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*.

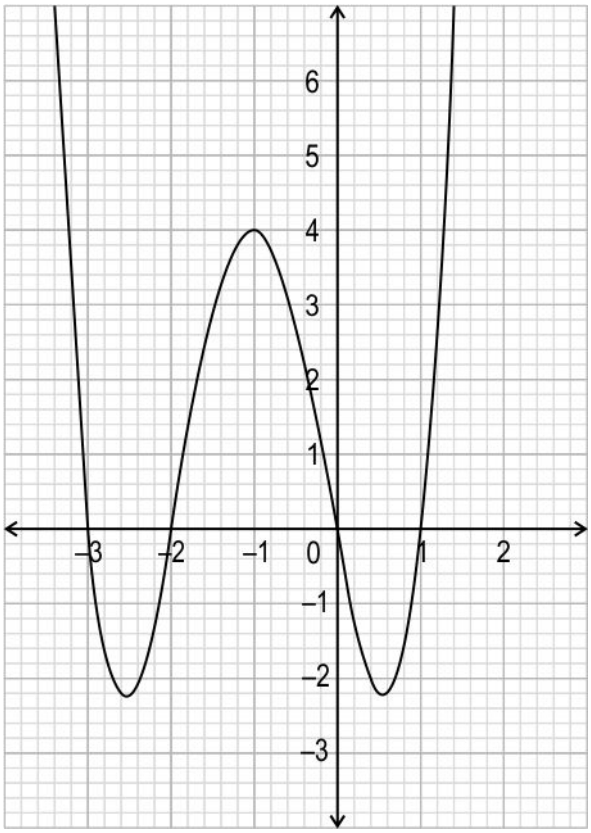
Show your steps.

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]**

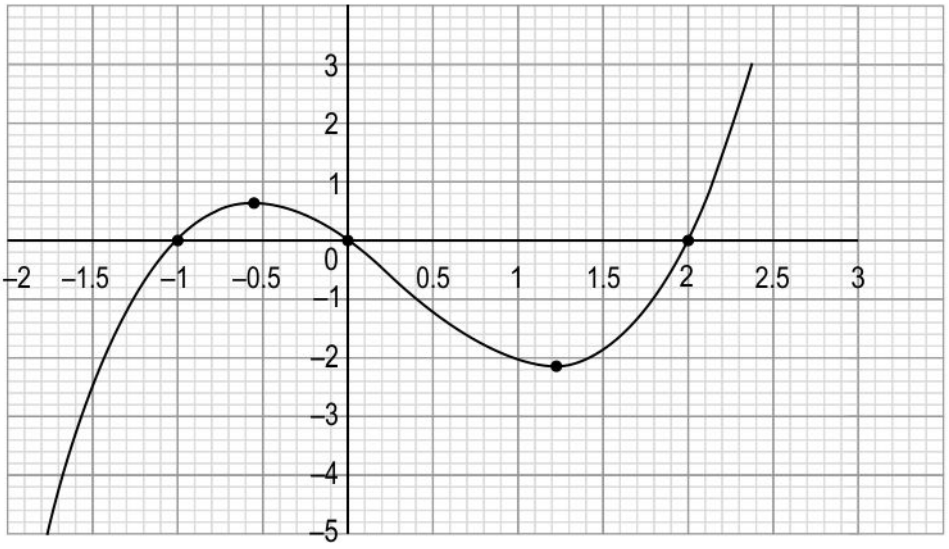
Find the zeroes of $p(x)$. Show your work.

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)

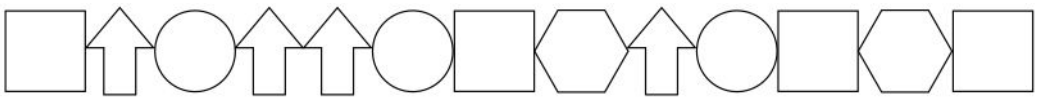
Q: 4 **A card is drawn at random from a well shuffled standard deck of 52 cards.**

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]**

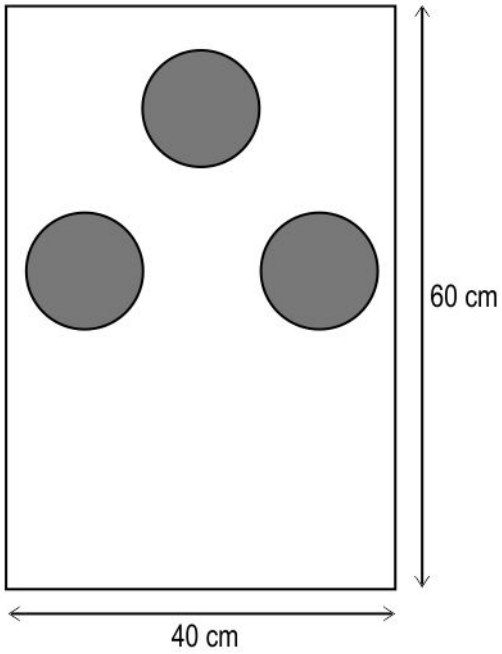
What is the probability that the sum of the numbers shown on the pair of dice is greater than 1? Justify your answer.

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.

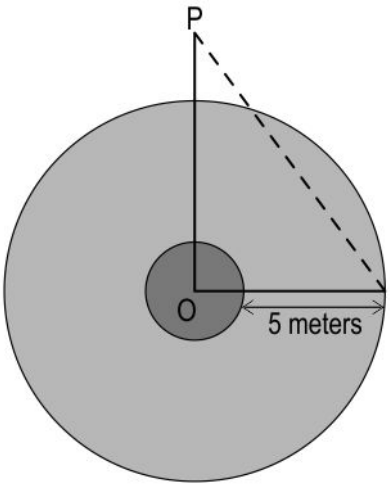
Q: 20 **The sum of the squares of two consecutive odd integers is 290.** **[3]**

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.

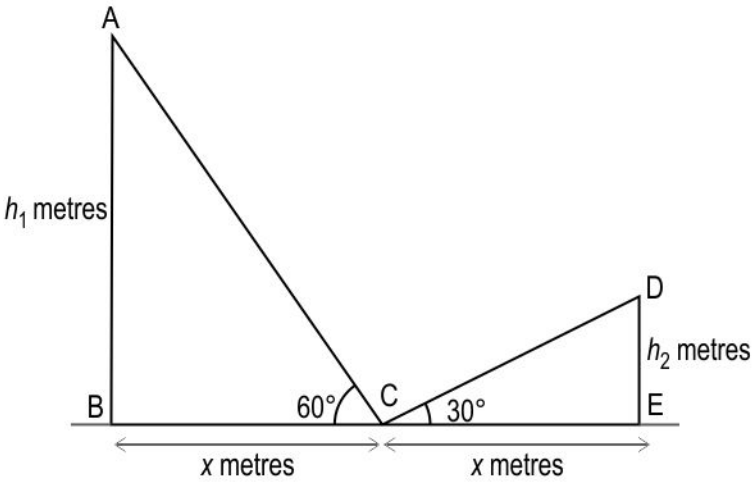
(Note: The horizontal distance is measured between the central axes.)

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.

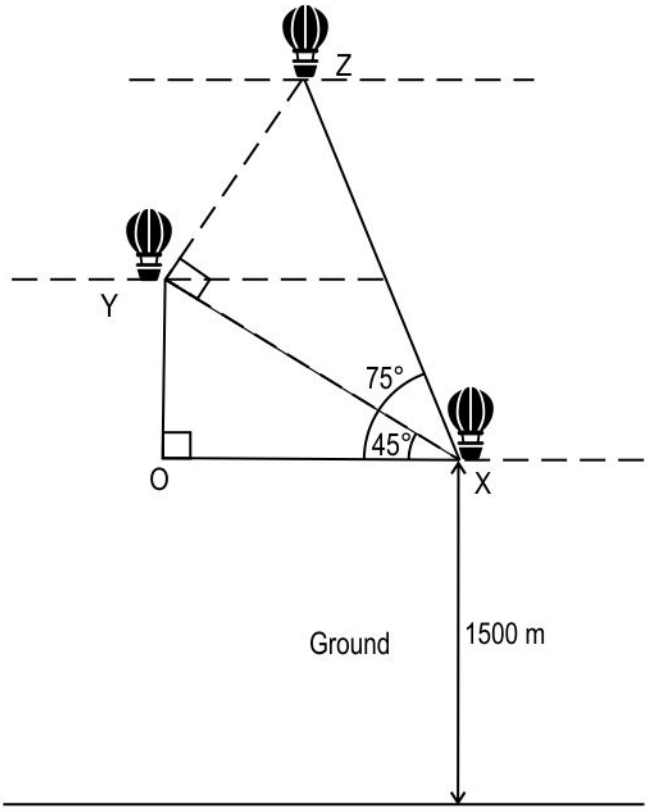
Q: 22 **A tree breaks at a point 5 m from its bottom and falls to the ground. The top of the broken tree touches the ground at a distance of 12 m from its base. The tree is at a right angle with the ground.** **[3]**

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]**

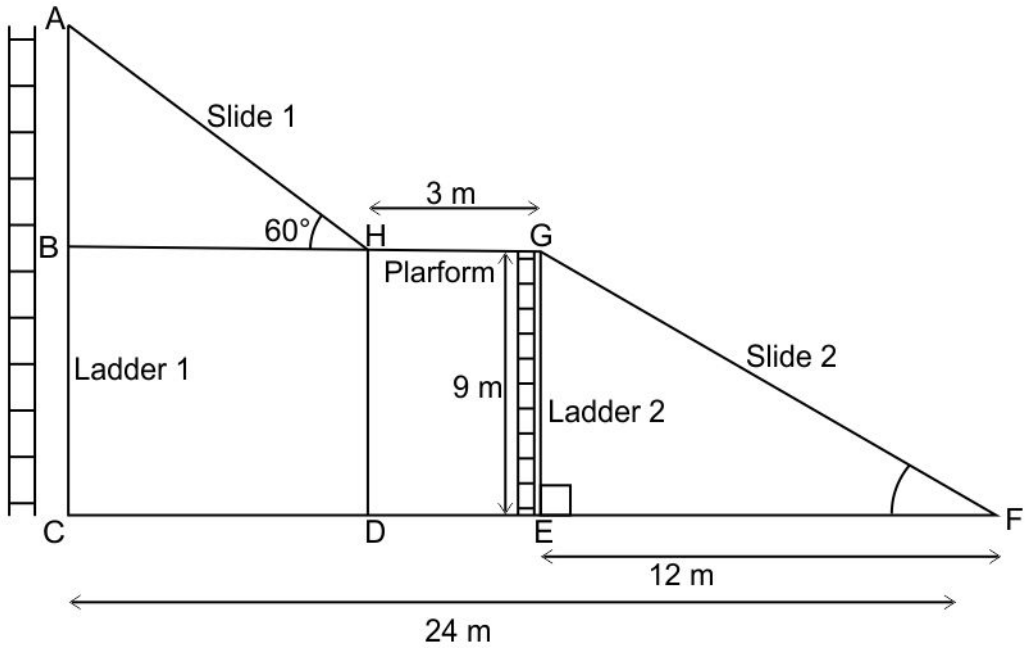


♦ The horizontal distance between balloons X and Y is equal to X's altitude.
♦ Balloons X, Y, and Z are placed such that ∠XYZ = 90°.

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.

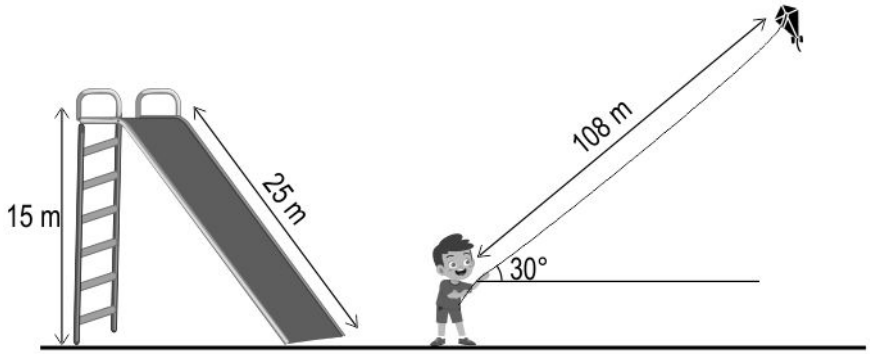


Fig (a) Fig (b)

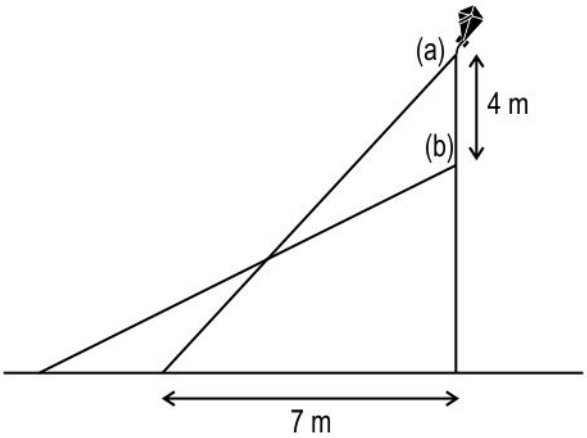
(Note: Take √2 as 1.414 and √3 as 1.732)

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.*)

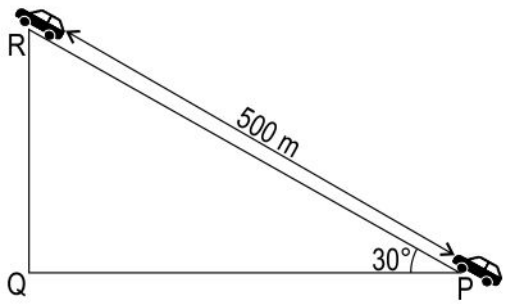
Q: 27 **Nikhil's kite got stuck on the roof of a neighbouring building. Suman saw this and used a ladder to climb up the roof. The ladder was 25 m long and was positioned 7m away from the base of the building. As Suman started to climb, the ladder slipped by 4 m from point (a) to (b) as shown below.**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

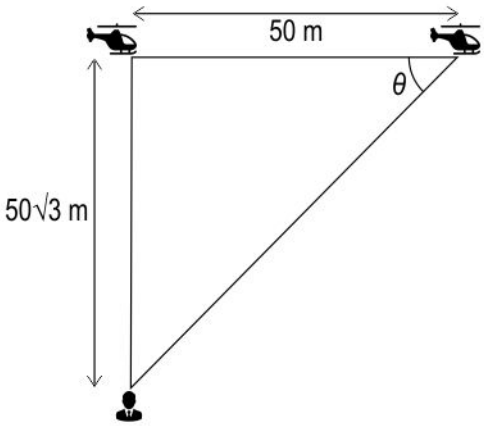


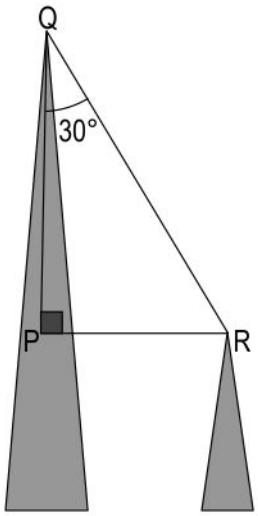
(Note: The figure is not to scale.)

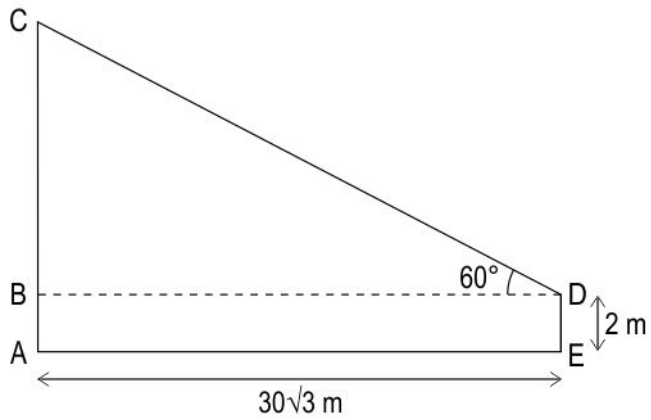
Find the distance by which the foot of the ladder slid along the ground. Show your work.

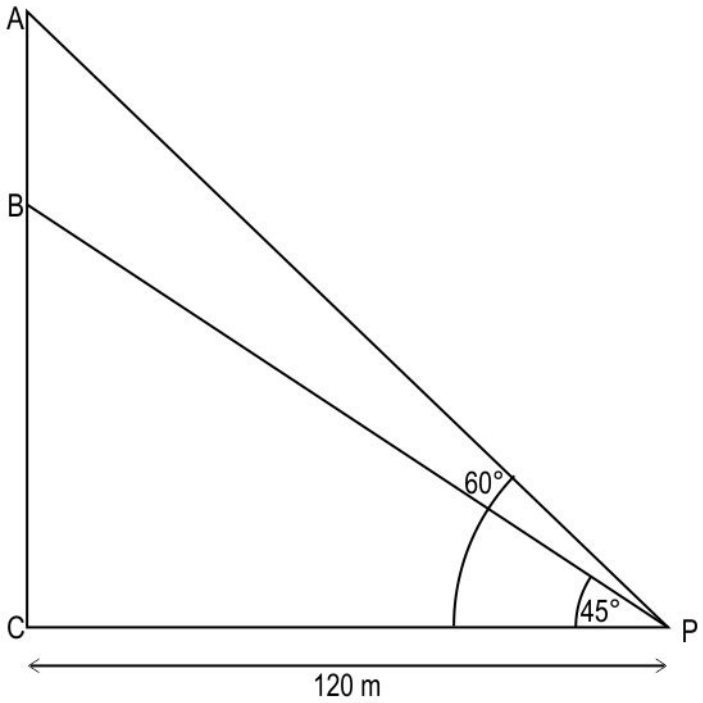
Q.No	Correct Answers
1	3
2	2
3	3
4	4
5	3
6	1
7	3
8	2

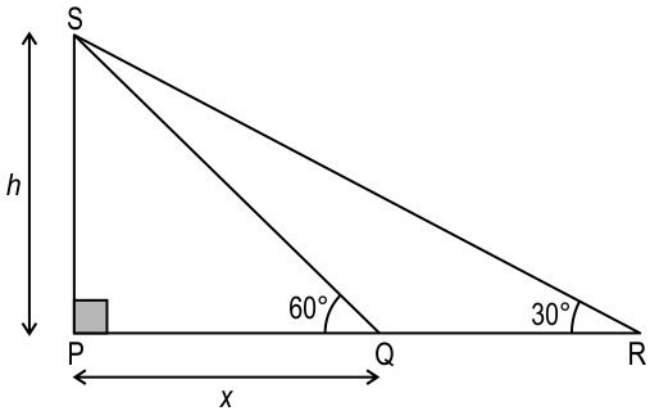
Q.No	What to look for	Marks
9	**i) Draws a figure representing the given information. The figure may look as follows:** 	**0.5**
	ii) Uses sin 30° in ΔPQR to find the vertical height of the car as $\frac{1}{2} = \frac{QR}{500}$ or 250 m.	**0.5**
10	**Uses the trigonometric ratio to write:** **cos 60° = $\frac{8}{length}$**	**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**

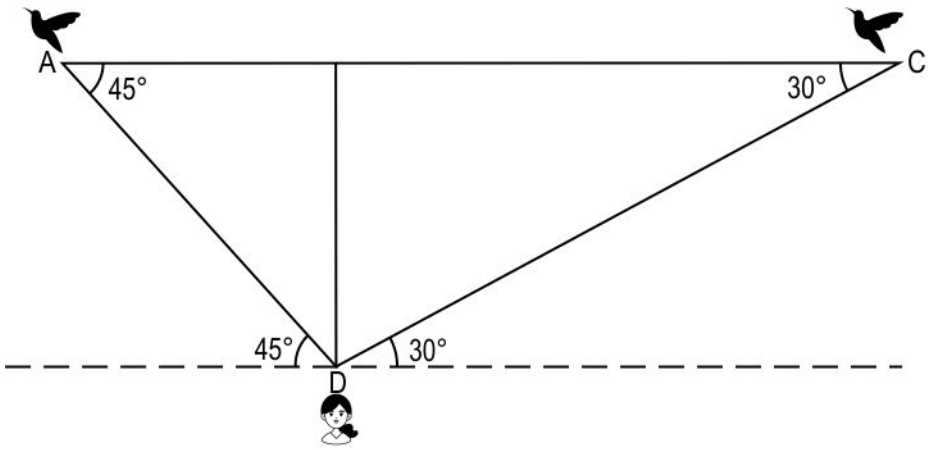
Q.No	What to look for	Marks
12	**Draws a rough diagram to represent the situation. The figure may look as follows:**  **(Note: The figure is not to scale.)**	**0.5**
	Uses the tan ratio to write : $\tan\theta = \frac{\text{altitude of the helicopter from boy}}{\text{horizontal distance covered by the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

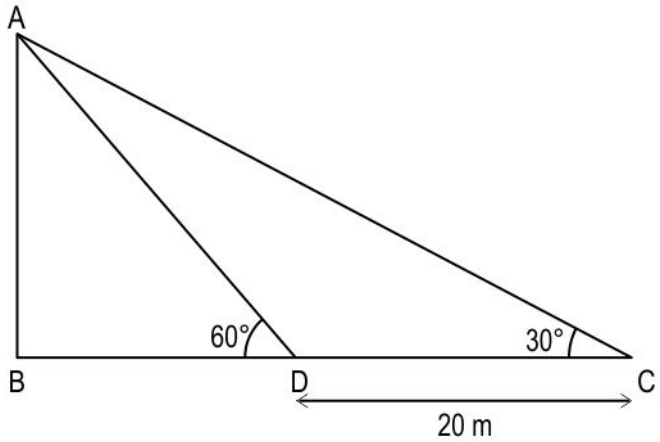
Q.No	What to look for	Marks
13	**Marks the triangle as shown**  **Writes that in ▲PQR,** **tan 30° = $\frac{PR}{PQ}$** **⇒ $\frac{1}{\sqrt{3}} = \frac{PR}{15}$**	**0.5**
	Solves the above equation and finds the horizontal distance between the towers as 5√3 m.	**0.5**

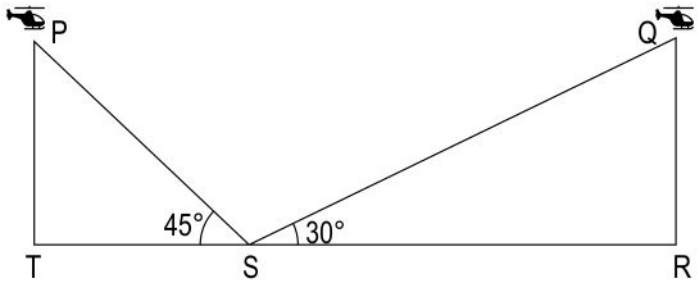
Q.No	What to look for	Marks
14	**i) Draws a diagram to represent the scenario. The diagram may look as follows:**  ***(Note: The figure is not to scale.)***	**0.5**
	ii) Uses the tangent trigonometric ratio in ΔBCD to write: **tan 60° = $\frac{BC}{BD}$** **tan 60° = $\frac{BC}{30\sqrt{3}}$ (BC = AE)** **=> 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**

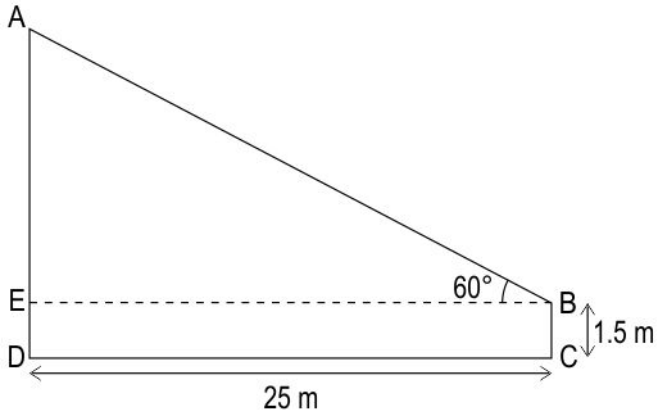
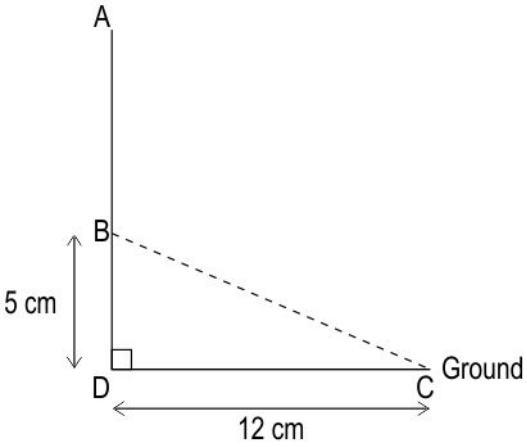
Q.No	What to look for	Marks
	Solves both the equations (i) and (ii) to write, $h_1 = \sqrt{3}\,x$ metres and $h = \frac{x}{\sqrt{3}}$ metres. **Uses the above to find the ratio as h_1 = 3:1.**	**1**
16	**Draws a rough diagram. The figure may look as follows:**  ***(Note: The figure is not to scale.)***	**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**

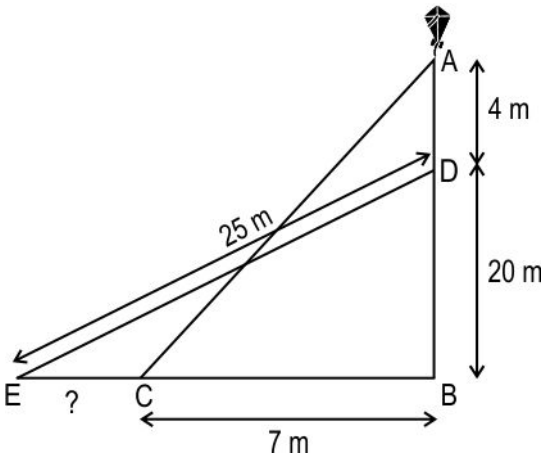
Q.No	What to look for	Marks
19	**Draws a diagram to represent the above scenario. The figure may look as follows:**  ***(Note: The figure is not to scale.)***	**0.5**
	i) Uses tan ratio in ΔABC to write: **tan 30° = $\frac{AB}{BC}$** **=> BC = √3AB m** **Uses tan ratio in ΔABD to write:** **tan 60° = $\frac{AB}{BD}$** **√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?

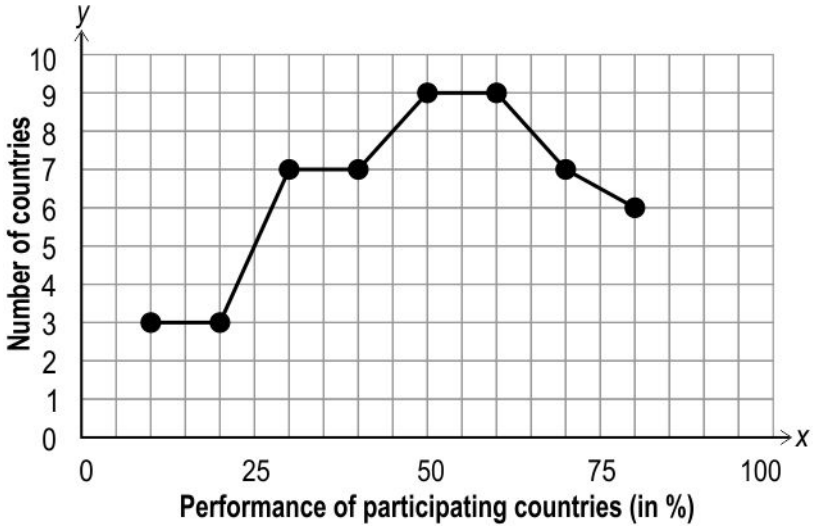
1 70.025 **2** 72.5 **3** 75 **4** 112.5

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:

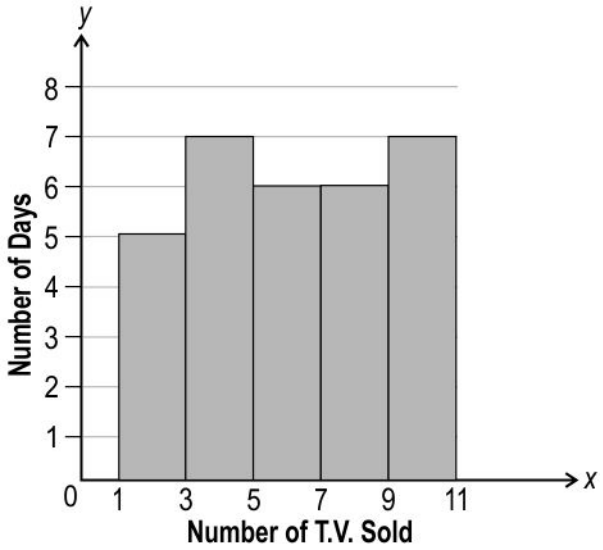
<table><tr><th>Number of bags sold</th><th>Number of Days</th><th>Cumulative Frequency</th></tr><tr><td>0 – 5</td><td>x</td><td>x</td></tr><tr><td>5 – 10</td><td>4</td><td>$x + 4$</td></tr><tr><td>10 – 15</td><td>15</td><td>$x + 19$</td></tr><tr><td>15 – 20</td><td>5</td><td>$x + 24$</td></tr><tr><td>20 – 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:

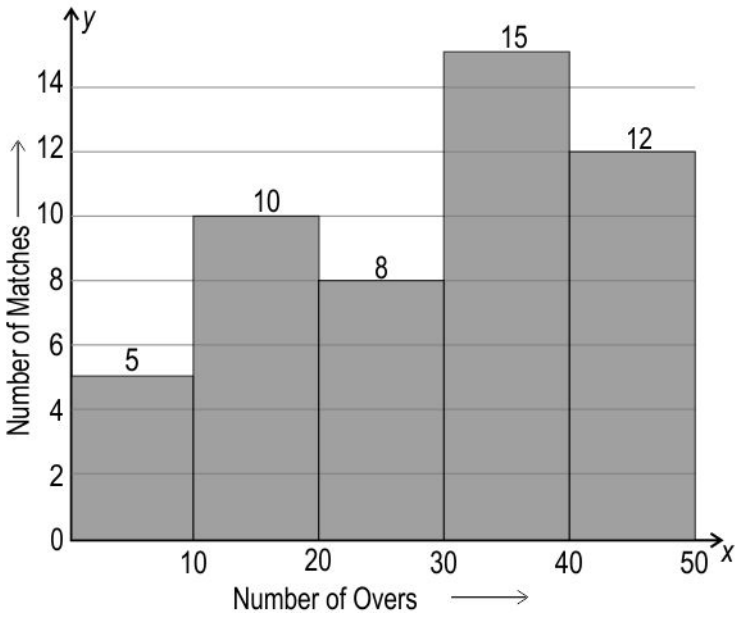
<table>
<tr><th>Class Interval</th><th>Frequency (f_i)</th><th>Class Mark (x_i)</th><th>$d_i = x_i - a$</th><th>$u_i = d_i / h$</th><th>$f_i u_i$</th></tr>
<tr><td>120-130</td><td>38</td><td>125</td><td>-20</td><td>-2</td><td>-76</td></tr>
<tr><td>130-140</td><td>40</td><td>135</td><td>-10</td><td>-1</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

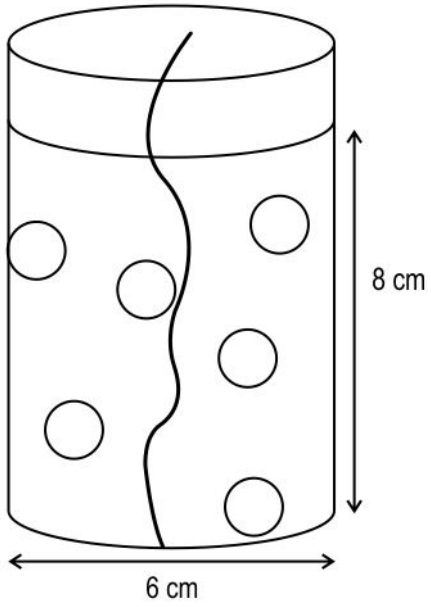
Multiple Choice Questions

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 $73\pi\ cm^3$

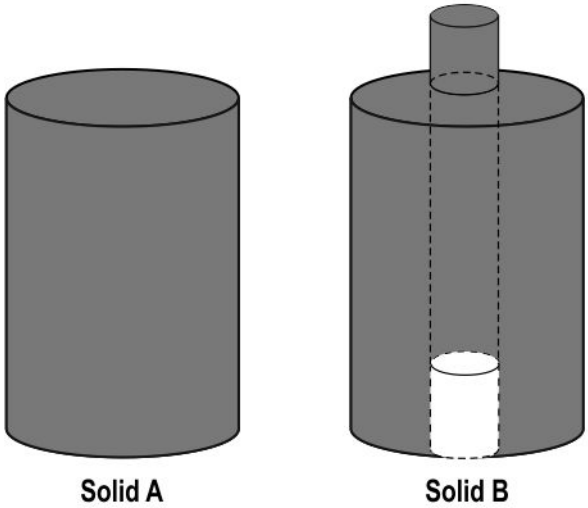
Q: 3 **Bipin is making iced tea in 2.2 litre jar. He adds some ice spherical balls of diameter 2 cm into the jar, followed by 1.32 litre of tea until it's full.**

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?

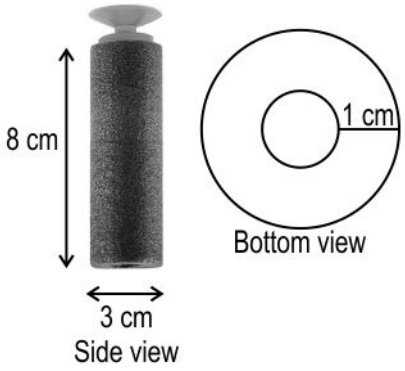
1 $\frac{5}{6}$
2 $\frac{11}{12}$
3 1
4 (cannot be determined without the exact dimensions)

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.

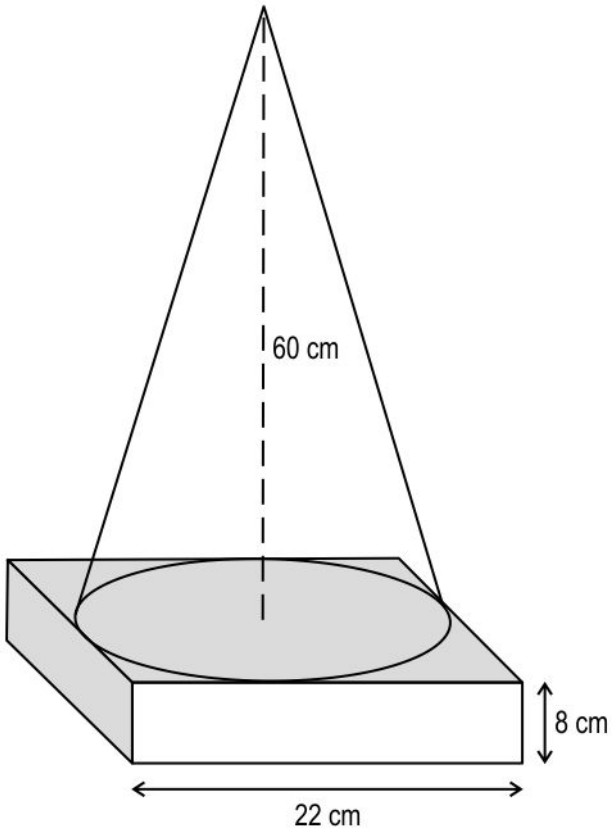
Q: 11 **What is the length of the side of a cube if its volume and surface area are numerically equal? Show your work.** **[1]**

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]**

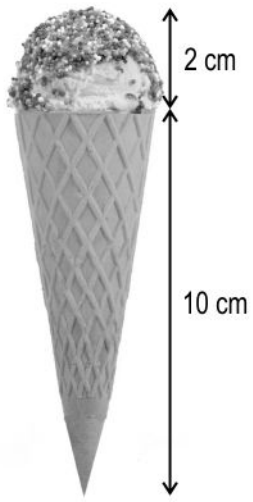


(*Note: The figure is not to scale.*)

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]**

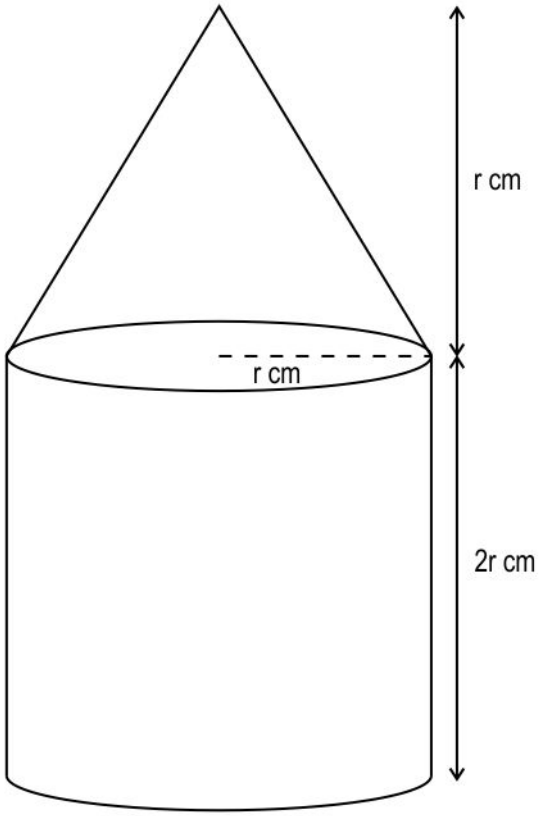


(Note: The figure is not to scale.)

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]**

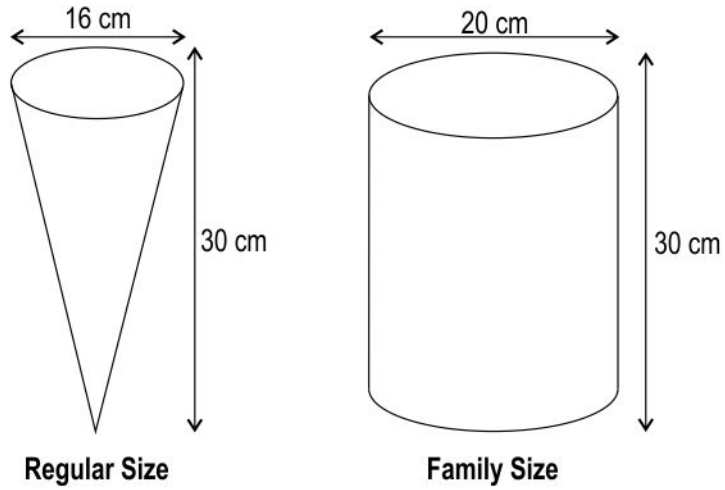
If the side of the cube is 4 cm, find the surface area of the paperweight that is to be polished? Show your work.

(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]**

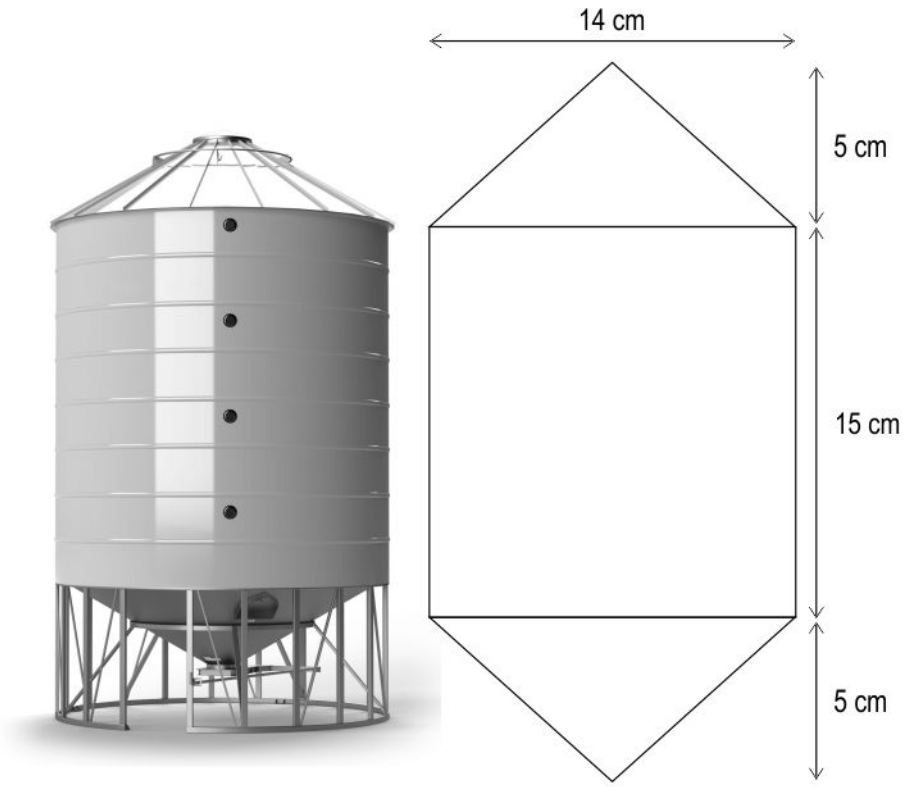


(Note: The figure is not to scale.)

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.

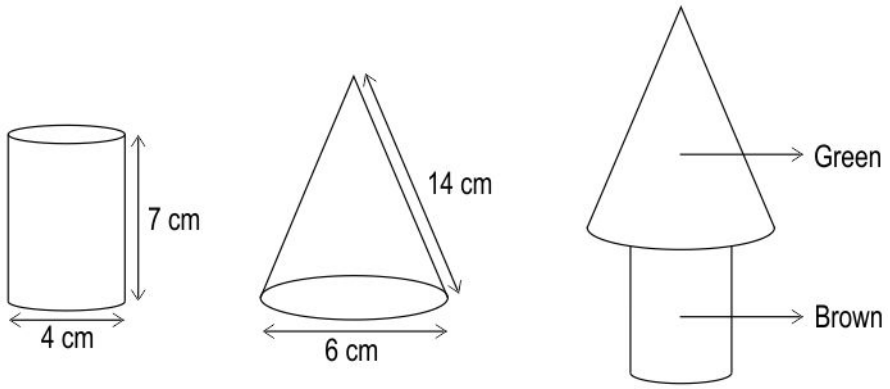
Q: 19 **A silo is used to store grains. It can be observed as a cylinder with 2 cones on its circular bases as shown in the figure below.** **[3]**



(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]**

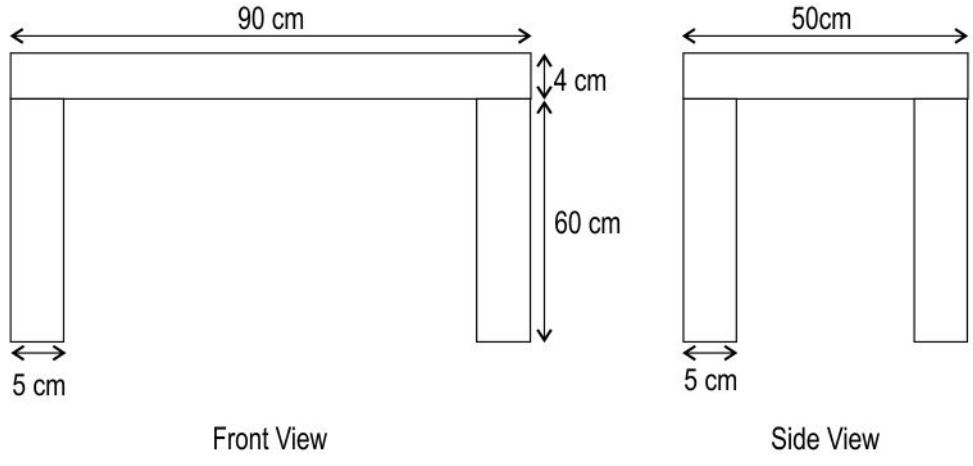


(Note: The figure is not to scale.)

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]**

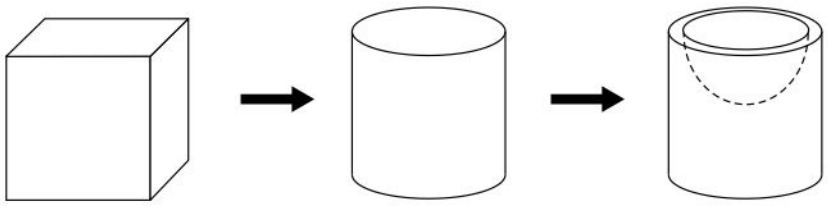


(Note: The figure is not to scale.)

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?

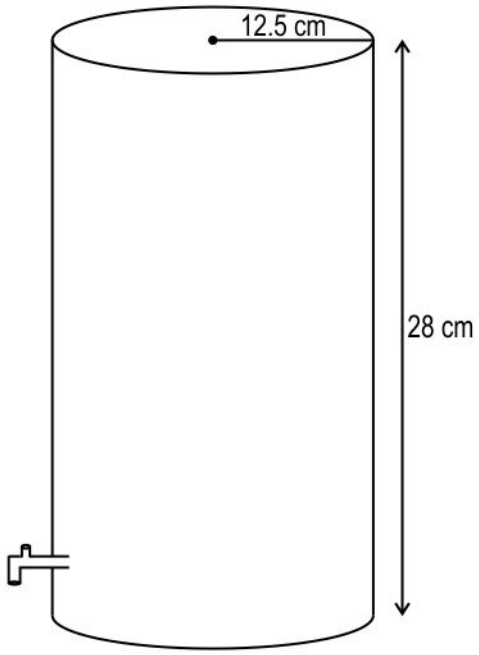
Show your work.

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

Case Study

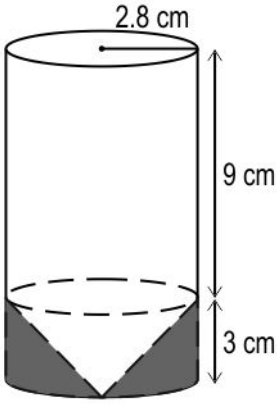
Answer the questions based on the information given.

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

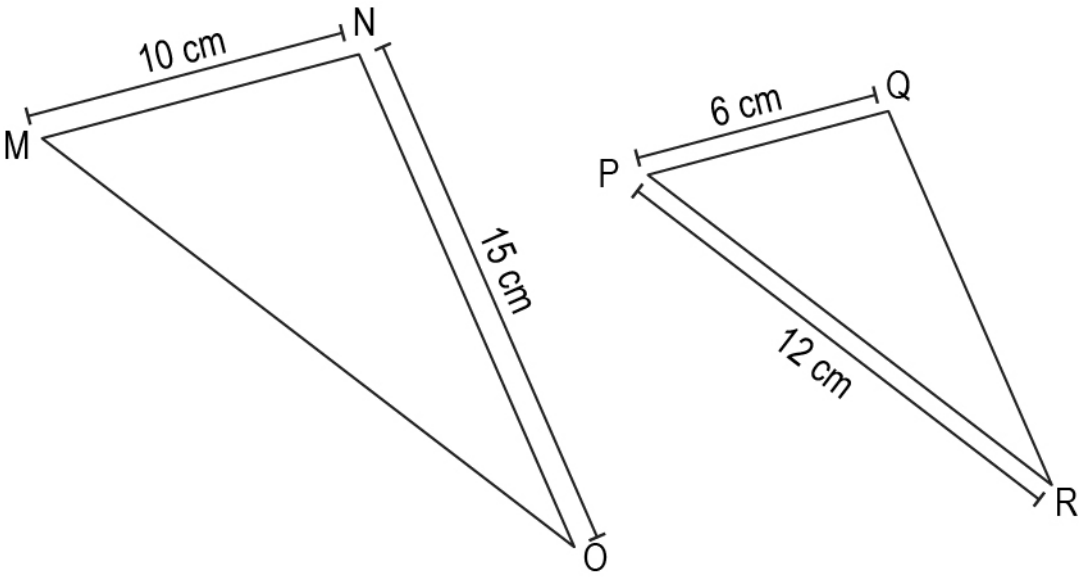
Multiple Choice Questions

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.**

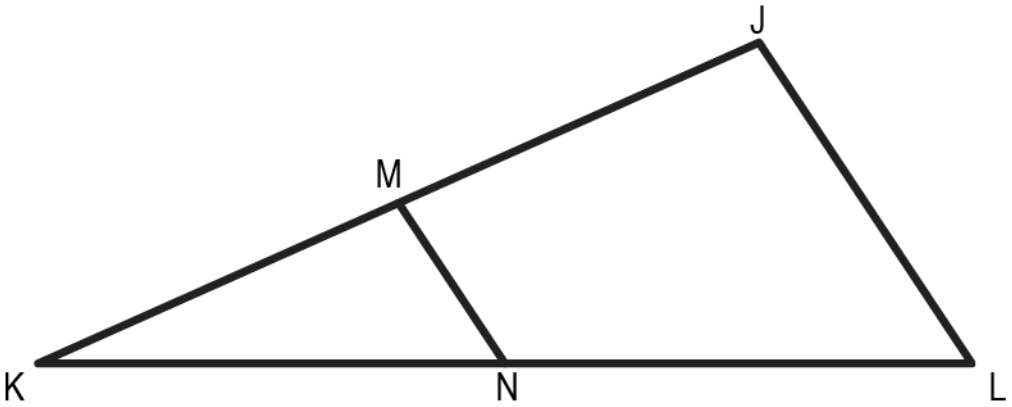


(Note: The figures are not to scale.)

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

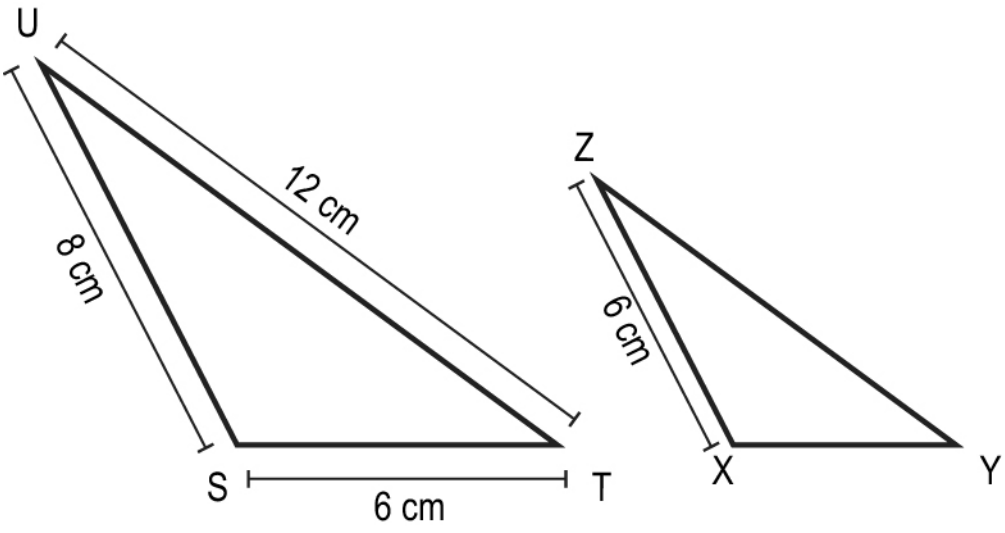
Q: 3 **In the following figure, MN is drawn such that M and N are mid-points on JK and KL, respectively.**



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.**

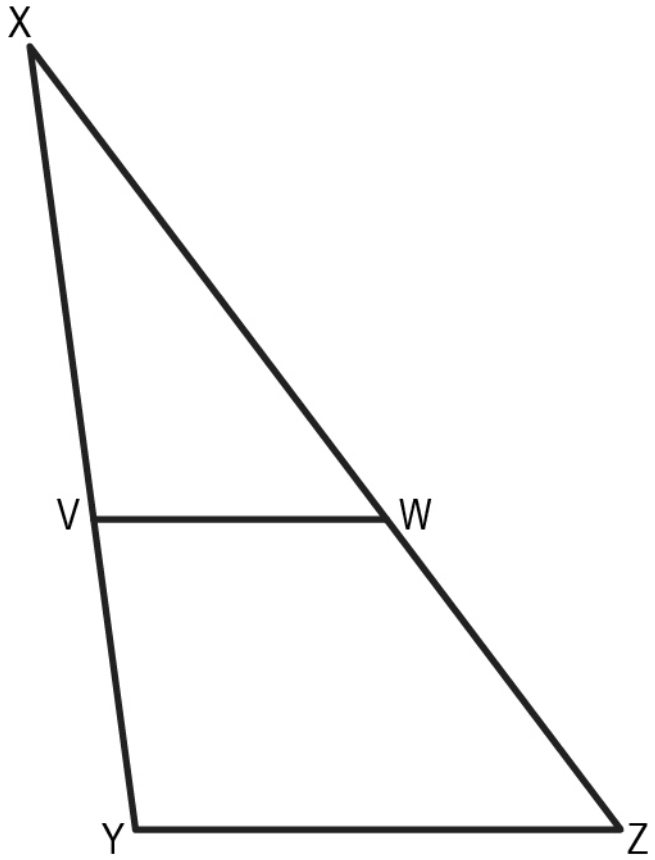


(*Note: The figures are not to scale.*)

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?

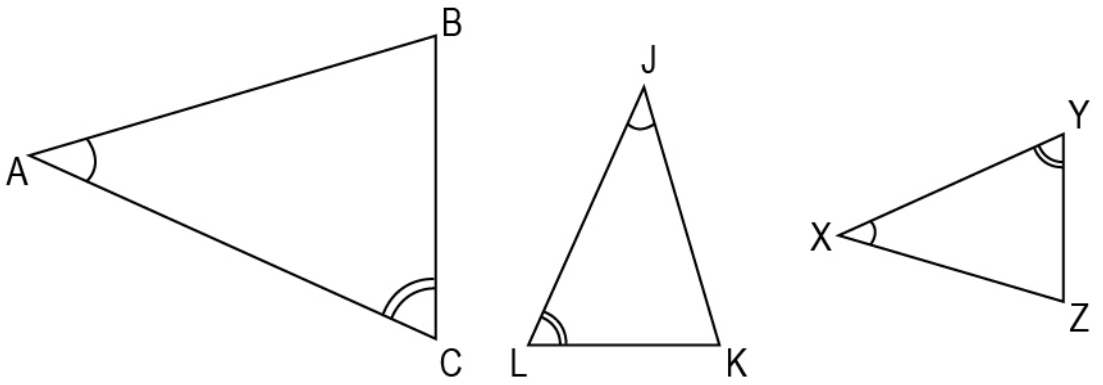
1 14 cm **2** 21 cm **3** 26 cm **4** 28 cm

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).

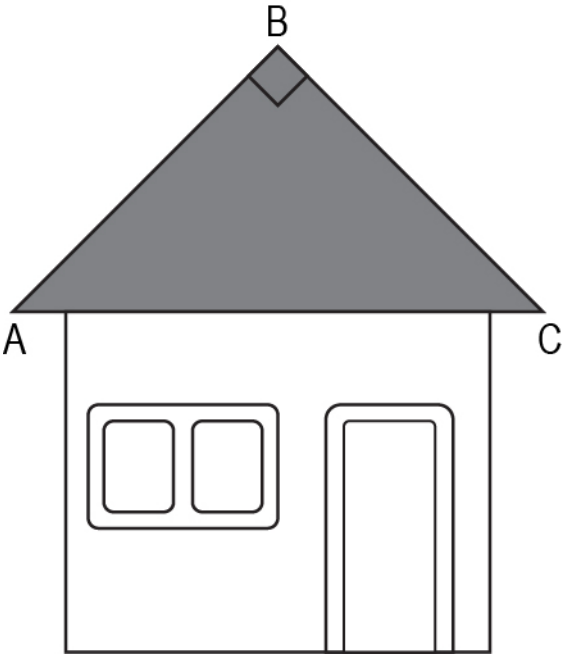
Assertion(A): ▲DEF is similar to ▲XYZ.

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]**

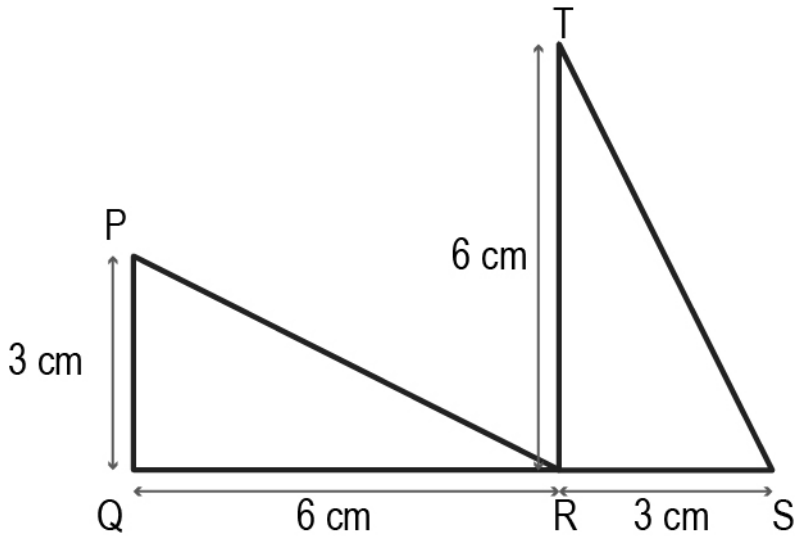


(Note: The figure is not to scale.)

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:

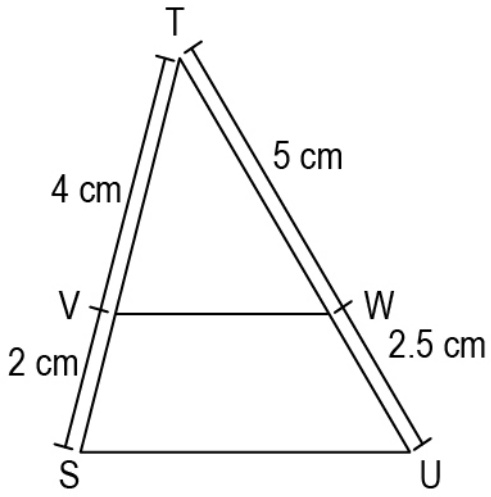
$\frac{PQ}{RT} = \frac{SR}{QR} = \frac{1}{2}$

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.

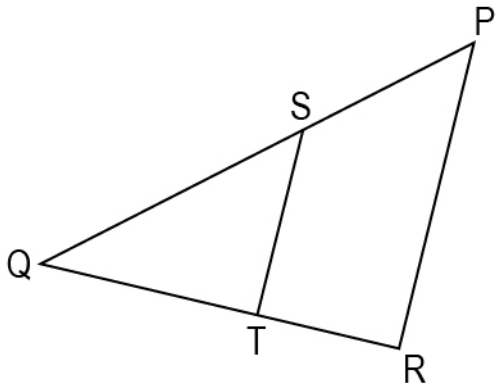
Q: 13 **Shown below is a figure.** **[1]**



(Note: The figure is not to scale.)

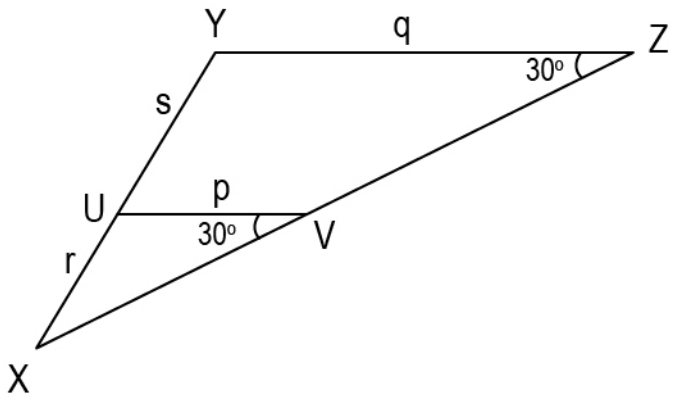
Show that ∠TUS = ∠TWV.

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.

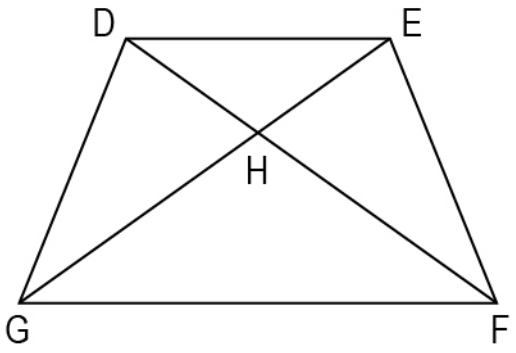
Q: 15 **Shown below are △XYZ and △XUV. All measurements are in cm.** **[2]**



(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.

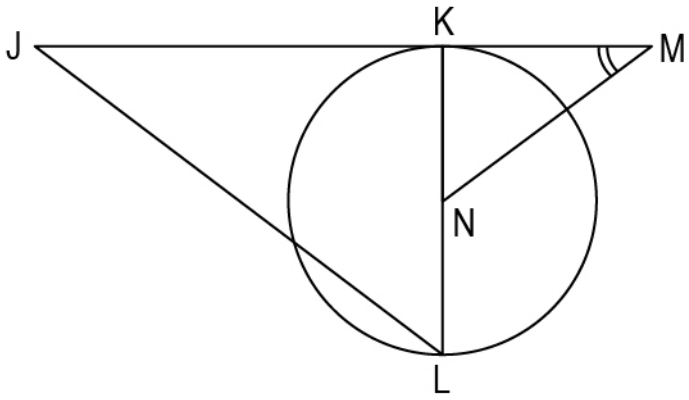
Q: 17 **Tanya cut a square piece of paper along its diagonal to get two right-angled triangles. He claimed that both these triangles are equilateral triangles.** **[2]**

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.

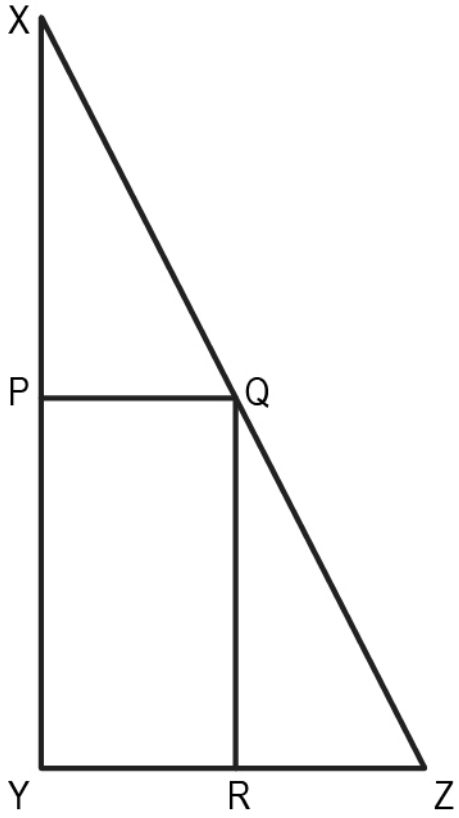
Q: 19 **In the figure below, JM is tangent to the circle which has its centre at point N and ∠LJK = ∠NMK.** **[2]**



(Note: The figure is not to scale.)

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

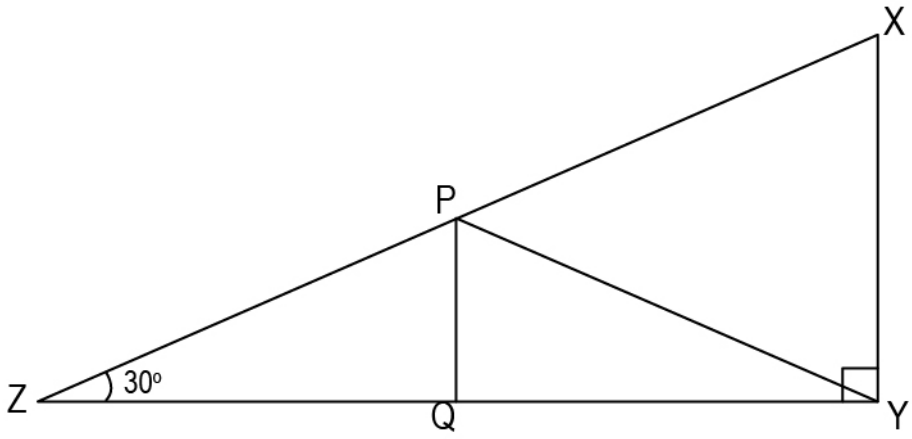
Q: 20 **In the figure below, QX = 10 cm, QZ = 8 cm, RZ = *b* cm, RY = (*b* + 1) cm and XY || QR.** **[3]**



(Note: The figure is not to scale.)

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

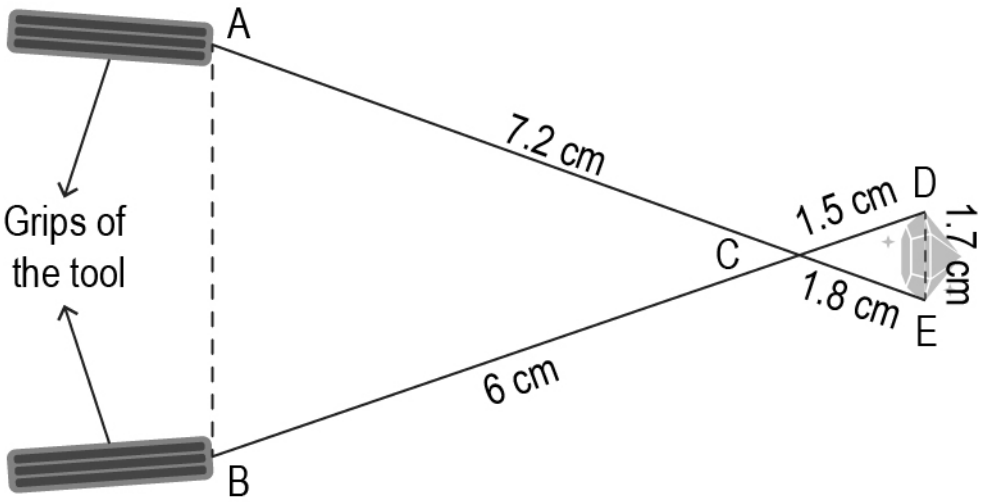
Q: 21 **In the figure below, PQ is drawn such that ZQ = QY and ZP = PX.** **[3]**



(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.)

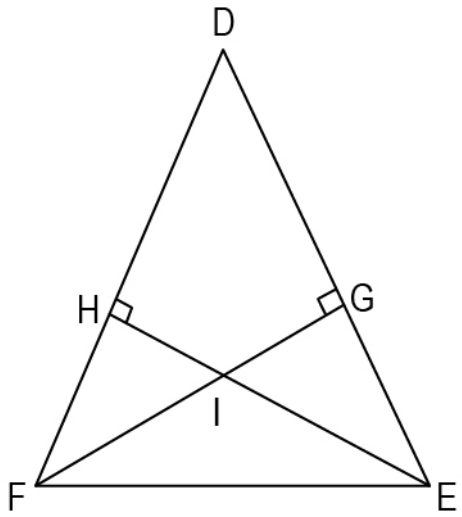
Ritika tells her grandfather tells her grandfather the width at which he needs to hold the tool.

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.

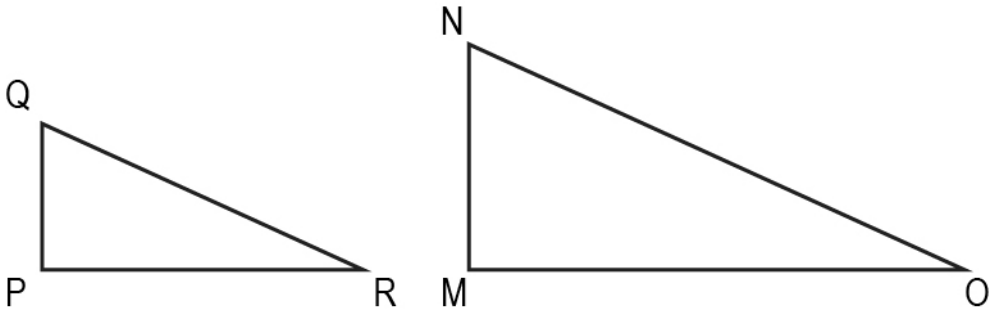
Q: 24 **In △DEF, altitudes EH and FG are altitudes intersecting at point I as shown below.** **[3]**



(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]**



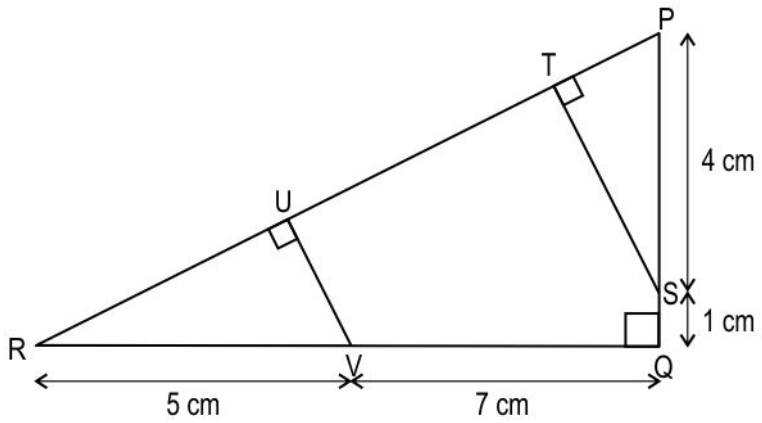
i) Shahnawaz claims, "△PQR is similar to △MNO as per the SSS similarity criterion." Dhruv claims, "△PQR is NOT similar to △MNO as per the AAA similarity criterion as ∠P ≠ ∠O."

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]**



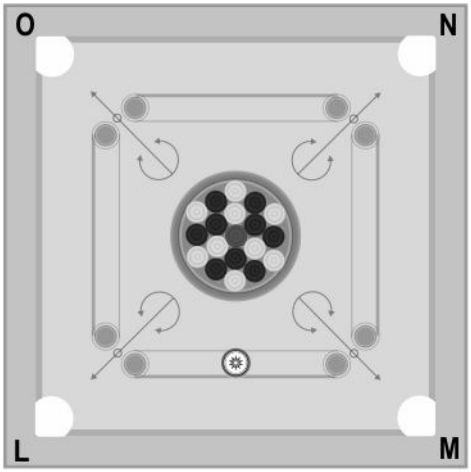
(Note: The figure is not to scale.)

Find the length of UT. Show your work.

Case Study

Answer the questions based on the given information.

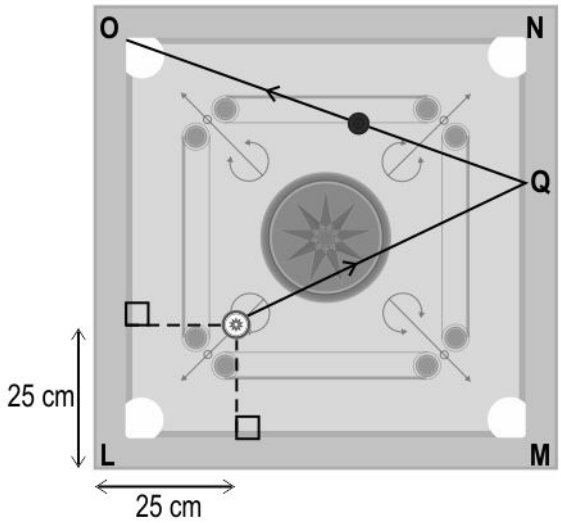
The carrom board has a 75 cm square playing top with four corner pockets. When coins hit the sides, they bounce off at the same angle. There are four types of coins: 9 white, 9 black, a red (the queen), and a larger and heavier striker. The striker is flicked to push these coins across the board to the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

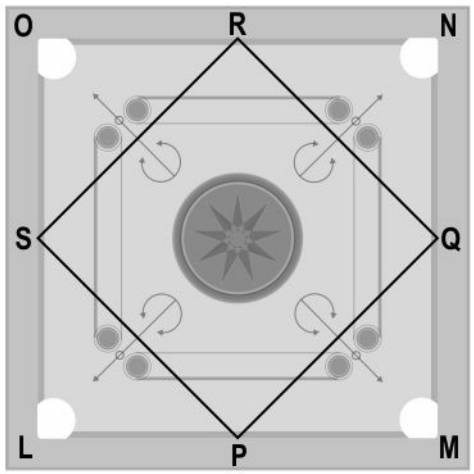
Q: 27 **Shown below is the path when Aryan strikes a white coin into pocket O.** **[3]**



(Note: The figure is not to scale.)

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

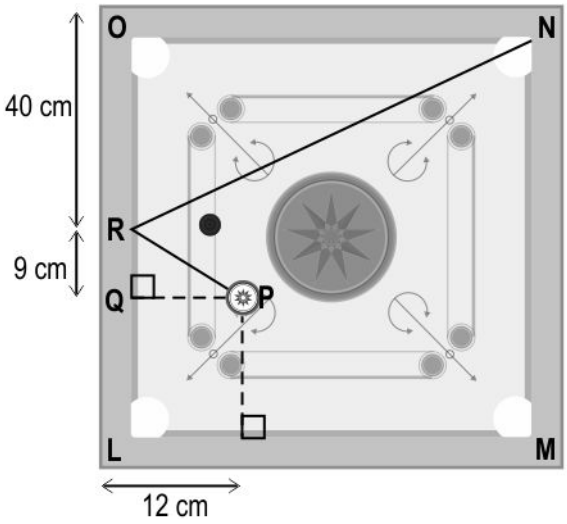
Q: 28 **Sai places the striker at the midpoint of LM. He flicks it in such a way that it hits the midpoints of all the sides and stops at the starting point. The rough sketch of the path of the striker is shown below.** **[1]**



(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

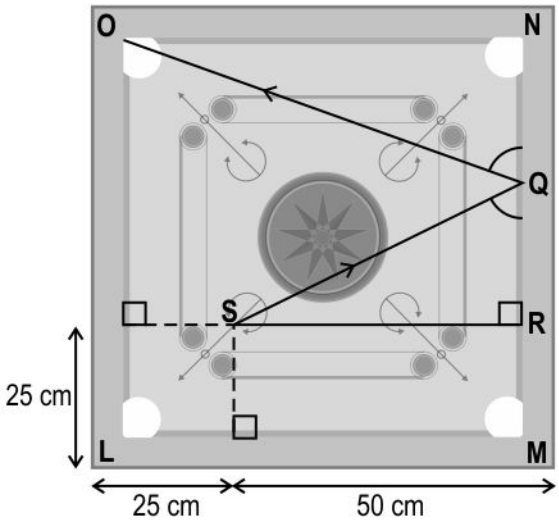
Q.No	What to look for	Marks
15	Writes that in △XYZ and △XUV, i) ∠YXZ = ∠UXV (common) ii) ∠YZX = ∠UVX = 30° (given) Hence, concludes that △XYZ ~ △XUV by AA similarity criterion.	1
	Uses similarity of triangles to write the relation of sides as: $\frac{XY}{XU} = \frac{YZ}{UV}$ Hence, concludes that $p = \frac{qr}{r+s}$.	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.

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