Time Allowed: 3 Hours   **Maximum Marks: 80**

General Instructions:

1. This Question Paper has 5 Sections A-E.
2. Section A has 20 MCQs carrying 1 mark each.
3. Section B has 5 questions carrying 2 marks each.
4. Section C has 6 questions carrying 3 marks each.
5. Section D has 4 questions carrying 5 marks each.
6. Section E has 3 case based integrated units of assessment (4 marks each) with sub-parts of the values of 1, 1 and 2 marks each respectively.
7. All Questions are compulsory. However, an internal choice in 2 questions of 5 marks, 2 questions of 3 marks and 2 questions of 2 marks has been provided. An internal choice has been provided in the 2 questions of 2 marks of Section E.
8. Draw neat figures wherever required. Take π as $\frac{22}{7}$ wherever required if not stated.

Section A – consists of 20 questions of 1 mark each.

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1) The graph of a polynomial $p(x)$ passes through the points (-5, 0), (0, -40), (8, 0) and (5, -30).

   Which among the following is a factor of $p(x)$?

A) $(x - 5)$
B) $(x - 8)$
C) $(x + 30)$
D) $(x + 40)$

2) Shown below is a pair of linear equations.

   $mx + 4y - 6 = 0$
   $ny - 12x + 12 = 0$

   For which of the following values of m and n do the above equations have infinitely many solutions?

A) $m = -1$ and $n = 2$
B) $m = -1$ and $n = 3$
C) $m = 6$ and $n = -8$
D) $m = 6$ and $n = -2$

3) A teacher asks three students to complete the following statement about the nature of the roots of a quadratic equation.

If $q^2 - 4pr > 0$, the roots of the quadratic equation $px^2 + qx + r = 0$ will be...

Zain answers, "always positive".
Vipul answers, "positive, if p, q, and r are positive".
Suman answers, "negative, if p, q, and r are positive".

Who answered correctly?

A) Zain
B) Vipul
C) Suman
D) (none of them)

4) Two concentric circles are centered at O(-4, 3). The ratio of the area of inner circle to that of the outer circle is 1:9. Points A and B lie on the boundaries of the inner and outer circle, respectively, as shown below.
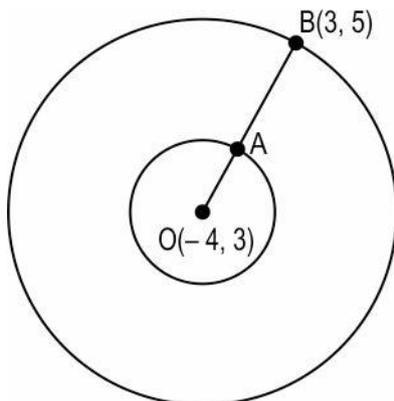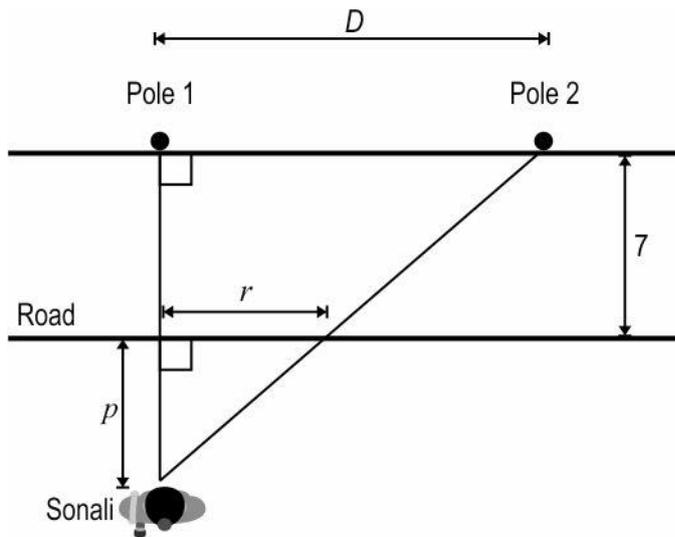

(Note: The figure is not to scale.)

The coordinates of point B are (3, 5). Which of the following are the coordinates of A?

A) $\left(\frac{2}{3}, \frac{13}{3}\right)$

B) $\left(\frac{-5}{3}, \frac{11}{3}\right)$

C) $\left(\frac{-9}{4}, \frac{14}{4}\right)$

D) $\left(\frac{-33}{10}, \frac{16}{5}\right)$

5) Sonali is standing on one side of a 7 m wide road as shown below. She wants to estimate the distance *(D)* between two light poles on the other side without crossing the road.

(Note: The figure is not to scale. All measurements are in metres.)

Which of the following expressions represent *D* in terms of *p* and *r*?

A) $\frac{7r}{p}$ m

B) $\frac{pr}{7}$ m

C) $\frac{pr}{p+7}$ m

D) $\frac{r(p+7)}{p}$ m

6) Shown below are two triangles such that length of two sides of each is known.
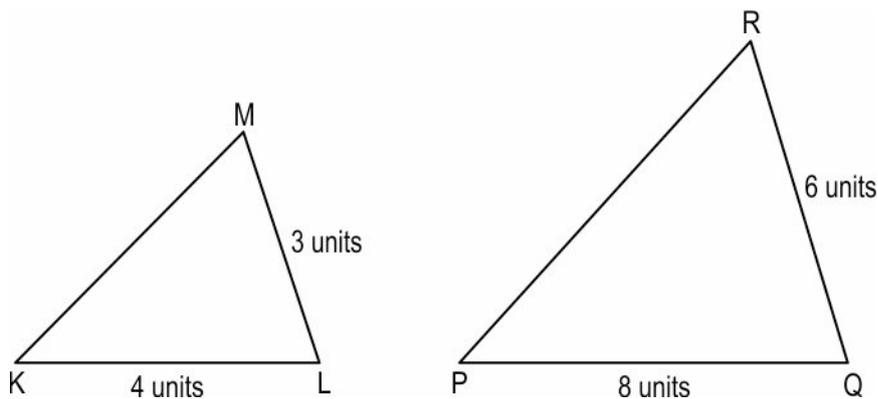
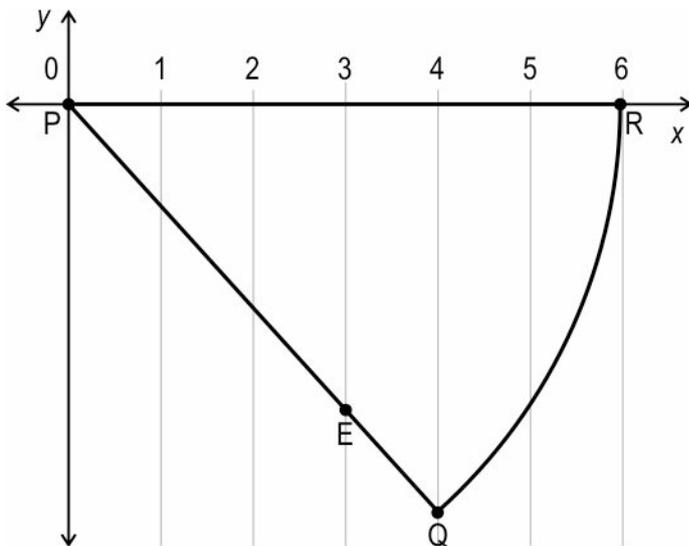*(Note: The figures are not to scale.)*

Along with the given information, which of these is sufficient to conclude whether ΔKLM is similar to ΔPQR?

(i)   ∠KLM = ∠PQR
(ii)   Ratio of KM:PR

A) only (i)
B) only (ii)
C) either (i) or (ii)
D) (the given information is enough to conclude that ΔKLM ~ ΔPQR as ratio of sides is known)

7) Shown below is a sector of a circle with centre P. All lengths are measured in cm.


What is the length of PE?

A) 3 cm
B) 3.5 cm
C) 4 cm
D) 4.5 cm

8) A circle is drawn. Two points are marked outside the circle such that only 3 tangents can be drawn to the circle using these two points.

Which of the following is true based on the above information?

A) All 3 tangents are equal in length.
B) Both the points lie on one of the tangents.
C) The tangents and the circle have two common points in total.
D) (such a situation is not possible as with 2 points, there will be 4 tangents to the circle)

9) Shown below is a circle with 3 tangents KQ, KP and LM. QL = 2 cm and KL = 6 cm. PM = $\frac{1}{2}$ KL.
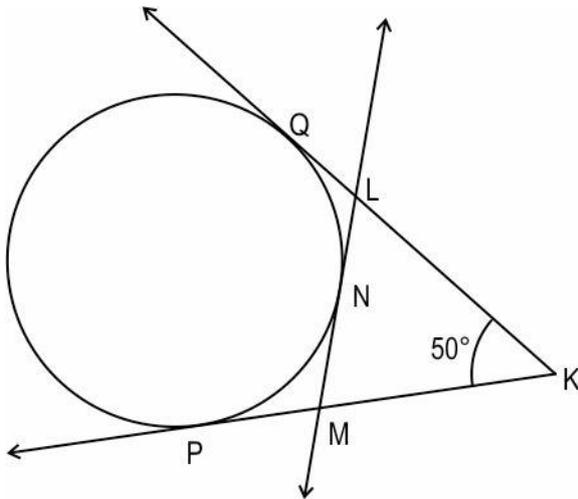
(Note: The figure is not to scale.)

What is the measure of ∠LMK?

A) 50°
B) 65°
C) 80°
D) (cannot be uniquely determined with the given information)

10) In the figure shown below, lines AB and PQ are parallel to each other. All measurements are in centimetres.
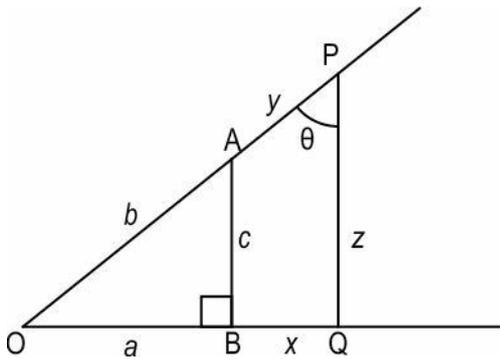
Which of the following gives the value of cos θ?

A) $\frac{b}{c}$

B) $\frac{c}{b}$

C) $\frac{c}{b+y}$

D) $\frac{a+x}{b+y}$

11) The sine of an angle in a right triangle is $\frac{4}{5}$.

Which of these could be the measures of the sides of the triangle?

A) 4 cm, 5 cm and 9 cm
B) 4 cm, 5 cm and √41 cm
C) 6 cm, 8 cm and 10 cm
D) 8 cm, 10 cm and 4√41 cm

12) The marks obtained by a set of students in an exam are recorded in a grouped frequency table. The maximum number of students are found to be in the range of (70-80) marks.

If the number of students in the ranges before and after the (70-80) range are equal, which of the following is the mode of the data?

A) 70 marks
B) 75 marks
C) 80 marks
D) (mode cannot be found as frequency is not given)

13) In the figure below, a unit square ROST is inscribed in a circular sector with centre O.
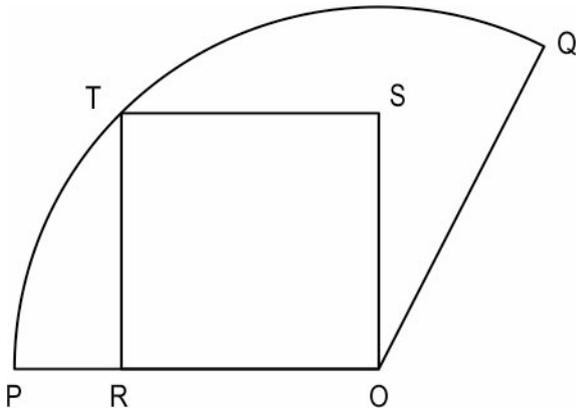
Along with the above information, which of these is SUFFICIENT to find the area of sector POQ?

A) area of the square ROST
B) radius of sector POQ
C) arc length PQ
D) (the given information is sufficient)

14) Fibonacci sequence is a pattern in which each number is obtained by adding the previous two numbers (except the first 2 numbers).

The pattern is 0, 1, 1, 2, 3, 5, 8, 13...

Shown below is a representation of the first few terms of the Fibonacci sequence in a unit square grid. The terms represent the side lengths of the squares.
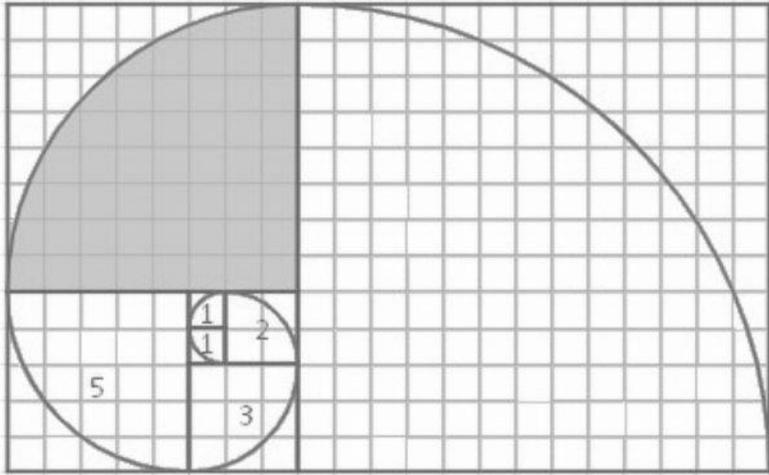
What is the area of the shaded sector?

A) 4π sq units
B) 16π sq units
C) 48π sq units
D) 64π sq units

15) Shown below is a solid made by joining a right circular cylinder and a hemisphere of equal radius (r cm). The total surface area of the solid is equal to the surface area of a sphere with twice the radius of this solid.
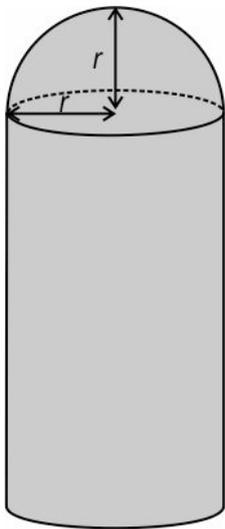
Which of the following gives the height of the cylinder in the above solid?

A) $6r$ cm
B) $6.5r$ cm
C) $7r$ cm
D) $7.5r$ cm

16) Which of the following is equal to the given expression?

$$\frac{\cot\theta\,\sec^2\theta}{\operatorname{cosec}\theta}$$

A) sec θ
B) cosec θ
C) $(\cot^2\theta)(\sec\theta)$
D) $(\cot^2\theta)(\operatorname{cosec}\theta)$

17) The heights of plants in Dipti's garden are recorded in the table given below. The median plant height is 55 cm.

Heights of plants (in cm)	0-20	20-40	40-60	60-80	80-100
Number of plants	$2x$	4	$4x$	8	4

Which of the following is the value of *x*?

A) 1
B) 2
C) 8
D) (the value of *x* cannot be found without knowing the total number of plants)

18) A bowl contains 3 red and 2 blue marbles. Roohi wants to pick a red marble.

Which of the following changes could she make so that the probability of picking a red marble is greater than it was before?

(i) Adding a red marble
(ii) Removing a blue marble
(iii)Adding 1 red and 1 blue marble

A) only (i)
B) only (i) and (ii)
C) only (i) and (iii)
D) (all of the above)

19) 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): 2 is a prime number.
Reason (R): The square of an irrational number is always a prime number.

A) Both (A) and (R) are true and (R) is the correct explanation of (A).
B) Both (A) and (R) are true and (R) is not the correct explanation of (A).
C) (A) is true but (R) is false.
D) (A) is false but (R) is true.

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

Assertion (A): The origin is the ONLY point equidistant from (2, 3) and (-2, -3).
Reason (R): The origin is the midpoint of the line joining (2, 3) and (-2, -3).

A) Both (A) and (R) are true and (R) is the correct explanation for (A).
B) Both (A) and (R) are true but (R) is not the correct explanation for (A).
C) (A) is true but (R) is false.
D) (A) is false but (R) is true.

Section B – consists of 5 questions of 2 marks each.

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21) Check whether the three lines represented by the equations given below intersect at a common point.
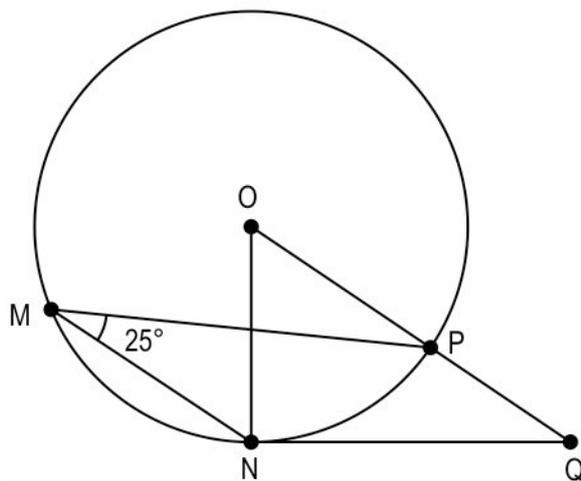
$2x + y - 1 = 0$
$4x + 3y + 5 = 0$
$5x + 4y + 8 = 0$

Show your work.

22) Shown below is a circle with centre O. NQ is a tangent to the circle.

(Note: The figure is not to scale.)

Find the measure of ∠OQN. Show your work and give valid reasons.

23) Find the smallest pair of 4-digit numbers such that the difference between them is 303 and their HCF is 101. Show your steps.

24) If cos $(A + 2B) = 0$, $0° \leq (A + 2B) \leq 90°$ and cos $(B - A) = \frac{\sqrt{3}}{2}$, $0° \leq (B - A) \leq 90°$, then find cosec $(2A + B)$. Show your work.

OR

State whether the following statements are true or false. Give reasons.

(i)   As the value of sin θ increases, the value of tan θ decreases.
(ii)   When the value of sin θ is maximum, the value of cosec θ is also maximum.

(Note: $0° < \theta < 90°$.)

25) A 3.5 cm chord subtends an angle of 60° at the centre of a circle.
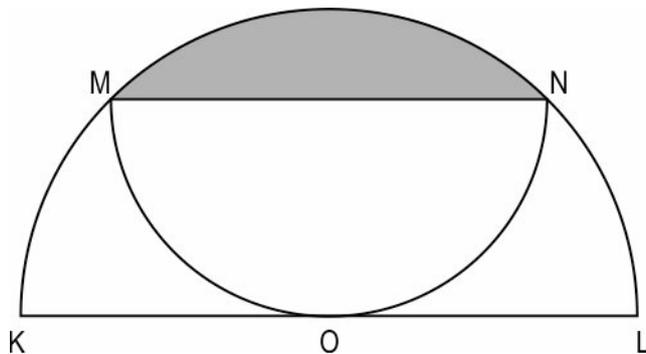
What is the arc length of the minor sector? Draw a rough figure and show your steps.

(Note: Take π as $\frac{22}{7}$.)

OR

A semicircle MON is inscribed in another semicircle. Radius OL of the larger semicircle is 6 cm.

(Note: The figure is not to scale.)

Find the area of the shaded segment in terms of π. Draw a rough figure and show your steps.

26) The LCM of 6^4, 8^2 and k is 12^4 where k is a positive integer. Find the smallest value of k. Show your steps.

27) If m and n are zeroes of the polynomial $(3x^2 - x - 2)$, find the values of the following without factorising the polynomial.

(i) $\frac{1}{m} + \frac{1}{n}$

(ii) $m^2 + n^2$

 Show your steps

28) The graph of a line represented by the equation $ax + y + 8 = 0$ is shown in the figure below.
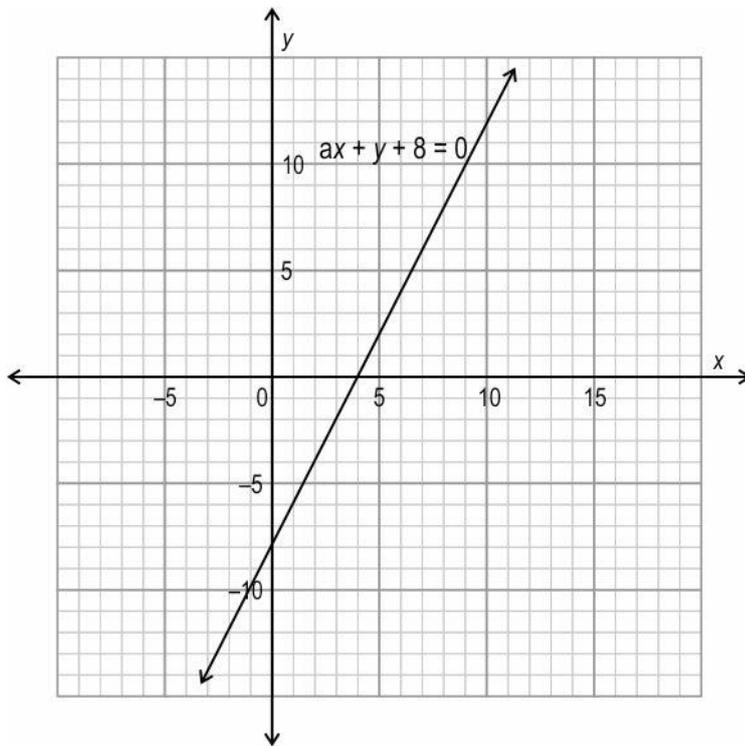
(i)   Find the value of a.
(ii)   Find the point of intersection of this line with the line represented by the equation $4x - 3y - 14 = 0$.

Show your work.

OR

Anuj and Safina started a new game zone consisting of two games - shooting and bowling. They released the following rate card for the customers:

Pack	Shooting	Bowling	Price (inclusive taxes)
Solo 1	-	1 round	Rs 60
Solo 2	1 round	-	Rs 75
Combo 1	3 rounds	2 rounds	Rs 285
Combo 2	4 rounds	5 rounds	Rs 485

The price of shooting is the same in both the combos and the price of bowling is the same in both the combos.

How much more is the price for one round of bowling in the solo pack than in the combo packs? Show your work.

29) Shown below is a circle and 2 congruent squares (PQRS & QTUR). ST, SU and UT are tangents to the circle. The side length of the square is 10 cm.
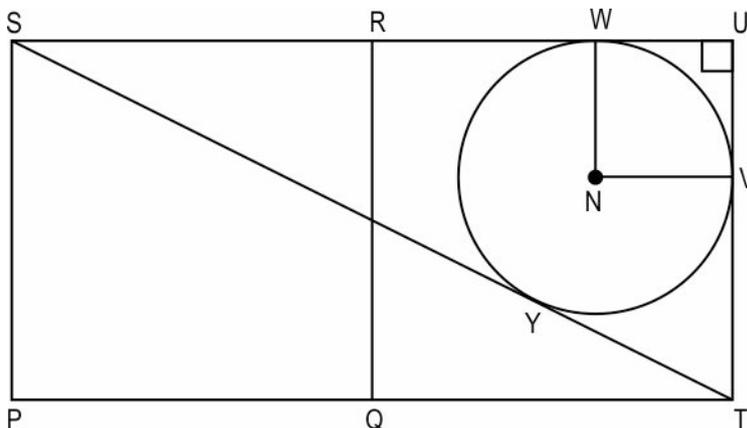
(Note: The figure is not to scale.)

Find the radius of the circle. Show your work.

OR

In the figure below, M and N are the centres of two semi-circles having radii 9 cm and 16 cm respectively. ST is a common tangent.

(Note: The figure is not to scale.)

Find the length of PQ. Draw a rough figure, show your work and give valid reasons.

30) Prove that:

$$\frac{\cos^4 x - \sin^4 x}{1 - \tan x} = \frac{(\cot x + 1)}{\sec x \, \cosec x}$$

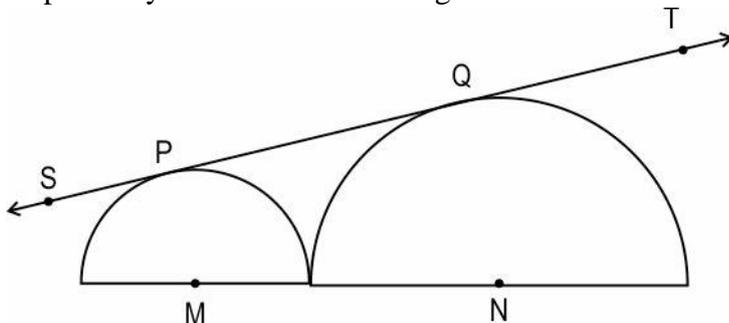31) A square dartboard has sections numbered from 1 to 12 as shown below. Players have to make a prediction and throw a dart. They win if their dart lands on the section that matches their prediction.

Arya says, "My dart will land on a composite number."
Bashir says, "My dart will land on an even number."
Cathy says, "My dart will land on a factor of 12."
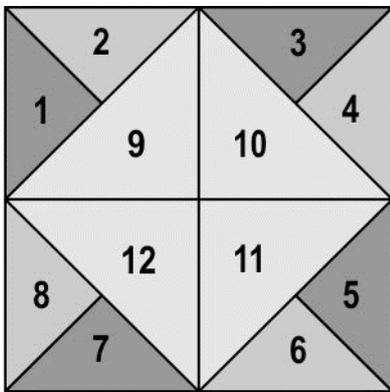
Calculate the probability of each of their predictions occurring and determine who has the highest chances of winning. Show your work.

Section D – consists of 4 questions of 5 marks each.

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32) Sejal started a business where she sells earrings online. She made Rs 12000 in sales in her first month. In the second month, when she decreased the price of her product by Rs 20, she sold 40 more items and increased her total sales by Rs 2000.

At what price did she sell the earrings in the second month? Show your work.

OR

A wall (shown below) measures 5 m in length and 4 m in height. The outer portion of the wall of uniform width 'x' m will be painted and the central portion will be tiled. The total budget, including the tiles at Rs 500 per m^2 and paint at Rs 200 per m^2, is Rs 5800.
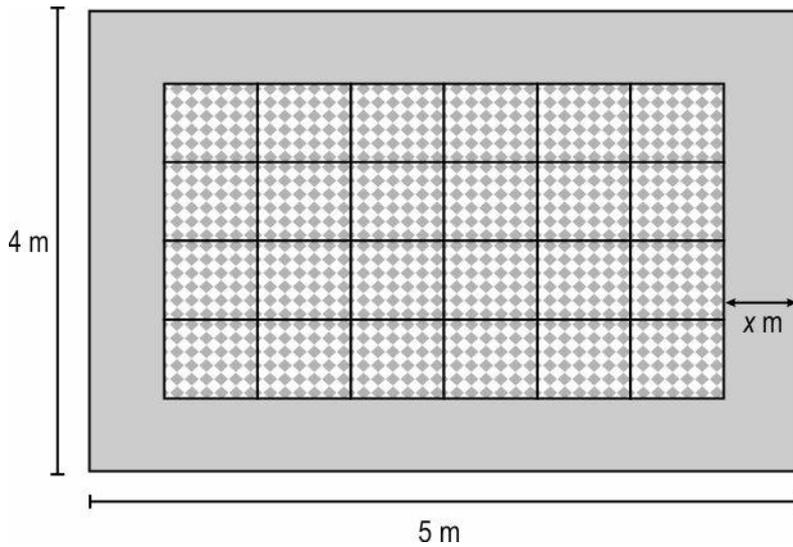
(Note: The figure is not to scale.)

Find *x* such that the work is completed as per the budget. Show your work.

33) A restaurant stores ice-cream in a box with a dispenser attached for filling ice-cream cones. The dimensions of the box and the ice-cream cones used by the restaurant are shown in Figure 1 below. To make each serving of dessert, the cone is first filled with ice-cream and then topped with a hemispherical scoop of ice-cream taken from the same box, as shown in Figure 2.

Figure 1   **Figure 2**
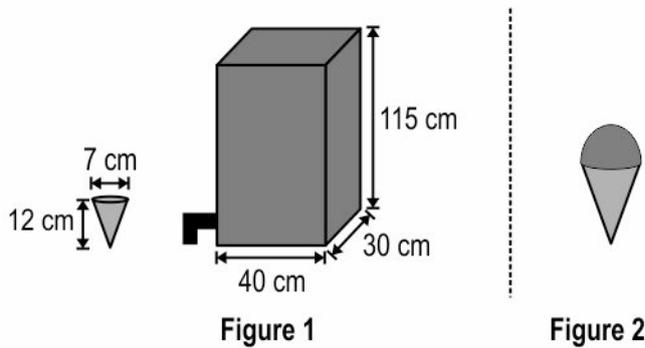
(Note: The figures are not to scale.)

Approximately how many desserts can be served out of a completely filled box of ice-cream? Show your steps.

(Note: Take π as $\frac{22}{7}$.)

OR

A right-circular cylindrical water tanker supplies water to colonies on the outskirts of a city and to nearby villages. Each colony has a cuboidal water tank. In villages, people come with *matkas* (spherical clay pots) to fill water for their household.
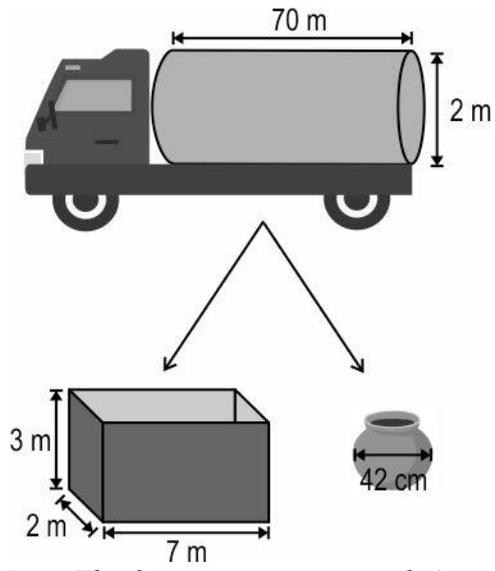
(Note: The figures are not to scale.)

i)   How many colonies in total would one full tanker be able to supply?

ii)   If a tanker supplies water to 3 colonies and then goes to a village where 400 people fill their *matkas*, roughly how much water is supplied by the tanker in all? Give your answer in m³.

Show your work.

(Note: Assume all the tanks/matkas are completely filled without any loss of water; Take π as $\frac{22}{7}$; Use 1000000 cm³ = 1 m³.)

34) In the figure below, ST ∥ PQ. All measurements are in units.
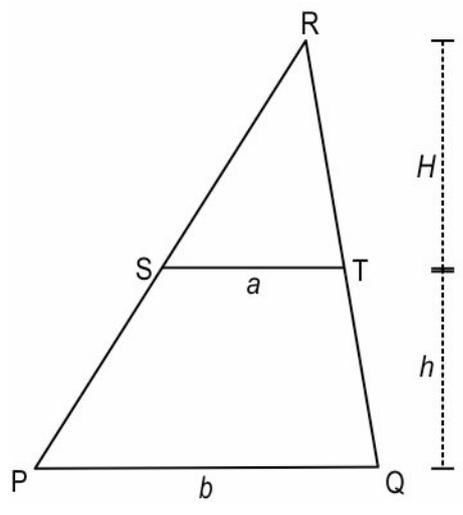
Prove that the area of the trapezium PQTS is $\left[\frac{1}{2}(a+b)h\right]$ sq units.

35) The pyramid graph below shows the ages of the 548 Members of Parliament in the 17th Lok Sabha.

Age distribution of 548 Members of Parliament (MP)

(Source of data: http://164.100.47.194/Loksabha/Members/MemberSearchByAge.aspx.)
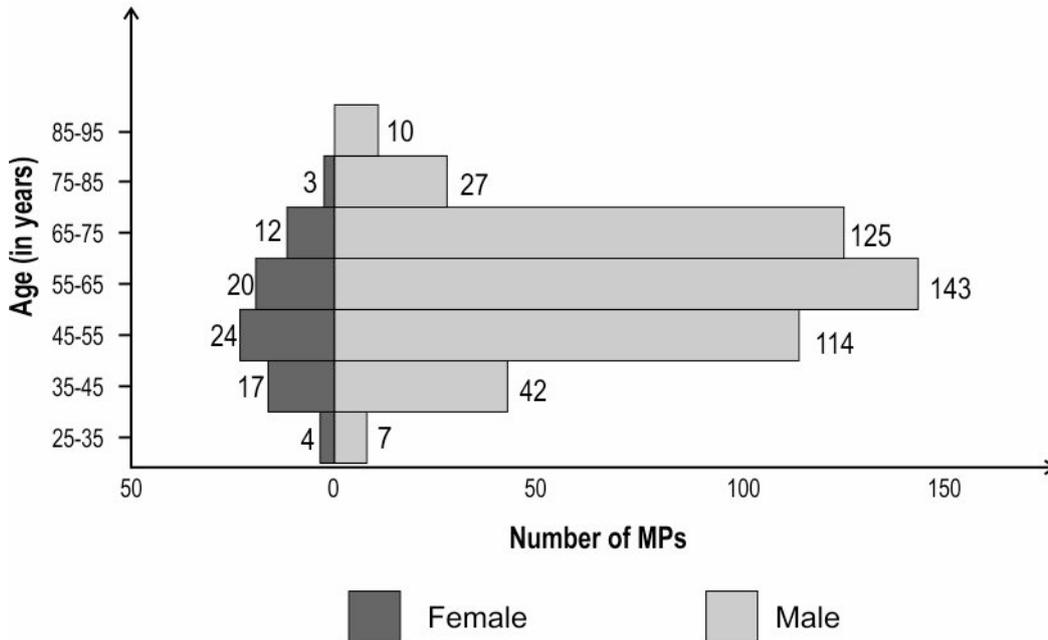
On an average, how much younger is a female MP than a male MP? Round your answer to the nearest whole number and show your work.

Section E – consists of 3 case-based questions of 4 marks each.

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36) **Answer the questions based on the given information.**

In space exploration missions, ion propulsion engine is an efficient way of travelling. The first such engine was used in Deep Space 1 spacecraft. It produced a constant acceleration. Given below are approximate velocities of the engine.

The initial average velocity of the engine in its first month was 27360 km/hour. When the spacecrafts passed the asteroid, Braille, it reached an average velocity of 55800 km/hour. Based on the first 6 months of Deep Space 1's monthly average velocity, the following table was created.

Average monthly velocity (in km/hour)
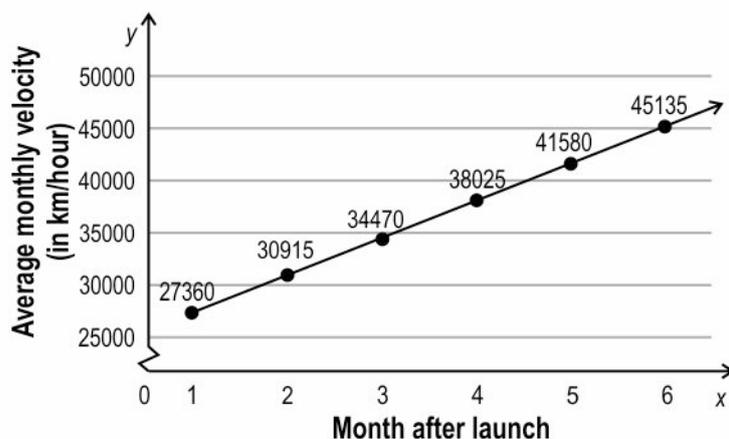
Month after launch	1	2	3	4	5	6
Average monthly velocity (in km/hour)	27360	30915	34470	38025	41580	45135

(Source: https://www.nasa.gov/.)

i) Does the average monthly velocity (in km/hour) form an arithmetic progression? Justify your answer.

ii) The distance travelled by the spacecraft in the first 10 months (or 7300 hours) can be expressed as 7300p km where p is the sum of average monthly velocity for the first 10 months.

Find p. Show your work.

iii) The spacecraft passed the comet, Borelly, 15 months after it passed Braille.

Find the average monthly velocity of the spacecraft when it passed Borelly. Show your work.

OR

After how many months did the spacecraft pass Braille? Show your work.

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37) **Answer the following questions based on the information given below.**

Raycasting is a technique used in the creation of computer games. The basic idea of raycasting is as follows: the map is a 2D square grid. Using rays generated from an object, this 2D map can be transformed into a 3D perspective. One of the methods involves sending out a ray from the player's location. To determine how far he/she is from a wall or an obstacle, the distance between the player's coordinates and the coordinate of the wall is calculated. If the player is near the obstacle, it looks larger and vice-versa.

Shown below is a game, Wolf 3D, which was created using raycasting.

Riju wants to create an online snooker game using raycasting. The game in the creation stage on a coordinate map is shown below.
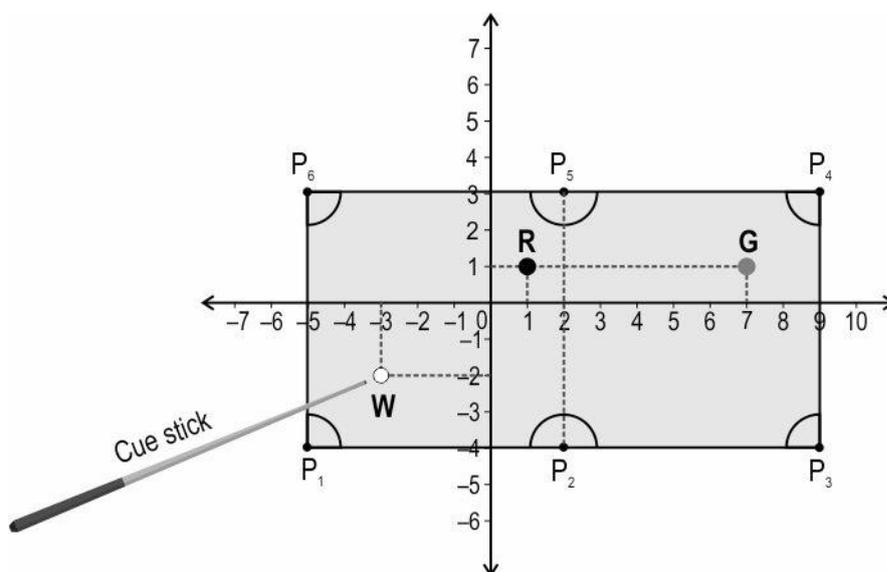
The snooker table has six pockets (P$_1$, P$_2$, P$_3$, P$_4$, P$_5$ and P$_6$) and he has shown three balls - white (W), red (R) and green (G) on the table. The objective of the game is to use the white ball to hit the coloured balls into the pockets using a cue stick.

i) How much distance will a ray travel if sent from the green ball to the nearest pocket? Show your work.

ii) Riju wants to place a yellow ball at the midpoint of the line connecting the white and green balls.

Find the coordinates of the point at which he should place the yellow ball. Show your steps.

iii) Riju is running a trial on his game. He struck the white ball in a way that it rebound off the rail (line connecting P_4 and P_6) and went into the pocket P_2.

♦ After the rebound, the ball crossed the x-axis at point X($\frac{2}{7}$, 0) on the way to the pocket.

♦ The ratio of the distance between the rail and point X and the distance between point X and the pocket was 3:4.

Find the coordinates of the point at which the ball struck the rail. Show your steps.

OR

Riju wants to hit a blue ball placed at (-1, -3) into pocket P_5 along a straight path. Would the red ball lie on the straight path between the blue ball and P_5? Justify your answer.

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38) Answer the following questions based on the given information.

The Surya Kiran is an aerobatics demonstration team of the Indian Air Force, and was formed in 1996. In Surya Kiran demonstrations, fighter pilots perform aerobatic maneuvers in groups of 3, to entertain an audience.

Anuja and Sarthak are watching planes A, B and C at a Surya Kiran demonstration in Jaipur. Anuja is watching the demonstration from the Hawa Mahal, while Sarthak is at the City Palace. Both of them are 1365 m apart, as shown in the figure below.
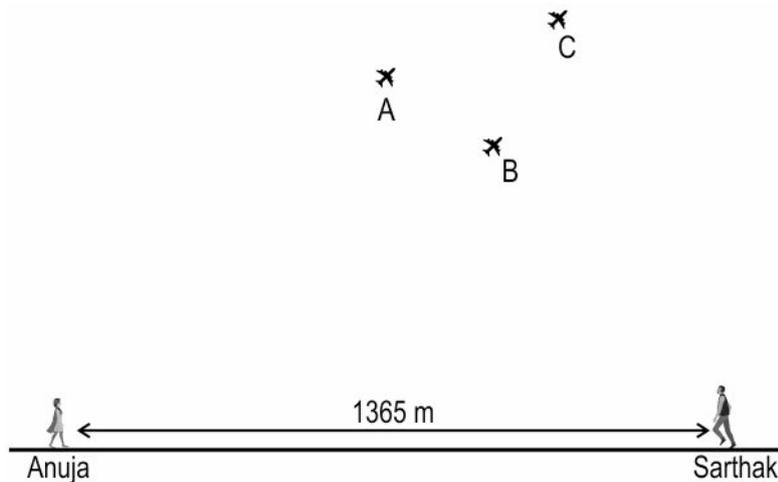
(Note: Treat the airplanes and people as point-sized objects. The figure is not to scale.)

i) When the angle of elevation of plane B from Anuja's eyes is 30°, the plane's altitude is 675 m above ground.

What is its horizontal distance from where Anuja is standing? Draw the figure and show your steps.

ii) When the planes are in landing formation, the pilot from plane B can see plane A at an angle of elevation of 30°. Plane B is 740 m above ground level, and the horizontal distance between plane A and plane B is 50√3 m.

What is the altitude of plane A? Draw the figure and show your steps.

iii) The angle of elevation of plane C from Sarthak's eyes is 60°, while its angle of elevation from Anuja's eyes is 45°.

What is the plane's horizontal distance from Sarthak? Draw the rough figure and show your steps.

OR

During a maneuver, the pilot from plane A can see Anuja at an angle of depression of 60°, and Sarthak at an angle of depression of 30 degrees.

What is the altitude of the plane? Draw the figure and show your steps.

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SECTION A - Multiple Choice Questions of 1 mark each.

Question number	Answer key
1	B
2	C
3	C
4	B
5	D
6	C
7	D
8	B
9	C
10	B
11	C
12	B
13	C
14	B
15	B
16	A
17	B
18	B
19	C
20	D

SECTION B – Very short answer questions of 2 marks each.

Q. no	Expected answer	Marks
21	Solves any two equations to get their point of intersection as (4, -7).	1
	Substitutes the coordinates (4, -7) in the third equation and shows that they satisfy it. Hence, concludes that the three lines intersect at a common point.	1
22	Writes that the angle subtended by arc NP at the centre is double the angle subtended at the circumference and finds the measure of ∠NOP as $2 \times 25° = 50°$.	0.5
	Writes that the radius is perpendicular to the tangent at the point of contact and finds the measure of ∠ONQ as 90°.	1
	Writes that sum of angles of a triangle is 180° and finds the measure of ∠OQN as 180° - (50° + 90°) = 40°.	0.5

23	Finds that the two numbers are of the form $101p$ and $101q$ where $p > q$ and p and q are co-prime to each other.	0.5
	Uses the given information and writes: $101p - 101q = 303$ $\Rightarrow 101(p - q) = 303$ $\Rightarrow p - q = 3$ $\Rightarrow p = q + 3$	0.5
	Identifies that the smallest 4-digit number can be found when q and p are 10 and 13 respectively. Finds the two numbers as 1010 and 1313.	1
24	Writes $(A + 2B) = 90°$, as $\cos 90° = 0$.	0.5
	Writes $(B - A) = 30°$, as $\cos 30° = \frac{\sqrt{3}}{2}$.	0.5
	Subtracts $(B - A)$ from $(A + 2B)$ to get $(2A + B) = 60°$.	0.5
	Writes that $\operatorname{cosec} 60° = \frac{2}{\sqrt{3}}$.	0.5
	OR	
	i) Writes that the statement is false.	0.5
	Gives a reason. For example, $\tan \theta = \frac{\sin \theta}{\cos \theta}$. So, since $\tan \theta$ is directly proportional to $\sin \theta$. In the given interval $(0° < \theta < 90°)$, as the value of $\sin \theta$ increases, the value of $\cos \theta$ decreases and hence the value of $\tan \theta$ increases.	0.5
	ii) Writes that the statement is false.	0.5
	Gives a reason. For example, as $\operatorname{cosec} \theta = \frac{1}{\sin \theta}$, the cosecant function is inversely proportional to the sine function. So, when the value of $\sin \theta$ is maximum, the value of $\operatorname{cosec} \theta$ will be minimum.	0.5
25	Draws a rough figure using the given information. The figure may look as follows:	0.5

	(Note: The figure is not to scale.)	
	Writes that since OM = ON (radii), hence ∠OMN = ∠ONM = 60° (angles opposite equal sides) and ΔMON is an equilateral triangle.	0.5
	Finds the arc length of the minor sector as $\frac{60°}{360°} \times 2 \times \frac{22}{7} \times \frac{7}{2} = \frac{22}{6}$ *or* $\frac{11}{3}$ cm.	1
	OR	
	Draws a rough figure joining O with M and N such that ∠MON = 90°. The figure may look as follows: *(Note: The figure is not to scale.)*	0.5
	Finds the area of sector MON as $\frac{90°}{360°} \times \pi \times 6^2 = 9\pi$ cm².	0.5
	Finds the area of ΔMON as $\frac{1}{2} \times 6 \times 6 = 18$ cm².	0.5
	Finds the area of the shaded segment as $(9\pi - 18)$ cm² or $9(\pi - 2)$ cm².	0.5
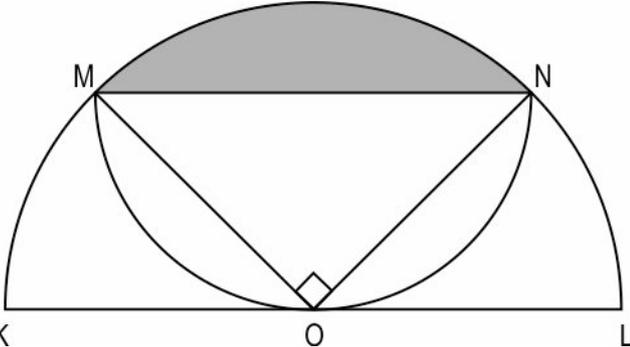
SECTION C – Short answer questions of 3 marks each.

Q. no	Expected answer	Marks
26	Finds the prime factorisation of 12^4 as $(2^8 \times 3^4)$.	1
	Finds the prime factorisation of 6^4 as $(2^4 \times 3^4)$ and the prime factorisation of 8^2 as 2^6.	1
	Compares the prime factorisations of 6^4, 8^2 and 12^4 and identifies that 256 or equivalently, 2^8 is the smallest value of k.	1
27	(i) Simplifies $\frac{1}{m} + \frac{1}{n}$ *as* $\frac{(m+n)}{mn}$.	0.5

	Identifies $m + n = \frac{1}{3}$ and $mn = \frac{-2}{3}$.	0.5
	Substitutes the values of $(m + n)$ and (mn) and finds: $$\frac{1}{m} + \frac{1}{n} = -\frac{1}{2}$$	0.5
	(ii) Rewrites $(m^2 + n^2)$ using the appropriate identity as: $$m^2 + n^2 = (m + n)^2 - 2mn$$	0.5
	Substitutes the values of $(m + n)$ and (mn) in the above expression to get: $$m^2 + n^2 = \left(\frac{1}{3}\right)^2 - 2\left(\frac{-2}{3}\right)$$	0.5
	Simplifies the expression and finds: $$m^2 + n^2 = \frac{13}{9}$$	0.5
28	i) Substitutes any point on the line from the graph in the equation $ax + y + 8 = 0$ and finds the value of a as (-2).	1
	ii) Solves the pair of linear equations either algebraically or graphically and finds the point of intersection of the two lines as (5, 2).	2
	OR	
	Assumes the prices of one round of shooting and bowling in the combo packs to be x and y respectively. Frames the pair of linear equations as: $3x + 2y = 285$ $4x + 5y = 485$	1
	Solves the above pair of linear equations by an appropriate method to find the value of y as Rs 45.	1.5
	Writes that the price of one round of bowling in the solo pack is Rs 60 and hence concludes that the price of one round of bowling in the solo pack is 60 – 45 = Rs 15 more than that of the combo pack.	0.5
29	Assumes the radius of the circle as x cm and since NVUW is a square, WU = UV = x cm.	0.5
	Uses the Pythagoras theorem in ΔSUT and finds the length of ST as $\sqrt{(400 + 100)} = 10\sqrt{5}$ cm.	0.5
		0.5

	Finds the length of VT as $(10 - x)$ cm and uses properties of tangents to write YT = VT.	
	Uses properties of tangents to equate SY and SW to write the equation as: $20 - x = 10\sqrt{5} - (10 - x)$	1
	Solves the above equation for x to find the radius of the circle as $(15 - 5\sqrt{5})$ cm.	0.5
	OR	
	Joins MP, NQ and uses the perpendicularity of radius to tangents to draw MR parallel line to PQ. The rough figure may look as follows: *(Note: The figure is not to scale.)*	1.5
	Finds RN as 16 - 9 = 7 cm and MN as 9 + 16 = 25 cm.	0.5
	Uses the Pythagoras theorem in ΔMRN to find the length of MR as $\sqrt{(25^2 - 7^2)} = 24$ cm.	0.5
	Writes that since MRQP is a rectangle, PQ = MR = 24 cm.	0.5
30	Simplifies LHS of the given equation using $(a^2 - b^2)$ identity and the trigonometric identity $\sin^2 x + \cos^2 x = 1$ as: $$\frac{(\cos^2 x - \sin^2 x)}{1 - \tan x}$$	1
	Simplifies the above expression by rewriting the denominator in terms of sine and cosine ratios as: $$\frac{\cos x\,(\cos^2 x - \sin^2 x)}{(\cos x - \sin x)}$$	1
	Simplifies the above expression using $(a^2 - b^2)$ identity as $\cos x\,(\cos x + \sin x)$.	0.5
		0.5
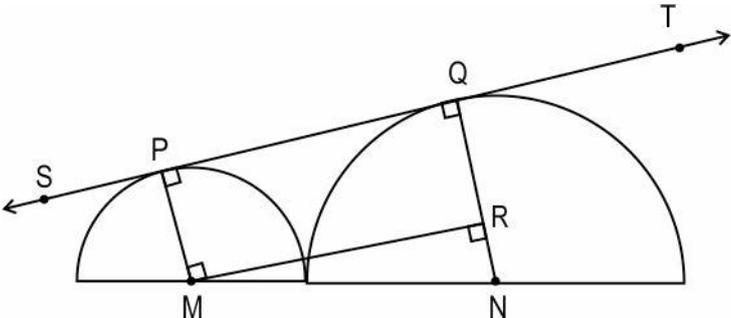
	Simplifies the above expression by multiplying and dividing with sin x to get $\frac{(\cot x + 1)}{\sec x \, \csc x}$.	
31	Calculates the probability of the dart landing on the smaller sections (1 to 8) as $\frac{1}{16}$ and the larger sections (9 to 12) as $\frac{1}{8}$.	1
	Finds the probability of the dart landing on a composite number as $\frac{9}{16}$. The working may look as follows: $(3 \times \frac{1}{16}) + (3 \times \frac{1}{8}) = \frac{9}{16}$	0.5
	Finds the probability of the dart landing on an even number as $\frac{1}{2}$. The working may look as follows: $(4 \times \frac{1}{16}) + (2 \times \frac{1}{8}) = \frac{1}{2}$	0.5
	Finds the probability of the dart landing on a factor of 12 as $\frac{7}{16}$. The working may look as follows: $(5 \times \frac{1}{16}) + (1 \times \frac{1}{8}) = \frac{7}{16}$	0.5
	Compares the above probabilities and concludes that Arya has the highest chances of winning.	0.5

SECTION D – Long answer questions of 5 marks each.

Q. no	Expected answer	Marks
32	Expresses the number of products sold in the first month (n) in terms of the price in the first month (p) as $n = \frac{12000}{p}$.	0.5
	Frames the following equation based on information given regarding the second month: $(p - 20)\left(\frac{12000}{p} + 40\right) = 12000 + 2000$	1.5
	Simplifies into standard quadratic form as $p^2 - 70p - 6000 = 0$.	1
	Solves the quadratic equation using any suitable method to obtain $p = 120$ or $p = -50$. (Neglects $p = -50$ as price cannot be negative.)	1
	Finds the price of the product in the second month as $p - 20 = 120 - 20 =$ Rs 100.	1

	OR	
	Expresses the area of the tiled portion as $(5 - 2x)(4 - 2x)$ m^2.	1
	Expresses the area of the painted portion as $[20 - (5 - 2x)(4 - 2x)]$ m^2.	1
	Frames a quadratic equation using the information given as follows: $500[(5 - 2x)(4 - 2x)] + 200[20 - (5 - 2x)(4 - 2x)] = 5800$	1
	Simplifies into standard quadratic form as $12x^2 - 54x + 42 = 0$.	1
	Solves the quadratic equation using any suitable method to obtain $x = 1$ or $x = 3.5$ to conclude that the width of the painted portion would be 1 m. ($x = 3.5$ m is not possible because the painted portion would exceed the length and height of the wall.)	1
33	Uses the formula $l \times b \times h$ to find the volume of the box as 138000 cm^3, where $l = 30$ cm, $b = 40$ cm and $h = 115$ cm.	1
	Uses the formula $\frac{1}{3}\pi r^2 h$ to find the volume of the ice-cream cone as 154 cm^3, where $r = 3.5$ cm and $h = 12$ cm.	1.5
	Uses the formula $\frac{2}{3}\pi r^3$ to find the volume of the hemisphere as 89.83 cm^3.	1.5
	Finds the volume of 1 serving of dessert as the (volume of cone) + (volume of hemisphere) = 243.83 cm^3. Rounds the volume of 1 serving off to 244 cm^3.	0.5
	Finds the approximate number of desserts that can be served as 565, on solving $\frac{138000}{244} = 565.57$.	0.5
	OR	
	i) Uses the formula $\pi r^2 h$ to find the volume of the tanker as 220 m^3, where $r = 1$ m and $h = 70$ m.	1
	Uses the formula lbh to find the volume of the cuboidal tank as 42 m^3, where $l = 7$ m, $b = 2$ m, and $h = 3$ m. Divides 220 m^3 by 42 m^3 to get 5.23. Writes that the tanker can supply water to 5 colonies. (Award full marks if student does not fully divide the numbers, but notices that the quotient is between 5 and 6, and uses that to conclude that 5 tanks can be completely filled.)	1
	ii) Uses formula $\frac{4}{3}\pi r^3$ to find the volume of one *matka* as 38,808 cm^3.	1

	Converts volume of one *matka* to m³ as roughly 0.04 m³. Finds volume of 400 *matkas* as roughly 16 m³.	1
	Finds volume of 3 cuboidal tanks as $42 \times 3 = 126$ m³.	0.5
	Finds the volume of water supplied by the tanker by adding $(126 + 16)$ to get the answer as 142 m³.	0.5
34	Writes that, in ΔPQR and ΔSTR, $\angle$PRQ = $\angle$SRT (common) $\angle$PQR = $\angle$STR (corresponding angles) _ _ _ _ _ _ _ (i)	1
	Uses the above step to conclude that by AA criterion of similarity of triangles, ΔPQR ~ ΔSTR. _ _ _ _ _ _ (ii)	0.5
	Finds the area of ΔPQR as $\frac{1}{2} b (H + h)$ square units. _ _ _ _ _ _ (iii)	0.5
	Finds the area of ΔSTR as $\frac{1}{2} aH$ square units. _ _ _ _ _ _ (iv)	0.5
	Finds the area of the trapezium PQTS as: $\frac{1}{2} b (H + h) - \frac{1}{2} aH = \frac{1}{2} (b - a)H + \frac{1}{2} bh$ square units. _ _ _ _ _ _ (v)	1
	Uses step 2 to write the ratio of the sides as: $\dfrac{H + h}{H} = \dfrac{b}{a}$ $\Rightarrow H = \dfrac{ah}{b-a}$ _ _ _ _ _ _ (vi)	1
	Uses steps 5 and 6 to find the area of the trapezium PQTS as $\frac{1}{2} (a + b)h$ square units.	0.5
35	Constructs the frequency distribution table for male and female MPs as:	
		3.5

Age (in years)	Class Mark (x_i)	Number of female MPs (f_i)	$f_i x_i$	Number of male MPs (m_i)	$m_i x_i$
25 - 35	30	4	120	7	210
35 - 45	40	17	680	42	1680
45 - 55	50	24	1200	114	5700
55 - 65	60	20	1200	143	8580
65 - 75	70	12	840	125	8750
75 - 85	80	3	240	27	2160
85 - 95	90	0	0	10	900
Total		80	4280	468	27980

0.5

0.5

0.5

Finds the mean age of female MPs as $\frac{4280}{80} = 53.5$ years.

Finds the mean age of male MPs as $\frac{27980}{468} = 59.8$ years.

Uses the above two steps to find the average difference between male and female MPs as 59.8 - 53.5 = 6.3 years which rounds to 6 years.

SECTION E – Case-based questions of 4 marks each.

Q. no	Expected answer	Marks
36 i)	Finds the common difference between two sets of consecutive terms as:	0.5
	Second term - First term = 30915 - 27360 = 3555	
	Third term - Second term = 34470 - 30915 = 3555	
	Concludes that the common difference is the same and hence the average monthly velocity forms an arithmetic progression.	0.5
36 ii)	Writes the expression for the sum of average monthly velocities of the first 10 months as $\frac{10}{2}[(2 \times 27360) + (10 - 1)(3555)]$.	0.5
	Simplifies the above expression to find p as 433575 km/hour.	0.5
36 iii)	Assumes that the spacecraft passed Braille after n months and writes that the expression for the average monthly velocity when it passed Borelly as:	1

	$27360 + (n + 15 - 1)(3555)$ $= 27360 + (n - 1)(3555) + (15 \times 3555)$ (It is given that the velocity when it passed Braille is $27360 + (n - 1)(3555) = 55800$ km/hr.) Simplifies the above expression to find the average monthly velocity of the spacecraft when it passed Borelly as: $55800 + (15 \times 3555)$ $= 109125$ km/hour	1	
	OR	1	
	Assumes that the spacecraft passed Braille after n months and finds the nth term of the progression as: $27360 + (n - 1)(3555) = 55800$	1	
	Solves the above equation for n as 9 months.	1	
37 i)	Identifies the coordinates of the green ball as (7, 1) and the nearest pocket P_4 as (9, 3).	0.5	
	Uses the distance formula to calculate the distance as $\sqrt{8}$ or $2\sqrt{2}$ units as follows: $\sqrt{(9-7)^2 - (3-1)^2} = \sqrt{8} = 2\sqrt{2}$ (Award full marks if any other method is used.)	0.5	
37 ii)	Finds the coordinates of the yellow ball using the midpoint formula with $W(-3, -2)$ and $G(7, 1)$ to obtain $\left(2, \frac{-1}{2}\right)$ as follows: $\left(\frac{-3 + 7}{2}, \frac{-2 + 1}{2}\right)$	1	
37 iii)	Considers the point where the ball struck the rail as $(c, 3)$ and the coordinates of P_2 (other end point) as (2, -4).	0.5	
	Finds c using the section formula as follows: $\left(\frac{2}{7}, 0\right) = \left(\frac{4 \times c + 3 \times 2}{4 + 3}, \frac{4 \times 3 + 3 \times (-4)}{4 + 3}\right)$ $\therefore \frac{4 \times c + 3 \times 2}{4 + 3} = \frac{2}{7}$ $c = -1$ Concludes that the point at which the ball struck the rail is (-1, 3).	1.5	

<table>
<tr><td></td><td colspan="2">OR</td></tr>
<tr><td></td><td>Calculates the distance between the blue ball and red ball (BR) as $2\sqrt{5}$ units using the distance formula as follows:

$BR = \sqrt{(-1-1)^2 + (-3-1)^2} = \sqrt{20} = 2\sqrt{5}$ units</td><td>0.5</td></tr>
<tr><td></td><td>Calculates the distance between the red ball and P_5 (RP_5) as $\sqrt{5}$ units using the distance formula as follows:

$RP_5 = \sqrt{(2-1)^2 + (3-1)^2} = \sqrt{5}$ units</td><td>0.5</td></tr>
<tr><td></td><td>Calculates the distance between the blue ball and P_5 (BP_5) as $3\sqrt{5}$ units using the distance formula as follows:

$BP_5 = \sqrt{(-1-2)^2 + (-3-3)^2} = \sqrt{45} = 3\sqrt{5}$ units</td><td>0.5</td></tr>
<tr><td></td><td>Concludes that red ball will lie on the straight path between the blue ball and P_5 by proving that the three points are collinear as $BR + RP_5 = BP_5$. The working may look as follows:

$BR + RP_5 = 2\sqrt{5} + \sqrt{5} = 3\sqrt{5} = BP_5$

(Award full marks if any other method is used.)</td><td>0.5</td></tr>
<tr><td>38 i)</td><td>Draws the required triangle as shown below, and labels BQ as 675 m.

(Note: The figure is not to scale.)</td><td>0.5</td></tr>
<tr><td></td><td>Uses $\tan 30° = \dfrac{1}{\sqrt{3}} = \dfrac{BQ}{PQ}$ to find PQ = $675\sqrt{3}$ m.</td><td>0.5</td></tr>
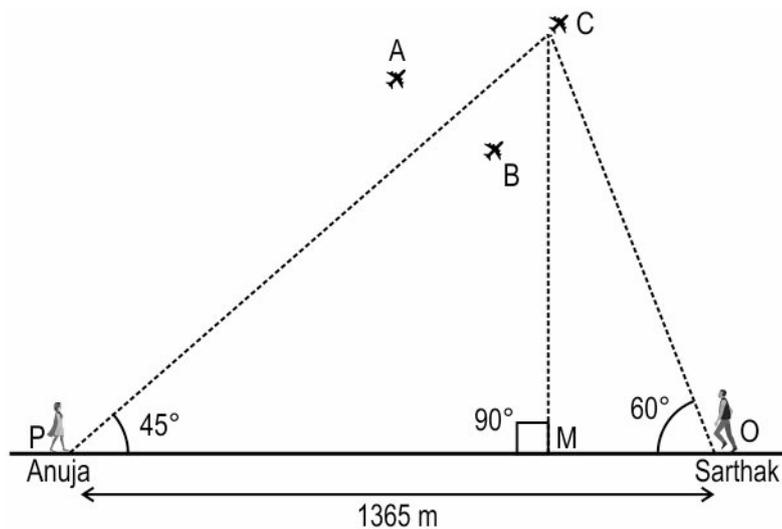<tr><td>38 ii)</td><td>Draws required triangle as shown below.</td><td>0.5</td></tr>
</table>
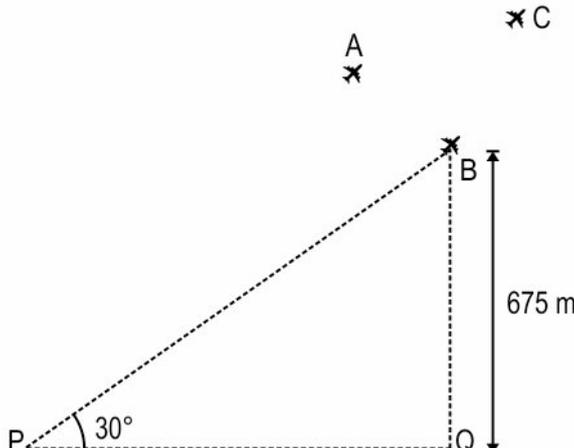
(Note: The figure is not to scale.)

Finds AX = BX tan 30° = $50\sqrt{3} \times \frac{1}{\sqrt{3}} = 50$ m.

0.5

38 iii) Finds the altitude of the plane as AX + XD = 740 + 50 = 790 m.

0.5

Draws the required triangles as shown below.

(Note: The figure is not to scale.)

1

Uses $\tan 45° = 1 = \frac{CM}{PM}$ to get CM = PM.

Uses $\tan 60° = \sqrt{3} = \frac{CM}{MO}$ to get CM = MO$\sqrt{3}$.

0.5

Finds the plane's horizontal distance from Sarthak using
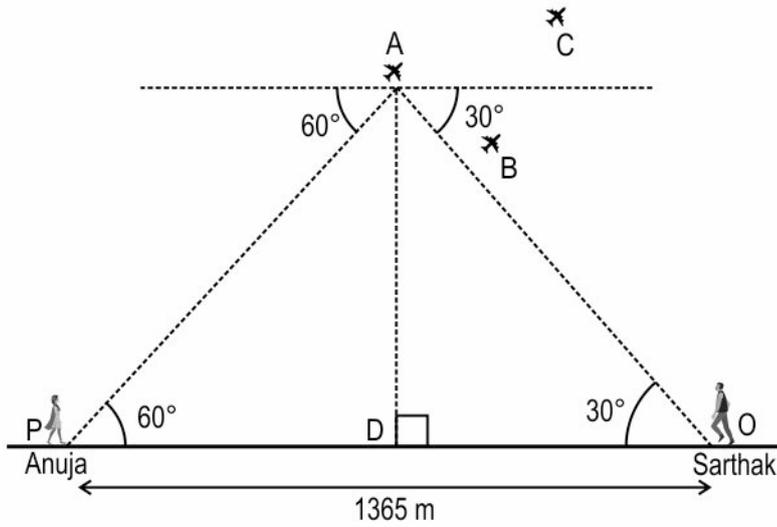PM + MO = 1365 m to get MO = $\frac{1365}{\sqrt{3}+1}$ m.

0.5

OR

0.5

Draws required triangles as shown below.

(Note: The figure is not to scale.)

Uses $\tan 60° = \frac{AD}{DP} = \sqrt{3}$ to get $DP = \frac{AD}{\sqrt{3}}$.

Uses $\tan 30° = \frac{AD}{DO} = \frac{1}{\sqrt{3}}$ to get $DO = AD\sqrt{3}$.

Uses $DP + DO = 1365$ m to get $\frac{AD}{\sqrt{3}} + AD\sqrt{3} = 1365$.

Solves this to get the altitude of the plane, $AD = 341.25\sqrt{3}$ m.

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