

Mathematics (Standard) 2025, Set 30/3/1

Q.P. Code 30/3/1 · Series EF3GH · 80 marks · 3 hours · March 2025. Questions are from the official CBSE paper. Step-by-step solutions are written by CogniGuru and checked against CBSE's published answer key. Where the key itself disagrees with the arithmetic, the solution says so.

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Section A: Multiple choice

20 questions, 1 mark each. MCQs (Q1 to Q18) and assertion-reason (Q19, Q20).

Q1 · TRIGONOMETRY · 1 MARK

If $\tan 3\theta = \sqrt{3}$, then $\frac{\theta}{2}$ equals:

- (A) 60° (B) 30°
(C) 20° (D) 10°

SOLUTION

$\tan 60^\circ = \sqrt{3}$, so $3\theta = 60^\circ$ and $\theta = 20^\circ$.

The question asks for $\frac{\theta}{2} = \frac{20^\circ}{2} = 10^\circ$.

Answer: (D) 10°

Common mistake: Stopping at $\theta = 20^\circ$. Read what is asked: $\frac{\theta}{2}$.

Q2 · REAL NUMBERS · 1 MARK

If x is the LCM of 4, 6, 8 and y is the LCM of 3, 5, 7 and p is the LCM of x and y , then which of the following is true?

- (A) $p = 35x$ (B) $p = 4y$
(C) $p = 8x$ (D) $p = 16y$

SOLUTION

$4 = 2^2$, $6 = 2 \times 3$, $8 = 2^3$, so $x = \text{LCM} = 2^3 \times 3 = 24$.

3, 5, 7 are primes, so $y = 3 \times 5 \times 7 = 105$.

$p = \text{LCM}(24, 105)$. $24 = 2^3 \times 3$ and $105 = 3 \times 5 \times 7$, so $p = 2^3 \times 3 \times 5 \times 7 = 840$.

$\frac{840}{24} = 35$, so $p = 35x$.

Answer: (A) $p = 35x$

Q3 · LINEAR EQUATIONS · 1 MARK

The value of k for which the system of linear equations $6x + y = 3k$ and $36x + 6y = 3$ have infinitely many solutions is:

- (A) 6 (B) $\frac{1}{6}$
(C) $\frac{1}{2}$ (D) $\frac{1}{3}$

SOLUTION

Infinitely many solutions need $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$.

$$\frac{6}{36} = \frac{1}{6} = \frac{3k}{3}, \text{ so } k = \frac{1}{6}.$$

Answer: (B) $\frac{1}{6}$

Q4 · POLYNOMIALS · 1 MARK

If α and β are the zeroes of the polynomial $p(x) = x^2 - ax - b$, then the value of $(\alpha + \beta + \alpha\beta)$ is equal to:

(A) $a + b$

(B) $-a - b$

(C) $a - b$

(D) $-a + b$

SOLUTION

For $x^2 - ax - b$: sum of zeroes $\alpha + \beta = -\frac{-a}{1} = a$.

Product of zeroes $\alpha\beta = \frac{-b}{1} = -b$.

$$\alpha + \beta + \alpha\beta = a + (-b) = a - b.$$

Answer: (C) $a - b$

Common mistake: Using $\alpha\beta = b$. The constant term is $-b$, so the product is $-b$.

Q5 · QUADRATIC EQUATIONS · 1 MARK

If $\frac{x}{12} - \frac{3}{x} = 0$, then the values of x are:

(A) ± 6

(B) ± 4

(C) ± 12

(D) ± 3

SOLUTION

$$\frac{x}{12} = \frac{3}{x}. \text{ Cross-multiply: } x^2 = 36.$$

So $x = \pm 6$.

Answer: (A) ± 6

Q6 · COORDINATE GEOMETRY · 1 MARK

The line represented by $\frac{x}{4} + \frac{y}{6} = 1$ intersects the x -axis and y -axis respectively at P and Q . The coordinates of the mid-point of line segment PQ are:

(A) $(2, 3)$

(B) $(3, 2)$

(C) $(2, 0)$

(D) $(0, 3)$

SOLUTION

On the x -axis $y = 0$: $\frac{x}{4} = 1$, so $P = (4, 0)$. On the y -axis $x = 0$: $\frac{y}{6} = 1$, so $Q = (0, 6)$.

$$\text{Mid-point of } PQ = \left(\frac{4+0}{2}, \frac{0+6}{2} \right) = (2, 3).$$

Answer: (A) $(2, 3)$

Q7 · COORDINATE GEOMETRY · 1 MARK

Two of the vertices of $\triangle PQR$ are $P(-1, 5)$ and $Q(5, 2)$. The coordinates of a point which divides PQ in the ratio 2 : 1 are:

- (A) $(3, -3)$ (B) $(5, 5)$
(C) $(3, 3)$ (D) $(5, 1)$

SOLUTION

Section formula with $m : n = 2 : 1$: $x = \frac{2 \times 5 + 1 \times (-1)}{2 + 1} = \frac{9}{3} = 3$.

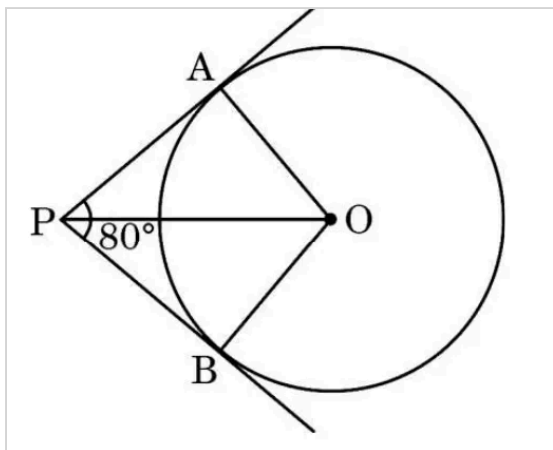
$y = \frac{2 \times 2 + 1 \times 5}{3} = \frac{9}{3} = 3$. The point is $(3, 3)$.

Answer: (C) $(3, 3)$

Common mistake: Swapping the ratio. For 2 : 1 from P , the weight 2 goes with the coordinates of Q .

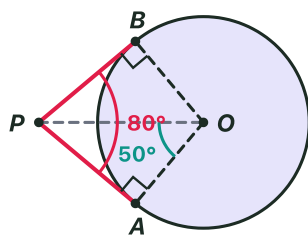
Q8 · CIRCLES · 1 MARK

If tangents PA and PB drawn from an external point P to the circle with centre O are inclined to each other at an angle of 80° as shown in the given figure, then the measure of $\angle POA$ is:



- (A) 40° (B) 50°
(C) 60° (D) 80°

SOLUTION



OP bisects $\angle P$: $\angle OPA = 40^\circ$, so $\angle POA = 90^\circ - 40^\circ = 50^\circ$

$\angle APB = 80^\circ$. The line PO bisects it, so $\angle OPA = 40^\circ$.

$OA \perp PA$ (radius to the point of contact), so $\angle OAP = 90^\circ$.

In $\triangle OAP$: $\angle POA = 180^\circ - 90^\circ - 40^\circ = 50^\circ$.

Answer: (B) 50°

Common mistake: Answering 40° , the angle at P . The question asks for the angle at the centre.

Q9 · TRIGONOMETRY · 1 MARK

$(\cot \theta + \tan \theta)$ equals:

(A) $\operatorname{cosec} \theta \sec \theta$

(B) $\sin \theta \sec \theta$

(C) $\cos \theta \tan \theta$

(D) $\sin \theta \cos \theta$

SOLUTION

$$\begin{aligned}\cot \theta + \tan \theta &= \frac{\cos \theta}{\sin \theta} + \frac{\sin \theta}{\cos \theta} = \frac{\cos^2 \theta + \sin^2 \theta}{\sin \theta \cos \theta} \\ &= \frac{1}{\sin \theta \cos \theta} = \frac{1}{\sin \theta} \cdot \frac{1}{\cos \theta} = \operatorname{cosec} \theta \sec \theta.\end{aligned}$$

Answer: (A) $\operatorname{cosec} \theta \sec \theta$

Q10 · TRIANGLES · 1 MARK

If in two triangles DEF and PQR , $\angle D = \angle Q$ and $\angle R = \angle E$, then which of the following is not true?

(A) $\frac{DE}{QR} = \frac{DF}{PQ}$

(B) $\frac{EF}{PR} = \frac{DF}{PQ}$

(C) $\frac{EF}{RP} = \frac{DE}{QR}$

(D) $\frac{DE}{PQ} = \frac{EF}{RP}$

SOLUTION

Match the equal angles: $D \leftrightarrow Q$ and $E \leftrightarrow R$, so $F \leftrightarrow P$. By AA, $\triangle DEF \sim \triangle QRP$.

Corresponding sides are in proportion: $\frac{DE}{QR} = \frac{EF}{RP} = \frac{DF}{QP}$.

Options (A), (B) and (C) are all taken from these equal ratios, so they are true.

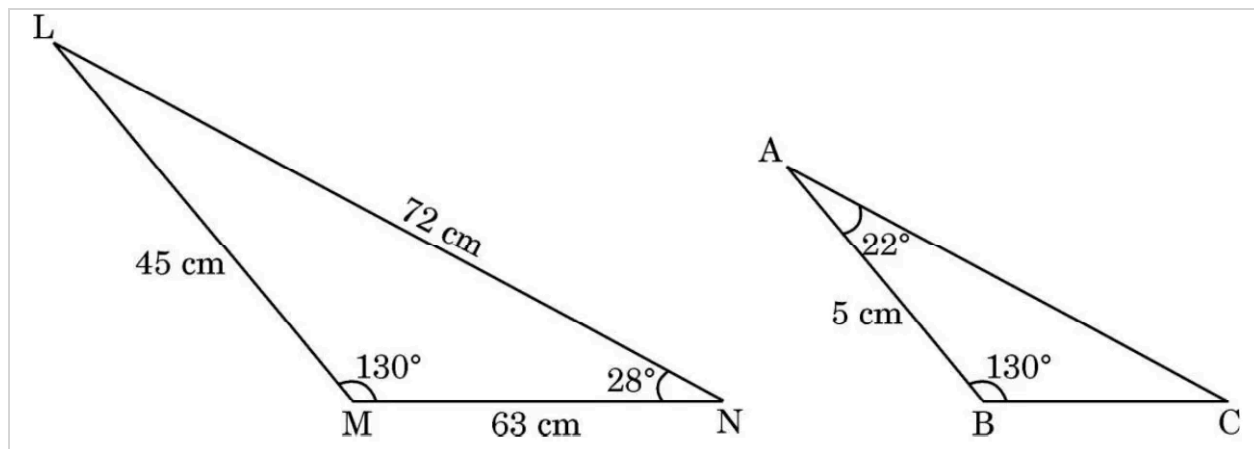
In (D), DE is paired with PQ , but DE corresponds to QR . So (D) is not true.

Answer: (D) $\frac{DE}{PQ} = \frac{EF}{RP}$

Common mistake: Pairing sides in the order the letters are written. Match the vertices by the equal angles first.

Q11 · TRIANGLES · 1 MARK

The measurements of $\triangle LMN$ and $\triangle ABC$ are shown in the figure given below. The length of side AC is:



- (A) 16 cm (B) 7 cm
(C) 8 cm (D) 4 cm

SOLUTION

In $\triangle LMN$: $\angle L = 180^\circ - 130^\circ - 28^\circ = 22^\circ$.

In $\triangle ABC$: $\angle A = 22^\circ$ and $\angle B = 130^\circ$, so $\angle C = 28^\circ$.

So $\triangle LMN \sim \triangle ABC$ by AA with $L \leftrightarrow A$, $M \leftrightarrow B$, $N \leftrightarrow C$.

$\frac{LM}{AB} = \frac{LN}{AC}$: $\frac{45}{5} = \frac{72}{AC}$, so $9 = \frac{72}{AC}$ and $AC = 8$ cm.

Answer: (C) 8 cm

Common mistake: Matching LN with BC . AC is opposite $\angle B = 130^\circ$, so it matches LN , which is opposite $\angle M = 130^\circ$.

Q12 · SURFACE AREAS AND VOLUMES · 1 MARK

If the volumes of two cubes are in the ratio 8 : 125, then the ratio of their surface areas is:

- (A) 8 : 125 (B) 4 : 25
(C) 2 : 5 (D) 16 : 25

SOLUTION

Volume of a cube = a^3 , so $\frac{a_1^3}{a_2^3} = \frac{8}{125}$ and $\frac{a_1}{a_2} = \frac{2}{5}$.

Surface area = $6a^2$, so the ratio of surface areas = $\left(\frac{2}{5}\right)^2 = \frac{4}{25}$.

Answer: (B) 4 : 25

Common mistake: Squaring the volume ratio. First take the cube root to get the ratio of sides.

Q13 · AREAS RELATED TO CIRCLES · 1 MARK

If the area of a sector of circle of radius 36 cm is 54π cm², then the length of the corresponding arc of the sector is:

- (A) 8π cm (B) 6π cm
(C) 4π cm (D) 3π cm

SOLUTION

Area of a sector = $\frac{1}{2} \times \text{arc length} \times r$.

$$54\pi = \frac{1}{2} \times l \times 36 = 18l, \text{ so } l = \frac{54\pi}{18} = 3\pi \text{ cm.}$$

Answer: (D) 3π cm

Q14 · PROBABILITY · 1 MARK

A die is thrown once. The probability of getting a number which is not a factor of 36, is:

(A) $\frac{1}{2}$
(C) $\frac{1}{6}$

(B) $\frac{2}{3}$
(D) $\frac{5}{6}$

SOLUTION

Factors of 36 are 1, 2, 3, 4, 6, 9, 12, 18, 36. Of the numbers 1 to 6 on a die, 1, 2, 3, 4, 6 are factors.

The only number that is not a factor is 5, so there is 1 favourable outcome out of 6.

$$P = \frac{1}{6}.$$

Answer: (C) $\frac{1}{6}$

Q15 · STATISTICS · 1 MARK

If the mean of 2, 9, $x + 6$, $2x + 3$, 5, 10, 5 is 7, then the value of x is:

(A) 9
(C) 5

(B) 6
(D) 3

SOLUTION

There are 7 numbers and the mean is 7, so their sum is $7 \times 7 = 49$.

$$\text{Sum} = 2 + 9 + (x + 6) + (2x + 3) + 5 + 10 + 5 = 40 + 3x.$$

$$40 + 3x = 49, \text{ so } 3x = 9 \text{ and } x = 3.$$

Answer: (D) 3

Q16 · COORDINATE GEOMETRY · 1 MARK

$AOBC$ is a rectangle whose three vertices are $A(0, 2)$, $O(0, 0)$ and $B(4, 0)$. The square of the length of its diagonal is equal to:

(A) 36
(C) 16

(B) 20
(D) 4

SOLUTION



The diagonal AB: $4^2 + 2^2 = 20$.

In rectangle $AOBC$ the diagonals are AB and OC , and they are equal. Use AB , since both A and B are given.

$$AB^2 = (4 - 0)^2 + (0 - 2)^2 = 16 + 4 = 20.$$

Answer: (B) 20

Common mistake: Giving the side length (4 or 2). The question asks for the square of the diagonal.

Q17 · POLYNOMIALS · 1 MARK

Zeros of the polynomial $p(x) = x^2 - 3\sqrt{2}x + 4$ are:

(A) $2, \sqrt{2}$

(B) $2\sqrt{2}, \sqrt{2}$

(C) $4\sqrt{2}, -\sqrt{2}$

(D) $\sqrt{2}, 2$

SOLUTION

Split the middle term: $x^2 - 2\sqrt{2}x - \sqrt{2}x + 4$, because $2\sqrt{2} \times \sqrt{2} = 4$ and $2\sqrt{2} + \sqrt{2} = 3\sqrt{2}$.

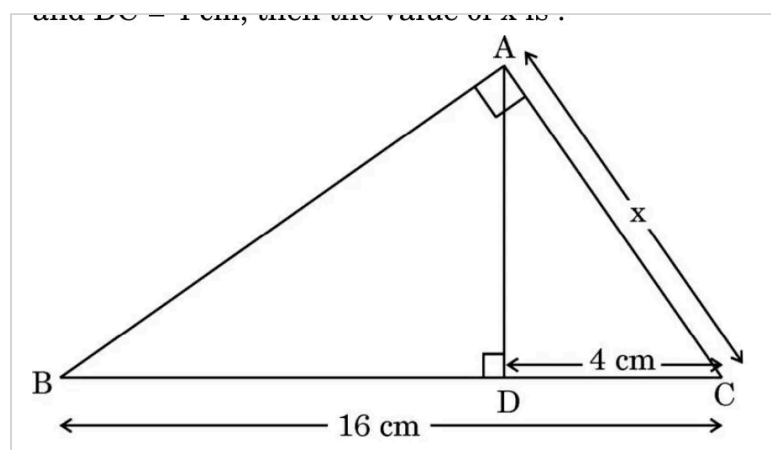
$$= x(x - 2\sqrt{2}) - \sqrt{2}(x - 2\sqrt{2}) = (x - 2\sqrt{2})(x - \sqrt{2}).$$

The zeroes are $2\sqrt{2}$ and $\sqrt{2}$. Check: sum = $3\sqrt{2}$ ✓ and product = 4 ✓.

Answer: (B) $2\sqrt{2}, \sqrt{2}$

Q18 · TRIANGLES · 1 MARK

In the given figure, in $\triangle ABC$, $AD \perp BC$ and $\angle BAC = 90^\circ$. If $BC = 16$ cm and $DC = 4$ cm, then the value of x is:



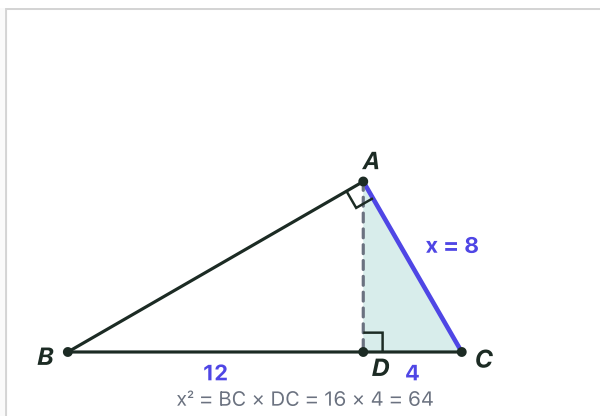
(A) 4 cm

(B) 5 cm

(C) 8 cm

(D) 3 cm

SOLUTION



In $\triangle ADC$ and $\triangle BAC$: $\angle ADC = \angle BAC = 90^\circ$ and $\angle C$ is common. So $\triangle ADC \sim \triangle BAC$ (AA).

$$\frac{DC}{AC} = \frac{AC}{BC}, \text{ so } AC^2 = BC \times DC = 16 \times 4 = 64.$$

$$x = AC = 8 \text{ cm.}$$

Answer: (C) 8 cm

Q19 · APPLICATIONS OF TRIGONOMETRY · 1 MARK

Assertion (A): A ladder leaning against a wall, stands at a horizontal distance of 6 m from the wall. If the height of the wall up to which the ladder reaches is 8 m, then the length of the ladder is 10 m.

Reason (R): The ladder makes an angle of 60° with the ground.

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

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

(C) A is true, but R is false

(D) A is false, but R is true

SOLUTION

(A) Ladder = $\sqrt{6^2 + 8^2} = \sqrt{100} = 10$ m. The assertion is true.

(R) The angle with the ground θ has $\tan \theta = \frac{8}{6} = \frac{4}{3} \neq \sqrt{3} = \tan 60^\circ$. So the angle is not 60° and the reason is false.

Answer: (C) A is true, R is false

Common mistake: Accepting the reason because it sounds plausible. Check it with the given 6 m and 8 m.

Q20 · CIRCLES · 1 MARK

Assertion (A): If two tangents are drawn to a circle from an external point, then they subtend equal angles at the centre of the circle.

Reason (R): A parallelogram circumscribing a circle is a rhombus.

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

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

(C) A is true, but R is false

(D) A is false, but R is true

SOLUTION

(A) From an external point P , $PA = PB$, $OA = OB$ and OP is common, so $\triangle OAP \cong \triangle OBP$ (SSS). So $\angle AOP = \angle BOP$: equal angles at the centre. True.

(R) A parallelogram circumscribing a circle has $AB + CD = AD + BC$, which forces all sides equal, so it is a rhombus. True.

The reason is a separate result about parallelograms. It does not explain the assertion, so R is not the explanation of A.

Answer: (B) Both true, but R is not the correct explanation of A

Section B: Very short answer

5 questions, 2 marks each.

Q21 · TRIGONOMETRY · 2 MARKS

If $4k = \tan^2 60^\circ - 2 \operatorname{cosec}^2 30^\circ - 2 \tan^2 30^\circ$, then find the value of k .

SOLUTION

$\tan 60^\circ = \sqrt{3}$, so $\tan^2 60^\circ = 3$. $\operatorname{cosec} 30^\circ = 2$, so $\operatorname{cosec}^2 30^\circ = 4$. $\tan 30^\circ = \frac{1}{\sqrt{3}}$, so $\tan^2 30^\circ = \frac{1}{3}$.

$$4k = 3 - 2 \times 4 - 2 \times \frac{1}{3} = 3 - 8 - \frac{2}{3} = -5 - \frac{2}{3} = -\frac{17}{3}.$$

$$k = -\frac{17}{12}.$$

Answer: $k = -\frac{17}{12}$

Common mistake: Forgetting the squares: the question has $\operatorname{cosec}^2 30^\circ$ and $\tan^2 30^\circ$, not $\operatorname{cosec} 30^\circ$ and $\tan 30^\circ$.

Q22 · PROBABILITY · 2 MARKS

The probability of guessing the correct answer of a certain test question is $\frac{x}{12}$. If the probability of not guessing the correct answer is $\frac{5}{6}$, then find the value of x .

SOLUTION

$$P(E) + P(\text{not } E) = 1.$$

$$\frac{x}{12} + \frac{5}{6} = 1, \text{ so } \frac{x}{12} = 1 - \frac{5}{6} = \frac{1}{6}.$$

$$x = \frac{12}{6} = 2.$$

Answer: $x = 2$

Q23 · REAL NUMBERS · 2 MARKS

(a) Find the smallest number which is divisible by both 644 and 462.

OR

(b) Two numbers are in the ratio 4 : 5 and their HCF is 11. Find the LCM of these numbers.

SOLUTION

(a) The smallest number divisible by both is their LCM. $644 = 2^2 \times 7 \times 23$ and $462 = 2 \times 3 \times 7 \times 11$.

$$\text{LCM} = 2^2 \times 3 \times 7 \times 11 \times 23 = 12 \times 7 \times 253 = 84 \times 253 = 21252.$$

(b) Let the numbers be $4x$ and $5x$, where x is their HCF, so $x = 11$. The numbers are 44 and 55.

$$\text{LCM} = 4 \times 5 \times 11 = 220 \text{ (check: } 44 \times 55 = 2420 = 11 \times 220 \text{ ✓)}.$$

Answer: (a) 21252 (b) 220

Common mistake: In (b), using $4 \times 5 = 20$ as the LCM. The common factor 11 must be multiplied back.

Q24 · QUADRATIC EQUATIONS · 2 MARKS

(a) Find the value(s) of k so that the quadratic equation $4x^2 + kx + 1 = 0$ has real and equal roots.

OR

(b) If α and β are the zeroes of the polynomial $p(y) = y^2 - 5y + 3$, then find the value of $\alpha^4\beta^3 + \alpha^3\beta^4$.

SOLUTION

(a) Real and equal roots need the discriminant $D = b^2 - 4ac = 0$.

$k^2 - 4 \times 4 \times 1 = 0$, so $k^2 = 16$ and $k = \pm 4$.

(b) For $y^2 - 5y + 3$: $\alpha + \beta = 5$ and $\alpha\beta = 3$.

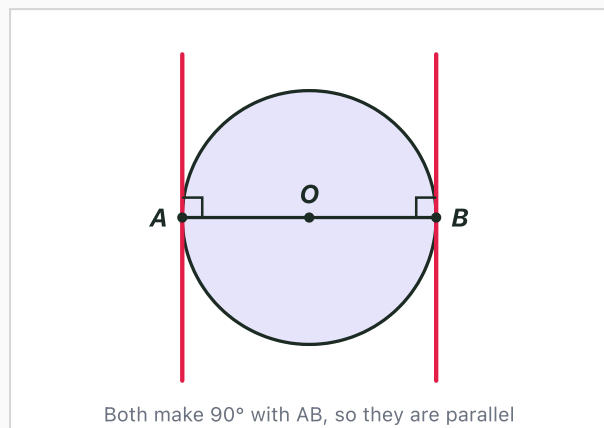
$\alpha^4\beta^3 + \alpha^3\beta^4 = \alpha^3\beta^3(\alpha + \beta) = (\alpha\beta)^3(\alpha + \beta) = 27 \times 5 = 135$.

Answer: (a) $k = \pm 4$ (b) 135

Common mistake: In (a), giving only $k = 4$. Both $k = 4$ and $k = -4$ work.

Q25 · CIRCLES · 2 MARKS

Prove that the tangents drawn at the ends of a diameter of a circle are parallel.

SOLUTION

Let AB be a diameter of a circle with centre O , and let PQ and RS be the tangents at A and B .

A tangent is perpendicular to the radius through the point of contact: $OA \perp PQ$ so $\angle OAP = 90^\circ$, and $OB \perp RS$ so $\angle OBR = 90^\circ$.

OA and OB lie along the same line AB , so AB is a transversal to PQ and RS . Then $\angle BAP = 90^\circ$ and $\angle ABS = 90^\circ$ are alternate angles.

Alternate angles are equal, so $PQ \parallel RS$.

Answer: Proved

Common mistake: Not stating why the angle is 90° : the radius is perpendicular to the tangent at the point of contact.

Section C: Short answer

6 questions, 3 marks each.

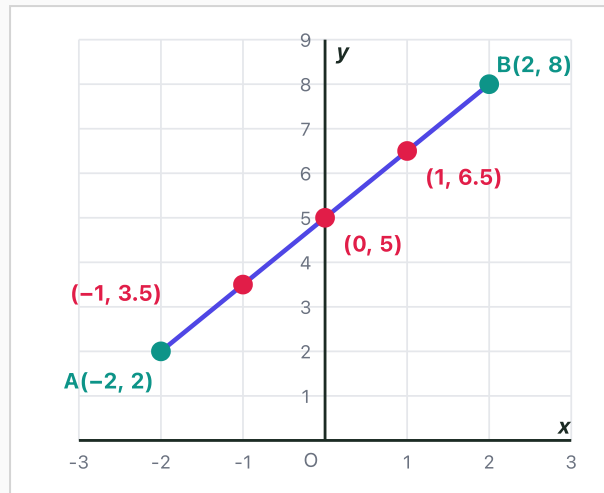
Q26 · COORDINATE GEOMETRY · 3 MARKS

(a) If the mid-point of the line segment joining the points $A(3, 4)$ and $B(k, 6)$ is $P(x, y)$ and $x + y - 10 = 0$, find the value of k .

OR

(b) Find the coordinates of the points which divide the line segment joining $A(-2, 2)$ and $B(2, 8)$ into four equal parts.

SOLUTION



(a) Mid-point $P = \left(\frac{3+k}{2}, \frac{4+6}{2} \right) = \left(\frac{3+k}{2}, 5 \right)$.

Put in $x + y - 10 = 0$: $\frac{3+k}{2} + 5 - 10 = 0$, so $\frac{3+k}{2} = 5$, $3+k = 10$ and $k = 7$.

(b) Let the three points be P_1, P_2, P_3 . P_2 is the mid-point of AB : $\left(\frac{-2+2}{2}, \frac{2+8}{2} \right) = (0, 5)$.

P_1 is the mid-point of A and P_2 : $\left(\frac{-2+0}{2}, \frac{2+5}{2} \right) = (-1, 3.5)$.

P_3 is the mid-point of P_2 and B : $\left(\frac{0+2}{2}, \frac{5+8}{2} \right) = (1, 6.5)$.

Answer: (a) $k = 7$ (b) $(-1, \frac{7}{2}), (0, 5), (1, \frac{13}{2})$

Common mistake: In (b), using the section formula with a wrong ratio. Three points make four equal parts: use mid-points, or ratios $1 : 3, 1 : 1, 3 : 1$.

Q27 · REAL NUMBERS · 3 MARKS

Prove that $\left(5\sqrt{3} + \frac{2}{3} \right)$ is an irrational number given that $\sqrt{3}$ is an irrational number.

SOLUTION

Suppose $5\sqrt{3} + \frac{2}{3}$ is rational, equal to $\frac{p}{q}$ with integers p, q and $q \neq 0$.

Then $5\sqrt{3} = \frac{p}{q} - \frac{2}{3} = \frac{3p-2q}{3q}$, so $\sqrt{3} = \frac{3p-2q}{15q}$.

p and q are integers, so $\frac{3p-2q}{15q}$ is a rational number. That would make $\sqrt{3}$ rational.

But $\sqrt{3}$ is irrational (given). This is a contradiction, so our assumption was wrong. Hence $5\sqrt{3} + \frac{2}{3}$ is irrational.

Answer: Proved by contradiction

Common mistake: Writing the contradiction without saying which given fact it contradicts (that $\sqrt{3}$ is irrational).

Q28 · TRIGONOMETRY · 3 MARKS

(a) Prove that: $\sqrt{\frac{\sec A - 1}{\sec A + 1}} + \sqrt{\frac{\sec A + 1}{\sec A - 1}} = 2 \operatorname{cosec} A$

OR

(b) Prove that: $\left(\frac{1}{\cos A} - \cos A\right) \left(\frac{1}{\sin A} - \sin A\right) = \frac{1}{\tan A + \cot A}$

SOLUTION

(a) Put $s = \sec A$. Over a common root: $\frac{(s-1) + (s+1)}{\sqrt{(s+1)(s-1)}} = \frac{2s}{\sqrt{s^2-1}}$.

$s^2 - 1 = \sec^2 A - 1 = \tan^2 A$, so this is $\frac{2 \sec A}{\tan A} = 2 \times \frac{1}{\cos A} \times \frac{\cos A}{\sin A} = \frac{2}{\sin A} = 2 \operatorname{cosec} A$.

(b) $\frac{1}{\cos A} - \cos A = \frac{1 - \cos^2 A}{\cos A} = \frac{\sin^2 A}{\cos A}$ and $\frac{1}{\sin A} - \sin A = \frac{\cos^2 A}{\sin A}$.

LHS = $\frac{\sin^2 A}{\cos A} \times \frac{\cos^2 A}{\sin A} = \sin A \cos A$.

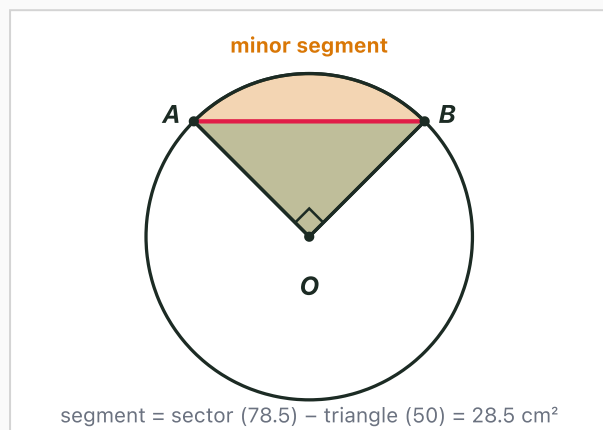
RHS: $\tan A + \cot A = \frac{\sin^2 A + \cos^2 A}{\sin A \cos A} = \frac{1}{\sin A \cos A}$, so $\frac{1}{\tan A + \cot A} = \sin A \cos A$. LHS = RHS.

Answer: Both identities proved

Q29 · AREAS RELATED TO CIRCLES · 3 MARKS

A chord of a circle of radius 10 cm subtends a right angle at the centre of the circle. Find the area of the corresponding minor segment. [Use $\pi = 3.14$]

SOLUTION



Area of minor segment = area of sector – area of the triangle formed by the radii and the chord.

Sector with $\theta = 90^\circ$: $\frac{90}{360} \times 3.14 \times 10 \times 10 = \frac{314}{4} = 78.5 \text{ cm}^2$.

Right triangle OAB with both legs 10 cm: $\frac{1}{2} \times 10 \times 10 = 50 \text{ cm}^2$.

Minor segment = $78.5 - 50 = 28.5 \text{ cm}^2$.

Answer: 28.5 cm²

Common mistake: Giving the sector area (78.5) and forgetting to subtract the triangle.

Q30 · PROBABILITY · 3 MARKS

Three unbiased coins are tossed simultaneously. Find the probability of getting:

- (a) exactly two tails
- (b) at least one head
- (c) at most two heads

SOLUTION

All outcomes: $HHH, HHT, HTH, HTT, THH, THT, TTH, TTT$. That is 8 equally likely outcomes.

(a) Exactly two tails: $HTT, THT, TTH \rightarrow 3$ outcomes. $P = \frac{3}{8}$.

(b) At least one head: every outcome except $TTT \rightarrow 7$ outcomes. $P = \frac{7}{8}$.

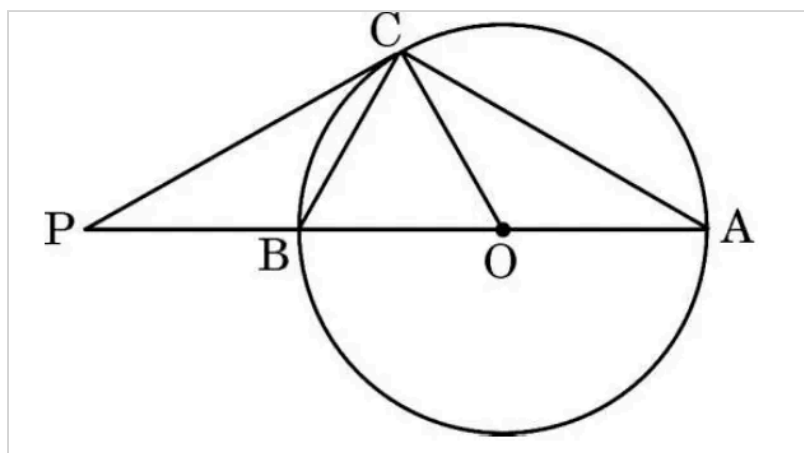
(c) At most two heads: every outcome except $HHH \rightarrow 7$ outcomes. $P = \frac{7}{8}$.

Answer: (a) $\frac{3}{8}$ (b) $\frac{7}{8}$ (c) $\frac{7}{8}$

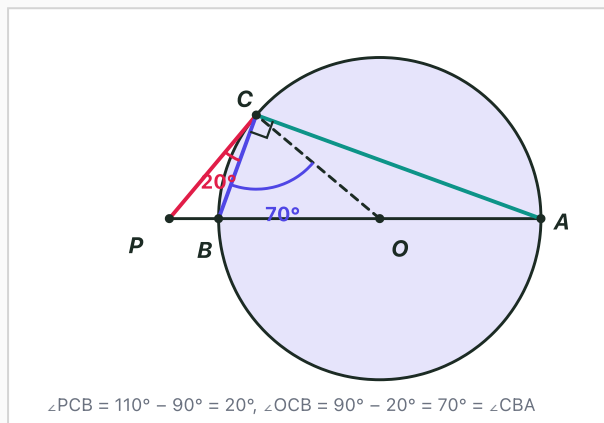
Common mistake: Confusing "at least one" with "exactly one". At least one head means 1, 2 or 3 heads.

Q31 · CIRCLES · 3 MARKS

In the given figure, PC is a tangent to the circle at C . AOB is the diameter which when extended meets the tangent at P . Find $\angle CBA$ and $\angle BCO$, if $\angle PCA = 110^\circ$.



SOLUTION



AB is a diameter, so the angle in a semicircle $\angle ACB = 90^\circ$.

$\angle PCA = \angle PCB + \angle BCA$, so $\angle PCB = 110^\circ - 90^\circ = 20^\circ$.

$OC \perp PC$ (radius to the tangent), so $\angle PCB + \angle BCO = 90^\circ$ and $\angle BCO = 90^\circ - 20^\circ = 70^\circ$.

$OB = OC$ (radii), so $\triangle OBC$ is isosceles and $\angle CBA = \angle OBC = \angle OCB = 70^\circ$.

Answer: $\angle CBA = 70^\circ$ and $\angle BCO = 70^\circ$

Common mistake: Forgetting that B lies between P and O , so $\angle PCA$ is made of two angles: $\angle PCB$ and $\angle BCA = 90^\circ$.

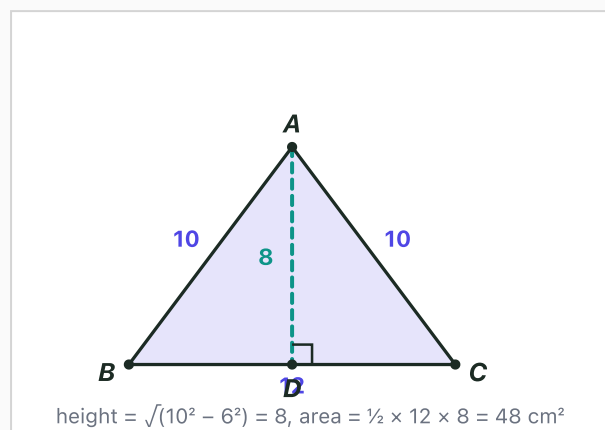
Section D: Long answer

4 questions, 5 marks each.

Q32 · LINEAR EQUATIONS · 5 MARKS

The perimeter of an isosceles triangle is 32 cm. If each equal side is $\frac{5}{6}$ th of the base, find the area of the triangle.

SOLUTION



Let each equal side be x cm and the base y cm. Perimeter: $2x + y = 32$ (i)

Each equal side is $\frac{5}{6}$ of the base: $x = \frac{5}{6}y$ (ii)

Put (ii) in (i): $\frac{5}{3}y + y = 32$, so $\frac{8}{3}y = 32$ and $y = 12$. Then $x = \frac{5}{6} \times 12 = 10$.

The sides are 10 cm, 10 cm and 12 cm. Semi-perimeter $s = \frac{32}{2} = 16$ cm.

Area = $\sqrt{s(s-a)(s-b)(s-c)} = \sqrt{16 \times 6 \times 6 \times 4} = 4 \times 6 \times 2 = 48 \text{ cm}^2$.

Check by height: the height on the base is $\sqrt{10^2 - 6^2} = 8$, so area = $\frac{1}{2} \times 12 \times 8 = 48 \text{ cm}^2 \checkmark$.

Answer: Area = 48 cm^2

Common mistake: Taking the equal side as $\frac{6}{5}$ of the base. " $\frac{5}{6}$ th of the base" means $x = \frac{5}{6}y$.

Q33 · ARITHMETIC PROGRESSIONS · 5 MARKS

(a) The sum of the third term and the seventh term of an AP is 6 and their product is 8. Find the sum of the first sixteen terms of the AP.

OR

(b) The minimum age of children eligible to participate in a painting competition is 8 years. It is observed that the age of the youngest boy was 8 years and the ages of the participants, when seated in order of age, have a common difference of 4 months. If the sum of the ages of all the participants is 168 years, find the age of the eldest participant in the painting competition.

SOLUTION

(a) $a_3 + a_7 = (a + 2d) + (a + 6d) = 2a + 8d = 6$, so $a + 4d = 3$ and $a = 3 - 4d$.

$a_3 \cdot a_7 = (a + 2d)(a + 6d) = (3 - 2d)(3 + 2d) = 9 - 4d^2 = 8$, so $d^2 = \frac{1}{4}$ and $d = \pm \frac{1}{2}$.

If $d = \frac{1}{2}$: $a = 1$ and $S_{16} = \frac{16}{2} \left[2 \times 1 + 15 \times \frac{1}{2} \right] = 8 \times 9.5 = 76$.

If $d = -\frac{1}{2}$: $a = 5$ and $S_{16} = 8 \left[2 \times 5 + 15 \times \left(-\frac{1}{2}\right) \right] = 8 \times 2.5 = 20$.

(b) Ages in years: $8, 8\frac{1}{3}, 8\frac{2}{3}, 9, \dots$ (since 4 months = $\frac{1}{3}$ year). So $a = 8$ and $d = \frac{1}{3}$.

$S_n = \frac{n}{2} \left[16 + (n-1)\frac{1}{3} \right] = 168$, so $n(n+47) = 1008$, that is $n^2 + 47n - 1008 = 0$.

$(n+63)(n-16) = 0$. n cannot be negative, so $n = 16$.

Eldest participant: $a_{16} = 8 + 15 \times \frac{1}{3} = 13$ years.

Answer: (a) $S_{16} = 76$ or 20 (b) 13 years

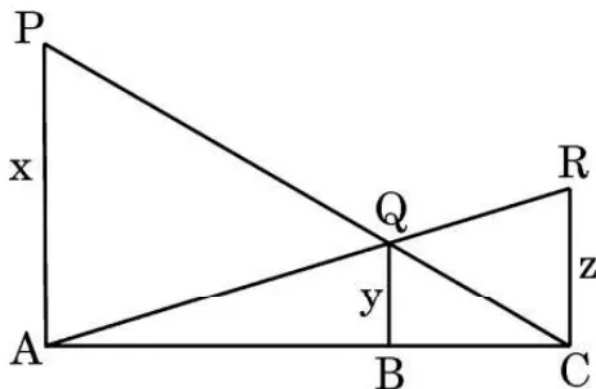
Common mistake: In (a), keeping only one value of d . Both $d = \frac{1}{2}$ and $d = -\frac{1}{2}$ fit, so there are two answers.

Q34 · TRIANGLES · 5 MARKS

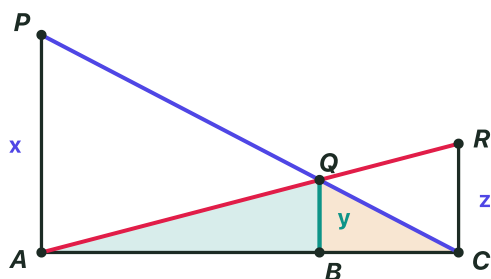
(a) In the given figure, PA , QB and RC are perpendicular to AC . If $PA = x$ units, $QB = y$ units and $RC = z$ units, prove that $\frac{1}{x} + \frac{1}{z} = \frac{1}{y}$.

OR

(b) Sides AB and BC and median AD of triangle ABC are respectively proportional to sides PQ and QR and median PM of $\triangle PQR$. Show that $\triangle ABC \sim \triangle PQR$.



SOLUTION



$$AB/AC = y/z \text{ and } BC/AC = y/x \rightarrow \text{add: } 1 = y(1/z + 1/x)$$

(a) $QB \parallel RC$ (both perpendicular to AC). In $\triangle ABQ$ and $\triangle ACR$, $\angle A$ is common and $\angle ABQ = \angle ACR = 90^\circ$, so $\triangle ABQ \sim \triangle ACR$ (AA).

$$\frac{AB}{AC} = \frac{QB}{RC} = \frac{y}{z} \dots (i)$$

Similarly $QB \parallel PA$, so $\triangle CBQ \sim \triangle CAP$ and $\frac{BC}{AC} = \frac{QB}{PA} = \frac{y}{x} \dots (ii)$

Add (i) and (ii): $\frac{AB+BC}{AC} = y \left(\frac{1}{z} + \frac{1}{x} \right)$. Since $AB + BC = AC$, the left side is 1.

So $1 = y \left(\frac{1}{x} + \frac{1}{z} \right)$, that is $\frac{1}{x} + \frac{1}{z} = \frac{1}{y}$.

(b) AD and PM are medians, so $BD = \frac{BC}{2}$ and $QM = \frac{QR}{2}$. Given $\frac{AB}{PQ} = \frac{BC}{QR} = \frac{AD}{PM}$, this gives $\frac{AB}{PQ} = \frac{2BD}{2QM} = \frac{AD}{PM}$, so $\frac{AB}{PQ} = \frac{BD}{QM} = \frac{AD}{PM}$.

So $\triangle ABD \sim \triangle PQM$ (SSS), which gives $\angle B = \angle Q$.

In $\triangle ABC$ and $\triangle PQR$: $\frac{AB}{PQ} = \frac{BC}{QR}$ and $\angle B = \angle Q$. So $\triangle ABC \sim \triangle PQR$ (SAS).

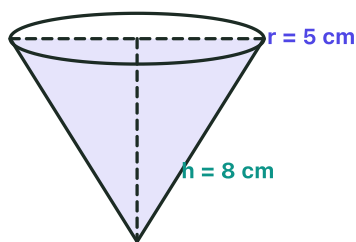
Answer: (a) $\frac{1}{x} + \frac{1}{z} = \frac{1}{y}$ **(b)** $\triangle ABC \sim \triangle PQR$

Common mistake: In (a), using the wrong pair of similar triangles. Q lies on both AR and PC , so use $\triangle ABQ \sim \triangle ACR$ and $\triangle CBQ \sim \triangle CAP$.

Q35 · SURFACE AREAS AND VOLUMES · 5 MARKS

A vessel is in the form of an inverted cone. Its height is 8 cm and the radius of its top, which is open, is 5 cm. It is filled with water up to the brim. When lead shots, each of which is a sphere of radius 0.5 cm, are dropped into the vessel, one-fourth of the water flows out. Find the number of lead shots dropped in the vessel.

SOLUTION



water out = $\frac{1}{4} \times 200\pi/3 = 50\pi/3$; one shot = $\pi/6$; shots = 100

Volume of water in the cone = $\frac{1}{3}\pi r^2 h = \frac{1}{3} \times \pi \times 5^2 \times 8 = \frac{200\pi}{3} \text{ cm}^3$.

One-fourth flows out: volume of water out = $\frac{1}{4} \times \frac{200\pi}{3} = \frac{50\pi}{3} \text{ cm}^3$.

This is the volume of the lead shots (they displace exactly that much water).

Volume of one shot = $\frac{4}{3}\pi r^3 = \frac{4}{3} \times \pi \times \left(\frac{1}{2}\right)^3 = \frac{4\pi}{24} = \frac{\pi}{6} \text{ cm}^3$.

Number of shots = $\frac{50\pi/3}{\pi/6} = \frac{50}{3} \times 6 = 100$.

Answer: 100 lead shots

Common mistake: Using the full cone volume instead of one-fourth of it. The shots displace only the water that flowed out.

Section E: Case studies

3 case studies, 4 marks each.

Q36 · QUADRATIC EQUATIONS · 4 MARKS

Case study 1. A garden designer is planning a rectangular lawn that is to be surrounded by a uniform walkway. The total area of the lawn and the walkway is 360 square metres. The width of the walkway is same on all sides. The dimensions of the lawn itself are 12 metres by 10 metres.

Based on the above information, answer the following questions:

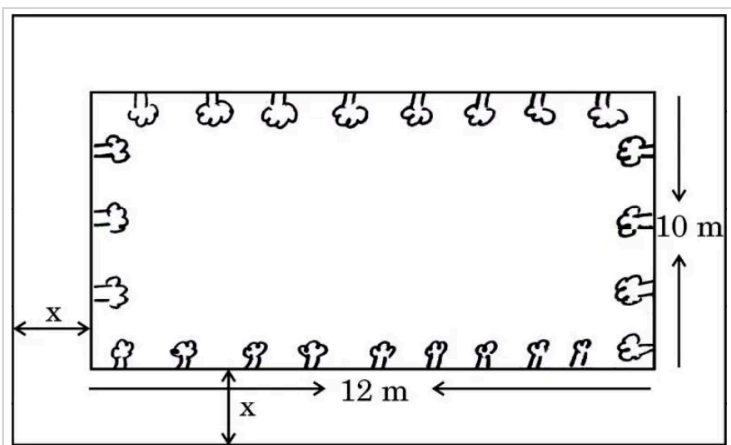
(i) Formulate the quadratic equation representing the total area of the lawn and the walkway, taking width of walkway = x m. [1]

(ii) (a) Solve the quadratic equation to find the width of the walkway ' x '. [2]

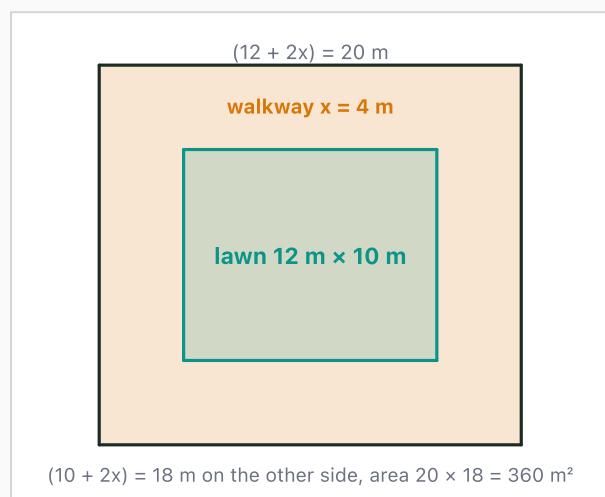
OR

(ii) (b) If the cost of paving the walkway at the rate of ₹ 50 per square metre is ₹ 12,000, calculate the area of the walkway. [2]

(iii) Find the perimeter of the lawn. [1]



SOLUTION



(i) With a walkway of width x on all sides, the whole rectangle is $(12 + 2x)$ by $(10 + 2x)$. Its area is 360: $(12 + 2x)(10 + 2x) = 360$.

Expanding: $120 + 24x + 20x + 4x^2 = 360$, so $4x^2 + 44x - 240 = 0$ and $x^2 + 11x - 60 = 0$.

(ii)(a) Factorise: $x^2 + 15x - 4x - 60 = (x + 15)(x - 4) = 0$. The width cannot be negative, so $x = 4$ m.

(ii)(b) Area of the walkway = $\frac{12000}{50} = 240 \text{ m}^2$. (Check: total 360 – lawn $12 \times 10 = 120$ gives 240 ✓, which matches $x = 4$.)

(iii) Perimeter of the lawn = $2(12 + 10) = 44$ m.

Answer: (i) $x^2 + 11x - 60 = 0$ (ii)(a) $x = 4$ m (ii)(b) 240 m^2 (iii) 44 m

Common mistake: Using $(12 + x)(10 + x)$. The walkway is on both sides of each length, so it adds $2x$.

Q37 · APPLICATIONS OF TRIGONOMETRY · 4 MARKS

Case study 2. A lighthouse stands tall on a cliff by the sea, watching over ships that pass by. One day a ship is seen approaching the shore and from the top of the lighthouse, the angles of depression of the ship are observed to be 30° and 45° as it moves from point P to point Q. The height of the lighthouse is 50 metres.

Based on the information given above, answer the following questions:

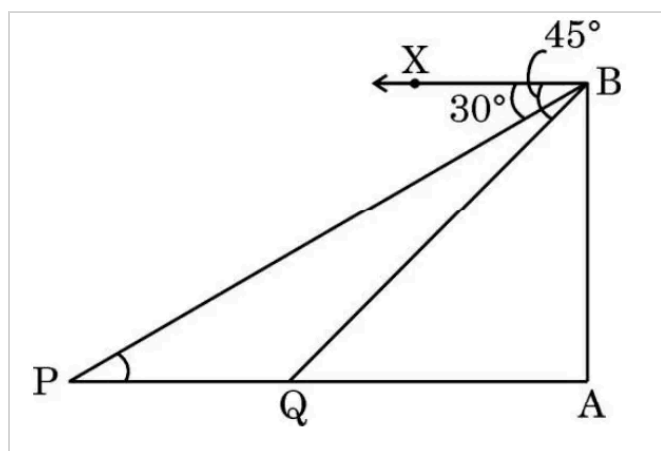
(i) Find the distance of the ship from the base of the lighthouse when it is at point Q, where the angle of depression is 45° . [1]

(ii) Find the measures of $\angle PBA$ and $\angle QBA$. [1]

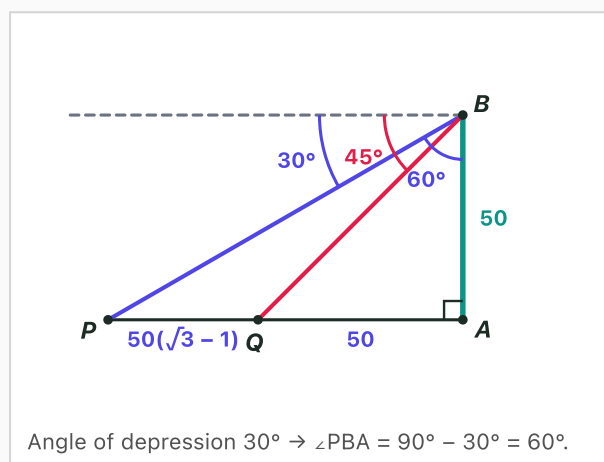
(iii) (a) Find the distance travelled by the ship between points P and Q. [2]

OR

(iii) (b) If the ship continues moving towards the shore and takes 10 minutes to travel from Q to A, calculate the speed of the ship in km/h, from Q to A. [2]



SOLUTION



$AB = 50$ m. The angle of depression equals the angle of elevation of B from the ship (alternate angles).

(i) In $\triangle ABQ$: $\tan 45^\circ = \frac{AB}{AQ} = \frac{50}{AQ} = 1$, so $AQ = 50$ m.

(ii) BX is horizontal and BA is vertical, so $\angle XBA = 90^\circ$. The angle of depression $\angle XBP = 30^\circ$, so $\angle PBA = 90^\circ - 30^\circ = 60^\circ$. Likewise $\angle QBA = 90^\circ - 45^\circ = 45^\circ$.

(iii)(a) In $\triangle ABP$: $\tan 30^\circ = \frac{50}{AP} = \frac{1}{\sqrt{3}}$, so $AP = 50\sqrt{3}$ m.

$PQ = AP - AQ = 50\sqrt{3} - 50 = 50(\sqrt{3} - 1)$ m ≈ 36.6 m.

(iii)(b) From Q to A is 50 m in 10 minutes. Speed = $\frac{50}{10} = 5$ m/min = $5 \times 60 = 300$ m/h = 0.3 km/h.

Answer: (i) 50 m (ii) $\angle PBA = 60^\circ$, $\angle QBA = 45^\circ$ (iii)(a) $50(\sqrt{3} - 1)$ m (iii)(b) 0.3 km/h

Common mistake: Answering $\angle PBA = 30^\circ$. The angle of depression is measured from the horizontal, so $\angle PBA = 90^\circ - 30^\circ = 60^\circ$.

Q38 · STATISTICS · 4 MARKS

Case study 3. The India Meteorological Department observes seasonal and annual rainfall every year in different sub-divisions of our country. It helps them to compare and analyse the results. The table below shows sub-divisions wise seasonal (monsoon) rainfall (in mm) in 2023.

Based on the information given above, answer the following questions:

(i) Write the modal class. [1]

(ii) (a) Find the median of the given data. [2]

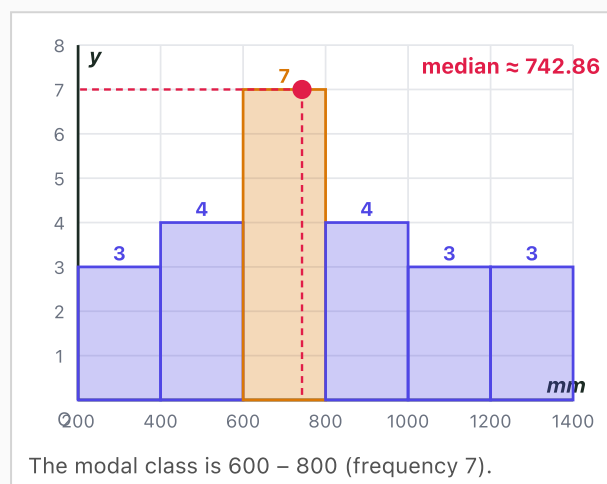
OR

(ii) (b) Find the mean rainfall in the season. [2]

(iii) If a sub-division having at least 800 mm rainfall during monsoon season is considered a good rainfall sub-division, then how many sub-divisions had good rainfall? [1]

Rainfall (mm)	No. of sub-divisions
200 – 400	3
400 – 600	4
600 – 800	7
800 – 1000	4
1000 – 1200	3
1200 – 1400	3

SOLUTION



(i) The highest frequency is 7, so the modal class is 600 – 800.

(ii)(a) Cumulative frequencies: 3, 7, 14, 18, 21, 24. $N = 24$ and $\frac{N}{2} = 12$, so the median class is 600 – 800 (first cumulative frequency above 12).

$$l = 600, cf = 7, f = 7, h = 200. \text{ Median} = l + \frac{\frac{N}{2} - cf}{f} \times h = 600 + \frac{12 - 7}{7} \times 200 = 600 + \frac{1000}{7} \approx 742.86 \text{ mm.}$$

(ii)(b) Class marks x_i : 300, 500, 700, 900, 1100, 1300. Products $f_i x_i$: 900, 2000, 4900, 3600, 3300, 3900. Their sum is $\sum f_i x_i = 18600$.

$$\text{Mean} = \frac{18600}{24} = 775 \text{ mm.}$$

(iii) At least 800 mm: the classes 800 – 1000, 1000 – 1200 and 1200 – 1400 have $4 + 3 + 3 = 10$ sub-divisions.

Answer: (i) 600 – 800 (ii)(a) ≈ 742.86 mm (ii)(b) 775 mm (iii) 10

Common mistake: Using N instead of $\frac{N}{2}$ to find the median class.

Stuck on a step? CogniGuru's AI tutor explains any doubt one minute at a time, in English or Hindi.

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