CBSE Class 10 Mathematics Basic 2026-27

Sample Paper with Solutions

Conducted by the Central Board of Secondary Education (CBSE)

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

General Instructions

(i) This question paper contains **38 questions**. All questions are compulsory.

(ii) This question Paper is divided into **5 Sections A, B, C, D and E**.

(iii) In **Section A**, Question numbers **1-18** are multiple choice questions (MCQs) and question no. **19 and 20** are Assertion-Reason based questions of **1 mark** each.

(iv) In **Section B**, Question numbers **21-25** are very short answer (VSA) type questions, carrying **02 marks** each.

(v) In **Section C**, Question numbers **26-31** are short answer (SA) type questions, carrying **03 marks** each.

(vi) In **Section D**, Question numbers **32-35** are long answer (LA) type questions, carrying **05 marks** each.

(vii) In **Section E**, Question numbers **36-38** are case study-based questions carrying **4 marks** each with sub parts of the values of **1, 1 and 2 marks** each respectively.

(viii) There is no overall choice. However, an internal choice in **2 questions of Section B, 2 questions of Section C and 2 questions of Section D** has been provided. An internal choice has been provided in all **2 marks** questions of Section E.

(ix) Draw neat and clean figures wherever required. Take $\pi = 22/7$ wherever required if not stated.

(x) Use of calculators is not allowed.

Section A (20 marks)

This section comprises of 18 multiple choice questions and two assertion and reason type questions of 1 mark each.

1. If HCF (2520, 6600) = 40 and LCM (2520, 6600) = 252 × k, then the value of k is [1 mark]

(A) 165

(B) 1600

(C) 1625

(D) 1650

Correct Answer: (D) 1650

Solution:

Concept:

- For any two positive integers, the product of the two numbers equals the product of their HCF and their LCM.
- So here HCF × LCM = 2520×6600.

Step 1: Key Formula or Approach HCF(a, b) × LCM$(a, b) = a \times b$.
We put the given HCF as 40 and the LCM as $252 \times k$, then solve for k.

Step 2: Detailed Explanation Substitute the values in the formula:

$$40 \times 252 \times k = 2520 \times 6600$$

Left side number: $40 \times 252 = 10080$.
Right side number: $2520 \times 6600 = 16632000$.
So $10080\,k = 16632000$.

$$k = \frac{16632000}{10080} = 1650$$

Step 3: Why the other options are wrong If $k = 165$, then $40 \times 252 \times 165 = 1663200$, which is ten times too small.
If $k = 1600$, the product is $10080 \times 1600 = 16128000$, which is not 16632000.
If $k = 1625$, the product is $10080 \times 1625 = 16380000$, which is also not 16632000.
Only $k = 1650$ makes both sides equal.

Step 4: Conclusion Using HCF times LCM equals the product of the numbers, we get $k = 1650$. This is option (D).

Quick Tip to Solve: Use HCF × LCM = product of the two numbers, and put the HCF as given in the question.

2. If α and β are the Zeroes of the polynomial $2x^2 - 4x - 5$, the value of $(\alpha - \beta)^2$ is [1 mark]

(A) 4

(B) 6

(C) 14

(D) 56

Correct Answer: (C) 14

Solution:

Concept:

- For a quadratic $ax^2 + bx + c$ with zeroes α and β, the sum and the product of the zeroes are linked to the coefficients.
- We can write $(\alpha - \beta)^2$ using only the sum and the product, so no need to find the zeroes themselves.

Step 1: Key Formula or Approach 1. $\alpha + \beta = -\frac{b}{a}$ and $\alpha\beta = \frac{c}{a}$.
2. $(\alpha - \beta)^2 = (\alpha + \beta)^2 - 4\alpha\beta$.

Step 2: Find the sum and the product Here $a = 2$, $b = -4$, $c = -5$.

$$\alpha + \beta = -\frac{-4}{2} = 2$$

$$\alpha\beta = \frac{-5}{2} = -\frac{5}{2}$$

Step 3: Put the values in the identity

$$(\alpha - \beta)^2 = 2^2 - 4\left(-\frac{5}{2}\right)$$

$$= 4 + 10 = 14$$

Step 4: Why the other options are wrong Option (A) 4 is only $(\alpha + \beta)^2$. The $-4\alpha\beta$ part is missing.
Option (D) 56 is the discriminant $b^2 - 4ac = 16 + 40$. It is not divided by $a^2 = 4$.
Option (B) 6 does not come from any correct form of the identity.

Step 5: Conclusion The value of $(\alpha - \beta)^2$ is 14, which is option (C).

Quick Tip to Solve: Write $(\alpha - \beta)^2$ as $(\alpha + \beta)^2 - 4\alpha\beta$ and use the sum and product of zeroes.

3. For what value of p does the pair of Linear equations $4x + py + 8 = 0$ and $2x + 2y + 2 = 0$ has a unique solution [1 mark]

(A) $p = 4$ only

(B) $p = 2$ only

(C) $p \neq 4$

(D) $p \neq 2$

Correct Answer: (C) $p \neq 4$

Solution:

Concept:

- A pair of linear equations $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$ has exactly one solution when the two lines cross at a single point.
- That happens when the lines are not parallel.

Step 1: Key Formula or Approach Unique solution condition: $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$.

Step 2: Read off the coefficients From $4x + py + 8 = 0$: $a_1 = 4$, $b_1 = p$, $c_1 = 8$.
From $2x + 2y + 2 = 0$: $a_2 = 2$, $b_2 = 2$, $c_2 = 2$.

Step 3: Apply the condition

$$\frac{4}{2} \neq \frac{p}{2}$$

$$2 \neq \frac{p}{2} \Rightarrow p \neq 4$$

Step 4: Why the other options are wrong Options (A) and (B) say p must be exactly one value. But the condition only rules out $p = 4$, so every other value works.
For $p = 4$ we get $\frac{4}{2} = \frac{4}{2} \neq \frac{8}{2}$, which means parallel lines and no solution.
Option (D) $p \neq 2$ is wrong because $p = 2$ gives $\frac{4}{2} \neq \frac{2}{2}$, so it does give a unique solution.

Step 5: Conclusion The pair has a unique solution for every p except 4. This is option (C).

Quick Tip to Solve: A unique solution needs $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$. Compare the x and y coefficients.

4. The sum of the numerator and denominator of a fraction is 11. If the denominator is increased by 1, the fraction becomes $\frac{1}{2}$, then the fraction is [1 mark]

(A) $\frac{2}{9}$

(B) $\frac{3}{8}$

(C) $\frac{4}{7}$

(D) $\frac{5}{6}$

Correct Answer: (C) $\frac{4}{7}$

Solution:

Concept:

- We have two unknowns, the numerator and the denominator.
- The question gives two facts, so we can form two equations.

Step 1: Form the equations Let the numerator be x and the denominator be y.
Sum is 11: $x + y = 11$. (1)
Denominator increased by 1 gives $\frac{x}{y+1} = \frac{1}{2}$, so $2x = y + 1$, that is $2x - y = 1$. (2)

Step 2: Solve the equations Add (1) and (2): $(x + y) + (2x - y) = 11 + 1$, so $3x = 12$ and $x = 4$.
Put $x = 4$ in (1): $4 + y = 11$, so $y = 7$.

Step 3: Write the fraction and check The fraction is $\frac{x}{y} = \frac{4}{7}$.
Check: $4 + 7 = 11$. And with the denominator 8, $\frac{4}{8} = \frac{1}{2}$. Both conditions hold.

Step 4: Why the other options are wrong $\frac{2}{9}$: sum is 11, but $\frac{2}{10} = \frac{1}{5}$, not $\frac{1}{2}$.
$\frac{3}{8}$: sum is 11, but $\frac{3}{9} = \frac{1}{3}$, not $\frac{1}{2}$.
$\frac{5}{6}$: sum is 11, but $\frac{5}{7} \neq \frac{1}{2}$.

Step 5: Conclusion The fraction is $\frac{4}{7}$, which is option (C).

Quick Tip to Solve: Let the numerator be x and the denominator y. Form $x + y = 11$ and $\frac{x}{y+1} = \frac{1}{2}$.

5. If one root of the quadratic equation $ax^2 + bx + c = 0$ is the reciprocal of the other, then [1 mark]

(A) $b = c$

(B) $a = b$

(C) $ac = 1$

(D) $a = c$

Correct Answer: (D) $a = c$

Solution:

Concept:

- For $ax^2 + bx + c = 0$, the product of the roots is $\frac{c}{a}$.

Step 1: Use the given condition One root is the reciprocal of the other. Let the roots be α and $\frac{1}{\alpha}$.
Their product is $\alpha \times \frac{1}{\alpha} = 1$.

Step 2: Equate the two products

$$\frac{c}{a} = 1$$

So $c = a$, that is $a = c$.

Step 3: Why the other options are wrong (A) $b = c$ and (B) $a = b$: the middle coefficient b depends on the sum of the roots, which can be anything, so no such link is forced.
(C) $ac = 1$ is also not forced. For example, $2x^2 - 5x + 2 = 0$ has roots 2 and $\frac{1}{2}$, but $ac = 4$.

Step 4: Conclusion The condition gives $a = c$, which is option (D).

Quick Tip to Solve: Call the roots α and $\frac{1}{\alpha}$, and compare their product with $\frac{c}{a}$.

6. The first term of AP is p and the common difference is q , then its 10^{th} term is [1 mark]

(A) $q + 10p$

(B) $p - 9q$

(C) $p + 9q$

(D) $p + 10q$

Correct Answer: (C) $p + 9q$

Solution:

Concept:

- In an AP, each term is the previous term plus the common difference.
- The nth term is the first term plus $(n - 1)$ times the common difference.

Step 1: Key Formula or Approach $a_n = a + (n - 1)d$.

Step 2: Put in the values Here the first term is $a = p$, the common difference is $d = q$, and $n = 10$.

$$a_{10} = p + (10 - 1)q$$

$$a_{10} = p + 9q$$

Step 3: Why the other options are wrong (A) $q+10p$ swaps the roles of the first term and the common difference.
(B) $p - 9q$ uses the wrong sign. The AP increases by q, so we add.
(D) $p + 10q$ uses n instead of $n - 1$. To reach the 10th term from the first, we take only 9 steps.

Step 4: Conclusion The 10th term is $p + 9q$, which is option (C).

Quick Tip to Solve: Use $a_n = a + (n - 1)d$ with $n = 10$.

7. Which term of the AP: 21, 42, 63, 84 ... is 210? [1 mark]

(A) 9^{th}

(B) 10^{th}

(C) 11^{th}

(D) 12^{th}

Correct Answer: (B) 10^{th}

Solution:

Concept:

- The list 21, 42, 63, 84, ... goes up by the same amount each time, so it is an AP.
- We need the position n of the term 210.

Step 1: Key Formula or Approach $a_n = a + (n-1)d$.

Step 2: Find a and d First term $a = 21$. Common difference $d = 42 - 21 = 21$.

Step 3: Solve for n Put $a_n = 210$:

$$210 = 21 + (n-1) \times 21$$

Subtract 21 from both sides: $189 = (n-1) \times 21$.

$$n - 1 = \frac{189}{21} = 9$$

$$n = 10$$

Step 4: Why the other options are wrong The 9th term is $21 + 8 \times 21 = 189$. The 11th term is $21 + 10 \times 21 = 231$. The 12th term is $21 + 11 \times 21 = 252$.
None of these is 210.

Step 5: Conclusion 210 is the 10th term of the AP. This is option (B).

Quick Tip to Solve: Find a and d, then solve $a + (n-1)d = 210$ for n.

8. If the point P (5, 2) divides the line segment joining A(8, 5) and B(4, y) in the ratio 3 : 1, then the value of y is [1 mark]

(A) 4

(B) 3

(C) 2

(D) 1

Correct Answer: (D) 1

Solution:

Concept:

- If a point P divides the segment joining $A(x_1, y_1)$ and $B(x_2, y_2)$ in the ratio $m : n$, the section formula gives its coordinates.

Step 1: Key Formula or Approach

$$P = \left(\frac{mx_2 + nx_1}{m+n}, \frac{my_2 + ny_1}{m+n}\right)$$

Step 2: Put in the values Here $A(8, 5)$, $B(4, y)$, and $m : n = 3 : 1$. The point P is $(5, 2)$.
Use the y-coordinate:

$$2 = \frac{3 \times y + 1 \times 5}{3+1} = \frac{3y+5}{4}$$

Step 3: Solve for y $3y + 5 = 8$, so $3y = 3$ and $y = 1$.
Check with the x-coordinate: $\frac{3 \times 4 + 1 \times 8}{4} = \frac{20}{4} = 5$. This matches P.

Step 4: Why the other options are wrong If $y = 4$, the y-coordinate would be $\frac{12+5}{4} = \frac{17}{4}$.
If $y = 3$, it would be $\frac{14}{4} = 3.5$. If $y = 2$, it would be $\frac{11}{4}$.
None of these equals 2.

Step 5: Conclusion The value of y is 1, which is option (D).

Quick Tip to Solve: Use the section formula for the y-coordinate with $m : n = 3 : 1$ and set it equal to 2.

9. A letter from the word INDEPENDENCE is selected at random. What is the probability that the letter selected is a vowel which occurs the maximum number of times in the given word? [1 mark]

(A) $\frac{1}{12}$

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

(C) $\frac{1}{3}$

(D) $\frac{5}{12}$

Correct Answer: (C) $\frac{1}{3}$

Solution:

Concept:

- We need the chance of picking a letter that is a vowel and also the vowel that appears most often in the word INDEPENDENCE.
- Probability is the number of favourable outcomes divided by the total number of outcomes.

Step 1: Count the letters INDEPENDENCE has the letters I, N, D, E, P, E, N, D, E, N, C, E.
Total letters = 12.
I occurs 1 time, N occurs 3 times, D occurs 2 times, E occurs 4 times, P occurs 1 time, C occurs 1 time.
Check: $1 + 3 + 2 + 4 + 1 + 1 = 12$.

Step 2: Find the favourable outcomes The vowels in the word are I and E.
E occurs 4 times and I occurs 1 time, so the vowel that occurs the maximum number of times is E.
Favourable outcomes = 4.

Step 3: Find the probability

$$P = \frac{4}{12} = \frac{1}{3}$$

Step 4: Why the other options are wrong (A) $\frac{1}{12}$ is the chance of picking one particular letter that occurs once, such as I.
(B) $\frac{1}{4} = \frac{3}{12}$ would be the chance of picking N, which is a consonant, not a vowel.
(D) $\frac{5}{12}$ is the chance of picking any vowel (I or E), but the question asks only for the most frequent vowel.

Step 5: Conclusion The probability is $\frac{1}{3}$, which is option (C).

Quick Tip to Solve: Count every letter of INDEPENDENCE, find the vowel that repeats most, then divide its count by the total letters.

10. For the following distribution

Class	0-5	5-10	10-15	15-20	20-25
Frequency	10	15	12	20	9

The lower limit of the median class is [1 mark]

(A) 5

(B) 10

(C) 15

(D) 20

Correct Answer: (B) 10

Solution:

Concept:

- The median class is the class that contains the middle observation.
- To find it we need the total frequency N and the cumulative frequency of each class.

Step 1: Find the cumulative frequencies Add the frequencies step by step:
0-5: 10.
5-10: $10 + 15 = 25$. 10-15: $25 + 12 = 37$. 15-20: $37 + 20 = 57$. 20-25: $57 + 9 = 66$.
So $N = 66$.

Step 2: Locate the median class

$$\frac{N}{2} = \frac{66}{2} = 33$$

We look for the first class whose cumulative frequency is at least 33. The class 5-10 has 25, which is less than 33. The class 10-15 has 37, which is at least 33.
So the median class is 10-15.

Step 3: Read the lower limit The lower limit of the class 10-15 is 10.

Step 4: Why the other options are wrong (A) 5 is the lower limit of 5-10. That class only reaches a cumulative frequency of 25, so it does not hold the 33rd observation.
(C) 15 is the lower limit of 15-20. The 33rd observation is already reached before this class begins.
(D) 20 is the lower limit of 20-25, the last class, which is far beyond the middle.

Step 5: Conclusion The lower limit of the median class is 10, which is option (B).

Quick Tip to Solve: Make a cumulative frequency column and find the class where the cumulative frequency first reaches $\frac{N}{2}$.

11. The length of a tangent drawn from a point at a distance of 10 cm from the centre of the circle is 8 cm. The radius of the circle is [1 mark]

(A) 4 cm

(B) 5 cm

(C) 6 cm

(D) 7 cm

Correct Answer: (C) 6 cm

Solution:

Concept:

- Let O be the centre of the circle, P the outside point and T the point where the tangent from P touches the circle.
- A tangent is always perpendicular to the radius drawn to the point of contact. So $\angle OTP = 90°$.
- This makes $\triangle OTP$ a right-angled triangle, with the right angle at T.

Step 1: Write down the given lengths The distance of P from the centre is $OP = 10$ cm. This is the longest side, the hypotenuse.
The tangent length is $PT = 8$ cm.
The radius is $OT = r$, which we need to find.

Step 2: Apply the Pythagoras theorem In a right triangle, (hypotenuse)^2 = (base)^2 + (perpendicular)^2.

$$OP^2 = PT^2 + OT^2$$

$$10^2 = 8^2 + r^2$$

$$100 = 64 + r^2$$

$$r^2 = 100 - 64 = 36$$

Radius cannot be negative, so $r = \sqrt{36} = 6$ cm.

Step 3: Why the other options are wrong If $r = 4$ cm, then $OP^2 = 8^2 + 4^2 = 80$, which is not 100. So (A) is wrong.
If $r = 5$ cm, then $OP^2 = 64 + 25 = 89$, which is not 100. So (B) is wrong.
If $r = 7$ cm, then $OP^2 = 64 + 49 = 113$, which is not 100. So (D) is wrong.
Only $r = 6$ cm gives $64 + 36 = 100$, so (C) is right.

Step 4: Conclusion The radius of the circle is 6 cm. This is option (C).

Quick Tip to Solve: A tangent is perpendicular to the radius at the point of contact. That gives a right triangle, so use the Pythagoras theorem.

12. Mean and median of certain data are 32 and 30 respectively. Using empirical formula, the value of mode is [1 mark]

(A) 36

(B) 26

(C) 30

(D) 20

Correct Answer: (B) 26

Solution:

Concept:

- For a moderately skewed distribution, mean, median and mode are linked by an empirical formula.
- It lets us find the mode when the mean and the median are known.

Step 1: Key Formula

$$\text{Mode} = 3 \times \text{Median} - 2 \times \text{Mean}$$

Step 2: Substitute the values Median $= 30$ and Mean $= 32$.

$$\text{Mode} = 3 \times 30 - 2 \times 32$$

$$\text{Mode} = 90 - 64 = 26$$

Step 3: Why the other options are wrong Option (A) 36 comes from swapping the numbers: $3 \times 32 - 2 \times 30 = 36$. The formula puts 3 with the median, not the mean.
Option (C) 30 is just the median given in the question. It is not the result of the formula.
Option (D) 20 does not come from the formula at all.
Only 26 satisfies Mode = 3 Median - 2 Mean, so (B) is right.

Step 4: Conclusion The mode is 26. This is option (B).

Quick Tip to Solve: Use the empirical relation: Mode = 3 Median - 2 Mean.

13. A ladder 15 m long reaches a window 12 m above the ground. The distance of the foot of the ladder from the base of the wall is [1 mark]

(A) 8 m

(B) 9 m

(C) 10 m

(D) 13 m

Correct Answer: (B) 9 m

Solution:

Concept:

- The wall stands straight up from level ground, so the wall and the ground meet at 90 degrees.
- The ladder leans from the ground to the window. So the ladder is the hypotenuse of a right triangle.

Step 1: Write down the given lengths Ladder (hypotenuse) = 15 m.
Height of the window on the wall = 12 m.

Distance of the foot of the ladder from the wall = x m, which we need to find.

Step 2: Apply the Pythagoras theorem

$$15^2 = 12^2 + x^2$$

$$225 = 144 + x^2$$

$$x^2 = 225 - 144 = 81$$

$$x = 9 \text{ m}$$

Step 3: Why the other options are wrong If $x = 8$, then $12^2 + 8^2 = 208$, not 225. So (A) is wrong.
If $x = 10$, then $12^2 + 10^2 = 244$, not 225. So (C) is wrong.
If $x = 13$, then $12^2 + 13^2 = 313$, not 225. So (D) is wrong.
For $x = 9$, $144 + 81 = 225 = 15^2$, so (B) is right.

Step 4: Conclusion The foot of the ladder is 9 m from the wall. This is option (B).

Quick Tip to Solve: The wall, the ground and the ladder form a right triangle. Use the Pythagoras theorem.

14. The value of $\sin^2 60^\circ - 2\tan^2 45^\circ - \cos^2 30^\circ$ is [1 mark]

(A) -2

(B) -1

(C) 1

(D) 2

Correct Answer: (A) -2

Solution:

Concept:

- The question uses the standard trigonometric values of 30, 45 and 60 degrees.
- We replace each ratio by its value and simplify.

Step 1: Recall the values $\sin 60^\circ = \frac{\sqrt{3}}{2}$
$\tan 45^\circ = 1$
$\cos 30^\circ = \frac{\sqrt{3}}{2}$

Step 2: Square each ratio $\sin^2 60^\circ = (\frac{\sqrt{3}}{2})^2 = \frac{3}{4}$
$2\tan^2 45^\circ = 2 \times 1^2 = 2$
$\cos^2 30^\circ = (\frac{\sqrt{3}}{2})^2 = \frac{3}{4}$

Step 3: Put the values in the expression

$$\frac{3}{4} - 2 - \frac{3}{4}$$

The two fractions $\frac{3}{4}$ cancel each other, so the result is -2.

Step 4: Why the other options are wrong Option (B) -1 comes from forgetting the factor 2 in front of $\tan^2 45°$.
Option (C) 1 and option (D) 2 come from a sign slip: the term $2\tan^2 45°$ is subtracted, not added.

Step 5: Conclusion The value is -2. This is option (A).

Quick Tip to Solve: Put in the standard values: $\sin 60° = \frac{\sqrt{3}}{2}$, $\tan 45° = 1$, $\cos 30° = \frac{\sqrt{3}}{2}$.

15. The perimeter of two similar triangles is 28 cm and 35 cm respectively. If one side of the first triangle is 8cm, then the corresponding side of the second triangle is [1 mark]

(A) 10 cm

(B) 12cm

(C) 14cm

(D) 16cm

Correct Answer: (A) 10 cm

Solution:

Concept:

- In similar triangles, all corresponding sides are in the same ratio.
- The perimeter is the sum of the sides, so the ratio of the perimeters is also equal to this same ratio.

Step 1: Key Formula

$$\frac{\text{Perimeter of first triangle}}{\text{Perimeter of second triangle}} = \frac{\text{Side of first triangle}}{\text{Corresponding side of second triangle}}$$

Step 2: Substitute the values Let the required side be x cm.

$$\frac{28}{35} = \frac{8}{x}$$

Cross-multiply: $28x = 8 \times 35 = 280$.

$$x = \frac{280}{28} = 10 \text{ cm}$$

Step 3: Why the other options are wrong The second triangle is bigger (35 is more than 28), so its side must be more than 8 cm. The scale is $\frac{35}{28} = 1.25$, so the side is $8 \times 1.25 = 10$.
12 cm would need a scale of 1.5, 14 cm a scale of 1.75, and 16 cm a scale of 2. None of these matches the perimeters.

Step 4: Conclusion The corresponding side is 10 cm. This is option (A).

Quick Tip to Solve: For similar triangles, the ratio of perimeters equals the ratio of corresponding sides.

16. If in $\triangle ABC$ and $\triangle PQR$, $\angle B = \angle Q$, $\angle R = \angle C$ and $AB = 2PQ$, then the two triangles are [1 mark]

(A) Congruent but not similar

(B) Similar but not congruent

(C) Neither congruent nor similar

(D) Congruent as well as similar

Correct Answer: (B) Similar but not congruent

Solution:

Concept:

- Two triangles are similar if two angles of one are equal to two angles of the other (AA criterion). The third angles are then equal too, because the angles of a triangle add up to $180°$.
- Two triangles are congruent only if they are similar and the matching sides are also equal.

Step 1: Check similarity Given $\angle B = \angle Q$ and $\angle C = \angle R$.
By the AA criterion, $\triangle ABC \sim \triangle PQR$. So $\angle A = \angle P$ as well.

Step 2: Check congruence In the similar triangles, AB and PQ are the sides opposite the equal angles C and R, so they are corresponding sides.
We are given $AB = 2PQ$, so $\frac{AB}{PQ} = 2$, not 1.
If the triangles were congruent, this ratio would be 1. So they are not congruent.

Step 3: Why the other options are wrong (A) says congruent but not similar. This is impossible, because congruent triangles are always similar.
(C) is wrong because we proved the triangles are similar.
(D) is wrong because the sides are not equal (AB is twice PQ).

Step 4: Conclusion The triangles are similar but not congruent. This is option (B).

Quick Tip to Solve: Two pairs of equal angles prove similarity (AA). Then check whether the matching sides are equal.

17. If tangents PA and PB from a point P to a circle with centre O and respective point of contacts as A and B, are inclined to each other at angle of $80°$, then $\angle AOB$ is equal to [1 mark]

(A) $60°$

(B) $70°$

(C) $80°$

(D) $100°$

Correct Answer: (D) $100°$

Solution:

Concept:

- A tangent is perpendicular to the radius at the point of contact.
- Join OA and OB. Then $\angle OAP = 90°$ and $\angle OBP = 90°$.

Step 1: Use the angle sum of a quadrilateral AOBP is a quadrilateral, so its four angles add up to $360°$.

$$\angle APB + \angle OAP + \angle AOB + \angle OBP = 360°$$

$$80^\circ + 90^\circ + \angle AOB + 90^\circ = 360^\circ$$

$$\angle AOB + 260^\circ = 360^\circ$$

$$\angle AOB = 100^\circ$$

Step 2: Why the other options are wrong $\angle AOB$ and $\angle APB$ are supplementary here, so they add up to 180°. Then $\angle AOB = 180^\circ - 80^\circ = 100^\circ$.
Option (C) 80° is just the angle at P given in the question. Options (A) and (B) have no link with the angle sum, and 60° or 70° would not make the total 360°.

Step 3: Conclusion $\angle AOB = 100^\circ$. This is option (D).

Quick Tip to Solve: Join OA and OB. Each makes 90° with the tangent. Use the angle sum of the quadrilateral AOBP.

18. Two cubes each of volume 64 cm^3 are joined end to end to form a cuboid. The total surface area of the resulting cuboid is [1 mark]

(A) 128 cm^2

(B) 160 cm^2

(C) 176 cm^2

(D) 192 cm^2

Correct Answer: (B) 160 cm^2

Solution:

Step 1: Find the edge of the cube Volume of a cube is a^3. Here $a^3 = 64$, so $a = 4$ cm.

Step 2: Find the size of the cuboid Two cubes joined end to end put the two edges in one line, so the length doubles.
Length $l = 4 + 4 = 8$ cm, breadth $b = 4$ cm, height $h = 4$ cm.

Step 3: Apply the formula for total surface area

$$\text{TSA} = 2(lb + bh + hl)$$

$$= 2(8 \times 4 + 4 \times 4 + 4 \times 8)$$

$$= 2(32 + 16 + 32) = 2 \times 80 = 160 \text{ cm}^2$$

Step 4: Why the other options are wrong (D) 192 is the surface area of the two cubes taken separately: $2 \times 6 \times 16 = 192$. It forgets that two faces are now hidden inside.
(C) 176 removes only one joined face (16) from 192. But two faces, one from each cube, are hidden.
(A) 128 is only the four long side faces: $4 \times 32 = 128$. It leaves out the two square end faces.

Step 5: Conclusion The total surface area of the cuboid is 160 cm^2. This is option (B).

Quick Tip to Solve: Find the edge of one cube from its volume. The cuboid is 8 cm long, 4 cm broad and 4 cm high.

19. ASSERTION (A): The probability of getting number 8 on rolling a die is zero (0)
REASON (R): The probability of an impossible event is zero (0) [1 mark]

(A) Both Assertion (A) and Reason (R) are true and (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true but (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true but Reason (R) is false.

(D) Assertion (A) is false but Reason (R) is true.

Correct Answer: (A) Both Assertion (A) and Reason (R) are true and (R) is the correct explanation of Assertion (A).

Solution:

Concept:

- The probability of an event is (favourable outcomes) divided by (total outcomes).
- An event that cannot happen is called an impossible event. It has no favourable outcome.

Step 1: Check Assertion (A) A die has six faces, numbered 1, 2, 3, 4, 5 and 6. There is no face with 8. Favourable outcomes = 0, total outcomes = 6.

$$P(\text{getting } 8) = \frac{0}{6} = 0$$

So (A) is TRUE.

Step 2: Check Reason (R) An impossible event has 0 favourable outcomes, so its probability is $\frac{0}{n} = 0$ for any n.
So (R) is TRUE.

Step 3: Does R explain A? Getting 8 on a die is an impossible event. The reason says such an event has probability 0, and this is exactly why the answer in (A) is 0.
So (R) is the correct explanation of (A).

Step 4: Why the other options are wrong (B) says R does not explain A, but R is the very rule used in A. (C) and (D) call one statement false, but both are true.

Step 5: Conclusion Both statements are true and R explains A. This is option (A).

Quick Tip to Solve: A die shows only 1 to 6. Decide whether getting 8 is possible, then recall the probability of an impossible event.

20. ASSERTION (A): If a line divides any two sides of a triangle in the same ratio, then the line is parallel to the third side.
REASON (R): Line drawn from midpoint of one side of triangle parallel to another will bisect the third side. [1 mark]

(A) Both Assertion (A) and Reason (R) are true and (R) is the correct explanation of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true but (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true but Reason (R) is false.

(D) Assertion (A) is false but Reason (R) is true.

Correct Answer: (B) Both Assertion (A) and Reason (R) are true but (R) is not the correct explanation of Assertion (A).

Solution:

Concept:

- The Basic Proportionality Theorem (BPT) says: a line parallel to one side of a triangle divides the other two sides in the same ratio.
- Its converse says: if a line divides two sides in the same ratio, it is parallel to the third side.

Step 1: Check Assertion (A) Assertion (A) is exactly the converse of the BPT. This converse is a proved theorem.
So (A) is TRUE.

Step 2: Check Reason (R) Take a line through the midpoint of one side, parallel to a second side. By the BPT it divides the third side in the ratio $1 : 1$, so it bisects it. This is the midpoint theorem.
So (R) is TRUE.

Step 3: Does R explain A? R starts with a parallel line and ends with a bisected side. A starts with equal ratios and ends with a parallel line. The direction is opposite.
R also deals only with the ratio $1 : 1$ (midpoints), while A covers every ratio. So R does not prove A and is not the correct explanation.

Step 4: Why the other options are wrong (A) is wrong because R is not the explanation. (C) and (D) are wrong because both statements are true.

Step 5: Conclusion Both are true but R is not the correct explanation of A. This is option (B).

Quick Tip to Solve: A is the converse of the Basic Proportionality Theorem. R is its special case in the forward direction. Ask whether R proves A.

Section B (10 marks)

This section comprises of 5 very short answer (VSA) type questions of 2 marks each.

21(A). Find the smallest number which when increased by 17 is exactly divisible by both 520 and 468. [2 marks]

Solution:

Concept:

- Let the required number be N. When we add 17 to it, the sum $N + 17$ must be divisible by both 520 and 468.
- So $N + 17$ has to be a common multiple of 520 and 468.
- We want the smallest N, so $N + 17$ must be the smallest common multiple. That is the LCM of 520 and 468.

Step 1: Write both numbers as products of primes

$$520 = 2 \times 260 = 2 \times 2 \times 130 = 2 \times 2 \times 2 \times 65 = 2^3 \times 5 \times 13$$

$$468 = 2 \times 234 = 2 \times 2 \times 117 = 2^2 \times 3^2 \times 13$$

Step 2: Find the LCM The LCM takes the highest power of every prime that appears in either number. The highest power of 2 is 2^3, of 3 is 3^2, of 5 is 5, and of 13 is 13.

$$\text{LCM} = 2^3 \times 3^2 \times 5 \times 13 = 8 \times 9 \times 65 = 72 \times 65 = 4680$$

Step 3: Find the number We need $N + 17 = 4680$, so $N = 4680 - 17 = 4663$.
Check: $4663 + 17 = 4680$. Also $520 \times 9 = 4680$ and $468 \times 10 = 4680$, so 4680 is divisible by both numbers.
The next common multiple is 9360, which would give a bigger number, 9343. So 4663 is the smallest.

Step 4: Conclusion The smallest number is 4663.

Quick Tip to Solve: The number plus 17 must be a common multiple of 520 and 468. Think of the smallest one, the LCM.

OR

21(B). Show that $(25)^n$ will never end with digit zero for any natural number n. [2 marks]

Solution:

Step 1: Recall when a number ends in zero A number ends with the digit 0 only when it is divisible by 10.
Since $10 = 2 \times 5$, such a number must have both 2 and 5 in its prime factorisation.

Step 2: Write the prime factorisation of the given number

$$(25)^n = (5^2)^n = 5^{2n}$$

So the only prime in the factorisation of $(25)^n$ is 5.

Step 3: Use the Fundamental Theorem of Arithmetic The Fundamental Theorem of Arithmetic says the prime factorisation of a number is unique, apart from the order of the primes.
So no other prime, and in particular no factor of 2, can appear in $(25)^n$ in some other way.

Step 4: Conclude For $(25)^n$ to end with 0, the factorisation must contain both 2 and 5. It contains only 5.
So $(25)^n$ is not divisible by 10 for any natural number n, and it can never end with the digit 0.

Step 5: Conclusion The factorisation of $(25)^n$ has no factor of 2, so it is not divisible by 10. Hence it never ends in 0.

Quick Tip to Solve: A number ends in 0 only if both 2 and 5 are in its prime factorisation. Write 25 ^ n as a power of 5.

22. If $3\sin\theta = 4\cos\theta$, find the value of $\sin\theta + \cos^2\theta - 1$; $0° < \theta < 90°$ [2 marks]

Solution:

Step 1: Find tan of the angle Divide both sides of $3\sin\theta = 4\cos\theta$ by $3\cos\theta$. This is allowed because $\cos\theta \neq 0$ for $0° < \theta < 90°$.

$$\frac{\sin\theta}{\cos\theta} = \frac{4}{3} \Rightarrow \tan\theta = \frac{4}{3}$$

Step 2: Draw a right triangle $\tan\theta = \dfrac{\text{opposite}}{\text{adjacent}}$, so take the opposite side as 4 and the adjacent side as 3.
By the Pythagoras theorem, hypotenuse $= \sqrt{3^2 + 4^2} = \sqrt{25} = 5$.

Step 3: Find sin and cos

$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}} = \frac{4}{5}, \qquad \cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}} = \frac{3}{5}$$

Both values are positive because θ is acute.

Step 4: Put the values in the expression

$$\sin\theta + \cos^2\theta - 1 = \frac{4}{5} + \left(\frac{3}{5}\right)^2 - 1 = \frac{4}{5} + \frac{9}{25} - 1$$

Take 25 as the common denominator.

$$= \frac{20}{25} + \frac{9}{25} - \frac{25}{25} = \frac{20 + 9 - 25}{25} = \frac{4}{25}$$

Step 5: Conclusion The value of the expression is $\frac{4}{25}$.

Quick Tip to Solve: Divide the given equation by cos theta to get tan theta, then build a right triangle with sides 3, 4, 5.

23. If one zero of the quadratic polynomial $2x^2 - 3x + p$ is 3, find the value of p. Also, find the other zero. [2 marks]

Solution:

Step 1: Use the meaning of a zero If 3 is a zero of $f(x) = 2x^2 - 3x + p$, then putting $x = 3$ must give $f(3) = 0$.

Step 2: Find p

$$2(3)^2 - 3(3) + p = 0$$

$$18 - 9 + p = 0 \Rightarrow 9 + p = 0 \Rightarrow p = -9$$

Step 3: Find the other zero with the sum of zeroes For $ax^2 + bx + c$, the sum of the zeroes is $-\frac{b}{a}$. Here $a = 2$ and $b = -3$, so the sum is $\frac{3}{2}$.
Let the other zero be β. Then

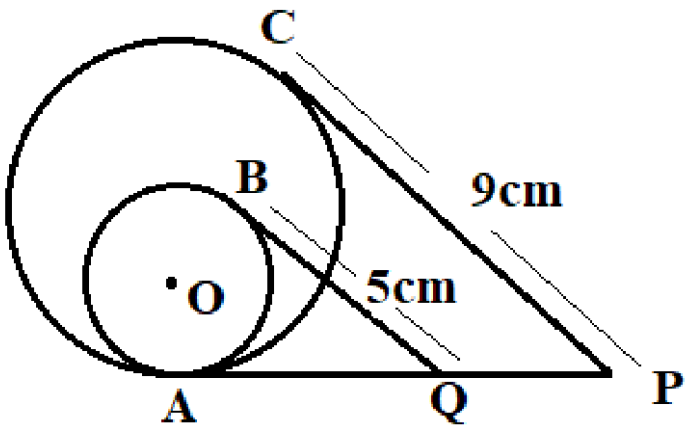
$$3 + \beta = \frac{3}{2} \Rightarrow \beta = \frac{3}{2} - 3 = -\frac{3}{2}$$

Step 4: Check with the product of zeroes The product of the zeroes should be $\frac{c}{a} = \frac{-9}{2}$.
Our zeroes give $3 \times \left(-\frac{3}{2}\right) = -\frac{9}{2}$. It matches.

Step 5: Conclusion The value of p is -9 and the other zero is $-\frac{3}{2}$.

Quick Tip to Solve: Put x = 3 in the polynomial to get p. Then use sum of zeroes = -b/a to find the other zero.

24. In the given figure, PA is a common tangent and QB and PC are the tangents from Q and P to the smaller and larger circle respectively. If QB = 5cm and PC = 9cm, then evaluate length of PQ.



[2 marks]

Solution:

Step 1: Recall the tangent length property The two tangent segments drawn to a circle from one external point are equal in length.

Step 2: Use it for the smaller circle From the point Q, the tangents to the smaller circle are QB and QA (A is the point where the common tangent touches the smaller circle).

$$QA = QB = 5 \text{ cm}$$

Step 3: Use it for the larger circle From the point P, the tangents to the larger circle are PC and PA (A is also the point where the common tangent touches the larger circle).

$$PA = PC = 9 \text{ cm}$$

Step 4: Find PQ The point Q lies on the line segment AP, between A and P. So $PA = PQ + QA$.

$$PQ = PA - QA = 9 - 5 = 4 \text{ cm}$$

Step 5: Conclusion The length of PQ is 4 cm.

Quick Tip to Solve: Tangents from one outside point to a circle are equal. Find QA and PA first, then subtract.

25(A). Points A (3, 1), B (5, 1), C (a, b) and D (4, 3) are vertices of a parallelogram ABCD. Find the values of a and b. [2 marks]

Solution:

Step 1: Use a property of the parallelogram The diagonals of a parallelogram bisect each other. In parallelogram ABCD the diagonals are AC and BD, so they have the same midpoint.

Step 2: Find the midpoint of each diagonal The midpoint of the segment joining (x_1, y_1) and (x_2, y_2) is $(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2})$.

Midpoint of AC with A(3, 1) and C(a, b): $(\frac{3 + a}{2}, \frac{1 + b}{2})$.

Midpoint of BD with B(5, 1) and D(4, 3): $(\frac{5 + 4}{2}, \frac{1 + 3}{2}) = (\frac{9}{2}, 2)$.

Step 3: Equate the midpoints

$$\frac{3 + a}{2} = \frac{9}{2} \Rightarrow 3 + a = 9 \Rightarrow a = 6$$

$$\frac{1 + b}{2} = 2 \Rightarrow 1 + b = 4 \Rightarrow b = 3$$

Step 4: Conclusion The values are $a = 6$ and $b = 3$.

Quick Tip to Solve: The diagonals of a parallelogram bisect each other, so AC and BD have the same midpoint.

OR

25(B). Find a linear relation between x and y such that P (x, y) is equidistant from the points A (1, 4) and B $(-1, 2)$. [2 marks]

Solution:

Step 1: Write the condition P is equidistant from A and B, so $PA = PB$.

Step 2: Use the distance formula The distance between (x_1, y_1) and (x_2, y_2) is $\sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$.

$$PA = \sqrt{(x-1)^2 + (y-4)^2}, \qquad PB = \sqrt{(x+1)^2 + (y-2)^2}$$

$$\sqrt{(x-1)^2 + (y-4)^2} = \sqrt{(x+1)^2 + (y-2)^2}$$

Step 3: Square both sides and expand

$$x^2 - 2x + 1 + y^2 - 8y + 16 = x^2 + 2x + 1 + y^2 - 4y + 4$$

Step 4: Simplify Cancel x^2, y^2 and 1 from both sides.

$$-2x - 8y + 16 = 2x - 4y + 4$$

$$16 - 4 = 2x + 2x + 8y - 4y \Rightarrow 12 = 4x + 4y$$

$$x + y = 3$$

Step 5: Conclusion The required linear relation is $x + y = 3$.

Quick Tip to Solve: Set PA = PB using the distance formula, square both sides and simplify.

Section C (18 marks)

This section comprises of 6 short answer (SA) type questions of 3 marks each.

26. Given that $\sqrt{5}$ is irrational, prove that $2 + 3\sqrt{5}$ is irrational. [3 marks]

Solution:

Step 1: Plan the proof We use proof by contradiction. We assume the opposite of what we want to prove and show that it leads to something false.

Step 2: Make the assumption Let us assume that $2 + 3\sqrt{5}$ is rational.
Then we can write $2 + 3\sqrt{5} = \frac{p}{q}$, where p and q are integers and $q \neq 0$.

Step 3: Solve for root 5

$$3\sqrt{5} = \frac{p}{q} - 2 = \frac{p - 2q}{q}$$

$$\sqrt{5} = \frac{p - 2q}{3q}$$

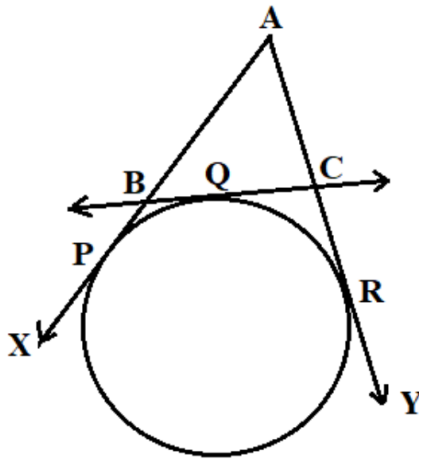
Step 4: Find the contradiction Since p and q are integers, $p - 2q$ and $3q$ are integers, and $3q \neq 0$. So $\frac{p-2q}{3q}$ is a rational number.
That makes $\sqrt{5}$ rational. But we are given that $\sqrt{5}$ is irrational. A number cannot be both rational and irrational. This is a contradiction.

Step 5: Conclude The contradiction came from our wrong assumption, so the assumption is false. Hence $2 + 3\sqrt{5}$ is irrational.

Step 6: Conclusion Hence $2 + 3\sqrt{5}$ is irrational.

Quick Tip to Solve: Assume 2 + 3 root 5 = p/q and solve for root 5. You will get a rational number equal to an irrational one.

27(A). In the given figure, AX, AY and BC are tangents to the circle with P, R and Q respective point of contacts. Prove that $AP = \frac{1}{2}(AB + BC + CA)$



[3 marks]

Solution:

Step 1: Recall the tangent length property The tangent segments drawn from an external point to a circle are equal in length.

Step 2: Apply it at the points B, C and A From B, the tangents are BP and BQ, so $BP = BQ$.
From C, the tangents are CQ and CR, so $CQ = CR$.
From A, the tangents are AP and AR, so $AP = AR$.

Step 3: Expand the perimeter Since Q lies on BC, we can write $BC = BQ + QC$. Then

$$AB + BC + CA = AB + BQ + CQ + AC$$

Now replace BQ by BP and CQ by CR.

$$AB + BC + CA = AB + BP + CR + AC$$

Step 4: Join the pieces along the tangent lines B lies on AP, so $AB + BP = AP$. C lies on AR, so $AC + CR = AR$.

$$AB + BC + CA = AP + AR$$

Since $AP = AR$,

$$AB + BC + CA = AP + AP = 2AP$$

Step 5: Finish

$$AP = \frac{1}{2}(AB + BC + CA)$$

Step 6: Conclusion Hence $AP = \frac{1}{2}(AB + BC + CA)$. Proved.

Quick Tip to Solve: Use BP = BQ, CQ = CR and AP = AR. Then write the perimeter AB + BC + CA in terms of AP and AR.

OR

27(B). Two tangents PA and PB are drawn to a circle with centre O from an external point P. Prove that $\angle APB = 2\angle OAB$ [3 marks]

Solution:

Step 1: Draw and mark the figure Draw the circle with centre O. From the external point P draw tangents PA and PB, touching the circle at A and B. Join OA, OB and AB.

Step 2: Use equal tangents in triangle APB The tangents from P are equal, so $PA = PB$. In triangle APB the angles opposite equal sides are equal, so $\angle PAB = \angle PBA$. Call each of them $\angle BAP$.
By the angle sum property of a triangle,

$$\angle APB + \angle BAP + \angle ABP = 180^\circ$$

$$\angle APB + 2\angle BAP = 180^\circ \qquad \cdots (i)$$

Step 3: Use the radius and tangent property The radius through the point of contact is perpendicular to the tangent. So $OA \perp PA$, which gives $\angle OAP = 90^\circ$.
Now $\angle OAP$ is made up of $\angle OAB$ and $\angle BAP$.

$$\angle OAB + \angle BAP = 90^\circ \Rightarrow \angle BAP = 90^\circ - \angle OAB \qquad \cdots (ii)$$

Step 4: Substitute Put the value of $\angle BAP$ from (ii) in (i).

$$\angle APB + 2(90^\circ - \angle OAB) = 180^\circ$$

$$\angle APB + 180^\circ - 2\angle OAB = 180^\circ$$

$$\angle APB = 2\angle OAB$$

Step 5: Conclusion Hence $\angle APB = 2\angle OAB$. Proved.

Quick Tip to Solve: Use PA = PB to write the angle sum of triangle APB, and use angle OAP = 90 degrees to link angle BAP with angle OAB.

28. Determine the ratio in which the point $(-6, y)$ divides the line segment joining the points $A(-3, -1)$ and $B(-8, 9)$. Also, find the value of y. [3 marks]

Solution:

Concept:

- The section formula finds the point that divides a line segment in a given ratio. If a point divides the segment joining (x_1, y_1) and (x_2, y_2) in the ratio $m : n$, its coordinates are $(\frac{mx_2 + nx_1}{m+n}, \frac{my_2 + ny_1}{m+n})$.
- Here the ratio is not given, so we take it as $k : 1$, find k from the known x-coordinate, and then use k to find y.

Step 1: Write the coordinates of the dividing point Take $A(-3, -1)$ as (x_1, y_1) and $B(-8, 9)$ as (x_2, y_2). Let the point $P(-6, y)$ divide AB in the ratio $k : 1$. Then

$$x = \frac{k(-8) + 1(-3)}{k+1} = \frac{-8k - 3}{k+1}, \qquad y = \frac{k(9) + 1(-1)}{k+1} = \frac{9k - 1}{k+1}$$

Step 2: Use the x-coordinate to find k The x-coordinate of P is given as -6, so

$$\frac{-8k - 3}{k+1} = -6$$

Multiply both sides by $k + 1$: $-8k - 3 = -6k - 6$.
Bring the k terms together: $-8k + 6k = -6 + 3$, which gives $-2k = -3$.
So $k = \frac{3}{2}$. The ratio is $\frac{3}{2} : 1$, which is $3 : 2$.

Step 3: Find y Put $k = \frac{3}{2}$ in the formula for y.

$$y = \frac{9(\frac{3}{2}) - 1}{\frac{3}{2} + 1} = \frac{\frac{27}{2} - 1}{\frac{5}{2}} = \frac{\frac{25}{2}}{\frac{5}{2}} = 5$$

Step 4: Check the answer With the ratio $3 : 2$, the x-coordinate is $\frac{3(-8) + 2(-3)}{5} = \frac{-30}{5} = -6$, which matches the given point.
The y-coordinate is $\frac{3(9) + 2(-1)}{5} = \frac{25}{5} = 5$, which matches our value of y.

Step 5: Conclusion The point $(-6, y)$ divides AB in the ratio $3 : 2$, and $y = 5$.

Quick Tip to Solve: Let the ratio be $k : 1$ and write the x-coordinate using the section formula. Equate it to -6 to find k.

29. Consider $\triangle$ ACB, right-angled at C, in which AB = 29 units, BC = 21 units and $\angle$ABC = θ. Determine the values of

(i) $1 + \tan^2\theta$

(ii) $\cos^2\theta - \sin^2\theta$ [3 marks]

Solution:

Concept:

- In a right triangle, the trigonometric ratios of an angle are ratios of its sides. For the angle θ at B, the side opposite is AC, the side adjacent is BC, and the hypotenuse is AB (opposite the right angle at C).
- We know two sides, so we first find the third side with the Pythagoras theorem.

Step 1: Find the side AC

$$AC^2 = AB^2 - BC^2 = 29^2 - 21^2 = 841 - 441 = 400$$

So $AC = 20$ units.

Step 2: Write the ratios of the angle theta

$$\sin\theta = \frac{AC}{AB} = \frac{20}{29}, \quad \cos\theta = \frac{BC}{AB} = \frac{21}{29}, \quad \tan\theta = \frac{AC}{BC} = \frac{20}{21}$$

Step 3: Solve part (i)

$$1 + \tan^2\theta = 1 + (\frac{20}{21})^2 = 1 + \frac{400}{441} = \frac{441 + 400}{441} = \frac{841}{441}$$

Step 4: Solve part (ii)

$$\cos^2\theta - \sin^2\theta = (\frac{21}{29})^2 - (\frac{20}{29})^2 = \frac{441}{841} - \frac{400}{841} = \frac{41}{841}$$

Step 5: Conclusion (i) $1 + \tan^2\theta = \frac{841}{441}$ and (ii) $\cos^2\theta - \sin^2\theta = \frac{41}{841}$.

Quick Tip to Solve: Find AC by the Pythagoras theorem, then write $\sin\theta$, $\cos\theta$ and $\tan\theta$ for the angle at B.

30(A). The mean of the following distribution is 48 and sum of all the frequencies is 50. Find the missing frequencies x and y.

Class	20 - 30	30 - 40	40 - 50	50 - 60	60 - 70
Frequency	8	6	x	11	y

[3 marks]

Solution:

Concept:

- We have two unknowns, x and y, so we need two equations.
- One comes from the sum of frequencies, and the other comes from the given mean.
- We find the mean with the step deviation method.

Step 1: Equation from the sum of frequencies

$$8+6+x+11+y=50 \implies x+y=25 \quad \cdots(1)$$

Step 2: Prepare the table Class width $h=10$. Take the assumed mean $a=45$ and let $u_i=\dfrac{x_i-45}{10}$, where x_i is the class mark.
Class 20-30: $x_i=25$, $u_i=-2$, $f_iu_i=8\times(-2)=-16$.
Class 30-40: $x_i=35$, $u_i=-1$, $f_iu_i=6\times(-1)=-6$.
Class 40-50: $x_i=45$, $u_i=0$, $f_iu_i=0$.
Class 50-60: $x_i=55$, $u_i=1$, $f_iu_i=11$.
Class 60-70: $x_i=65$, $u_i=2$, $f_iu_i=2y$.
So $\sum f_i=25+x+y=50$ and $\sum f_iu_i=-16-6+0+11+2y=2y-11$.

Step 3: Use the mean formula

$$\text{Mean}=a+\frac{\sum f_iu_i}{\sum f_i}\times h$$

$$48=45+\frac{2y-11}{50}\times 10 \implies 48=45+\frac{2y-11}{5}$$

Subtract 45: $3=\dfrac{2y-11}{5}$, so $2y-11=15$ and $y=13$.

Step 4: Find x From equation (1), $x=25-y=25-13=12$.

Step 5: Check Direct check: $8(25)+6(35)+12(45)+11(55)+13(65)=200+210+540+605+845=2400$. Dividing by 50 gives 48, the given mean.

Step 6: Conclusion The missing frequencies are $x=12$ and $y=13$.

Quick Tip to Solve: Use $\sum f=50$ for one equation. Find $\sum f_ix_i$ (or use step deviation) and equate the mean to 48 for the second.

OR

30(B). The distribution below gives the weight of 50 students of class X. Find the Modal weight of the students.

Weight (in kg)	35 - 45	45 - 55	55 - 65	65 - 75	75 - 85
Number of students	5	10	20	12	3

[3 marks]

Solution:

Concept:

- The mode of grouped data lies in the modal class, which is the class with the highest frequency. We then use the mode formula.
- Here l is the lower limit of the modal class, h is the class width, f_1 is the frequency of the modal class, f_0 is the frequency of the class before it, and f_2 is the frequency of the class after it.

Step 1: Find the modal class The highest frequency is 20, so the modal class is 55 - 65.

Step 2: Read the values $l=55$, $h=10$, $f_1=20$, $f_0=10$ (class 45 - 55) and $f_2=12$ (class 65 - 75).

Step 3: Put the values in the formula

$$\text{Mode}=55+\left(\frac{20-10}{2(20)-10-12}\right)\times 10$$

The denominator is $40 - 10 - 12 = 18$, so

$$\text{Mode} = 55 + \frac{10}{18} \times 10 = 55 + \frac{100}{18} = 55 + 5.56 = 60.56 \text{ (approx.)}$$

Step 4: Conclusion The modal weight of the students is about 60.56 kg.

Quick Tip to Solve: The modal class is the one with the greatest frequency. Use $l + \dfrac{f_1 - f_0}{2f_1 - f_0 - f_2} \times h$.

31. The sum of the digits of a two-digit number is 9. Also, nine times this number is twice the number obtained by reversing the order of the digits. Find the number. [3 marks]

Solution:

Concept:

- A two-digit number with tens digit x and units digit y has the value $10x + y$.
- When the digits are reversed, the number becomes $10y + x$.
- We turn the two given facts into two linear equations in x and y.

Step 1: Form the equations Sum of digits is 9: $x + y = 9 \quad \cdots(1)$.
Nine times the number equals twice the reversed number:

$$9(10x + y) = 2(10y + x)$$

$$90x + 9y = 20y + 2x \implies 88x - 11y = 0 \implies 8x - y = 0 \quad \cdots(2)$$

Step 2: Solve the pair From (2), $y = 8x$. Put this in (1): $x + 8x = 9$, so $9x = 9$ and $x = 1$.
Then $y = 8 \times 1 = 8$.

Step 3: Write the number and check The number is $10(1) + 8 = 18$. The reversed number is 81.
Check: digit sum $1 + 8 = 9$. Also $9 \times 18 = 162$ and $2 \times 81 = 162$. Both conditions are true.

Step 4: Conclusion The required number is 18.

Quick Tip to Solve: Let the digits be x and y. The number is $10x + y$ and the reversed number is $10y + x$. Form two equations.

Section D (20 marks)

This section comprises of 4 long answer (LA) type questions of 5 marks each.

32. Prove that if a line is drawn parallel to one side of a triangle intersecting the other two sides in distinct points, then the other two sides are divided in the same ratio. [5 marks]

Solution:

Concept:

- This is the Basic Proportionality Theorem (also called Thales theorem).
- We prove it using areas of triangles.
- The key facts are: triangles with the same height have areas in the ratio of their bases, and triangles on the same base between the same parallel lines have equal areas.

Step 1: Given, To Prove and Figure Given: In $\triangle ABC$, a line DE is drawn parallel to BC. It meets AB at D and AC at E.
To prove: $\frac{AD}{DB} = \frac{AE}{EC}$.
Draw the triangle ABC and mark D on AB and E on AC so that DE is parallel to BC.

Step 2: Construction Join BE and CD. Draw $EF \perp AB$ and $DG \perp AC$.

Step 3: Areas on the side AB The area of a triangle is half of base times height.

$$ar(\triangle ADE) = \frac{1}{2} \times AD \times EF, \qquad ar(\triangle BDE) = \frac{1}{2} \times DB \times EF$$

Both triangles have the same height EF, so

$$\frac{ar(\triangle ADE)}{ar(\triangle BDE)} = \frac{\frac{1}{2} \times AD \times EF}{\frac{1}{2} \times DB \times EF} = \frac{AD}{DB} \quad \cdots (1)$$

Step 4: Areas on the side AC In the same way, with the common height DG,

$$\frac{ar(\triangle ADE)}{ar(\triangle CDE)} = \frac{\frac{1}{2} \times AE \times DG}{\frac{1}{2} \times EC \times DG} = \frac{AE}{EC} \quad \cdots (2)$$

Step 5: Compare the two areas $\triangle BDE$ and $\triangle CDE$ stand on the same base DE and lie between the same parallel lines DE and BC. Triangles on the same base and between the same parallels have equal area, so

$$ar(\triangle BDE) = ar(\triangle CDE) \quad \cdots (3)$$

Step 6: Combine From (1), (2) and (3), the right-hand sides of the area ratios are equal because the denominators are equal:

$$\frac{AD}{DB} = \frac{AE}{EC}$$

Hence the line parallel to BC divides the other two sides in the same ratio.

Step 7: Conclusion Hence proved: if $DE \parallel BC$, then $\frac{AD}{DB} = \frac{AE}{EC}$.

Quick Tip to Solve: Join BE and CD and compare areas. Triangles with the same height have areas in the ratio of their bases, and $ar(BDE) = ar(CDE)$.

33(A). A train travels a distance of 360 km at a uniform speed. If the speed had been 5 km/h more, then it would have taken 1 hour less to cover the same distance. Find the speed of the train. [5 marks]

Solution:

Concept:

- Time taken equals distance divided by speed.
- The train covers the same 360 km in two cases, and the time in the second case is 1 hour less.
- This gives a quadratic equation in the speed.

Step 1: Form the equation Let the speed of the train be x km/h. Then the time taken is $\frac{360}{x}$ hours.
With speed $(x+5)$ km/h, the time taken is $\frac{360}{x+5}$ hours.
The second time is 1 hour less than the first, so

$$\frac{360}{x} - \frac{360}{x+5} = 1$$

Step 2: Simplify Take the common denominator $x(x+5)$:

$$\frac{360(x+5) - 360x}{x(x+5)} = 1 \implies \frac{1800}{x^2+5x} = 1$$

$$x^2 + 5x - 1800 = 0$$

Step 3: Solve with the quadratic formula Here $a = 1$, $b = 5$, $c = -1800$.

$$x = \frac{-5 \pm \sqrt{5^2 + 4(1800)}}{2} = \frac{-5 \pm \sqrt{25 + 7200}}{2} = \frac{-5 \pm \sqrt{7225}}{2} = \frac{-5 \pm 85}{2}$$

So $x = 40$ or $x = -45$.

Step 4: Reject the negative value Speed cannot be negative, so $x = -45$ is rejected. The speed of the train is 40 km/h.

Step 5: Check At 40 km/h the time is $\frac{360}{40} = 9$ hours. At 45 km/h the time is $\frac{360}{45} = 8$ hours. The difference is 1 hour, as required.

Step 6: Conclusion The speed of the train is 40 km/h.

Quick Tip to Solve: Let the speed be x km/h and write $\frac{360}{x} - \frac{360}{x+5} = 1$. Simplify to a quadratic equation.

OR

33(B). John and Jivanti together have 45 marbles. Both of them lost 5 marbles each, and the product of the number of marbles they now have is 124. Find the number of marbles they had with them in the beginning. [5 marks]

Solution:

Concept:

- We take the number of marbles John had as an unknown.
- Jivanti's number follows from the total of 45.
- After each loses 5 marbles, the product of the two new numbers is 124, which gives a quadratic equation.

Step 1: Form the equation Let John have x marbles in the beginning. Then Jivanti had $45-x$ marbles. After losing 5 each, John has $x-5$ and Jivanti has $45-x-5=40-x$.

$$(x-5)(40-x)=124$$

Step 2: Expand and simplify

$$40x-x^2-200+5x=124$$

$$-x^2+45x-324=0 \implies x^2-45x+324=0$$

Step 3: Solve with the quadratic formula Here $a=1$, $b=-45$, $c=324$.

$$x=\frac{45\pm\sqrt{45^2-4(324)}}{2}=\frac{45\pm\sqrt{2025-1296}}{2}=\frac{45\pm\sqrt{729}}{2}=\frac{45\pm27}{2}$$

So $x=36$ or $x=9$.

Step 4: Write the two cases Case 1: John had 36 marbles, so Jivanti had $45-36=9$ marbles.
Case 2: John had 9 marbles, so Jivanti had $45-9=36$ marbles.
Both cases are possible. In the beginning one of them had 36 marbles and the other had 9.

Step 5: Check After losing 5 each: 31 and 4, and $31\times4=124$. This matches the given product.

Step 6: Conclusion John and Jivanti had 36 and 9 marbles (in either order) in the beginning.

Quick Tip to Solve: Let John have x marbles, so Jivanti has $45-x$. Form $(x-5)(40-x)=124$.

34. The largest possible hemisphere is drilled out of a wooden cubical block of side 21 cm such that the base of the hemisphere is on one of the faces of the cube. Then, find
(i) the volume of the wood left in the block.
(ii) the total surface area of the remaining solid. [5 marks]

Solution:

Concept:

- The largest hemisphere that fits on a face of the cube has its diameter equal to the side of the cube. So the radius of the hemisphere is $r=\frac{21}{2}$ cm.
- Volume of wood left = volume of cube minus volume of hemisphere. Since the hemisphere is cut out of a face, the circular area of the face is removed, and the curved surface of the hemisphere appears inside the block.

Step 1: Formulas Volume of cube $= a^3$. Volume of hemisphere $= \frac{2}{3}\pi r^3$.
Total surface area of the remaining solid $= 6a^2 - \pi r^2 + 2\pi r^2$, because we lose a circle of area πr^2 from the top face and gain the curved surface $2\pi r^2$ of the hollow.

Step 2: Part (i): Volume of the wood left $a = 21$ cm and $r = \frac{21}{2}$ cm. Use $\pi = \frac{22}{7}$.

$$V = 21^3 - \frac{2}{3} \times \frac{22}{7} \times \left(\frac{21}{2}\right)^3$$

$21^3 = 9261$. For the hemisphere: $\frac{2}{3} \times \frac{22}{7} \times \frac{21 \times 21 \times 21}{2 \times 2 \times 2} = \frac{2 \times 22 \times 9261}{3 \times 7 \times 8} = 2425.5$.

$$V = 9261 - 2425.5 = 6835.5 \text{ cm}^3$$

Step 3: Part (ii): Total surface area of the remaining solid

$$\text{TSA} = 6a^2 - \pi r^2 + 2\pi r^2 = 6a^2 + \pi r^2$$

$$= 6(21)^2 + \frac{22}{7} \times \left(\frac{21}{2}\right)^2 = 2646 + \frac{22}{7} \times \frac{441}{4}$$

$$= 2646 + 346.5 = 2992.5 \text{ cm}^2$$

Step 4: Conclusion (i) The volume of wood left is 6835.5 cm^3. (ii) The total surface area is 2992.5 cm^2.

Quick Tip to Solve: The radius of the largest hemisphere is half the side of the cube. Remember that the circular top is lost and the curved surface is added.

35(A). To assist an ambulance, a drone is hovering over an accident site at a constant height on a highway. The angle of depression of the ambulance, approaching the accident site, observed from drone is $30°$. Twelve minutes later, the angle of depression of the ambulance is found to be $60°$. If the ambulance is moving at a constant speed then, find the total time taken by the ambulance to reach the site of accident. [5 marks]

Solution:

Concept:

- The angle of depression from the drone equals the angle of elevation of the drone from the ambulance (alternate angles). Let the drone be at A, directly above the accident site B, at height $AB = h$ metres. The ambulance is at D when the angle is $30°$, and 12 minutes later it is at C when the angle is $60°$. B, C and D lie on the highway with C between B and D.
- Let the speed of the ambulance be x m/min. In 12 minutes it covers $CD = 12x$ metres.

Step 1: Triangle ABC In right $\triangle ABC$, $\angle ACB = 60°$.

$$\tan 60° = \frac{AB}{BC} \implies \sqrt{3} = \frac{h}{BC} \implies BC = \frac{h}{\sqrt{3}}$$

Step 2: Triangle ABD In right $\triangle ABD$, $\angle ADB = 30^\circ$.

$$\tan 30^\circ = \frac{AB}{BD} \implies \frac{1}{\sqrt{3}} = \frac{h}{BD} \implies BD = h\sqrt{3}$$

Step 3: Use BD = BC + CD

$$h\sqrt{3} = \frac{h}{\sqrt{3}} + 12x$$

$$h\sqrt{3} - \frac{h}{\sqrt{3}} = 12x \implies \frac{3h - h}{\sqrt{3}} = 12x \implies \frac{2h}{\sqrt{3}} = 12x \implies h = 6\sqrt{3}\,x$$

Step 4: Find BC

$$BC = \frac{h}{\sqrt{3}} = \frac{6\sqrt{3}\,x}{\sqrt{3}} = 6x \text{ metres}$$

Step 5: Time from C to B Time $= \dfrac{\text{distance}}{\text{speed}} = \dfrac{6x}{x} = 6$ minutes.

Step 6: Total time Total time taken from D to the site B = time from D to C + time from C to B = $12 + 6 = 18$ minutes.

Step 7: Conclusion The ambulance takes 18 minutes in all to reach the accident site.

Quick Tip to Solve: Draw the figure with the drone at A above B. Find BC and BD in terms of the height, then use $CD = BD - BC$ and constant speed.

OR

35(B). A statue standing on a pedestal, is 1.6 m tall. From a point on the ground, the angles of elevation of the top and bottom of the statue are 60° and 45° respectively. Find the height of the pedestal. [5 marks]

Solution:

Concept:

- Let BC be the pedestal and CD the statue, so D is the top of the statue, C is its bottom (the top of the pedestal), and B is the foot of the pedestal on the ground. Let A be the point on the ground from which the angles are measured. The angle of elevation of C is 45° and of D is 60°.
- Let the height of the pedestal be $BC = h$ m, so $CD = 1.6$ m and $BD = h + 1.6$ m.

Step 1: Triangle ABC (bottom of the statue) In right $\triangle ABC$, $\angle BAC = 45^\circ$.

$$\tan 45^\circ = \frac{BC}{AB} \implies 1 = \frac{h}{AB} \implies AB = h \quad \cdots (i)$$

Step 2: Triangle ABD (top of the statue) In right $\triangle ABD$, $\angle BAD = 60^\circ$.

$$\tan 60^\circ = \frac{BD}{AB} \implies \sqrt{3} = \frac{h + 1.6}{AB} \implies AB = \frac{h + 1.6}{\sqrt{3}} \quad \cdots (ii)$$

Step 3: Equate (i) and (ii)

$$h = \frac{h + 1.6}{\sqrt{3}} \implies \sqrt{3}\,h = h + 1.6 \implies (\sqrt{3} - 1)h = 1.6$$

Step 4: Solve for h

$$h = \frac{1.6}{\sqrt{3}-1}$$

Multiply the top and bottom by $\sqrt{3}+1$:

$$h = \frac{1.6(\sqrt{3}+1)}{(\sqrt{3})^2 - 1^2} = \frac{1.6(\sqrt{3}+1)}{2} = 0.8(\sqrt{3}+1)$$

Using $\sqrt{3} = 1.732$, $h = 0.8 \times 2.732 = 2.19$ m (approx.).

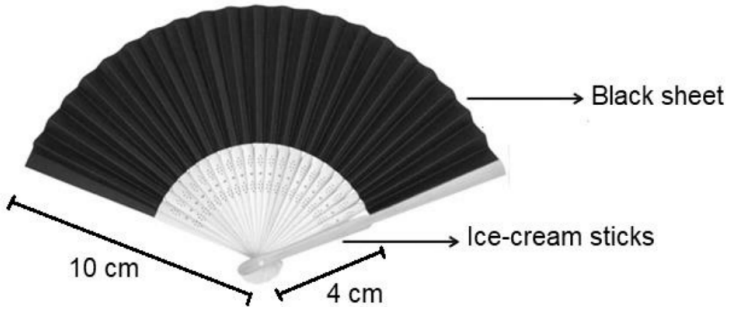
Step 5: Conclusion The height of the pedestal is $0.8(\sqrt{3}+1)$ m, which is about 2.19 m.

Quick Tip to Solve: Let the pedestal be h m. From $\tan 45°$, the distance of the observer from the foot is h. Then use $\tan 60°$ for the top of the statue.

Section E (12 marks)

This section comprises of 3 case-study/passage-based questions of 4 marks each with sub parts. The first two case study questions have three sub parts (i), (ii), (iii) of marks 1, 1, 2 respectively.

36(i). An Art and craft teacher prepared a fan which looked like the sector of a circle



using ice-cream sticks and black sheet as shown in the given figure:
The angle subtended at the centre of the sector is $60°$. Find the area of one face of the fan. [1 mark]

Solution:

Concept:

- The fan is a sector of a circle. The whole fan, from the centre to the outer edge, is 10 cm long. So the radius is $R = 10$ cm.
- The angle at the centre is $\theta = 60°$. One face of the fan means the full sector, black sheet and ice-cream sticks together.

Step 1: Write the formula Area of a sector of angle θ and radius R is

$$A = \frac{\theta}{360°} \times \pi R^2$$

Step 2: Put in the values Take $\pi = \frac{22}{7}$. Then

$$A = \frac{60}{360} \times \frac{22}{7} \times 10^2 = \frac{1}{6} \times \frac{22}{7} \times 100$$

$$A = \frac{2200}{42} = \frac{1100}{21}$$

Dividing, $\frac{1100}{21} = 52.38$ (rounded to two decimal places).

Step 3: Conclusion The area of one face of the fan is about 52.38 square cm.

Quick Tip to Solve: One face of the fan is a full sector of radius 10 cm. Use $\frac{\theta}{360} \times \pi R^2$.

36(ii). With the given sector angle of $60°$ at the centre, find area of black sheet used in the fan. [1 mark]

Solution:

Concept:

- The ice-cream sticks form the inner sector of radius $r = 4$ cm. The black sheet covers the part beyond it, up to $R = 10$ cm.
- So the black sheet is the outer sector minus the inner sector. Both have the same angle $60°$.

Step 1: Write the formula

$$\text{Area of black sheet} = \frac{\theta}{360} \times \pi\left(R^2 - r^2\right)$$

Step 2: Put in the values

$$= \frac{60}{360} \times \frac{22}{7} \times \left(10^2 - 4^2\right)$$

$$= \frac{1}{6} \times \frac{22}{7} \times (100 - 16) = \frac{1}{6} \times \frac{22}{7} \times 84$$

Now $\frac{84}{7} = 12$, so $\frac{22 \times 12}{6} = 22 \times 2 = 44$.

Step 3: Conclusion The black sheet used in the fan has an area of 44 square cm.

Quick Tip to Solve: Black sheet area is the big sector (radius 10 cm) minus the small sector (radius 4 cm), same angle.

36(iii)(A). The boundary of the black sheet region on one face is to be covered by a designer tape. What length of tape is required? [2 marks]

Solution:

Step 1: List the parts of the boundary The black sheet region on one face is a piece of a ring. Its boundary has four parts:
1. The outer arc of radius 10 cm.
2. The inner arc of radius 4 cm.
3 and 4. Two straight edges along the radii. Each one runs from radius 4 cm to radius 10 cm, so each is $10 - 4 = 6$ cm long.

Step 2: Write the formula Arc length of a sector is $\frac{\theta}{360} \times 2\pi \times$ radius. The tape length is

$$L = 2(10 - 4) + \frac{60}{360} \times 2 \times \frac{22}{7} \times (10 + 4)$$

We added the two radii, $10+4$, because both arcs use the same fraction $\frac{60}{360}$ of $2\pi\times$ radius.

Step 3: Calculate Straight edges: $2\times 6=12$ cm.
Arcs: $\frac{1}{6}\times 2\times\frac{22}{7}\times 14=\frac{1}{6}\times 88=\frac{44}{3}$ cm.

$$L=12+\frac{44}{3}=\frac{36+44}{3}=\frac{80}{3}\text{ cm}$$

This is about 26.67 cm.

Step 4: Conclusion The length of designer tape needed is $\frac{80}{3}$ cm, about 26.67 cm.

Quick Tip to Solve: Add the outer arc, the inner arc and the two straight edges of length $10-4$ cm.

OR

36(iii)(B). If 29.6 cm of designer tape is required to cover the boundary of the black sheet region on one face of the fan, then evaluate the central angle of the sector. [2 marks]

Solution:

Step 1: Write the tape length in terms of the angle As in the earlier part, the boundary of the black sheet has two straight edges of 6 cm each and two arcs. For an unknown angle θ,

$$L=2(10-4)+\frac{\theta}{360}\times 2\times\frac{22}{7}\times(10+4)$$

We are given $L=29.6$ cm.

Step 2: Form the equation

$$12+\frac{\theta}{360}\times 2\times\frac{22}{7}\times 14=29.6$$

Since $2\times\frac{22}{7}\times 14=88$, this becomes

$$12+\frac{\theta}{360}\times 88=29.6$$

Step 3: Solve for the angle Move 12 to the right side: $\frac{\theta}{360}\times 88=29.6-12=17.6$.

$$\theta=\frac{17.6\times 360}{88}$$

Now $\frac{17.6}{88}=0.2$, so $\theta=0.2\times 360=72$.

Step 4: Conclusion The central angle of the sector is 72°.

Quick Tip to Solve: Tape length $=2(10-4)+\frac{\theta}{360}\times 2\pi(10+4)$. Put this equal to 29.6 and solve for θ.

37(i). Delhi's pollution is a severe, often seasonal issue caused by a combination of factors like high vehicular and industrial emissions, dust from construction, and crop burning in surrounding states. In a school, students of classes I to XII thought of planting trees in and around the school to reduce air pollution.



It was decided that the number of trees that each section of each class will plant be three more than the double of the class in which they are studying, e.g., a section of class IV will plant 11 trees. If in the given school, there are two sections of each class, then answer the following questions:

If number of trees planted by students class-wise follow arithmetic progression, then find the common difference. [1 mark]

Solution:

Step 1: Find the trees planted by each class A section of class n plants $2n + 3$ trees. There are two sections in each class, so class n plants $2(2n + 3)$ trees.
Class I: $2(2 \times 1 + 3) = 2 \times 5 = 10$.
Class II: $2(2 \times 2 + 3) = 2 \times 7 = 14$.
Class III: $2(2 \times 3 + 3) = 2 \times 9 = 18$.

Step 2: Check that the list is an AP The numbers are $10, 14, 18, 22, \ldots$ A list is an arithmetic progression when the gap between neighbours stays the same.
$14 - 10 = 4$ and $18 - 14 = 4$. The gap is the same, so it is an AP.

Step 3: Common difference

$$d = 14 - 10 = 4$$

Step 4: Conclusion The trees planted class by class form an AP with common difference 4.

Quick Tip to Solve: Each class has two sections, so class n plants $2(2n + 3)$ trees. Write the first few terms and subtract.

37(ii). What is the number of trees planted by students of class VI? [1 mark]

Solution:

Step 1: Use the rule for one class Class n plants $2(2n + 3)$ trees because there are two sections and each section plants $2n + 3$ trees.
For class VI, $n = 6$.

Step 2: Substitute

$$2(2 \times 6 + 3) = 2(12 + 3) = 2 \times 15 = 30$$

Step 3: Conclusion Class VI plants 30 trees.

Quick Tip to Solve: Class n plants $2(2n + 3)$ trees. Put $n = 6$.

37(iii)(A). What is the total number of trees planted by the students of given school? [2 marks]

Solution:

Step 1: Set up the AP The trees planted by class I, II, III, and so on up to class XII form an AP: $10, 14, 18, \ldots$
First term $a = 10$, common difference $d = 4$, and the number of terms $n = 12$ (classes I to XII).

Step 2: Write the formula for the sum The sum of the first n terms of an AP is

$$S_n = \frac{n}{2}\left[2a + (n-1)d\right]$$

Step 3: Put in the values

$$S_{12} = \frac{12}{2}\left[2(10) + (12-1) \times 4\right]$$

$$S_{12} = 6\left[20 + 44\right] = 6 \times 64$$

$$S_{12} = 384$$

Step 4: Conclusion The students of the school plant 384 trees in all.

Quick Tip to Solve: The school has classes I to XII, so add the first 12 terms of the AP $10, 14, 18, \ldots$

OR

37(iii)(B). Identify the class that planted 34 trees. [2 marks]

Solution:

Step 1: Write the number of trees for class n Let the class that plants 34 trees be class n. Class n plants $2(2n + 3)$ trees, because there are two sections and each plants $2n + 3$ trees.

Step 2: Form the equation

$$2(2n + 3) = 34$$

Step 3: Solve Divide both sides by 2: $2n + 3 = 17$.
Subtract 3: $2n = 14$.

$$n = 7$$

Check: $2(2 \times 7 + 3) = 2 \times 17 = 34$, which matches.

Step 4: Conclusion Class VII planted 34 trees.

Quick Tip to Solve: Class n plants $2(2n + 3)$ trees. Put this equal to 34.

38(i). **A labourer prints 400 T-shirts in a day. The supervisor checked the T-shirts and found that 312 prints were good, 54 prints were with minor defects and rest of the prints were of major defects.**



Harish, a customer will buy a T-shirt only if it is good but a trader will buy, if it has no major defect. If a random T-shirt is picked, then

Find the probability that Harish will buy a T-shirt. [1 mark]

Solution:

Step 1: Count the outcomes Total T-shirts $= 400$. Good T-shirts $= 312$, minor defects $= 54$, major defects $= 400 - 312 - 54 = 34$.
One T-shirt is picked at random, so every T-shirt is equally likely.

Step 2: Find when Harish buys Harish buys a T-shirt only if it is good. So the favourable outcomes are the 312 good T-shirts.

Step 3: Use the probability formula

$$P = \frac{\text{favourable outcomes}}{\text{total outcomes}} = \frac{312}{400}$$

Divide the top and bottom by 8: $\frac{312 \div 8}{400 \div 8} = \frac{39}{50}$.

Step 4: Conclusion The probability that Harish buys the T-shirt is $\frac{39}{50}$.

Quick Tip to Solve: Harish buys only a good T-shirt. Divide the number of good T-shirts by 400.

38(ii). **Find the probability that a trader will buy the T-shirt.** [1 mark]

Solution:

Step 1: Find when the trader buys The trader buys a T-shirt if it has no major defect. A T-shirt with no major defect is either good or has only a minor defect.
So the favourable outcomes are $312 + 54 = 366$.

Step 2: Use the probability formula

$$P = \frac{366}{400}$$

Divide the top and bottom by 2: $\frac{366}{400} = \frac{183}{200}$.

Step 3: Conclusion The probability that the trader buys the T-shirt is $\frac{183}{200}$.

Quick Tip to Solve: The trader buys any T-shirt without a major defect, so count good plus minor-defect T-shirts.

38(iii)(A). Find the probability that the T-shirt is not good. [2 marks]

Solution:

Concept:

- A T-shirt is not good when it has a minor defect or a major defect.
- Number of T-shirts with a major defect $= 400 - 312 - 54 = 34$. So the T-shirts that are not good number $54 + 34 = 88$.

Step 1: Use the complement rule For any event E, $P(\text{not } E) = 1 - P(E)$. Here E is that the T-shirt is good, and $P(E) = \frac{312}{400}$.

Step 2: Calculate

$$P(\text{not good}) = 1 - \frac{312}{400} = \frac{400 - 312}{400} = \frac{88}{400}$$

Divide the top and bottom by 8: $\frac{88}{400} = \frac{11}{50}$.

Check with direct counting: $\frac{54 + 34}{400} = \frac{88}{400}$, the same value.

Step 3: Conclusion The probability that the T-shirt is not good is $\frac{11}{50}$.

Quick Tip to Solve: Use $P(\text{not good}) = 1 - P(\text{good})$.

OR

38(iii)(B). Find the probability that neither Harish nor trader buy the T-shirt. [2 marks]

Solution:

Step 1: Find who buys which T-shirt Harish buys only good T-shirts. The trader buys good T-shirts and those with a minor defect. So every T-shirt that Harish buys is also acceptable to the trader. Together, Harish or the trader will buy the 312 good T-shirts and the 54 minor-defect T-shirts, which is 366 T-shirts.

Step 2: Find the T-shirts that neither will buy Neither of them buys the T-shirts that remain, the ones with a major defect.

$$400 - 54 - 312 = 34$$

Step 3: Use the probability formula

$$P = \frac{34}{400} = \frac{17}{200}$$

We divided the top and bottom by 2.

Step 4: Conclusion The probability that neither Harish nor the trader buys the T-shirt is $\frac{17}{200}$.

Quick Tip to Solve: Neither buys a T-shirt that has a major defect. Count those and divide by 400.