The figure is not to scale.)

Show that the sum of the areas of semicircles with diameters PQ and QR is equal to the area of semicircle with diameter PR.

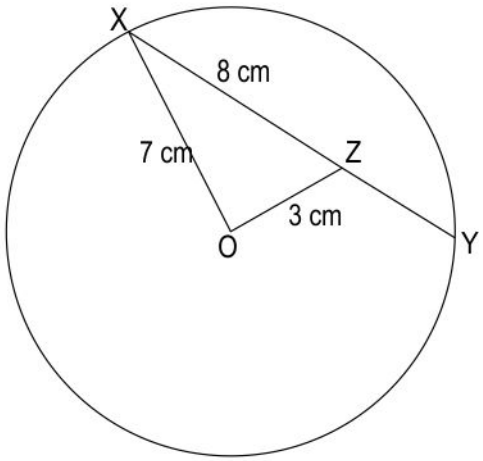
Q: 5 **Shown below is a figure with two rectangles. The ratio of UV:VW = QR:RS = 3:4. Area of TUVW is 36 cm^2.** **[3]**



(Note: The figure is not to scale.)

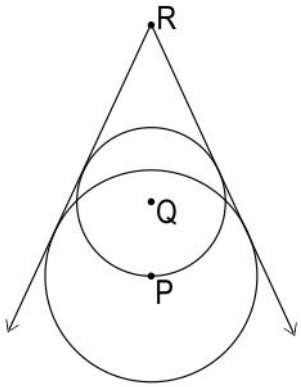
What is the area of the shaded region? Show your work.

Q: 6 **i) Two chords of a circle, PQ and MN intersect at a point T. Show that PT × TQ = MT × TN. Draw a figure.** **[5]**
ii) Shown below is a circle with centre O. Use the result from part i) to find the length of ZY. Show your work.



(Note: The figure is not to scale.)

Q: 7 **In the figure below, P, Q and R are collinear. P and Q are centres of the two circles. P lies on the circumference of the circle with centre Q. R is 10 cm from Q and 15 cm from P. Both circles have 2 common tangents from point R.** **[5]**



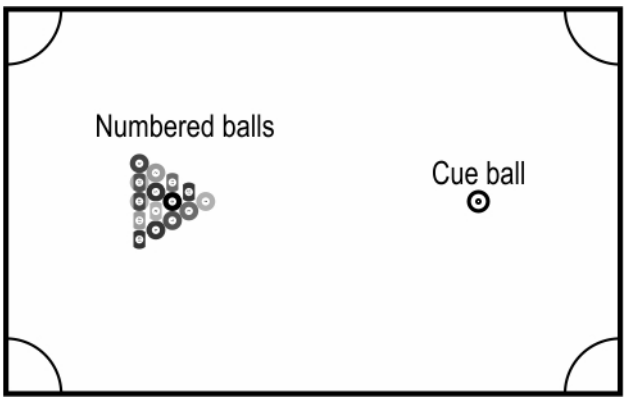
(Note: The figure is not to scale.)

Find the radius of circle P. Draw a rough figure and show your steps.

Case-Based Questions

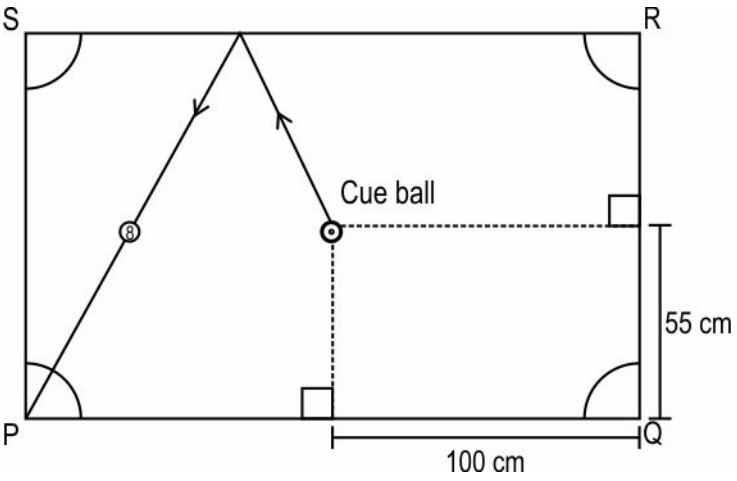
Answer the questions based on the given information.

The rectangular playing top of a pool table is 220 cm long and 110 cm wide. It has 4 pockets in the corners. When a ball hits a side of the table, it bounces off the side at the same angle as it hit that side. There are two kinds of balls - a white cue ball and 15 numbered coloured balls. The cue ball must be used hit a numbered ball into one of the pockets. Shown below is a pool table.



(Note: The figure is not to scale.)

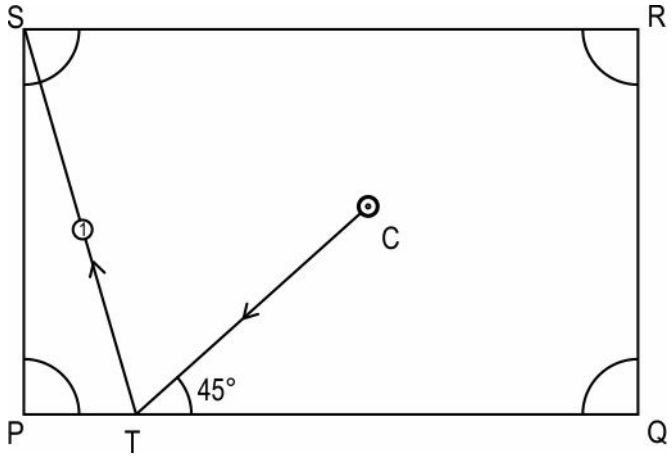
Q: 8 **Tanmay had hit a numbered ball into pocket P. The path followed by the cue ball and ball 8 is shown below. The cue ball's initial distance from the edges of the table is marked in the figure.** **[3]**



(Note: The figure is not to scale.)

What is the distance of the cue ball from pocket S when the ball hits side RS? Draw a diagram and show your work.

Q: 9 **Shown below is the path when Tanmay hits a ball number 1 in pocket S. The distance CT is 50 cm and TS is 120 cm. The cue ball hits the side PQ at an angle of 45°.** **[2]**

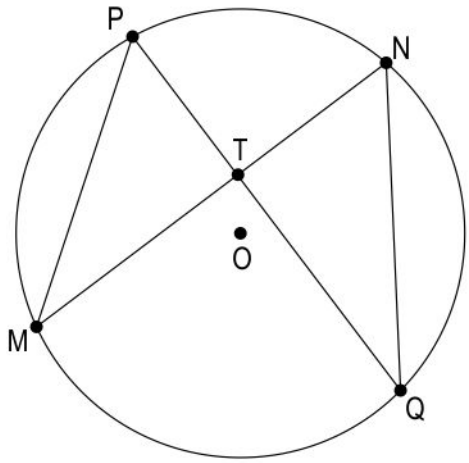


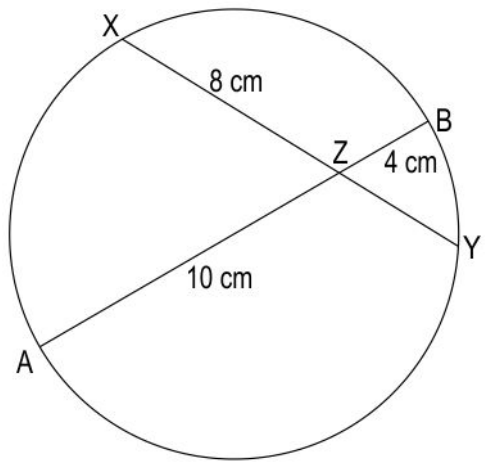
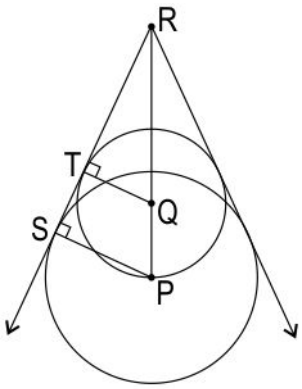
(Note: The figure is not to scale.)

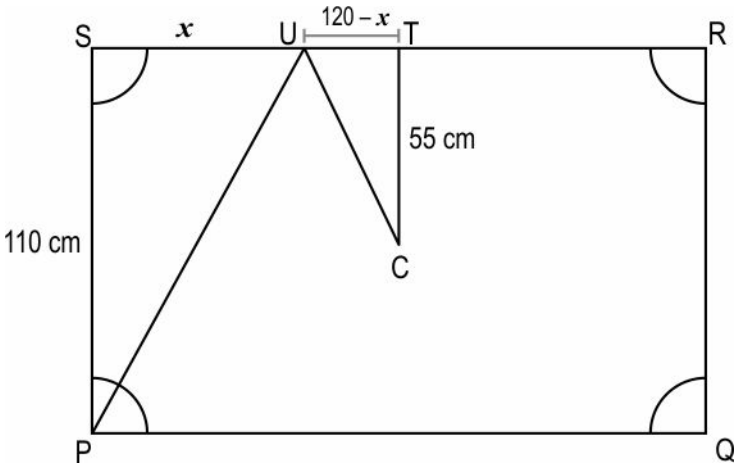
Find the distance between the cue ball's initial position and pocket S. Draw a rough figure, show your work and give valid reasons.

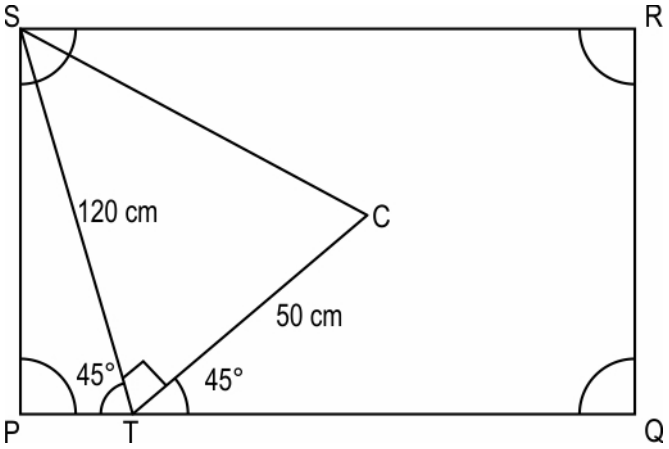
Q.No	What to look for	Marks
1	**i) Writes an example for when two rectangles are similar. For example,** **rectangle 1 has length and breadth of 3 cm and 4 cm respectively.** **rectangle 2 has length and breadth of 6 cm and 8 cm respectively.**	**0.5**
	ii) Writes an example for when two rectangles are not similar. For example, **rectangle 1 has length and breadth as 1 cm and 4 cm respectively.** **rectangle 2 has length and breadth as 2 cm and 5 cm respectively.**	**0.5**
2	**Finds the diagonal of the front face of Solid P as √(25 + 144) = 13 cm.**	**0.5**
	Finds the area of the face of Solid Q that is not painted as 13 × 20 = 260 cm^2.	**0.5**
3	**Assumes PQ = QR as *m* and writes the equation for the area of the triangle as:** $\frac{1}{2} \times m^2 = 18$ $\Rightarrow m = 6$	**0.5**
	Uses the Pythagoras theorem to find the length of PR as: $\sqrt{(m^2 + m^2)}$ $= 6\sqrt{2}$ cm	**0.5**
4	**Finds the area of semicircle with diameter PQ as:** $\frac{\pi PQ^2}{8}$ cm^2	**0.5**
	Finds the area of semicircle with diameter QR as: $\frac{\pi QR^2}{8}$ cm^2	**0.5**
	Finds the area of semicircle with diameter PR as: $\frac{\pi PR^2}{8}$ cm^2	**0.5**

Q.No	What to look for	Marks
	Finds the sum of the areas of semicircles with diameters PQ and QR as: $\frac{\pi PQ^2}{8} + \frac{\pi QR^2}{8} = \frac{\pi(PQ^2+QR^2)}{8}$ cm^2	**0.5**
	Uses the pythagoras theorem in ▲PQR to write $PQ^2 + QR^2 = PR^2$ and simplifies the above expression as: $\frac{\pi PR^2}{8}$ cm^2 **Hence, concludes that the sum of the areas of semicircles with diameters PQ and QR is equal to the area of semicircle with diameter PR.**	**1**
5	**Writes that in ▲UVW and ▲QRS,** $\frac{UV}{QR} = \frac{VW}{RS} = \frac{3}{4}$ **(given)** **∠UVW = ∠QRS (90°)**	**0.5**
	Concludes that ▲UVW ~ ▲QRS by SAS criterion of similarity.	**0.5**
	Finds area of ▲UVW as $\frac{1}{2} \times 36 = 18$ cm^2.	**0.5**
	Finds the area of ▲QRS as $18 \times \frac{16}{9} = 32$ cm^2.	**1**
	Finds the area of the shaded region as $32 - 18 = 14$ cm^2.	**0.5**

Q.No	What to look for	Marks
6	**i) Draws a circle with chords PQ and MN. Joins PM and QN to form △PMT and △NQT. The figure may look as follows:**  	**1**
	Writes that in △PMT and △NQT, **∠PMT = ∠NQT (angles in the same segment subtended by the same arc)** **∠TPM = ∠TNQ (angles in the same segment subtended by the same arc)** **Hence, △PMT ~ △NQT by AA similarity criterion.**	**1.5**
	Uses the above to write the ratio of sides as: $\frac{MT}{TQ} = \frac{PT}{TN}$ **=> PT × TQ = MT × TN**	**1**

Q.No	What to look for	Marks
	ii) Draws a rough figure with diameter AB. The figure may look as follows:  	**1**
	Finds length of ZY as $\frac{10\times4}{8}$ = 5 cm.	**0.5**
7	**Draws a rough figure with the radii of the two circles. The figure may look as follows:**  	**1**
	Writes that in ▲PSR and ▲QTR, **∠PRS = ∠QRT (common)** **∠PSR = ∠QTR = 90° (radius is perpendicular to the tangent at the point of contact)**	**1.5**

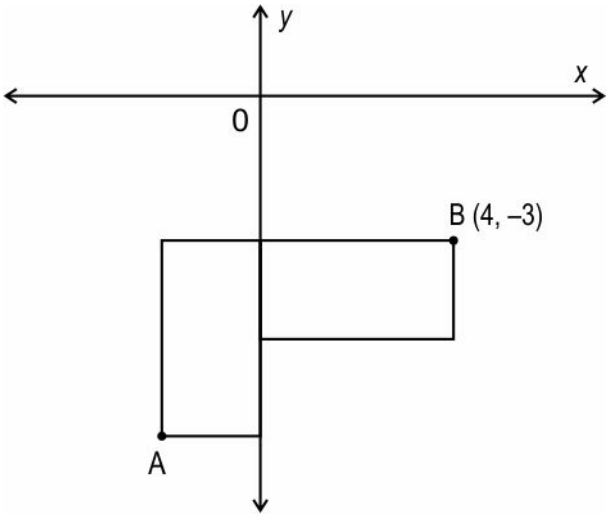
Q.No	What to look for	Marks
	Uses the above step to conclude that by AA criterion of similarity, ▲PSR ~ ▲QTR	**0.5**
	Finds the radius of circle Q as PR - PQ = 15 - 10 = 5 cm.	**0.5**
	Uses step 3 to write the ratio of sides as: $\frac{PS}{QT} = \frac{PR}{QR}$ $\Rightarrow \frac{PS}{5} = \frac{15}{10}$	**1**
	Uses the above step to find the radius of circle P as $\frac{15}{2}$ or 7.5 cm.	**0.5**
8	**Assumes SU as *x* cm and draws a rough diagram. The figure may look as follows:**  **(Note: The figure is not to scale.)**	**0.5**
	Writes that, in ▲PSU and ▲CTU, **∠PSU = ∠CTU = 90°** **∠SUP = ∠CUT (Angle at which ball hits = angle at which it bounces off)**	**1**
	Uses the above step to conclude that by AA criterion of similarity of triangles, ▲PSU ~ ▲CTU.	**0.5**

Q.No	What to look for	Marks
	Writes the ratio of the sides as: $\frac{x}{120-x} = \frac{110}{55}$	**0.5**
	Solves the above equation for *x* to find the distance of the ball from pocket S when the ball hits side RS as 80 cm.	**0.5**
9	**Draws a rough diagram. The diagram may look as follows:**  ***(Note: The figure is not to scale.)***	**0.5**
	Writes that, since the ball bounces off the side at the same angle as it hit that side, ∠CTS = 90°.	**0.5**
	Writes that, by using the Pythagoras theorem in ▲WVU, the distance between the cue ball's initial position and pocket S is $\sqrt{(50^2 + 120^2)}$ = 130 cm.	**1**

Chapter - 7
Coordinate Geometry

Multiple Choice Questions

Q: 1 **Shown below are 2 identical rectangles such that their breadth is half their length.**

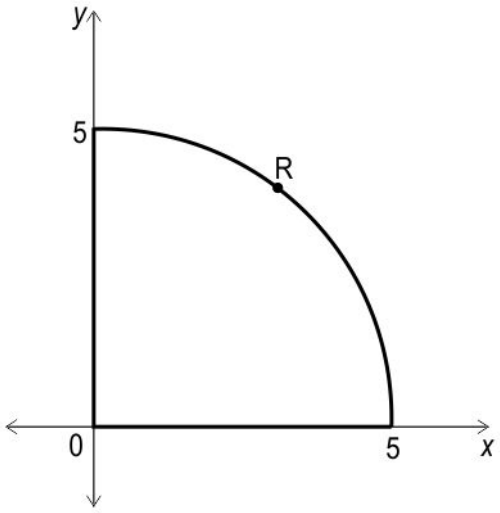


What are the coordinates of point A?

1 (4, -5) **2** (-4, -6) **3** (-2, -7) **4** (-2, -9)

Free Response Questions

Q: 2 **Shown below is a quarter of a circle with centre at (0, 0). An arbitrary point R lies on the boundary of the quadrant.** **[1]**

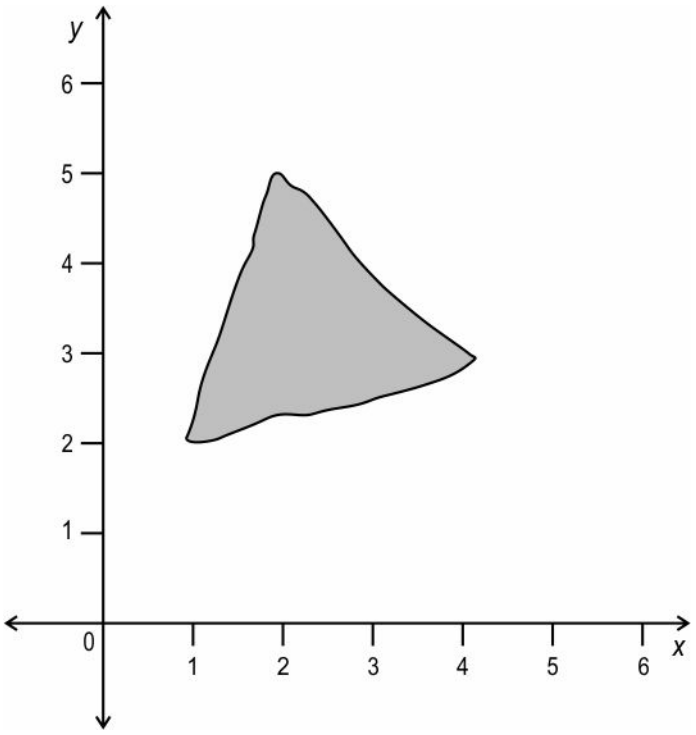


Write one possible pair of coordinates of point R.

Q: 3 **A circle has its centre at the origin. The radius of the circle is 5 units.** **[1]**

Does the point (3, -5) lie inside the circle, on its circumference or outside the circle? Show your work.

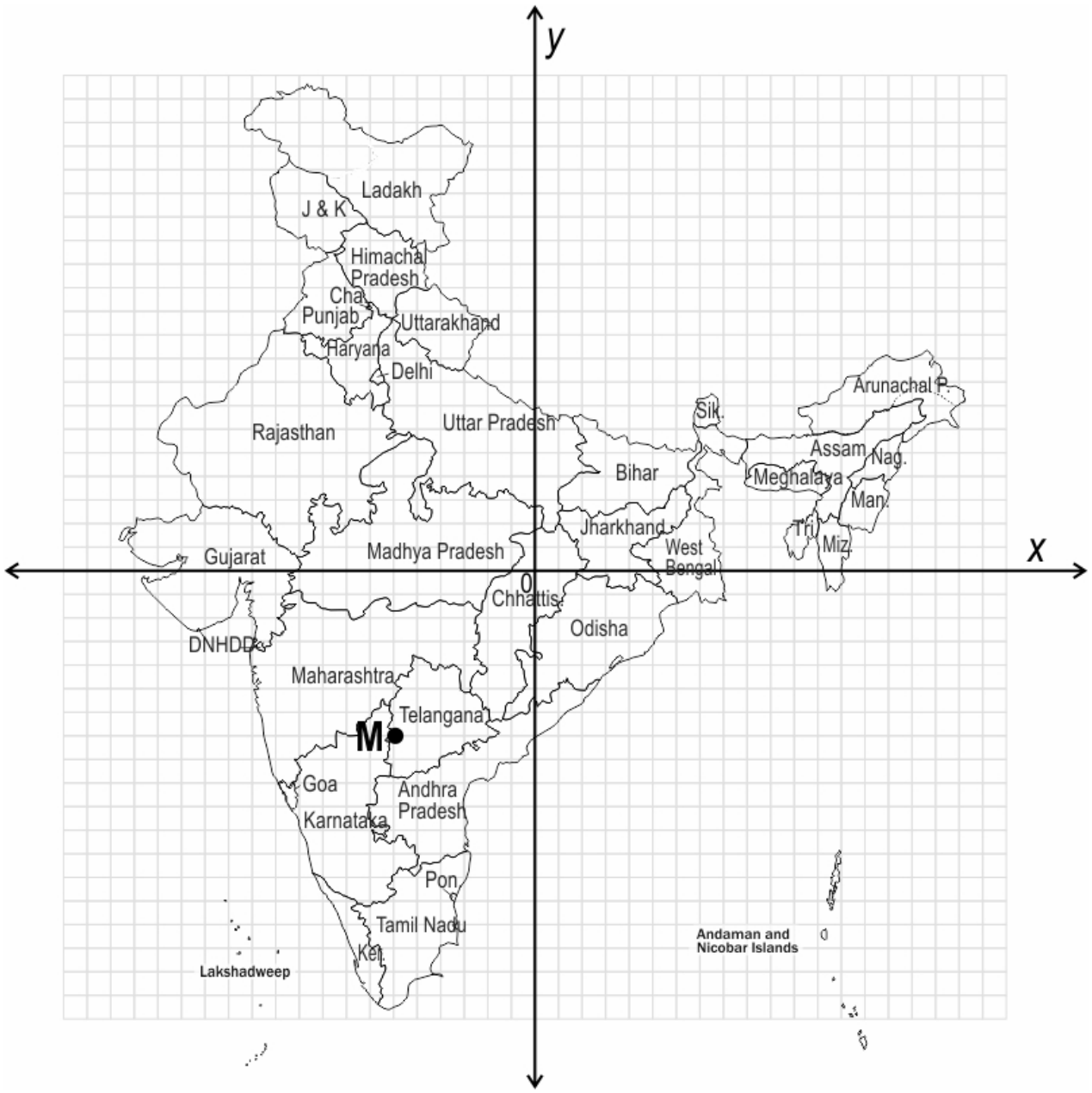
Q: 4 **Arshad was eating chips while working with graph paper. One chip fell on his graph paper as shown below.** **[2]**



Out of curiosity, he tried estimating the area of his chip.

What is the approximate area occupied by the chip? Show your work.

Q: 5 **Shown below is the map of India put on a coordinate plane where each small square represents 1 sq unit.** **[5]**



Alok has to travel from his home at point (0, 5) in Uttar Pradesh to point M(-6,-7) in Telangana. Assume that his travels happen in the shortest straight path.

i) Find the approximate distance he travels from his home to reach point M in Telangana.
ii) He plans to take 2 stops in his journey such that their journey is divided into 3 equal parts. Find the coordinates of his stops and the corresponding state.

Show your work.

Q.No	Correct Answers
1	3

Q.No	What to look for	Marks
2	Identifies the radius of the quadrant as 5 units, assumes the coordinates of point P as (x, y) and uses the distance formula to write: $x^2 + y^2 = 25$	0.5
	Writes one possible pair satisfying the above equation. For example, (3, 4).	0.5
3	Finds the distance of the point (3, -5) from the origin as: $\sqrt{\{3^2 + (-5)^2\}} = \sqrt{34}$ units	0.5
	Writes that since $\sqrt{34} > 5$, the point (3, -5) lies outside the circle.	0.5
4	Considers the coordinates of the triangular chip as (1, 2), (4, 3) and (2, 5).	0.5
	Writes the expression to estimate the area of the chip as $\frac{1}{2}[(3 - 5) + 4(5 - 2) + 2(2 - 3)]$.	1
	Evaluates the above expression and finds the approximate area occupied by the chip as 4 square units.	0.5
5	i) Finds the distance from his home to point (-6, -7) in Telangana as: $\sqrt{\{(-6 - 0)^2 + (-7 - 5)^2\}} = \sqrt{180}$ units	1
	ii) Finds the first stop by taking the ratio 1:2 and using section formula as: $\left(\frac{0-6}{3}, \frac{10-7}{3}\right)$ $= (-2, 1)$	1.5
	Locates the point (-2, 1) and identifies the corresponding state as Chattisgarh.	0.5
	Finds the second stop by using the midpoint formula as: $\left(\frac{-2-6}{2}, \frac{1-7}{2}\right)$ $= (-4, -3)$ (Award full marks if the section formula is used using the ratio 2:1.)	1.5

Q.No	What to look for	Marks
	Locates the point (-4, -3) and identifies the corresponding state as Telangana.	0.5

Chapter - 8
Introduction to Trigonometry

Multiple Choice Questions

Q: 1 **In a right-angled triangle, there is an acute angle *p* such that tan *p* = $\frac{12}{5}$.**

What is the value of sec (90° - *p*)?

1 $\frac{5}{13}$ **2** $\frac{5}{12}$ **3** $\frac{12}{13}$ **4** $\frac{13}{12}$

Q: 2 **Two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Read the statements carefully and choose the option that correctly describes statements (A) and (R).**

***Assertion (A)* : The value of tan 20° = $\frac{\tan 60°}{3}$ = $\frac{\sqrt{3}}{3}$.**

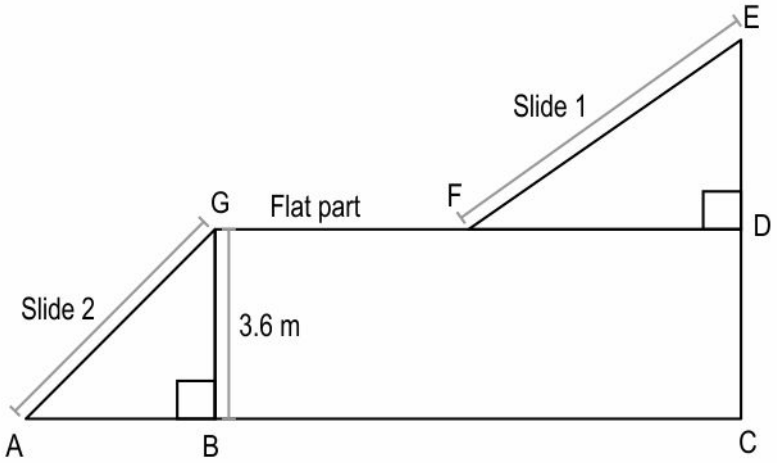
***Reason (R)* : For an acute angle θ, tan ($\frac{1}{3}$ θ) = $\frac{1}{3}$ tan θ.**

1 Both (A) and (R) are true and (R) is the correct explanation for (A).
2 Both (A) and (R) are true but (R) is not the correct explanation for (A).
3 (A) is false and (R) is true.
4 Both (A) and (R) are false.

Case-Based Questions

Study the given information and answer the questions that follow.

Shown below is the rough figure of the side view of a proposed water slide which has to be constructed in a water park.



(Note: The figure is not to scale.)
(Take √2 = 1.4, √3 = *1.7, wherever required.)*

Q: 3 **What should be the measure of the angle between slide 2 and ground if the length of AB is 1.2√3 m?**

1 30° **2** 45° **3** 60° **4** 90°

Q: 4 **What should be the value of tan AGB if the length of slide 2 is 6 m?**

1 $\frac{4}{3}$ **2** $\frac{4}{5}$ **3** $\frac{3}{4}$ **4** $\frac{3}{5}$

Q: 5 **If slide 1 makes an angle of 150° with the flat part and FD = 8.5 m, what is the height of the top point of slide 1 from the ground (EC)?**

1 5 m **2** 8.6 m **3** 10 m **4** 12.1 m

Q: 6 **What should be the length of slide 2 if the angle between slide 2 and ground is 30°?**

1 4.24 m **2** 5.04 m **3** 6.12 m **4** 7.2 m

Q: 7 **If ∠GAB = ∠EFD and ∠AGB = ∠FED, which of these is equal to sec ∠GAB?**

1 cos ∠EFD **2** cos ∠AGB **3** cosec ∠FED **4** cosec ∠EFD

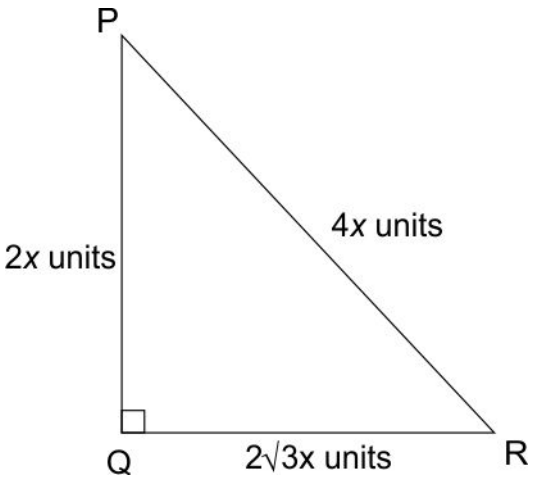
Free Response Questions

Q: 8 **Consider the statement given below.** **[1]**

In a right triangle, the value of cos A = √2 for some acute angle A.

Is the statement true or false? Give a valid reason.

Q: 9 **Shown below is a right-angled △PQR.** **[1]**



(Note: The figure is not to scale.)

What is measure of ∠QPR? Show your work.

Q: 10 **Prove that:** **[5]**

$$(1 + \tan x + \sec x)^2 = 2(1 + \sec x)(\sec x + \tan x)$$

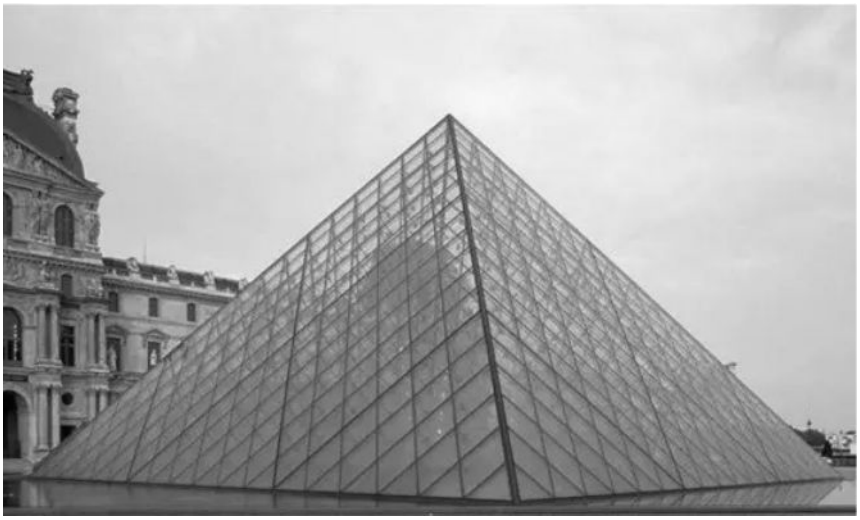
Q.No	Correct Answers
1	4
2	4
3	3
4	1
5	2
6	4
7	3

Q.No	What to look for	Marks
8	Writes that cos A = $\frac{\text{adjacent}}{\text{hypotenuse}}$, as hypotenuse is the largest side in a right triangle, the cosine ratio is always less than 1.	0.5
	Concludes that as √2 > 1, the given statement is false.	0.5
9	Uses an appropriate trigonometric ratio and finds the measure of ∠QPR as 60°. For example: tan ∠QPR = $\frac{2\sqrt{3}x}{2x}$ = tan 60° => ∠QPR = 60°	1
10	Expands the LHS of the given equation as: $1 + \tan^2 x + \sec^2 x + 2\tan x + 2\sec x + 2(\tan x)(\sec x)$	1
	Uses the identity $\sec^2 x - \tan^2 x = 1$ to simplify the above expression as: $2\sec^2 x + 2\tan x + 2\sec x + 2(\tan x)(\sec x)$	2
	Regroups the above expression as: $2\sec x (\sec x + 1) + 2\tan x (\sec x + 1)$	1
	Completes the factorisation of the above expression to get RHS as: $2(1 + \sec x)(\sec x + \tan x)$	1

Chapter - 9
Some Applications of Trigonometry

Multiple Choice Questions

Q: 1 **Shown below is The Louvre Museum, the world's most visited museum. In the shape of a square pyramid, it is 21.6 m high and has a base of edge 34 m.**

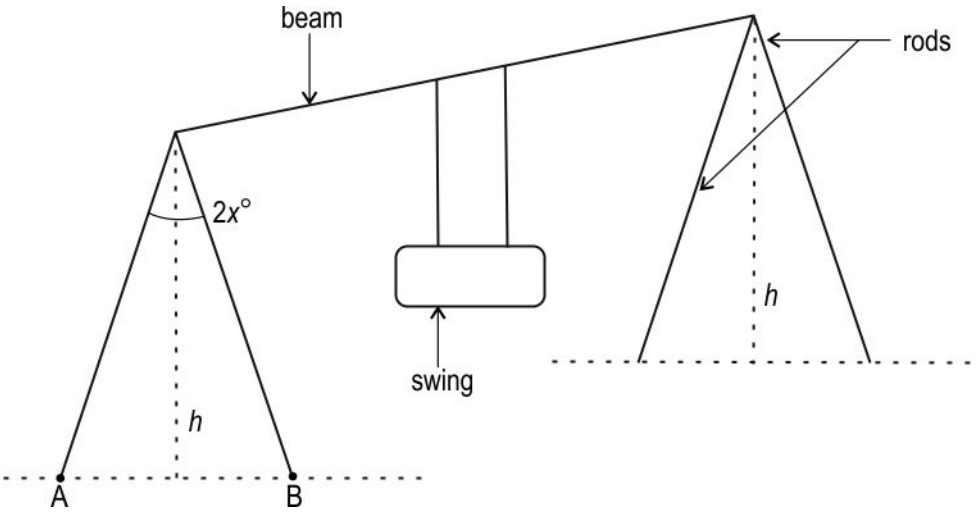


(Note: The image is for representation purpose only)

Which of these angles is closest to the angle of elevation of the top of the museum from the mid-point of its 34 m edge?

1 30° **2** 50° **3** 60° **4** 75°

Q: 2 **A park has a swing which is suspended to a beam. The beam is supported by a pair of identical rods on either side as shown in the figure below.**



The height of the beam from the ground is *h* metres and the angle between the rods on each side is 2 *x*°.

Which of the following is an appropriate expression for the distance AB, in terms of *h* and *x* ?

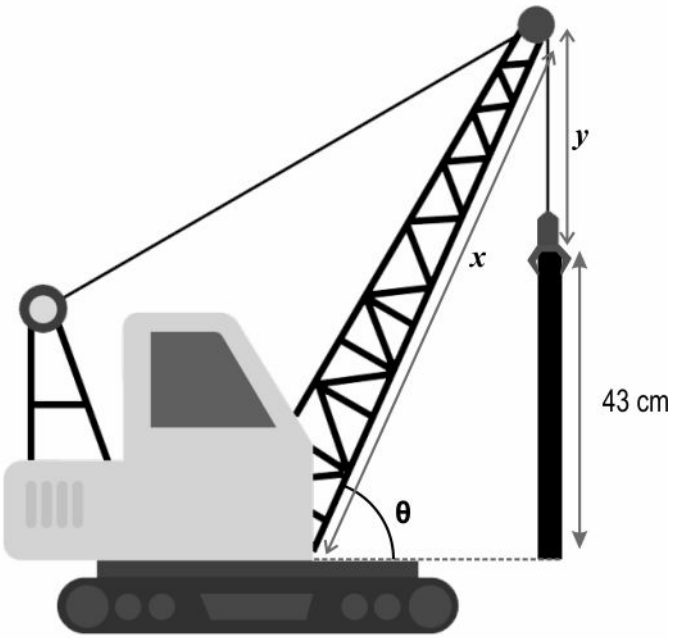
1 $h \tan 2x$

2 $2h \cot x$

3 $2h \tan x$

4 $2h \tan 2x$

Q: 3 **Ananya, Suman and Dipti see a crane lifting a metal rod, as shown in the following figure. They notice that more precision must be required in operating the crane as the rod gets closer to the base of the crane, since the rod could hit the crane if it tilts.**



(Note: The figure is not to scale.)

Taking the length of the crane's arm as *x* metres, and the length of the hanging line as *y* metres, they find the approximate horizontal distance between the end of the rod and the base of the crane's arm as follows:

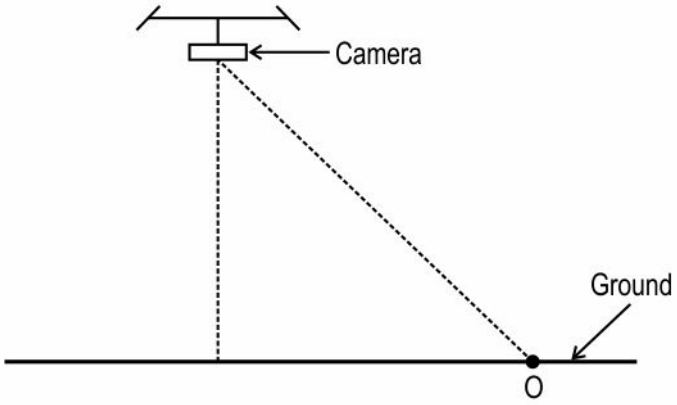
Ananya: $\frac{\tan\theta}{(y+43)}$**m**
Suman: *x* cos θ m
Dipti: *x* cosec θ m

Who is/are correct?

1 only Ananya
2 only Suman
3 only Suman and Dipti
4 only Ananya and Suman

Free Response Questions

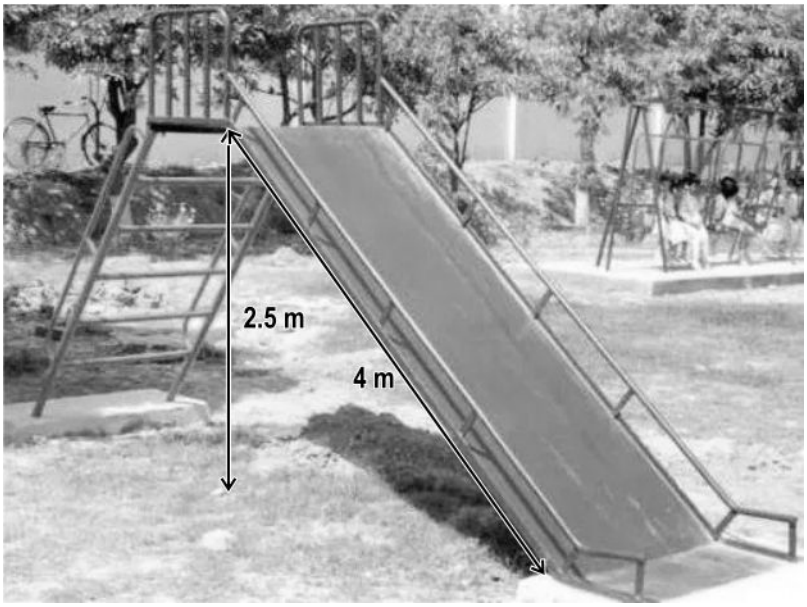
Q: 4 **A drone camera is used by a photographer for shooting videos. On some day, it is focussing at point O on the ground as shown in the figure.** **[1]**



The camera is at a perpendicular height of 6 m from the ground and at a distance of 4√3 m from point O.

Find the angle of depression of point O from the camera. Show your steps.

Q: 5 **Ajay wants to play on a newly installed slide in the playground, as shown in the figure below.** **[1]**



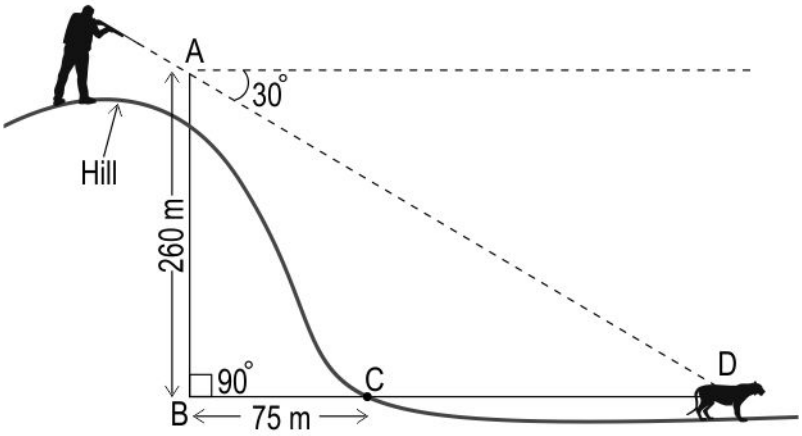
(Note: The figure is not to scale.)

For a slide to be safe for use, it is to be installed with the specification that the angle made by the slide with the ground should be less than 45°.

Is the slide in the playground safe for Ajay to use? Explain your reasoning.

(Note: Use √2 as 1.4.)

Q: 6 **A hunter is asked to stun a man-eater lioness with a stun gun from the top of a cliff. The angle of depression of the gun from the lioness is 30°. The vertical distance between point A and the lioness is 260 m and BC = 75 m (horizontal distance between point A to base point of the cliff).** **[1]**

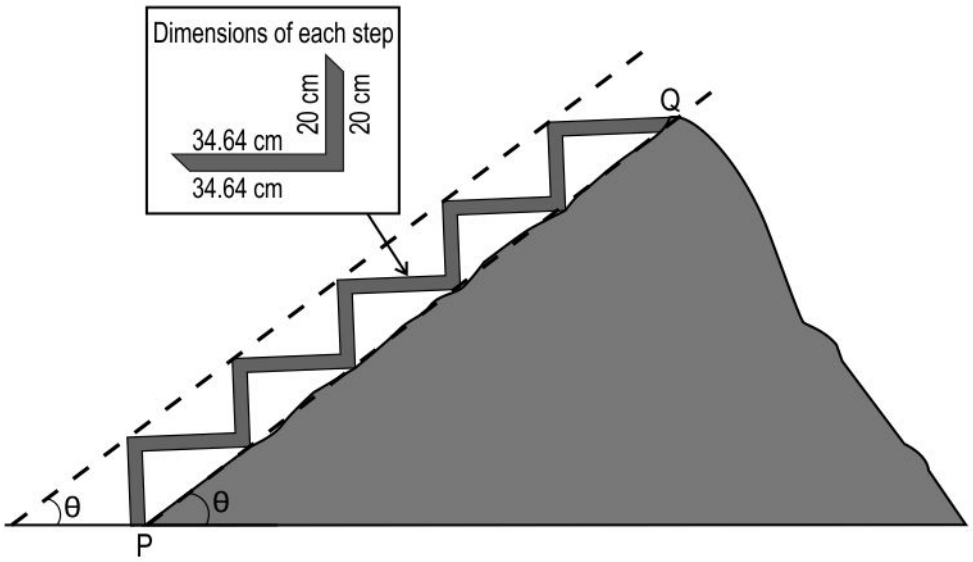


(*Note: The figure is not to scale*)

How far from point C at the base is the lioness standing? Round to the nearest whole number and show your work.

(*Note: Take √2 as 1.41 and √3 as 1.73.*)

Q: 7 **A hiking trail is built using stones' steps to reach the top of a small hill as shown below. There are a certain number of similar steps built each 34.64 cm wide and 20 cm high.** **[1]**

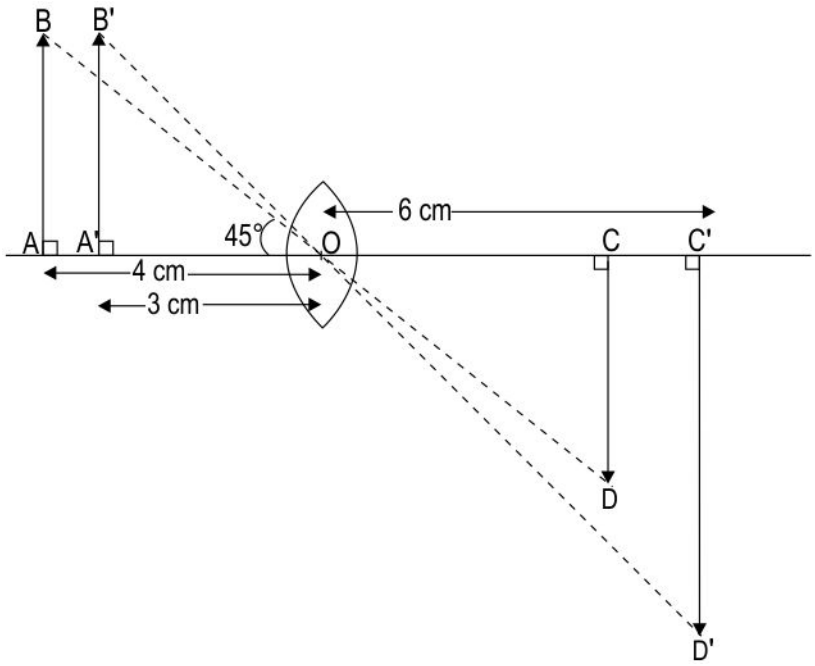


(Note: The figure is not to scale.)

What is the approximate angle of elevation from the point P at the base of the hill to peak Q? Show your work.

(*Note: Take √2 as 1.414 and* √3 as 1.732.)

Q: 8 **An inverted image CD is formed on the other side when an object AB is positioned in front of a convex lens at a distance of 4 cm from point O. Similarly, when the same object is placed at a distance of 3 cm, it forms an image C'D' as depicted in the diagram.** **[2]**



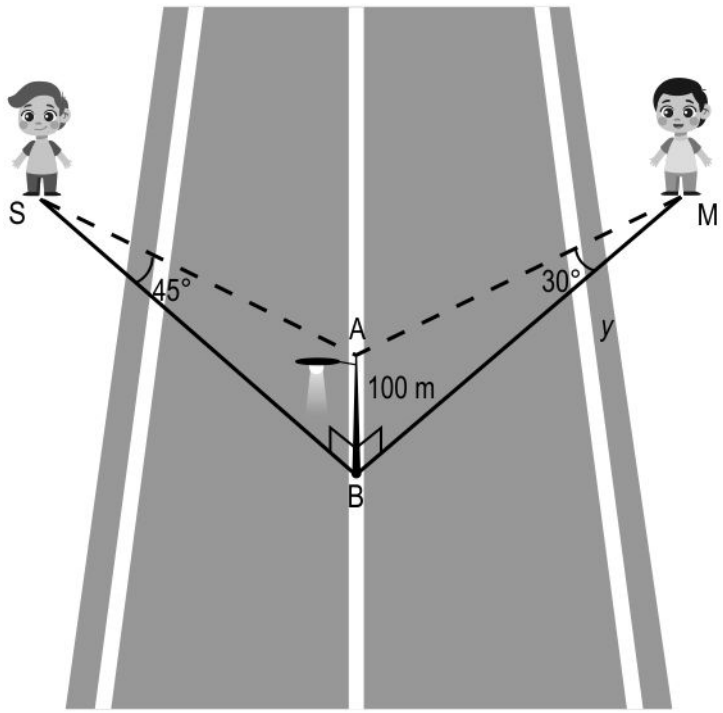
(Note: The figure is not to scale.)

i) Find the height of the object AB.

ii) Find the height of the image C'D'.

Show your work.

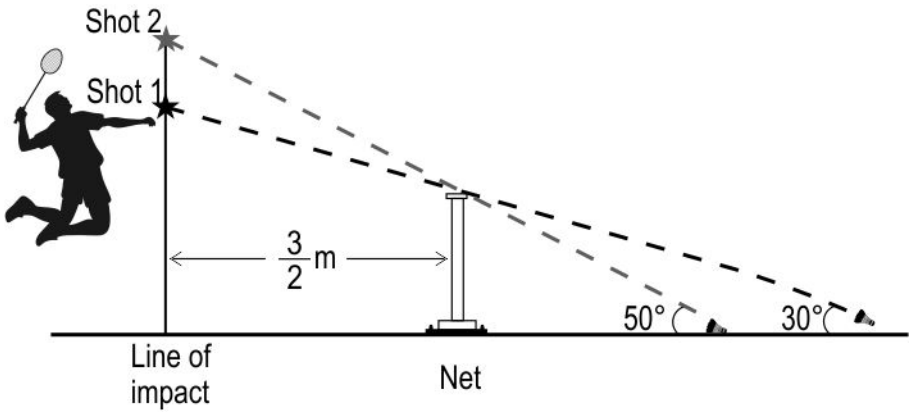
Q: 9 **Shoaib and Mihir are playing in their school playground which has a 100 m light pole. Shoib is standing towards the north of the light pole and Mihir is standing towards the east of the light pole. From the point where Shoaib and Mihir stand, the angle of elevation of the top of the pole is 45° and 30° respectively, as shown in the image below.** **[3]**



(Note: The figure is not to scale.)

Find the shortest distance between Shoib and Mihir. Show your work.

Q: 10 **A smash shot in badminton is when the shuttlecock travels in a straight line just above the nets. The line of impact and the net are perpendicular to the horizontal ground.** **[3]**

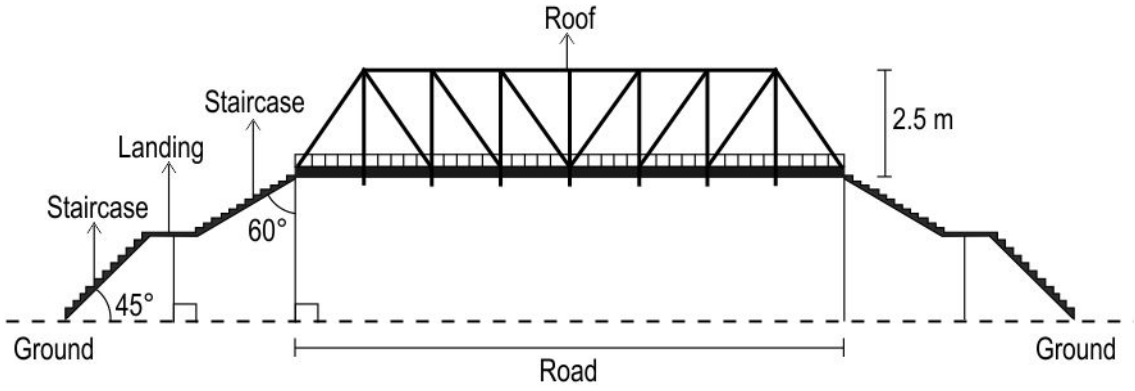


(Note: The figure is not to scale.)

How much higher is shot 2 than shot 1? Draw a rough diagram and show your work.

(Note: Take sin 30° as 0.5, cos 30° as 0.9, sin 50° as 0.8 and cos 50° as 0.6.)

Q: 11 **A pedestrian bridge is built across a main road to help pedestrians cross the road safely without slowing the traffic as shown below.** **[5]**

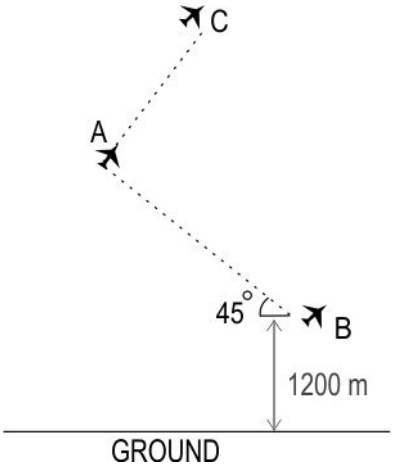


(*Note: Figure is not to scale.*)

The length of each staircase is approximately 3 metres and the length of each landing is 2 metres.

Find the approximate height of the roof from the ground. Show your work.

Q: 12 **Three fighter pilots are participating in a training activity. For one particular maneuver, planes A and C are at an altitude above plane B as shown below.** **[5]**



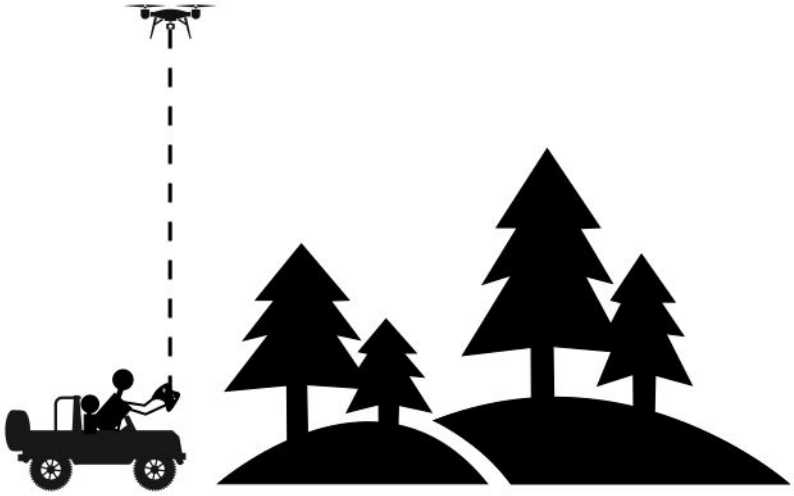
♦ The horizontal distance between planes A and B is equal to plane B's altitude.
♦ Planes A, B and C are placed such that ∠BAC = 90°, and the angle of elevation of plane C from plane B is 75°.

Find the:
i) altitude of plane A.
ii) shortest distance between planes A and C.
iv) shortest distance between planes B and C.

(Note: Consider the planes as point sized objects; the figure is not to scale.)

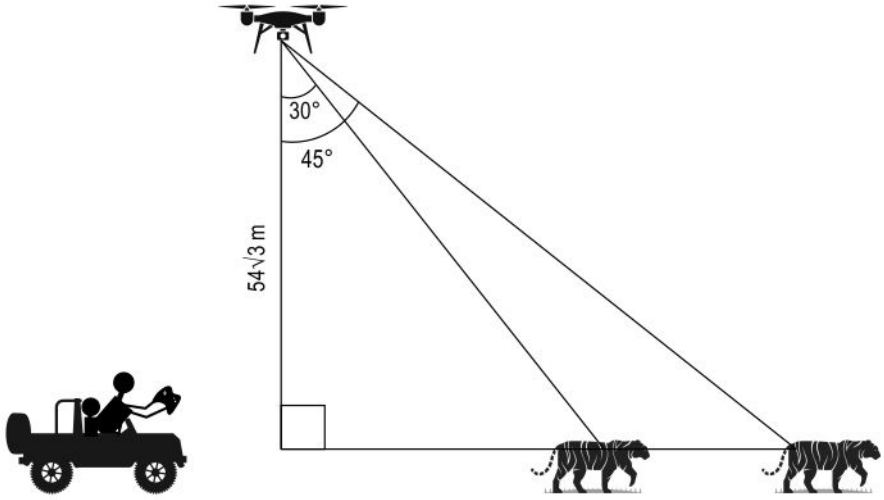
Case-Based Questions

Answer the questions based on the given information.
A drone, is an aircraft without any human pilot and is controlled by a remote control device. Its various applications include policing, surveillance, photography, precision agriculture, forest fire monitoring, river monitoring and so on.
David used an advanced drone with high resolution camera during an expedition in a forest region which could fly upto 100 m height above the ground level. David rode on an open jeep to go deeper into the forest. The initial position of drone with respect to the open jeep on which David was riding is shown below.



David started flying the drone as soon as the jeep started moving to enter the forest at an average speed of 10 m/s in the same direction as that of the jeep.

Q: 13 **At some point during the expedition, David kept the drone stationary for some time to capture the images of a tiger. The angle of depression from the drone to the tiger changed from 30° to 45° in 3 seconds as shown below.** **[2]**

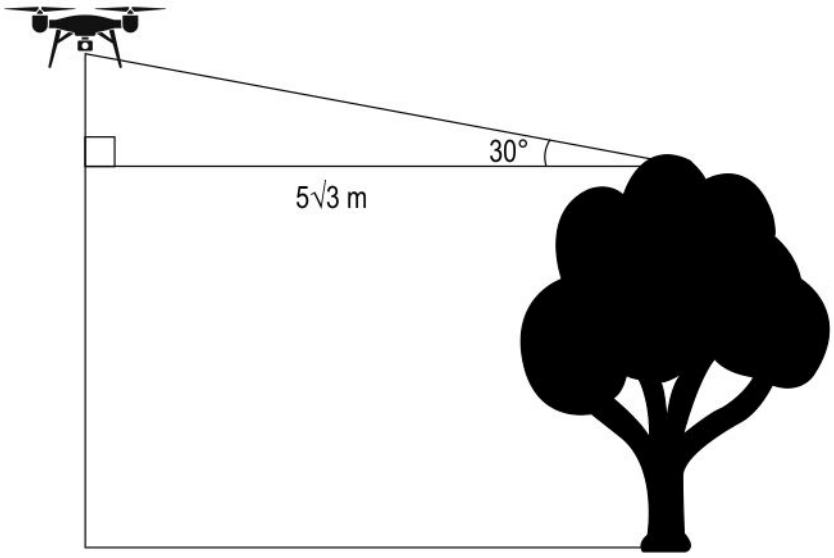


(Note: The figure is not to scale.)

What was the average speed of the tiger during that time? Show your work.

(Note: Take √3 as 1.73.)

Q: 14 **David reached near one of the tallest trees in the forest. He stopped the drone at a horizontal distance of 5√3 m from the top of the tree and at a vertical distance of 65 m below its maximum vertical range.** **[1]**



(Note: The figure is not to scale.)

If the angle of elevation of the drone from the top of the tree was 30°, find the height of the tree. Show your work.

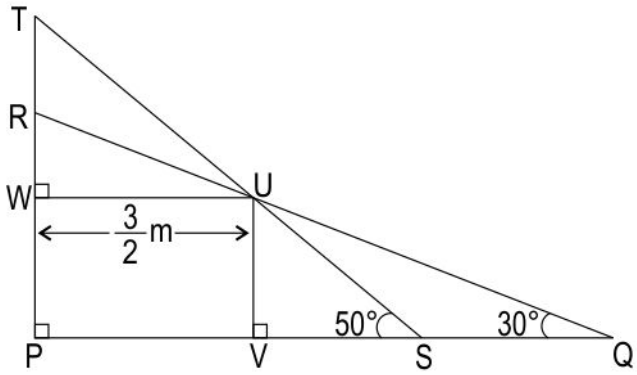
Q: 15 **The drone was flying at a height of 30√3 metres at a constant speed in the horizontal direction when it spotted a zebra near a pond, right below the drone.**
The drone travelled for 30 metres from there and it could see the zebra, at the same place, at an angle of depression of θ from it. **[1]**

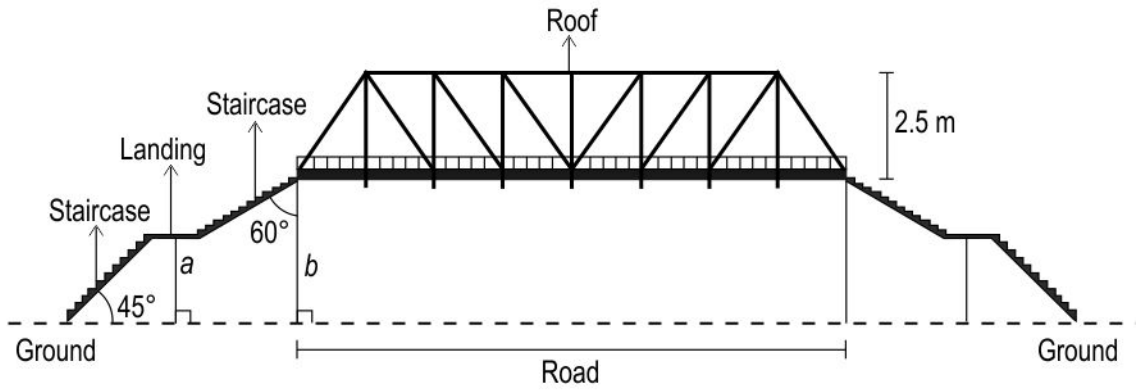
Draw a diagram to represent this situation and find θ. Show you work.

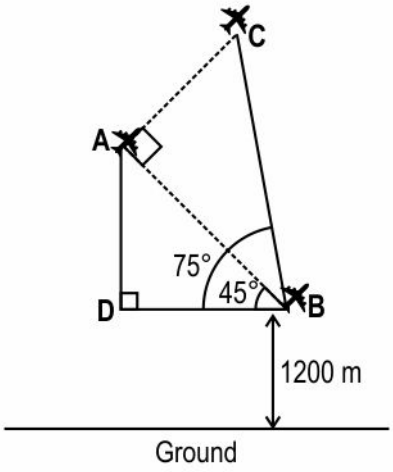
Q.No	Correct Answers
1	2
2	3
3	2

Q.No	What to look for	Marks
4	Uses sine ratio and writes: $\sin d = \frac{6}{4\sqrt{3}}$ $= \frac{\sqrt{3}}{2}$ where, d is the angle of depression.	0.5
	Finds $\angle d = 60°$.	0.5
5	Writes that the slide is safe for Ajay to use.	0.5
	Finds $\sin \theta = \frac{2.5}{4} = 0.625$, where θ is the angle at which the slide is inclined with the ground. Finds $\sin 45°$ as $\frac{1}{\sqrt{2}} = \frac{\sqrt{2}}{2} = 0.7$. Gives the following reason: Since $\sin \theta$ increases as θ increases when $0° < \theta < 90°$, if $\sin \theta < \sin 45°$, then $\theta < 45°$.	0.5
6	Finds BD as $260 \times \tan 60° = 260 \times \sqrt{3} = 260 \times 1.73 = 449.8$ m or 450 m.	0.5
	Finds distance of the lioness from the point C at the base as: CD = BD - BC = 450 - 75 = 375 m	0.5
7	Finds angle of elevation θ by solving for cot θ as follows: $\cot \theta = \frac{34.64}{20} = 1.732 = \sqrt{3}$ Hence, finds the value of θ as 30°.	1
8	i) From the figure, frames the equation as: $\frac{AB}{4} = \tan 45°$ Solves above to find the height of the object AB as 4 cm.	0.5
	ii) Assumes the ∠B'OA' to be θ. Writes the equation as: $\tan \theta = \frac{4}{3}$	0.5

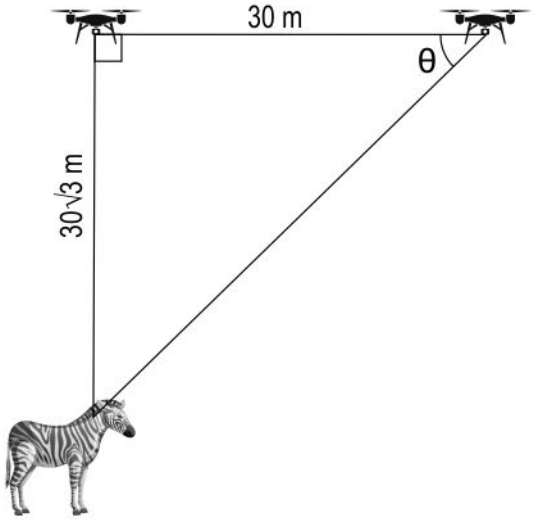
Q.No	What to look for	Marks
	Writes that alternate angles are equal and hence ∠C'OD' = θ. Writes the equation as: $\tan\theta = \frac{4}{3} = \frac{C'D'}{6}$ Finds the height of image C'D' as 8 cm. (Award full marks if any alternate method is correctly used.)	1
9	Finds the distance between the light pole and Shoib as: $\tan 45° = \frac{AB}{SB}$ $\Rightarrow 1 = \frac{100}{SB}$	0.5
	Solves the above equation and finds the distance between the light pole and Shoib as 100 m.	0.5
	Finds the distance between the light pole and Mihir as: $\tan 30° = \frac{AB}{MB}$ $\Rightarrow \frac{1}{\sqrt{3}} = \frac{100}{MB}$	0.5
	Solves the above equation and finds the distance between the light pole and Shoib as $100\sqrt{3}$ m.	0.5
	Uses Pythagoras' theorem to find the shortest distance between Shoib and Mihir as $\sqrt{[(100)^2 + (100\sqrt{3})^2]} = 200$ m.	1

Q.No	What to look for	Marks
10	**Draws a rough diagram with appropriate measurements. The diagram may look as follows:**  **(Note: The figure is not to scale.)**	**0.5**
	Finds ∠WUT as 50° and ∠WUR as 30°.	**1**
	Finds WT as $\frac{3}{2}$ tan 50° = $\frac{3}{2} \times \frac{0.8}{0.6}$ = 2 m.	**0.5**
	Finds WR as $\frac{3}{2}$ tan 30° = $\frac{3}{2} \times \frac{0.5}{0.9} = \frac{5}{6}$ m.	**0.5**
	Finds the height by which shot 2 is higher than shot 1 as: **2 - $\frac{5}{6} = \frac{7}{6}$ m**	**0.5**

Q.No	What to look for	Marks
11	**Given below is a rough figure of the figure in the question:**  **Identifies from the figure that the height of the roof from the ground is given by:** ***b* + 2.5 m** **or** ***a* + (*b* - *a*) + 2.5 m** **(Award full 1 mark even if the figure is not drawn.)**	**1**
	Identifies from the figure that: **sin 45° = $\frac{a}{3}$**	**0.5**
	Finds *a* by evaluating the above expression as: ***a* = $\frac{3}{\sqrt{2}}$ m**	**1**
	Identifies from the figure that: **sin 30° = cos 60° = $\frac{b-a}{3}$**	**1**
	Finds the value of *b a* s: **$\frac{3}{2} + \frac{3}{\sqrt{2}}$ m**	**1**

Q.No	What to look for	Marks
	Finds the height of the roof from the ground as: **(2.5 + $\frac{3}{2}$ + $\frac{3}{\sqrt{2}}$) m** **(*Note: Students are not expected to simplify the expression further.*)**	**0.5**
12	**Draws △ADB and △BAC. The figure may look as follows:**  **(Note: The figure is not to scale.)**	**1**
	i) Uses tan 45° = $\frac{AD}{DB}$ = 1 in △ADB to find AD = DB. **Writes that AD = 1200 m.** **(Award full marks if the student finds AD by using the properties of isosceles triangles.)**	**0.5**
	Finds plane A's altitude as 1200 + 1200 = 2400 m.	**0.5**
	ii) In △ADB, uses sin 45° = $\frac{AD}{AB}$ = $\frac{1}{\sqrt{2}}$. **Substitutes value of AD as 1200 m to find AB as 1200√2 m.**	**0.5**
	Finds ∠ABC as 75° - 45° = 30°.	**0.5**

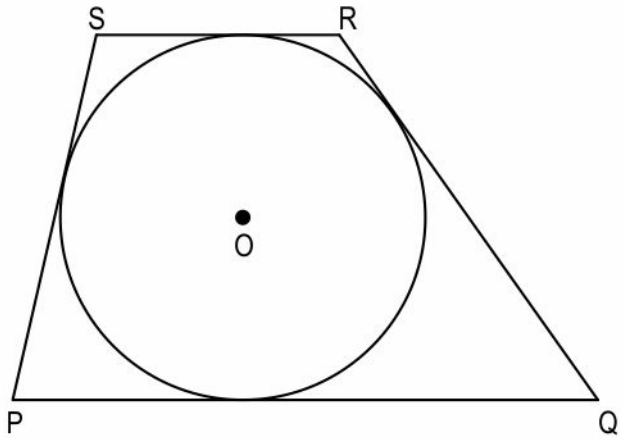
Q.No	What to look for	Marks
	In $\triangle ABC$, uses $\tan 30° = \frac{AC}{AB} = \frac{1}{\sqrt{3}}$. Substitutes value of AB as $1200\sqrt{2}$ m to find AC as $400\sqrt{6}$ m.	1
	iii) In $\triangle ABC$, uses $\cos 30° = \frac{AB}{BC} = \frac{\sqrt{3}}{2}$. Substitutes value of AB as $1200\sqrt{2}$ to find BC as $800\sqrt{6}$ m.	1
13	Assumes the horizontal distance between the drone and the tiger to be x when the angle of depression was 30° and finds the value of x as: $x = 54\sqrt{3} \times \tan 30° = 54\sqrt{3} \times \frac{1}{\sqrt{3}} = 54$ m	0.5
	Assumes the horizontal distance between the drone and the tiger after 3 seconds as y and finds the value of y as: $y = 54\sqrt{3} \times \tan 45° = 54\sqrt{3}$ m	0.5
	Finds the distance covered by the tiger in 3 seconds as: $54\sqrt{3} - 54 = 39.42$ m	0.5
	Finds the average speed of the tiger during that time as: $\frac{39.42}{3} = 13.14$ m/s.	0.5
14	Assumes the vertical distance between the top of the tree and the drone to be h and finds h as: $h = 5\sqrt{3} \times \tan 30° = 5\sqrt{3} \times \frac{1}{\sqrt{3}} = 5$ m.	0.5
	Finds the height of the tree as 100 - 65 - 5 = 30 m.	0.5

Q.No	What to look for	Marks
15	**Draws a rough diagram to represent the situation. The figure may look as follows:** 	**0.5**
	Finds the value of θ as: **tan $\theta = \frac{30\sqrt{3}}{30} = \sqrt{3}$.** **Thus finds the value of θ as 60°.**	**0.5**

Chapter - 10
Circles

Free Response Questions

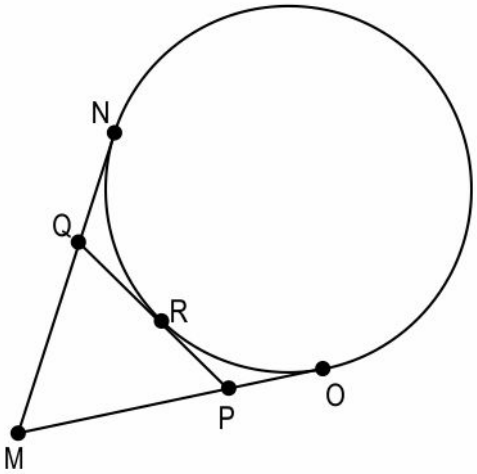
Q: 1 **Shown below is a circle O inscribed in a trapezium such that PQ || RS. The radius of the circle is 6 cm.** **[1]**



(Note: The figure is not to scale.)

What is the height of the trapezium? Show your work and give valid reasons.

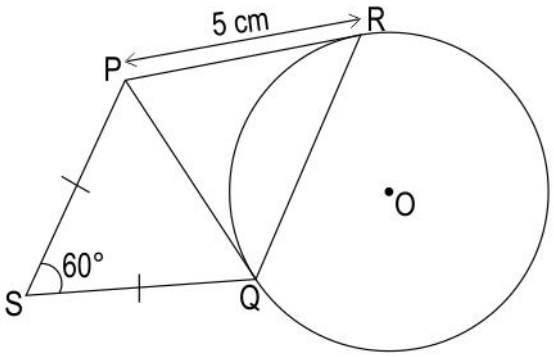
Q: 2 **Shown below is a circle with 3 tangents at points N, O and R. QN = PO = *x* units and ▲QMP is an equilateral triangle.** **[1]**



(Note: The figure is not to scale.)

Express the length MN in terms of *x*. Show your work.

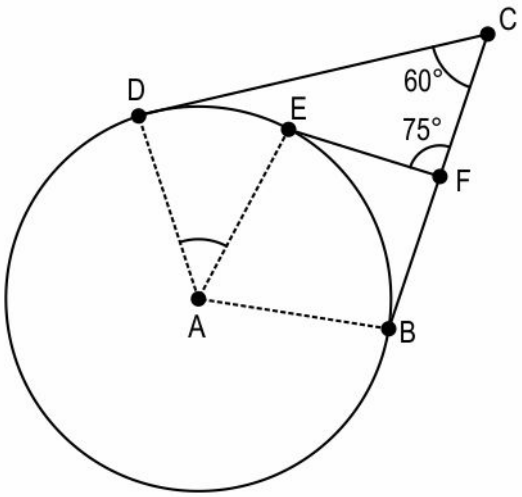
Q: 3 **In the figure below, PQ and PR are tangents to the circle.** **[1]**



(Note: The figure is not to scale.)

Find the perimeter of △SQP. Show your work.

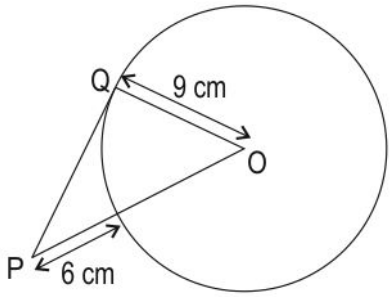
Q: 4 **Shown below is a circle with centre A. CD, CB and FE are tangents to the circle. ∠DCF = 60° and ∠EFC = 75°.** **[2]**



(Note: The figure is not to scale.)

Find the measure of ∠DAE. Show your work and give valid reasons.

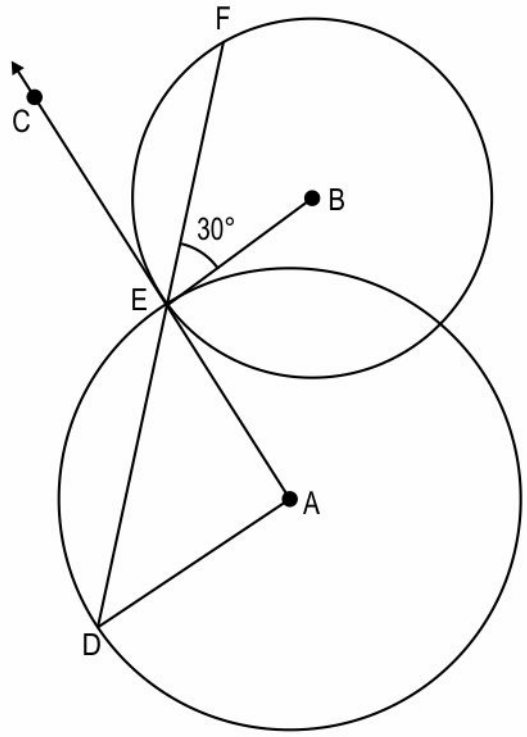
Q: 5 **Shown below is a circle with centre O. PQ is tangent to the circle at Q.** **[2]**



(Note: The figure is not to scale.)

What is the length of tangent PQ? Show your work and give valid reasons.

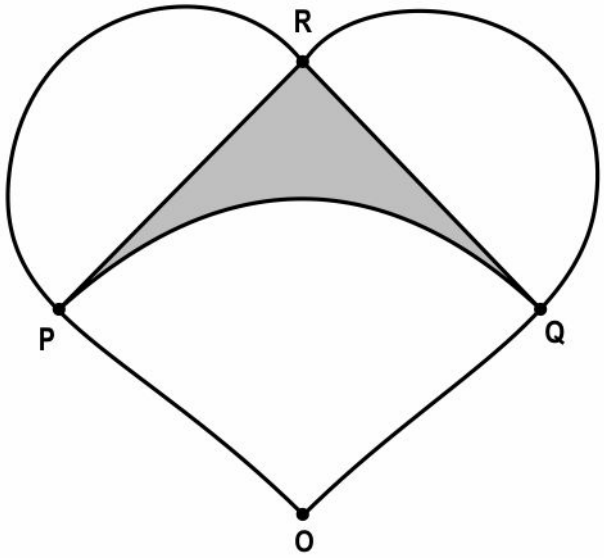
Q: 6 **Shown below are two circles with centres A and B. The circle with centre A has a radius of 5 cm. AC is a tangent to circle with centre B. FED is a straight line.** **[3]**



(Note: The figure is not to scale.)

What is the length of chord DE? Show your work and give valid reasons.

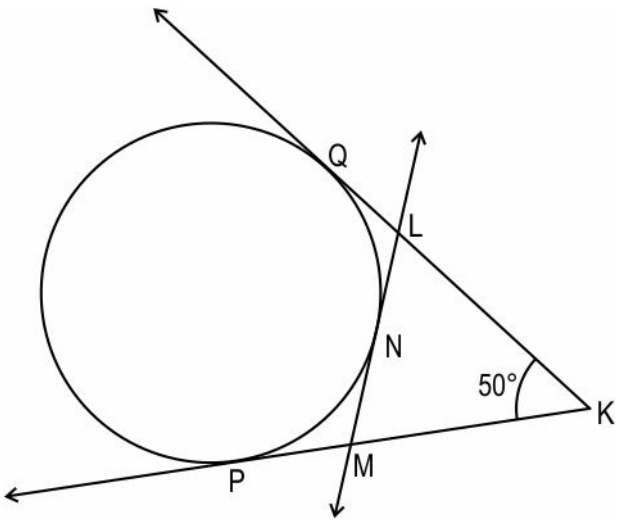
Q: 7 **In the figure below, PR and QR are tangents to a circle with centre O, at points P and Q. Two semicircles are drawn on tangents PR and QR. Each semicircle has an area of π square units. Quadrant POQ has an area of 2π square units.** **[3]**



(Note: The figure is not to scale.)

Find the area of the shaded region. Show your work and give valid reasons.

Q: 8 **Shown below is a circle with 3 tangents KQ, KP and LM.** **[3]**



(Note: The figure is not to scale.)

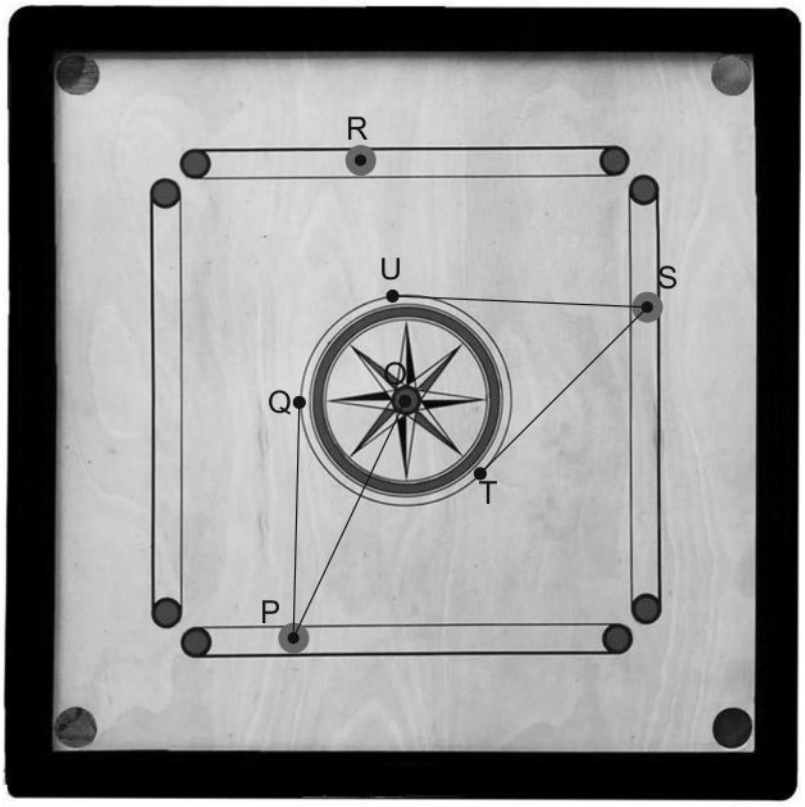
If PM:KL = 1:2, find the measure of ∠LMK. Show your steps.

Case Study

Answer the questions based on the given information.

The game of carrom is played on a square board with a pocket in each corner. They are played using small disks of wood or plastic known as carrom coins. A larger and heavier disk called a striker is used to push these coins across the board to the pockets. The positions of striker and a few coins at different instances in a game are shown in the figure:

P, R and S denote different positions of the striker.
Q, T and U denote different positions of the coins.
O is the centre of the carrom board.



The points P, Q and R do not lie on a straight line. The line PQ touches the circular part of the carrom board only at Q.

Q: 9 **The striker at P is 18 cm from the centre and ∠OPQ = 30°.** **[2]**

Find the distance between the striker at P and the coin at Q. Show your work and give valid reasons.

Q: 10 **Can QR be a tangent to the circle at Q? Give a valid reason.** **[1]**

Q: 11 **SU and ST are tangents to the circle at U and T respectively and ∠UQT = 55°.** **[2]**

Find ∠UST. Show your work and give valid reasons.

Q.No	What to look for	Marks
1	**Writes that the radius is perpendicular to the tangent at its point of contact, hence the diameter is the shortest distance between PQ and RS.**	**0.5**
	Finds the height of the trapezium as 2 × 6 = 12 cm.	**0.5**
2	**Identifies PR = PO = x, QR = QN = x and finds the length of PQ as 2 x units.**	**0.5**
	Identifies QM = PM = PQ = 2 x units and finds the length of MN as 2 x + x = 3 x units.	**0.5**
3	**Finds the length of PQ = PR = 5 cm.**	**0.5**
	Concludes that △SQP is an equilateral triangle and finds its perimeter as 3 × 5 = 15 cm.	**0.5**
4	**Writes that angles on a straight line are supplementary and finds the measure of ∠EFB as 180° - 75° = 105°.**	**0.5**
	Writes that a tangent to a circle is perpendicular to the radius through the point of contact and hence, ∠AEF = ∠ABF = ∠ADC = 90°.	**0.5**
	Writes that sum of angles in quadrilateral ABFE is 360° and finds the measure of ∠EAB as 360° - 285° = 75°.	**0.5**
	Writes that sum of angles in quadrilateral ABCD is 360° and finds the measure of ∠DAE as 360° - 315° = 45°.	**0.5**
5	**Finds the length of PO as 6 + 9 = 15 cm.**	**0.5**
	Writes that a tangent to a circle is perpendicular to the radius through the point of contact and hence ∠PQO = 90°.	**1**
	Uses pythagoras theorem in △PQO to find the length of tangent PQ as $\sqrt{(15^2 - 9^2)}$ = 12 cm.	**0.5**
6	**Writes that the radius is perpendicular to the tangent at the point of contact and finds ∠FEC as 90° - 30° = 60°.**	**1**

Q.No	What to look for	Marks
	Writes that alternate angles are equal and hence ∠AED = ∠FEC = 60°.	**0.5**
	Identifies that AD = AE and hence ∠AED = ∠ADE = 60°.	**0.5**
	Writes that sum of angles in a triangle is 180°, hence ∠DAE = 60°.	**0.5**
	Concludes from the above steps that ▲ADE is equilateral and hence the length of chord DE is 5 cm.	**0.5**
7	**Assumes the radius of the semicircles as *r* units and finds the diameter of the semicircles as:** $\frac{\pi r_2}{2} = \pi$ **=> 2 *r* = 2√2 units**	**0.5**
	Assumes the radius of the quadrant as *q* units and finds the radius of the quadrant as: $\frac{\pi q_2}{4} = 2\pi$ **=> *q* = 2√2 units**	**0.5**
	Writes that quadrilateral POQR is a square as all four sides measure 2√2 units and all vertex angles measure 90°.	**1**
	Finds the area of the square as 2√2 × 2√2 = 8 square units.	**0.5**
	Finds the area of the shaded region as (8 - 2π) square units.	**0.5**
8	**Assumes the lengths of PM as *x* units and KL as 2 *x* units. Writes the length of MN as *x* units.**	**0.5**
	Assumes the length of QL = LN as *y* units and writes the length of QK as (2 *x* + *y*) units.	**1**
	Writes the length of LM as MN + LN = (*x* + *y*) units.	**0.5**
	Writes the length of MK as (2 *x* + *y*) - *x* = (*x* + *y*) units.	**0.5**

Q.No	What to look for	Marks
	Writes that since LM = MK, the measure of ∠LMK = 180 - (50 + 50) = 80°.	**0.5**
9	**Finds that OQ is the radius of the circle and hence OQ is perpendicular to PQ.**	**0.5**
	Writes that in ▲OPQ: **PQ = OPcos 30° = 18 × $\frac{\sqrt{3}}{2}$**	**1**
	Simplifies the above expression and finds the distance between the striker at P and the coin at Q as 9√3 cm.	**0.5**
10	**Writes that only one tangent can be drawn from a point on the circle and since PQ and QR are two different straight lines and PQ is a tangent, QR cannot be a tangent to the circle at Q.**	**1**
11	**Finds ∠UOT as 110° and states that angles subtended by an arc at the centre of the circle is double the angle subtended by that arc anywhere on the circle.**	**1**
	Finds that ∠UST = 180° - 110° = 70° as OU is perpendicular to SU, OT is perpendicular to ST and angle-sum property of a quadrilateral.	**1**

Chapter - 11
Area Related to Circle

Free Response Questions

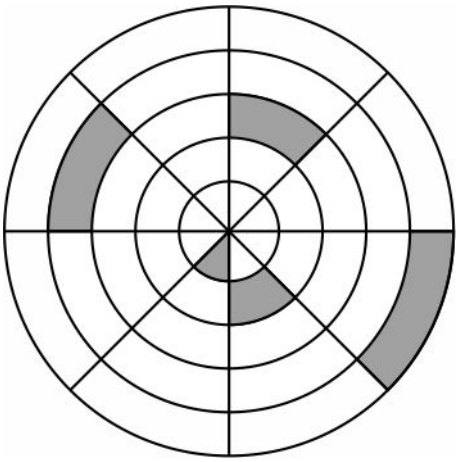
Q: 1 **Rohan got the question below in his school test.** **[1]**

"*A 7 cm chord of a circle subtends an angle of 60° at the centre. Find the area of the major sector.*"

After the test, he went to the teacher and said, "The question cannot be answered as it doesn't mention the radius of the circle".

Is Rohan right or wrong? Give a valid reason for your answer.

Q: 2 **Shown below is a figure such that each circle is divided into equal sectors by 4 straight lines. The combined area of the shaded region is 77 square units.** **[1]**



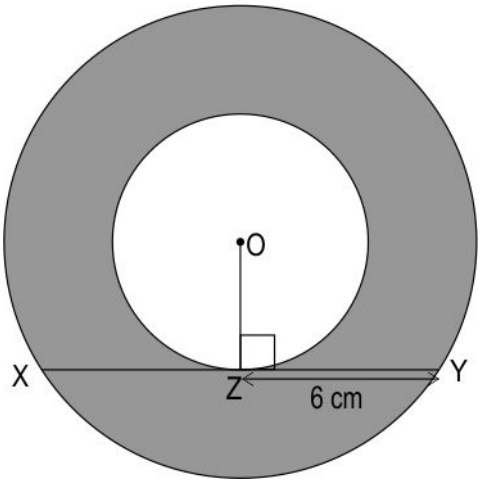
What is the radius of the largest circle? Show your work.

(Note: Take pi as $\frac{22}{7}$.)

Q: 3 **A chord of length 2√2 cm subtends an angle of 90° at the centre of a circle.** **[1]**

Find the area of the minor sector in terms of π. Show your work.

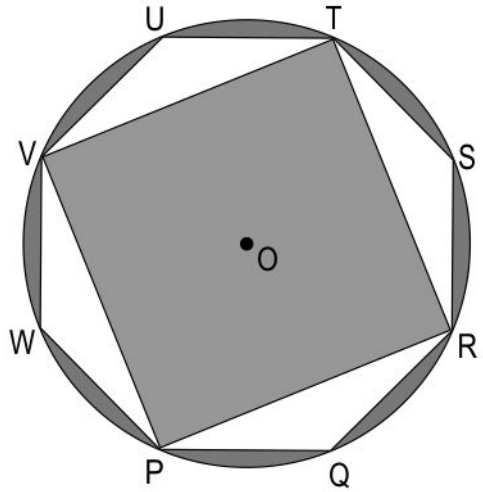
Q: 4 **Shown below are two concentric circles with centre O. XY is tangent to the inner circle at Z.** **[1]**



(Note: The figure is not to scale.)

What is the area of the shaded region in terms of π? Show your work.

Q: 5 **A regular octagon of side length 4 cm is inscribed in a circle of radius 7 cm. A square is inscribed in the same circle as shown below.** **[5]**

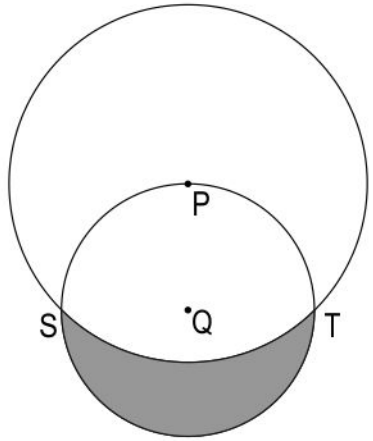


(Note: The figure is not to scale.)

Find the area of the shaded region. Show your work.

(Note: If needed, take pi as $\frac{22}{7}$, √3 as 1.7, √5 as 2.2.)

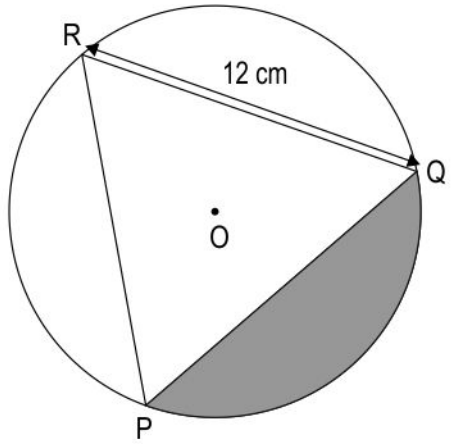
Q: 6 **Shown below are two circles with centres P and Q. Diameter ST is 6 cm.** **[5]**



(Note: The figure is not to scale.)

Find the area of the shaded region. Draw a rough diagram and show your work.

Q: 7 **Shown below is a circle with centre O. PQR is an equilateral triangle of side length 12 cm.** **[5]**



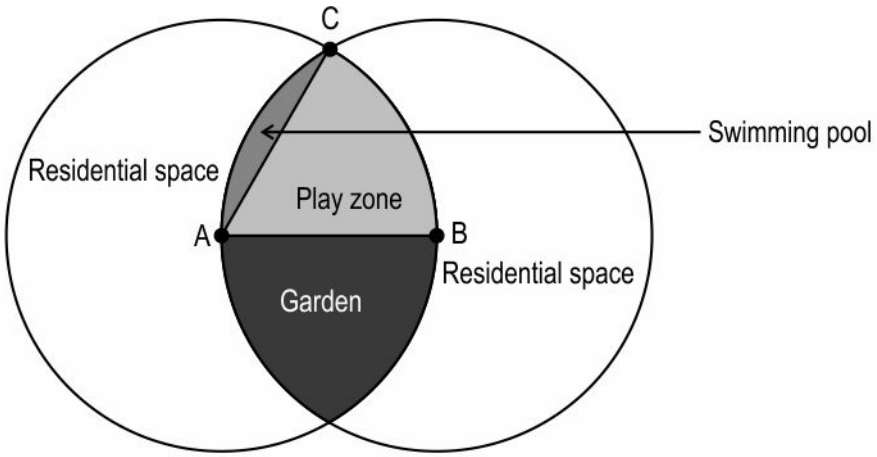
(Note: The figure is not to scale.)

Find the area of the shaded region in terms of π. Draw a rough diagram and show your work.

Case Study

Answer the following questions using the given information.

Shown below is a representation of some portion of an apartment complex. The area occupied by this portion is in the form of two identical intersecting circles whose centres are at A and B respectively. The radius of each circle is 21 metres. The intersecting area is converted into a recreational space comprising of a play zone, a garden and a swimming pool.



(Note: Take π as $\frac{22}{7}$) .

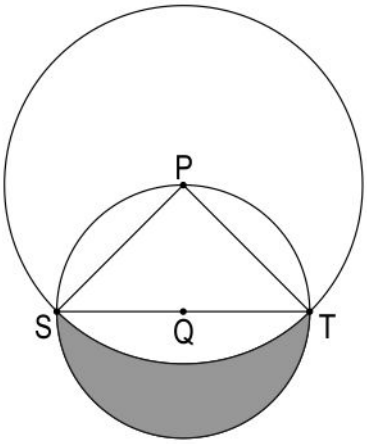
Q: 8 **Find the area of the play zone. Show your work.** **[2]**

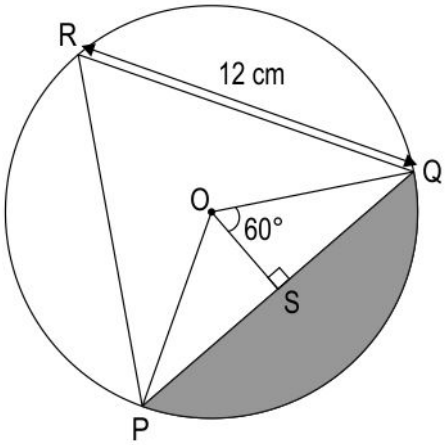
Q: 9 **The boundary of the recreational space is installed with some landscape lighting that costs is Rs 2500 per metre.** **[2]**

How much did it cost to install the lighting along the boundary? Show your work with valid reasons.

Q: 10 **If the area of the recreational space is 842 m^2, find the area of the residential space in the apartment. Show your work.** **[1]**

Q.No	What to look for	Marks
1	**Writes that Rohan is wrong and gives a reason. For example, since the chord extends an angle of 60° at the centre, it forms an equilateral triangle with the radii and hence, the radius is 7 cm.**	**1**
2	**Identifies that the shaded regions combined forms a sector, assumes the radius of the largest circle as *r* units and writes the equation as:** $\frac{1}{8} \times \frac{22}{7} \times r^2 = 77$	**0.5**
	Solves the above equation to find the value of *r* as 14 units.	**0.5**
3	**Identifies that the radii (*r* cm) and the chord make an isosceles right triangle, and uses the Pythagoras theorem to write:** $r^2 = 4\ cm^2$	**0.5**
	Finds the area of the minor sector as: $\frac{90}{360} \times \pi \times 4 = \pi\ cm^2$	**0.5**
4	**Assumes the radii of the outer and inner circles as R cm and *r* cm respectively. Writes the expression for the area of the shaded region as:** $\pi(R^2 - r^2)\ cm^2$	**0.5**
	Uses the Pythagoras theorem to find $(R^2 - r^2)\ cm^2$ as 36 cm^2 and hence finds the required area as $36\pi\ cm^2$.	**0.5**
5	**Writes that the octagon divides the circles into 8 equal sectors of 45° each and finds the area of each of the sectors as:** $\frac{45}{360} \times \frac{22}{7} \times 7 \times 7 = \frac{77}{4}$ **or 19.25 cm^2.**	**1**
	Finds the semiperimeter of ▲VOU as $\frac{7+7+4}{2}$ **= 9 cm.**	**0.5**
	Finds the area of ▲VOU as $\sqrt{(9 \times 2 \times 2 \times 5)} = 6\sqrt{5} = 13.2\ cm^2$.	**0.5**
	Finds the area of the 8 segments as $8(19.25 - 13.2) = 48.4\ cm^2$.	**1**

Q.No	What to look for	Marks
	Finds the area of square PRTV as $\frac{14}{\sqrt{2}} \times \frac{14}{\sqrt{2}} = 98\ cm^2$.	**1**
	Finds the area of the shaded region as $48.4 + 98 = 146.4\ cm^2$. **(Award full marks if an alternative approach is used to answer correctly.)**	**1**
6	**Draws a rough diagram. The figure may look as follows:**  ***(Note: The figure is not to scale.)***	**1**
	Uses properties of angles in a semicircle and writes that $\angle SPT = 90°$.	**0.5**
	Uses pythagoras theorem in $\triangle SPT$ where SP = PT to write: **$SP^2 + PT^2 = 6^2$** **$\Rightarrow SP^2 = 18\ cm^2$**	**1**
	Finds the area of $\triangle SPT$ as $\frac{1}{2} \times 18 = 9\ cm^2$.	**0.5**
	Finds the area of sector PST in circle with centre P as $\frac{90}{360} \times \pi \times 18 = \frac{9\pi}{2}\ cm^2$.	**1**
	Finds the area of semicircle with diameter ST as $\frac{1}{2} \times \pi \times 3^2 = \frac{9\pi}{2}\ cm^2$.	**0.5**
	Finds the area of the shaded region as $\frac{9\pi}{2} - \frac{9\pi}{2} + 9 = 9\ cm^2$.	**0.5**

Q.No	What to look for	Marks
7	**Draws a rough figure. The figure may look as follows:**  ***(Note: The figure is not to scale.)***	**1**
	Writes that angle subtended by a chord at the centre is double that of the circumference and hence finds ∠POQ as 120°.	**0.5**
	Writes that OS is perpendicular to PQ, hence ∠QOS = 60° and SQ = 6 cm.	**0.5**
	Finds the length of the radius, OQ as $\frac{6}{\sin 60°}$ } = 4√3 cm.	**0.5**
	Finds the length of OS as 4√3 × cos 60° = 2√3 cm. **(Award full marks if pythagoras theorem is used correctly.)**	**0.5**
	Finds the area of ▲OPQ as $\frac{1}{2}$ × 12 × 2√3 = 12√3 cm^2.	**0.5**
	Finds the area of sector POQ as $\frac{120}{360}$ × π × 4√3 × 4√3 = 16π cm^2.	**1**
	Finds the area of the shaded region as (16π - 12√3) cm^2.	**0.5**
8	**Writes that AB, BC and CA being radii of identical circles, are equal making ▲ABC an equilateral triangle.** **Hence concludes that ∠CAB = 60°.**	**1**

Q.No	What to look for	Marks
	Finds the area of the sector forming the playzone as: **$\frac{60}{360} \times \frac{22}{7} \times 21^2 = 231\ m^2$**	**1**
9	**Writes that AB, BC and CA being radii of identical circles are equal making $\triangle$ABC an equilateral triangle.** **Hence concludes that $\angle BAC = 60^o$.**	**0.5**
	Finds the arc length BC as: **$\frac{60}{360} \times 2\pi \times 21 = 22$ m**	**0.5**
	Calculates the length of the boundary or perimeter of the recreational space as: **4 × length of arc BC = 4 × 22 = 88 m**	**0.5**
	Finds the cost of installing the landscape lighting as 88 x 2500 = Rs 220000.	**0.5**
10	**Finds the area of each circle as $\frac{22}{7} \times 21^2 = 1386\ m^2$.**	**0.5**
	Finds the area of the residential space as: **(2 × area of circle) - (2 × area of recreational space)** **= 2 × (1386 - 842)** **= 1088 m^2**	**0.5**

Chapter - 12
Surface Areas and Volumes

Multiple Choice Question

Q: 1 **The table below shows the measurements of 3 right circular cones.**

Cone	Radius (in cm)	Slant Height (in cm)
P	3	5
Q	5	7
R	3.5	10

Which of these have the same curved surface area?

1 only P and Q
2 only Q and R
3 only R and P
4 (P, Q and R have different curved surface areas because they have different radii and slant heights)

Free Response Questions

Q: 2 **State whether the following statement is true or false. Explain your answer.** **[1]**

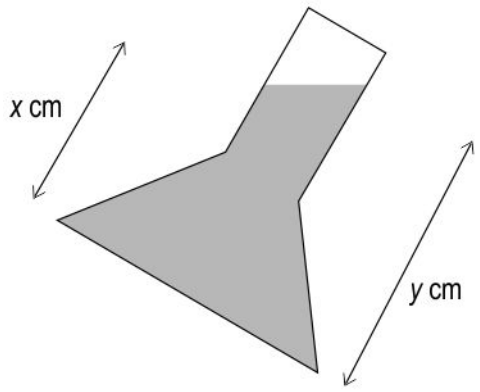
If a cylinder and a cone have equal radii and equal volume, then the height of the cylinder is 3 times that of the cone.

Q: 3 **Two solid hemispheres are joined together to make a sphere.** **[1]**

The total surface area of the sphere is _____ the sum of the total surface areas of the hemispheres.

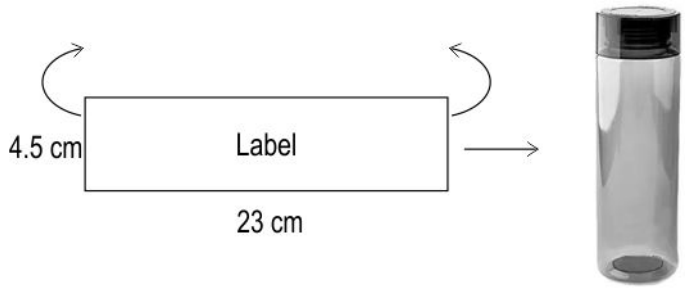
Fill in the blank and give a valid reason.

Q: 4 **Shown below is a flask comprising of a cylinder on top of a frustum. In a tilted position, the height of the liquid is marked.** **[1]**



Write an expression for height of the liquid when the flask is in upright position.

Q: 5 **Vidit is a designer who had printed a 23 cm by 4.5 cm rectangular label. He is now 3D printing a cylindrical water bottle for the label. He wants the label to be wrapped around the bottle such that there is an overlap of 1 cm for sticking.** **[2]**

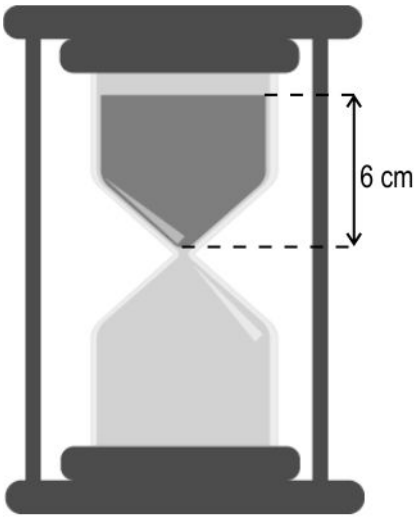


(Note: The figures are not to scale.)

What should be the radius of the water bottle? Show your work.

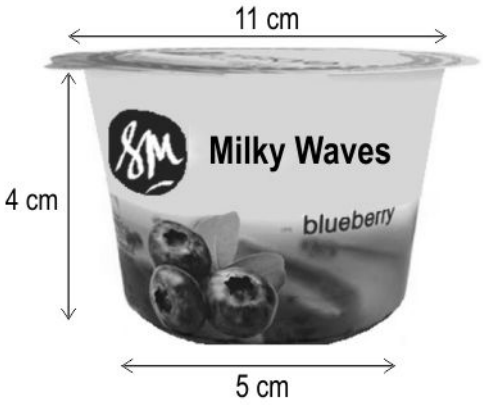
(Note: Take π as $\frac{22}{7}$.)

Q: 6 **Shown below is a 5-minute sand timer. At the beginning, the sand has a height of 6 cm. After 5 minutes, the sand only occupies space in the cylindrical portion.** **[3]**



If the height of each conical section is *h* cm, then find the height of the sand in the bottom portion, after 5 minutes, in terms of *h*. Show your work.

Q: 7 **Sudha's Printing Company has an order to print labels for flavoured yogurt cups for the brand Milky Waves, such that the label covers the entire curved surface of the cup. A picture of the cup is shown below.** **[5]**

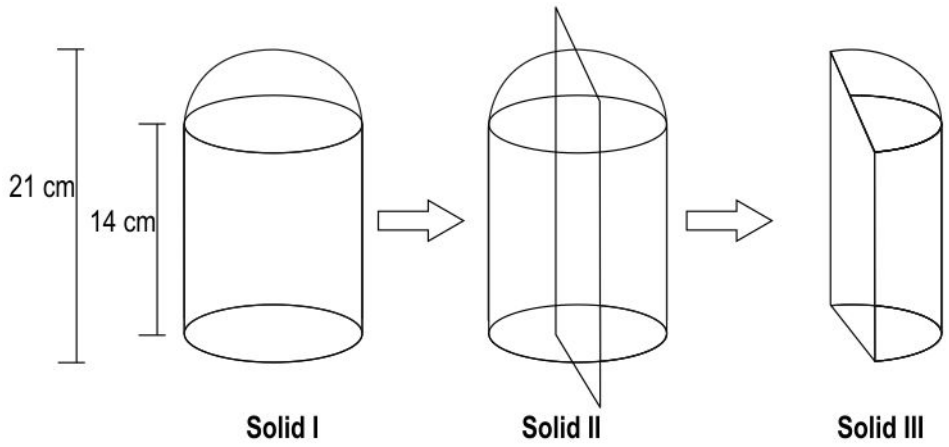


Each of Sudha's rectangular printing sheets is 1 m long and 2 m wide and about 40% of each sheet is wasted due to the shape of the cup.

Approximately how many labels can she print on one sheet? Show your work.

(Note: Assume that each label covers the curved surface area of the cup without any overlap; the figure is not to scale; use π as 3.14.)

Q: 8 **A solid is made using a cylinder and a hemisphere. It is then dipped in red paint and cut vertically along the axis of symmetry as shown below. The unpainted surface of solid III is then painted yellow.** **[5]**



(Note: The figures are not to scale.)

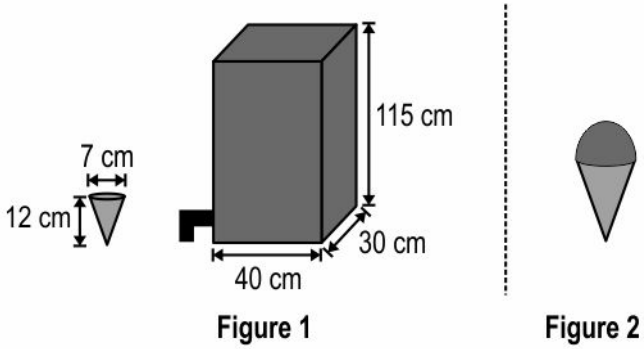
Find the surface area of solid III that is painted:

i) red.
ii) yellow.

Show your work.

(Note: Take π as $\frac{22}{7}$.)

Q: 9 **A restaurant stores ice-cream in a box with a dispenser attached for filling ice-cream cones. The dimensions of the box and the ice-cream cones used by the restaurant are shown in Figure 1 below. To make each serving of dessert, the cone is first filled with ice-cream and then topped with a hemispherical scoop of ice-cream taken from the same box, as shown in Figure 2.** **[5]**



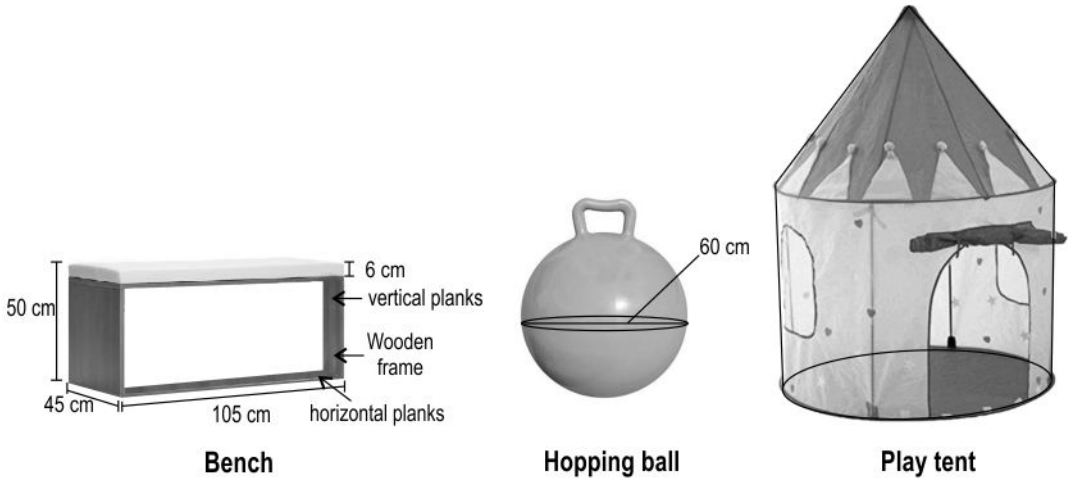
Approximately how many desserts can be served out of a completely filled box of ice-cream? Show your steps.

(Note: Take π as $\frac{22}{7}$.)

Case Study

Answer the questions based on the given information.

An indoor kids play area has a cuboidal sitting bench, a hopping ball and a play tent as shown in the figure. The hopping ball has a handle attached to a sphere. Air is filled in the spherical part which is locked using a peg. The tent consists of a conical section exactly on top of a cylindrical section.



Bench Hopping ball Play tent

(Note: The figure is not to scale.)

The height of the cylindrical section of the tent is one and a half times the height of the conical section of the tent. The height and the diameter of the conical section of the tent are equal.

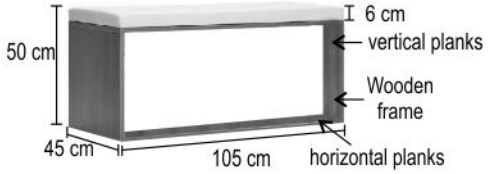
Q: 10 **Find the ratio of the volume of the cylindrical section to the volume of the conical section of the tent. Show your work.** **[2]**

Q: 11 **A kid pulls out the peg from the hopping ball. The ball starts to deflate such that the volume of the spherical part decreases at the rate of 18000 cm^3 per minute.** **[1]**

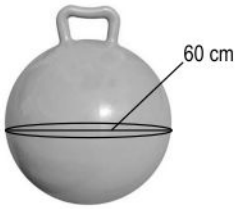
How long does it take to deflate the entire ball? Give your answer to the nearest minute.

Q: 12 **The bench has a wooden frame consisting of four wooden planks. The thickness of each plank is 2 cm. The vertical wooden planks are fitted between the horizontal wooden planks.** **[2]**

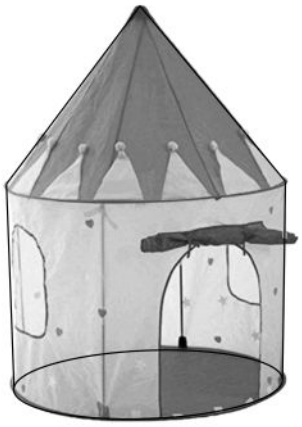
If the weight of each wooden plank is 0.5 g per cm^3, what is the total weight of the wood in the frame? Show your work.



Bench



Hopping ball



Play tent

Q.No	Correct Answers
1	2

Q.No	What to look for	Marks
2	Writes the equation by equating the volumes as $\pi r^2 H = \frac{1}{3} \pi r^2 h$, where H is the height of cylinder, h is the height of cone and r is the radius.	0.5
	Simplifies the above to get $H = \frac{h}{3}$ and concludes that the statement is false.	0.5
3	Writes that the total surface area of the sphere is <u>less than</u> the sum of the total surface areas of the hemispheres.	0.5
	Gives reason that, since two solid hemispheres are joined, the areas of the flat surfaces of the hemispheres are not part of the surface area of the sphere.	0.5
4	Writes an expression for height of the liquid when the flask is in upright position as $\frac{x+y}{2}$ cm.	1
5	Finds the length of the label after the overlap as 23 - 1 = 22 cm.	0.5
	Assumes the radius of the bottle as r cm and writes the equation as: $2 \times \frac{22}{7} \times r = 22$	1
	Solves the above equation to find the radius of the water bottle as $\frac{7}{2}$ cm or 3.5 cm.	0.5
6	Assumes the radius of the base as r cm and the height of the sand in the cylindrical bottom portion after 5 minutes as h_1 cm.	0.5
	Finds the height of the sand in the cylindrical top portion as (6 - h) cm.	0.5
	Writes the equation for the volume of the sand as: $\pi r^2 h_1 = \frac{1}{3} \pi r^2 h + \pi r^2 (6 - h)$	1
	Simplifies the above equation to find the height of the sand in the bottom portion, after 5 minutes, in terms of h as: $h_1 = \frac{1}{3} h + 6 - h$ $\Rightarrow h_1 = 6 - \frac{2}{3} h$ cm	1

Q.No	What to look for	Marks
7	Finds the radii of the top and bottom of the frustum as 5.5 cm and 2.5 cm respectively.	0.5
	Finds the slant height of the frustum as 5 cm as follows: $\sqrt{4^2 + (5.5 - 2.5)^2} = 5$ (Award 0.5 marks if only the formula for the slant height of a frustum is correctly written.)	1
	Finds CSA of frustum as $3.14 \times (5.5 + 2.5) \times 5 = 125.60\ cm^2$. (Award 0.5 marks if only the formula for the CSA of a frustum is correctly written.)	1
	Finds the area of one printing sheet in square centimetres as $20000\ cm^2$.	0.5
	Finds the usable area of the sheet as about 60% of $20000\ cm^2 = 12000\ cm^2$	0.5
	Divides $12000\ cm^2$ by $125.60\ cm^2$ to get quotient as approximately 95.54.	1
	Writes that approximately 95 labels can be printed on one sheet, since about $12000\ cm^2$ area is usable on the sheet.	0.5
8	Finds the radius of the hemisphere and cylinder as 21 - 14 = 7 cm.	0.5
	i) Finds the surface area of the hemisphere in solid I as $2 \times \frac{22}{7} \times 7^2 = 308\ cm^2$.	1
	Finds the curved surface area of the cylinder in solid I as $2 \times \frac{22}{7} \times 7 \times 14 = 616\ cm^2$.	1
	Finds the surface area of the bottom of solid I as $\frac{22}{7} \times 7^2 = 154\ cm^2$.	0.5
	Finds the surface area of solid III painted red as $\frac{1}{2}(308 + 616 + 154) = 539\ cm^2$.	1

Q.No	What to look for	Marks
	ii) Finds the surface area of solid III painted yellow as: **surface as area of semicircle + area of rectangle** $= (\frac{1}{2} \times \frac{22}{7} \times 7^2) + (14^2)$ $= 273\ cm^2$.	**1**
9	**Uses the formula $l \times b \times h$ to find the volume of the box as 1,38,000 cm^3, where l = 30 cm, b = 40 cm and h = 115 cm.**	**1**
	Uses the formula $\frac{1}{3} \pi r^2 h$ to find the volume of the ice-cream cone as 154 cm^3, where r = 3.5 cm and h = 12 cm.	**1.5**
	Uses the formula $\frac{2}{3} \pi r^3$ to find the volume of the hemisphere as 89.83 cm^3.	**1.5**
	Finds the volume of 1 serving of dessert as the (volume of cone) + (volume of hemisphere) = 243.83 cm^3. **Rounds the volume of 1 serving off to 244 cm^3.**	**0.5**
	Finds the approximate number of desserts that can be served as 565, on solving $\frac{1,38,000}{244} = 565.57$.	**0.5**
10	**Takes the height of the conical section to be h cm. Writes that:** **radius of the cylindrical section = radius of the conical section = $\frac{h}{2}$ cm**	**0.5**
	Finds the volume of the conical section as: $\frac{1}{3} \times \pi \times \left(\frac{h}{2}\right)^2 \times h$ $= \frac{\pi h^3}{12} cm^3$	**0.5**
	Finds the volume of the cylindrical section as $\frac{3}{8} \pi h^3$ cm^3 where the height of the cylinder is given by $\frac{3h}{2}$ cm.	**0.5**

Q.No	What to look for	Marks
	Finds the ratio of the volume of the cylindrical section to the volume of the conical section as 9 : 2. The working may look as follows: **volume of cylindrical section : volume of the conical section** $= \frac{3}{8}\pi h^3 : \frac{1}{12}\pi h^3$ $= \frac{3}{2} : \frac{1}{3}$ **= 9 : 2**	**0.5**
11	**Finds the volume of the spherical part of the ball as 36000π cm^3 (or 113040 cm^3) by substituting 30 cm for the radius in the formula for the volume of a sphere.**	**0.5**
	Divides the volume obtained in previous step by 18000 cm^3 to find the total time taken to deflate the ball as around 6 minutes.	**0.5**
12	**Finds the volume of the wood in the horizontal wooden planks as follows:** **volume of the wood in the horizontal wooden planks** **= 2 × volume of each horizontal wooden plank** **= 2 × (105 × 45 × 2)** **= 18900 cm^3**	**0.5**
	Finds the height of the vertical wooden planks as: **total height of the bench - height of the seat - 2(thickness of the horizontal wooden plank)** **= 50 - 6 - 4** **= 40 cm**	**0.5**
	Finds the volume of wood in the vertical wooden planks as follows: **volume of wood in the vertical wooden planks** **= 2 × volume of each horizontal plank = 2 × (40 x 2 x 45) = 7200 cm^3**	**0.5**
	Finds the weight of the wood in the frame as follows: **weight of the wood in the frame** **= 0.5 × (total volume of the wood in the planks)** **= 0.5 × (18900 + 7200)** **= 13050 grams or 13.05 kg.** **(Award full marks if the correct answer is obtained by a suitable alternate method.)**	**0.5**

Chapter - 13
Statistic

Multiple Choice Questions

Q: 1 **The chart below shows the marks obtained by students of sections A and B of grade 10. The results are recorded in groups as follows:**

	Number of students	
Mark	Section A	Section B
20 - 29	1	2
30 - 39	1	1
40 - 49	10	9
50 - 59	11	11
60 - 69	5	4
70 - 79	2	3

Based on the above information, two statements are given below - one labelled Assertion (A) and the other labelled Reason (R). Read the statements carefully and choose the option that correctly describes statements (A) and (R).

Assertion (A): The median mark of section A is equal to the median mark of section B.

Reason (R): The cumulative frequency of the median class and the preceding class are the same for both the sections.

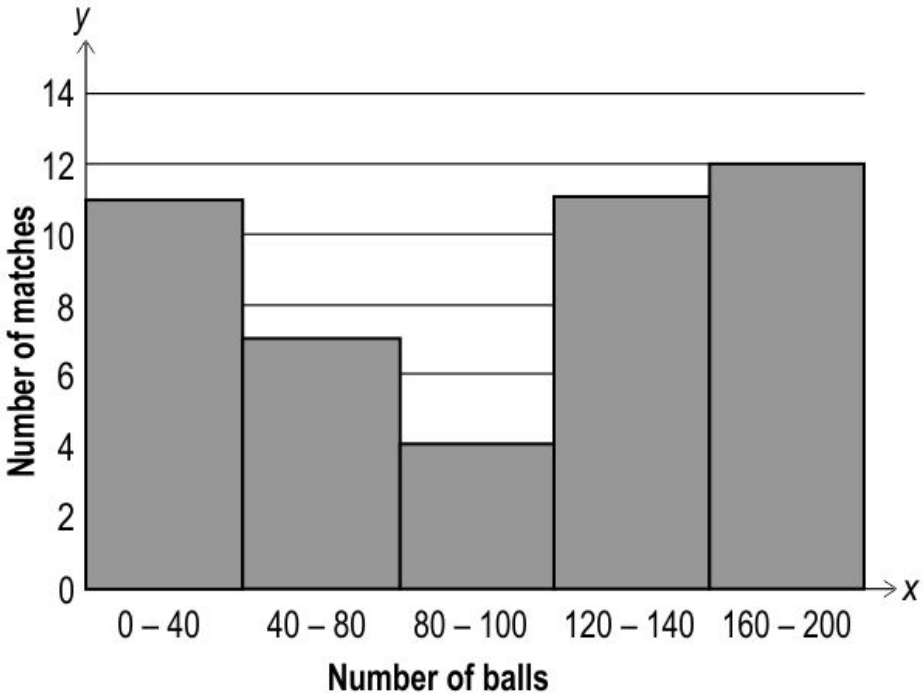
1 Both (A) and (R) are true and (R) is the correct explanation for (A).
2 Both (A) and (R) are true but (R) is not the correct explanation for (A).
3 (A) is true but (R) is false.
4 (A) is false but (R) is true.

Case Study

Study the given information and answer the questions that follow.

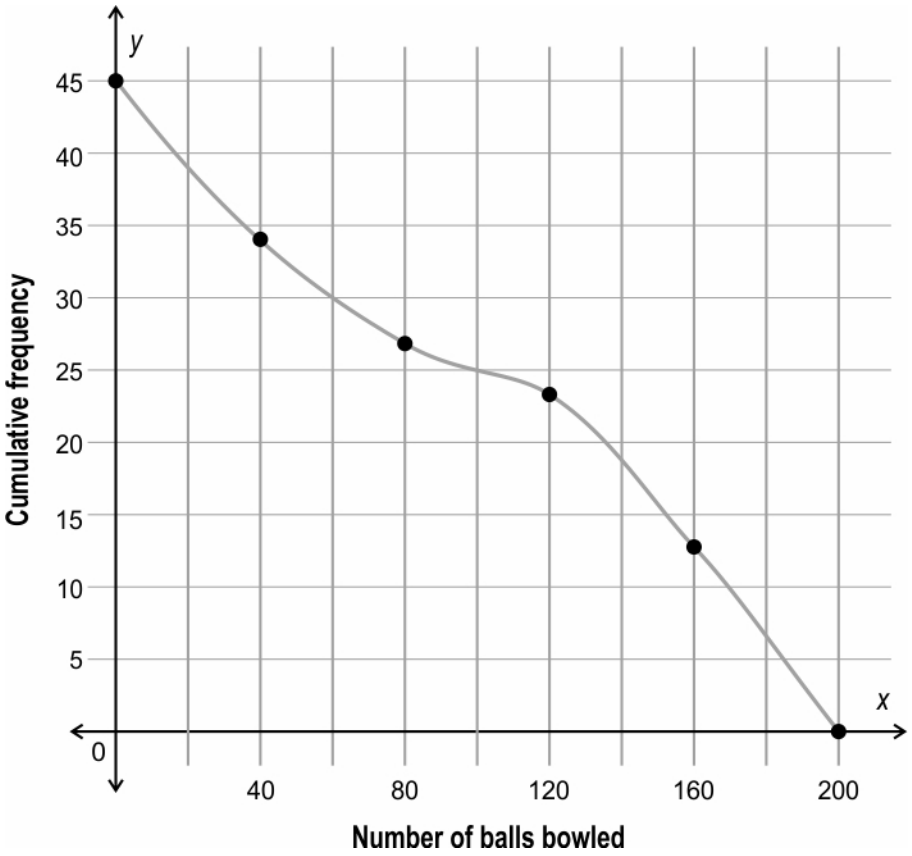
The game of cricket is a bat and ball game played between two teams, each consisting of 11 players. The length of a match is determined by the total number of balls bowled by both the teams.

Shown below is a histogram for the number of matches that were finished in or less than 200 balls.



(Note: Round all calculations to two decimal places.)

Q: 2 **Shown below is an ogive for the given data.**



Which of the following can be determined from the above graph?

i) Least number of balls bowled in a match.
ii) The number of matches with 80 balls bowled.
iii) The total number of matches played with less than 200 balls bowled.

1 only ii) **2** only iii) **3** only i) and ii) **4** only ii) and iii)

Q: 3 **Ankit used the given data and found the mean number of balls bowled in each match as 105.33 balls.**

Which of the following is definitely true?

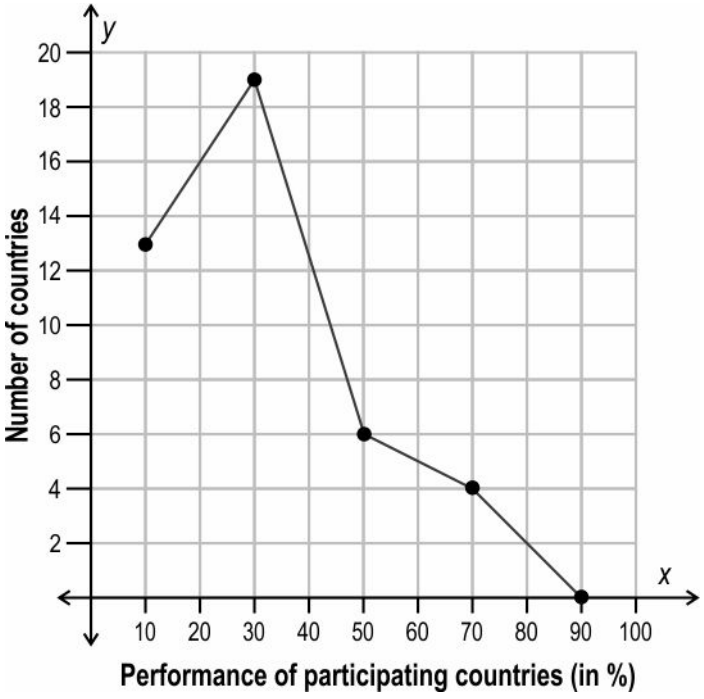
1 Mean number of balls bowled cannot be a decimal.
2 Mean number of balls bowled can be a decimal and 105.33 balls is the actual mean.
3 105.33 balls is an approximate mean as the exact number of matches with the number of balls bowled is not known.
4 (cannot be determined as method used by Ankit is unknown)

Q: 4 **What is the median class?**

1 40 - 80 **2** 80 - 120 **3** 120 - 160 **4** 160 - 200

Free Response Questions

Q: 5 **Shown below is the frequency polygon. It represents the performance of all participating countries in a question in an international assessment, TIMSS 2011.** **[1]**



If Japan's performance was 43%, did it perform better or worse than the average performance? Show your work.

Q: 6 **A football match is 90 minutes long and is divided into 15 minute intervals to collect data, like 0-15, 15-30, so on.** **[1]**

All goals scored in a football match between Brazil and Serbia at FIFA 2022 were in the 60-75 minute interval.

What is the mode of this data? Show your work.

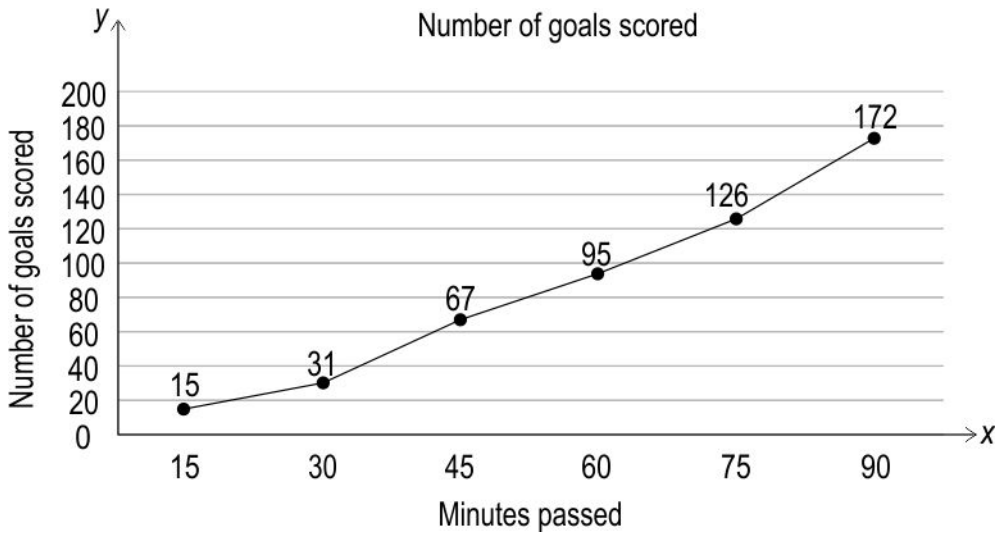
(Note: Any extra time to be ignored.)

Q: 7 **The median of the following distribution is 35. Some of the entries in the table are missing.** **[2]**

Class Interval	Frequency	Cumulative Frequency
10 – 20	5	5
20 – 30		A
30 – 40	5	
40 – 50		40
50 – 60	5	45

Find the value A. Show your steps.

Q: 8 **The graph below shows the number of goals scored upto a given minute-mark in all football matches in FIFA World Cup 2022.** **[5]**



Find the approximate minute in the 90-minute game before which about 50% of the goals in FIFA World Cup 2022 were scored. Show your work.

Q.No	Correct Answers
1	1
2	2
3	3
4	3

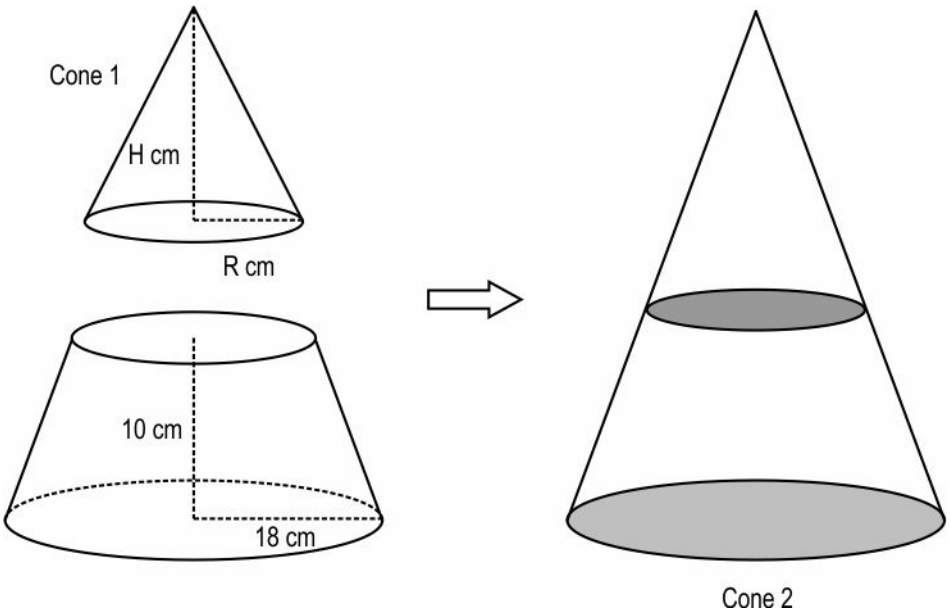
<table>
<tr><th>Q.No</th><th>What to look for</th><th>Marks</th></tr>
<tr><td rowspan="2">5</td><td>Finds the average performance of all countries as $\frac{130+570+300+280}{42} = \frac{1280}{40}$ or approximately 30%.</td><td>0.5</td></tr>
<tr><td>Writes that Japan performed better than the average performance.</td><td>0.5</td></tr>
<tr><td>6</td><td>Finds the mode of this data as $60 + \frac{1}{2} \times 15 = 67.5$ minutes.</td><td>1</td></tr>
<tr><td rowspan="2">7</td><td>Writes that $n = 45$ and $\frac{n}{2} = 22.5$.</td><td>0.5</td></tr>
<tr><td>Uses the formula of the median of grouped data and finds A as follows.
$35 = 30 + (\frac{22.5-A}{5} \times 10)$
$\Rightarrow A = 20$</td><td>1.5</td></tr>
<tr><td rowspan="2">8</td><td>Constructs the cumulative frequency distribution table as:
<table><tr><th>Class Intervals</th><th>Frequency</th><th>Cumulative Frequency</th></tr><tr><td>0-15</td><td>15</td><td>15</td></tr><tr><td>15-30</td><td>16</td><td>31</td></tr><tr><td>30-45</td><td>36</td><td>67</td></tr><tr><td>45-60</td><td>28</td><td>95</td></tr><tr><td>60-75</td><td>31</td><td>126</td></tr><tr><td>75-90</td><td>46</td><td>172</td></tr></table></td><td>2</td></tr>
<tr><td>Writes that $\frac{172}{2}$ = 86th observation lies in the class 45-60 and hence it is the median class.</td><td>1</td></tr>
</table>

Q.No	What to look for	Marks
	Substitutes the values in the formula for the median to get $45 + \frac{86-67}{28} \times 15$, where 45 = the lower limit of median class (l) 67 = the cumulative frequency of the class preceding the median class (cf) 28 = frequency of median class (f) 86 = $\frac{1}{2}$ of number of observations 15 = the class size (h)	1
	Finds the approximate median minute as $45 + (\frac{2}{3} \times 15) = 55$ minutes.	1

Chapter - 14
Application of Multiple Concepts

Multiple Choice Questions

Q: 1 **Shown below is a frustum, cone 1 and cone 2. Cone 2 is made by joining cone 1 to the frustum.**



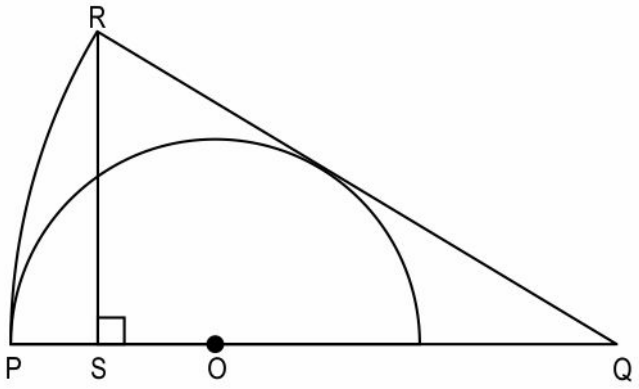
(Note: The figures are not to scale.)

Which of these could be the values of R and H for cone 1?

1 R = 9 cm; H = 5 cm
2 R = 6 cm; H = 5 cm
3 R = 9 cm; H = 20 cm
4 R = 6 cm; H = 20 cm

Free Response Questions

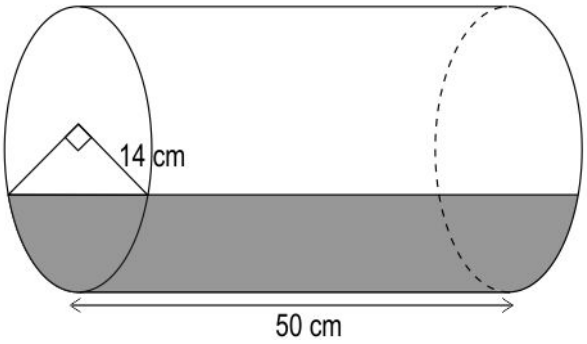
Q: 2 **Shown below is a semi-circle with centre O inscribed in a circular sector PQR. QR = 6 cm and RS = 2 cm.** **[5]**



(Note: The figure is not to scale.)

Find the radius of the semicircle. Draw a figure and show your work.

Q: 3 **Shown below is a horizontal cylinder of base radius 14 cm and length 50 cm. It is filled with water upto a certain height.** **[5]**

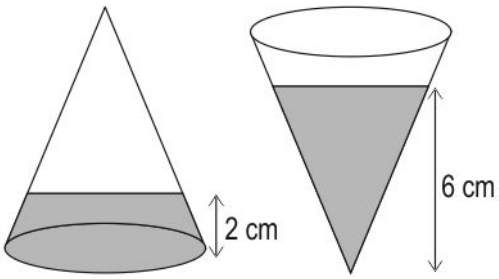


(Note: The figure is not to scale.)

Find the approximate volume of water in the cylinder. Draw a rough figure and show your steps.

(Note: Take π as $\frac{22}{7}$.)

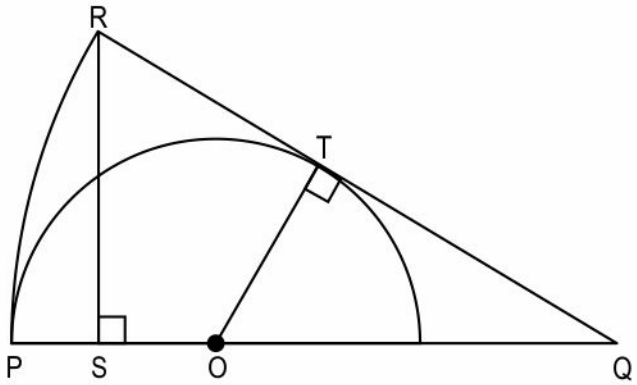
Q: 4 **A right-circular cone has a certain volume of water. Shown below is the cone in two orientations - upright and inverted.** **[5]**

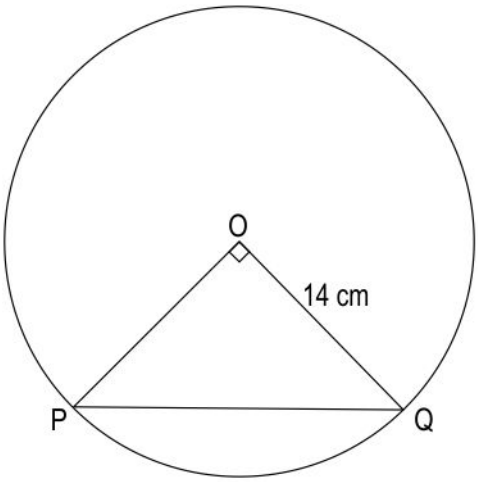


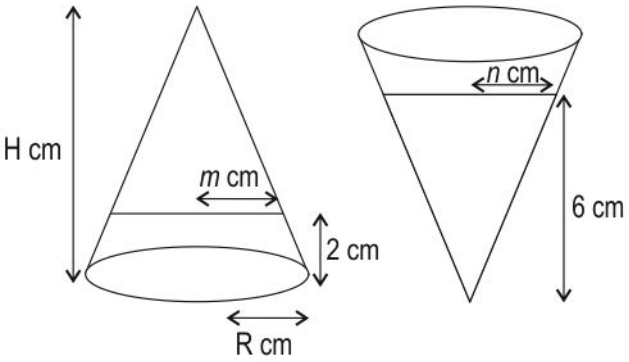
(Note: The figures are not to scale.)

Find the height of the cone. Show your work.

Q.No	Correct Answers
1	2

Q.No	What to look for	Marks
2	**Draws a figure with radius OT as *r* cm such that OT ⊥ QR. The figure may look as follows:**  ***(Note: The figure is not to scale.)***	**1**
	For ▲OQT and ▲RQS, writes that: **∠OTQ = ∠RSQ = 90°** **∠OQT = ∠RQS (common)** **Hence, ▲OQT ~ ▲RQS by AA similarity criterion.**	**1.5**
	Writes that PQ = QR = 6 cm as PQ and QR are radii of the circle with centre Q.	**0.5**
	Uses the above step to write the ratio of sides as: $\frac{OT}{RS} = \frac{OQ}{QR}$ $\Rightarrow \frac{r}{2} = \frac{6-r}{6}$	**1**
	Solves the above equation to find the radius of the semicircle as $\frac{12}{8}$ cm or 1.5 cm.	**1**

Q.No	What to look for	Marks
3	**Draws a rough figure of the base circle. The figure may look as follows:**  ***(Note: The figure is not to scale.)***	**1**
	Finds the area of sector POQ as $\frac{90}{360} \times \frac{22}{7} \times 14 \times 14 = 154\ cm^2$. **(Award 0.5 marks if only the formula for the area of a sector is written correctly.)**	**1**
	Finds the area of $\triangle$POQ as $\frac{1}{2} \times 14 \times 14 = 98\ cm^2$.	**1**
	Finds the area of segment PQ as $154 - 98 = 56\ cm^2$.	**1**
	Finds the approximate volume of water in the cylinder as $56 \times 50 = 2800\ cm^3$.	**1**

Q.No	What to look for	Marks
4	**Redraws the given figures and assumes the height as H and radii as *m*, *n* and R. The figures may look as follows:**  	**0.5**
	Uses similarity of triangles to write the relation for the upright cone as: $\frac{m}{R} = \frac{H-2}{H}$ $\Rightarrow m = \frac{(H-2)R}{H}$	**0.5**
	Uses similarity of triangles to write the relation for the inverted cone as: $\frac{n}{R} = \frac{6}{H}$ $\Rightarrow n = \frac{6R}{H}$	**0.5**
	Writes the equation for the volume of water in the two cones as: $\frac{1}{3}\pi R^2 H - \frac{1}{3}\pi m^2 (H - 2) = \frac{1}{3}\pi n^2 (6)$	**0.5**
	Substitutes values of *m* and *n* and simplifies the above equation as: $H - \frac{(H-2)^3}{H^2} = \frac{6^3}{H^2}$	**1**
	Simplifies the above equation as: $(H - 2)^3 = H^3 - 216$	**0.5**
	Simplifies the above equation as: $3H^2 - 6H - 104 = 0$	**0.5**

Q.No	What to look for	Marks
	Uses the quadratic formula to find the height of the cone as: $H = \frac{6+\sqrt{1284}}{6}$ cm (Rejects $H = \frac{6-\sqrt{1284}}{6}$ cm as height cannot be negative.)	**1**

Chapter - 15
Probability

Multiple Choice Question

Q: 1 **Pratik has blue and green coins of the same size in a bag. He has 50 coins each of blue and green.**

He is randomly picking up one coin at a time without replacement. He does not see which coin he has picked.

What is the MINIMUM number of coins he would have to pick to definitely get a pair of blue or green coins?

1 2 **2** 3 **3** 4 **4** 5

Free Response Questions

Q: 2 **Drish lives in India and Hugh lives in the USA. The date formats of both the countries is given below.** **[3]**

India: day/month
USA: month/day

They wrote dates everyday in 2022. If a day in 2022 is randomly selected, what is the probability that:

i) both their dates in the two formats are the same on that day?

ii) the date written by Hugh is a valid date for Drish in India?

Show your work and give valid reasons.

Q: 3 **Two jars, A and B, hold 5 identical coins each, numbered from 0 to 9. Jar A contains even-numbered coins, while Jar B contains odd-numbered coins. One coin from each jars is randomly chosen simultaneously, without looking. The selected coins are combined to form a new number.** **[5]**

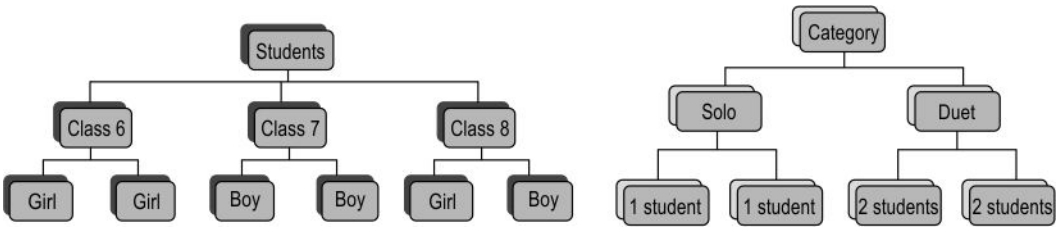
i) The coin from Jar A represents the tens place and the coin from Jar B represents the ones place. Find the probability that the number formed is:
a) greater than 50.
b) equal to 50.

ii) If the rule is changed such that the coin from Jar B represents the tens place and the coin from Jar A represents the ones place, does the probability of getting a number greater than 50 increase/decrease?

iii) The coins from the Jars are re-distributed equally such that each jar has some even and some odd coins. Write a rule with the appropriate arrangement of coins in both the jars such that the probability of forming an odd number is higher on combining coins one from each jar.

Show your work.

Q: 4 **6 students from Daffodil school participated in an inter school dance competition. Each of these 6 students were limited to one performance. There were 2 solo dance categories and 2 duet dance categories as depicted by the flow charts below.** **[5]**



The school's dance teacher used a chit system to select one performance for each of the 6 students in the below order:

Solo 1 --> Duet 1 --> Solo 2 --> Duet 2

i) If one girl was selected from class 6 for Solo 1, find the probability of NOT selecting both girls or both boys for Duet 1? ii) Find the probability of selecting one girl and one boy for Duet 1 such that only one student was left in each class.

iii) After selecting one girl and one boy for Duet 1 only one student was left in each class. The student who got selected for Solo 2 had the probability $\frac{2}{3}$ of getting selected. Was it a girl or a boy and from which class he/she could have been?

Show you work.

Q.No	Correct Answers
1	2

Q.No	What to look for	Marks
2	i) Writes that there are 12 dates in 2022 where the day and the month are interchangeable such as: 01/01, 02/02, 03/03, ... and so on	1
	Finds the probability that the date written by both of them for a random day in 2022 is exactly the same as $\frac{12}{365}$, as 2022 is a non-leap year.	0.5
	ii) Writes that since there are 12 months in a year, Hugh's date's day can have values from 1-12 of every month such that it is a valid date for Drish. Hence, the total number of favourable outcomes are 12 × 12 = 144.	1
	Finds the probability that the date written by Hugh for a random day in the USA format is a valid date for Drish in India as $\frac{144}{365}$.	0.5
3	i) a) Writes that the number formed on combining coins chosen from both the jars will be greater than 50 if either 6 or 8 is selected from Jar A, thus finds its probability as: $\frac{2}{5}$ = 0.4 (Award full marks if all the possible outcomes are listed and then probability is found.)	1
	b) Reasons that the number 50 cannot be formed because it has an even digit at its one's place, but the coins in Jar B are all odd, thus finds its probability as 0. (Award full marks if all possible outcomes are listed and then probability is found.)	0.5
	ii) Writes the possible 25 outcomes as {10, 12, 14, 16, 18, 30, 32, 34, 36, 38, 50, 52, 54, 56, 58, 70, 72, 74, 76, 78, 90, 92, 94, 96, 98} Finds the probability of number formed being more than 50 as: $\frac{14}{25}$ or 0.56 Concludes that the probability of number formed being greater than 50 increases on changing the rule.	1.5

Q.No	What to look for	Marks
	iii) Finds one such rearrangement of coins as: **Jar A: 0, 1, 2, 3, 4** **Jar B: 5, 6, 7, 8, 9** **Forms the rule that the coin from Jar B should represent the ones place and the coin from Jar A should represent the tens place.**	**1.5**
	Reasons that this arrangement of coins satisfies the mentioned condition and as Jar B has more odd numbered coins than even, the probability of getting an odd number will be higher in this rule.	**0.5**
4	**i) Assumes the students who participated from from class 6 were G1 and G2, class 7 were B1 and B2 and class 8 were G3 and B3 and G1 was selected for Solo 1.** **Writes all the possible outcomes on selecting 2 students out of the remaining students as:** **{(G2, B1), (G2, B2), (G2, G3), (G2, B3), (B1, B2), (B1, G3), (B1, B3), (B2, G3), (B2, B3), (G3, B3)}**	**1**
	Finds the probability of NOT selecting both girls or both boys for the Duet 1 as: **$1 - \frac{4}{10} = 0.6$**	**1**
	ii) Finds the desired outcomes of the possible outcomes from step 1 for Duet 1 as: **{(B1, G3), (B2, G3)}** **Finds the probability of selecting one girl and one boy for Duet 1 such that only one student was left in each class as:** **$\frac{2}{10} = 0.2$**	**1**
	iii) Writes that, either (B1, G3) or (B2, G3) were selected for Duet 1, the remaining in the group would have been: **Either** **Class 6: G2** **Class 7: B2** **Class 8: B3** **Or** **Class 6: G2** **Class 7: B1** **Class 8: B3**	**1**

Q.No	What to look for	Marks
	Concludes that in either of the above cases, only a boy either from class 7 or class 8 could have been selected with the probability $\frac{2}{3}$.	**1**

16. Annexure
Correct Answer Explanation

Chapter Name	Q.No	Correct Answer	Correct Answer Explanation
Introduction to trigonometry	1	2	As PQR is a right-angled triangle, ∠P and ∠R are complementary angles.
			Therefore, tan P = cot R.
			Hence, option B is the correct answer.
			PQ = PR (tangents to a circle from a point are equal),
			∠OQP = ∠ORP = 90° (tangents of a circle is perpendicular to radius).
			A unique quadrilateral which would be a square is formed when either ∠ROQ = 90° or ∠RPQ = 90°.
			Hence, option C is the correct answer.
Some Applications of trigonometry	2	3	The height h divides the triangle with base AB into two congruent triangles using RHS congruency criterion.
			In either one of the triangles,
			tan x = (AB/2)/h
			=> AB = 2h tan x
			Hence, option C is the correct answer.
Probability	1	2	The possible combinations when two coins are picked are {(G,G), (G,B), (B,G), (B,B)}, not all combinations have a pair of Green or Blue coins, hence, there is not a definite chance of picking a pair of blue or green coins.
			The possible combinations when three coins are picked are {(B,B,B), (B,B,G), (B,G,B), (G,B,B), (G,G,B), (G,B,G), (B,G,G), (G,G,G)}. Each combination in this sample space has a pair of blue or green coins, hence, there is a definite chance of picking a pair of blue or green coins.
			Hence, option B is the correct answer.

Central Board of Secondary Education
Shiksha Sadan, 17, Rouse Avenue,
New Delhi-110002