

Mathematics (Basic) 2025, Set 430/1/1

Q.P. Code 430/1/1 · Series GE1FH · 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 · REAL NUMBERS · 1 MARK

If the HCF of two positive integers a and b is 1, then their LCM is:

- (A) $a + b$ (B) a
(C) b (D) ab

SOLUTION

For any two positive integers, $\text{HCF} \times \text{LCM} = a \times b$.

With $\text{HCF} = 1$: $1 \times \text{LCM} = ab$, so the LCM is ab .

Answer: (D) ab

Common mistake: Choosing a or b . The LCM equals one of them only when the other divides it, which is not the case for numbers with HCF 1 (such as 4 and 9).

Q2 · REAL NUMBERS · 1 MARK

The number $3 + \sqrt{2}$ is:

- (A) a rational number (B) an irrational number
(C) an integer (D) a natural number

SOLUTION

$\sqrt{2}$ is irrational.

Suppose $3 + \sqrt{2}$ were a rational number r . Then $\sqrt{2} = r - 3$ would be rational, which is false.

So the sum of a rational number and an irrational number is irrational.

Answer: (B) an irrational number

Q3 · QUADRATIC EQUATIONS · 1 MARK

The discriminant of the quadratic equation $x^2 - 3x - 2 = 0$ is:

- (A) 1 (B) 17
(C) $\sqrt{17}$ (D) $-\sqrt{17}$

SOLUTION

Here $a = 1$, $b = -3$, $c = -2$.

Discriminant $D = b^2 - 4ac = (-3)^2 - 4(1)(-2) = 9 + 8 = 17$.

Answer: (B) 17

Common mistake: Giving $\sqrt{17}$. That is a part of the roots' formula. The discriminant itself is $b^2 - 4ac$.

Q4 · QUADRATIC EQUATIONS · 1 MARK

The equation $x + \frac{1}{x} = 3$ ($x \neq 0$) is expressed as a quadratic equation in the form $ax^2 + bx + c = 0$. The value of $a - b + c$ is:

- (A) 5 (B) 2
(C) 1 (D) -1

SOLUTION

Multiply both sides by x : $x^2 + 1 = 3x$.

Bring everything to one side: $x^2 - 3x + 1 = 0$. So $a = 1$, $b = -3$, $c = 1$.

$$a - b + c = 1 - (-3) + 1 = 5.$$

Answer: (A) 5

Common mistake: Forgetting that $b = -3$, which gives $1 - 3 + 1 = -1$.

Q5 · COORDINATE GEOMETRY · 1 MARK

For a point $(3, -5)$, the value of (abscissa - ordinate) is:

- (A) -8 (B) -2
(C) 2 (D) 8

SOLUTION

In (x, y) the abscissa is x and the ordinate is y . Here abscissa = 3 and ordinate = -5.

$$\text{Abscissa} - \text{ordinate} = 3 - (-5) = 8.$$

Answer: (D) 8

Q6 · COORDINATE GEOMETRY · 1 MARK

The mid-point of a line segment divides the line segment in the ratio:

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

SOLUTION

The mid-point is the point exactly halfway, so the two parts are equal.

The ratio is 1 : 1.

Answer: (C) 1 : 1

Q7 · TRIANGLES · 1 MARK

Which of the following is not the criterion for similarity of triangles?

- (A) AAA (B) SSS
(C) SAS (D) RHS

SOLUTION

The standard similarity criteria are AAA (or AA), SSS and SAS. These three are valid.

RHS is usually taught as a congruence rule, but for right-angled triangles it also works for similarity: if the hypotenuse and one other side of one right triangle are in the same ratio as those of another, the triangles are similar.

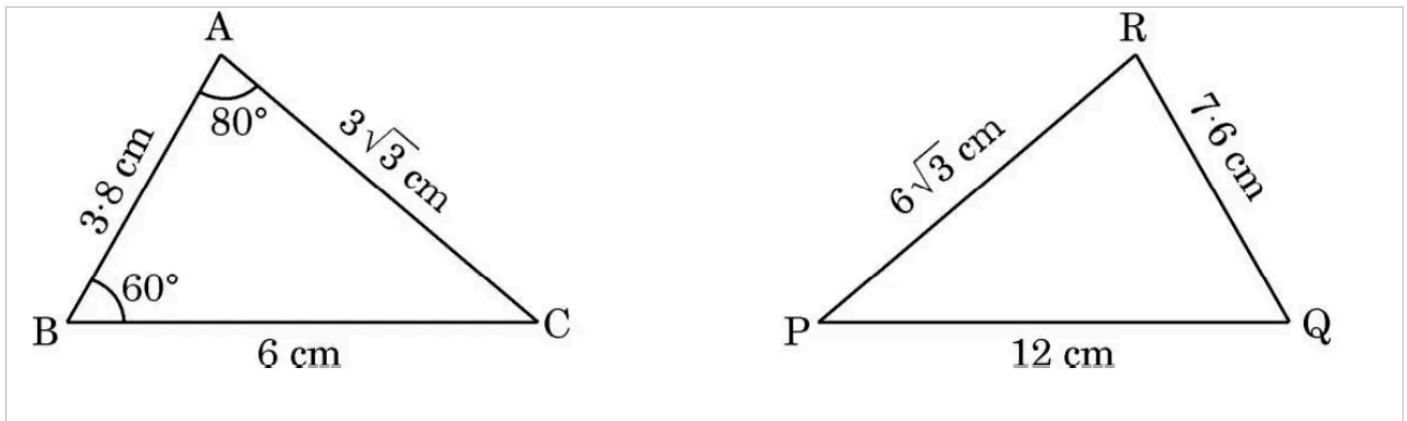
So every option can be used to show similarity, and none of them is "not a criterion". CBSE's own marking scheme for this paper says the same: none of the given options is correct.

Answer: None of the given options is correct (as stated in CBSE's answer key)

Common mistake: Spending time trying to force one letter. If you meet this in the exam, write your reasoning in a line next to your choice.

Q8 · TRIANGLES · 1 MARK

From the figures given below, which of the following is true about the measure of $\angle P$?



(A) $\angle P = 60^\circ$

(B) $\angle P = 80^\circ$

(C) $\angle P = 40^\circ$

(D) The measure of $\angle P$ cannot be determined

SOLUTION

Compare the sides of $\triangle ABC$ with those of $\triangle PQR$: $\frac{AB}{QR} = \frac{3.8}{7.6} = \frac{1}{2}$, $\frac{BC}{PQ} = \frac{6}{12} = \frac{1}{2}$, $\frac{AC}{PR} = \frac{3\sqrt{3}}{6\sqrt{3}} = \frac{1}{2}$.

All three ratios are equal, so $\triangle ABC \sim \triangle RQP$ by SSS similarity.

Match angles by the sides opposite them. QR (opposite P) corresponds to AB (opposite C), so $\angle P = \angle C$.

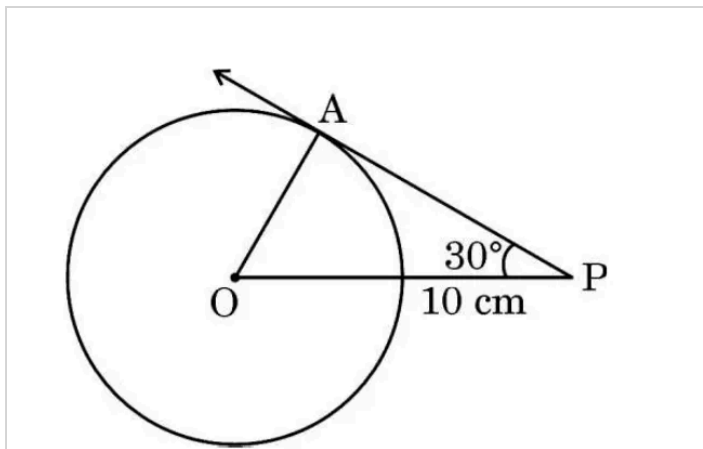
$\angle C = 180^\circ - 80^\circ - 60^\circ = 40^\circ$, so $\angle P = 40^\circ$.

Answer: (C) $\angle P = 40^\circ$

Common mistake: Pairing P with A because they are the first letters. In similar triangles the matching vertex is the one opposite the matching side.

Q9 · CIRCLES · 1 MARK

In the given figure, PA is a tangent to a circle with centre O . If $OP = 10$ cm, then the length of AP is:



(A) $10\sqrt{3}$ cm

(B) 20 cm

(C) 5 cm

(D) $5\sqrt{3}$ cm

SOLUTION

The radius OA is perpendicular to the tangent PA , so $\triangle OAP$ has a right angle at A .

$\angle OPA = 30^\circ$ and the hypotenuse is $OP = 10$ cm. AP is the side next to the 30° angle.

$$AP = OP \cos 30^\circ = 10 \times \frac{\sqrt{3}}{2} = 5\sqrt{3} \text{ cm.}$$

Answer: (D) $5\sqrt{3}$ cm

Common mistake: Using $\sin 30^\circ$ instead of $\cos 30^\circ$, which gives 5 (that is OA , not AP).

Q10 · TRIGONOMETRY · 1 MARK

Which of the following statements is false?

(A) $\tan 45^\circ = \cot 45^\circ$

(B) $\sin 90^\circ = \tan 45^\circ$

(C) $\sin 30^\circ = \cos 30^\circ$

(D) $\sin 45^\circ = \cos 45^\circ$

SOLUTION

(A) $\tan 45^\circ = 1$ and $\cot 45^\circ = 1$. True.

(B) $\sin 90^\circ = 1$ and $\tan 45^\circ = 1$. True.

(C) $\sin 30^\circ = \frac{1}{2}$ but $\cos 30^\circ = \frac{\sqrt{3}}{2}$. False.

(D) $\sin 45^\circ = \cos 45^\circ = \frac{1}{\sqrt{2}}$. True.

Answer: (C) $\sin 30^\circ = \cos 30^\circ$

Common mistake: Not noticing the question asks for the false statement, and picking a true one.

Q11 · TRIGONOMETRY · 1 MARK

The value of $\left(\tan^2 A - \frac{1}{\cos^2 A}\right)$ is:

- (A) more than 1 (B) 1
(C) 0 (D) -1

SOLUTION

$\frac{1}{\cos^2 A} = \sec^2 A$, so the expression is $\tan^2 A - \sec^2 A$.

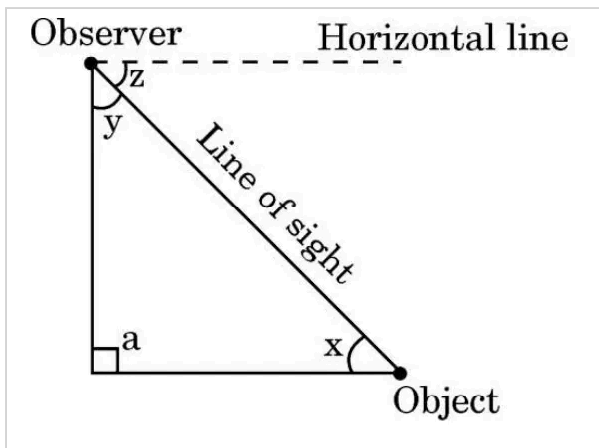
Since $\sec^2 A = 1 + \tan^2 A$, we get $\tan^2 A - (1 + \tan^2 A) = -1$.

Answer: (D) -1

Common mistake: Remembering $\sec^2 A - \tan^2 A = 1$ and answering 1, without noticing the order is reversed.

Q12 · APPLICATIONS OF TRIGONOMETRY · 1 MARK

In the given figure, which of the following angles represents the angle of depression?



- (A) x (B) y
(C) z (D) a

SOLUTION

The angle of depression is measured at the observer's eye, from the horizontal line down to the line of sight.

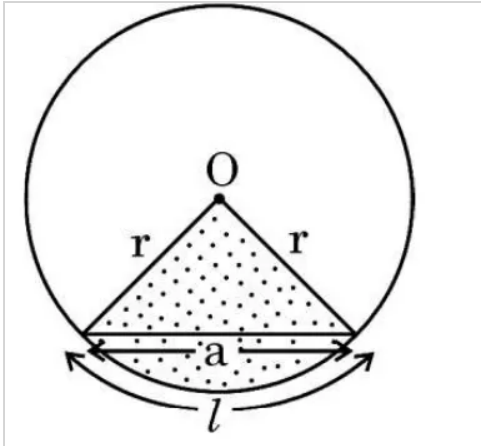
In the figure that is the angle between the dashed horizontal line and the line of sight, which is z .

(x is equal to z (alternate angles) but it sits at the object, so it is the angle of elevation of the observer from the object.)

Answer: (C) z

Q13 · AREAS RELATED TO CIRCLES · 1 MARK

The perimeter of the shaded region in the given figure is:



- (A) l (B) $l + a$
(C) $l + 2r$ (D) $l + 2r + a$

SOLUTION

The shaded region is the triangle together with the segment under the chord, so the chord is inside the region and is not part of its boundary.

Together they form a sector. Its boundary is the two radii and the arc: $r + r + l$.

Perimeter = $l + 2r$.

Answer: (C) $l + 2r$

Common mistake: Adding the chord a . A line inside a region is not part of its perimeter.

Q14 · AREAS RELATED TO CIRCLES · 1 MARK

The ratio of the area of a quadrant of a circle to the area of the same circle is:

- (A) 1 : 2 (B) 2 : 1
(C) 1 : 4 (D) 4 : 1

SOLUTION

A quadrant is $\frac{1}{4}$ of the circle, so its area is $\frac{1}{4}\pi r^2$.

Ratio = $\frac{1}{4}\pi r^2 : \pi r^2 = 1 : 4$.

Answer: (C) 1 : 4

Q15 · SURFACE AREAS AND VOLUMES · 1 MARK

For which of the following solids is the lateral/curved surface area and total surface area the same?

- (A) Cube (B) Cuboid
(C) Hemisphere (D) Sphere

SOLUTION

Curved and total surface area are equal only when the solid has no flat face.

A cube and a cuboid have flat faces. A hemisphere has a flat circular top, so its total surface area ($3\pi r^2$) is more than its curved area ($2\pi r^2$).

A sphere has one curved surface and nothing else: both are $4\pi r^2$.

Answer: (D) Sphere

Q16 · STATISTICS · 1 MARK

The class mark of the median class of the following data is:

Class interval	10 – 25	25 – 40	40 – 55	55 – 70	70 – 85	85 – 100
Frequency	2	3	7	6	6	6

(A) 40

(B) 55

(C) 47.5

(D) 62.5

SOLUTION

Total frequency $N = 2 + 3 + 7 + 6 + 6 + 6 = 30$, so $\frac{N}{2} = 15$.

Cumulative frequencies: 2, 5, 12, 18, 24, 30.

The first cumulative frequency that is at least 15 is 18, so the median class is 55 – 70.

Class mark = $\frac{55 + 70}{2} = 62.5$.

Answer: (D) 62.5

Common mistake: Taking the class with the highest frequency as the median class. That is the modal class, not the median class.

Q17 · STATISTICS · 1 MARK

The following distribution shows the number of runs scored by some batsmen in test matches. The lower limit of the modal class is:

Runs scored	3000 – 4000	4000 – 5000	5000 – 6000	6000 – 7000
Number of batsmen	5	10	9	8

(A) 3000

(B) 4000

(C) 5000

(D) 6000

SOLUTION

The modal class is the class with the highest frequency.

The highest frequency is 10, for the class 4000 – 5000. Its lower limit is 4000.

Answer: (B) 4000

Q18 · PROBABILITY · 1 MARK

In a random experiment of throwing a die, which of the following is a sure event?

(A) Getting a number between 1 and 6

(B) Getting an odd number < 7

(C) Getting an even number < 7

(D) Getting a natural number < 7

SOLUTION

A sure event is one that happens every time, with probability 1.

A die shows 1, 2, 3, 4, 5 or 6, and each of these is a natural number less than 7.

"Between 1 and 6" leaves out 1 and 6, odd numbers leave out 2, 4 and 6, and even numbers leave out 1, 3 and 5. So only the last option always happens.

Answer: (D) Getting a natural number < 7

Q19 · REAL NUMBERS · 1 MARK

Assertion (A): For any two natural numbers a and b , the HCF of a and b is a factor of the LCM.

Reason (R): HCF of any two natural numbers divides both the numbers.

- (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

The reason is true: the HCF divides both a and b .

Because the HCF divides a , and a divides the LCM (the LCM is a multiple of a), the HCF divides the LCM. So the assertion is true.

The reason is exactly the step that proves the assertion, so R explains A.

Answer: (A) Both true, and R is the correct explanation

Q20 · LINEAR EQUATIONS · 1 MARK

Assertion (A): The value of p for which the system of equations $4x + py + 8 = 0$ and $2x + 2y + 2 = 0$ is consistent is 4.

Reason (R): The system of equations $a_1x + b_1y = c_1$ and $a_2x + b_2y = c_2$ is consistent with infinitely many solutions, if $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$.

- (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

For the given system: $\frac{a_1}{a_2} = \frac{4}{2} = 2$, $\frac{b_1}{b_2} = \frac{p}{2}$, $\frac{c_1}{c_2} = \frac{8}{2} = 4$.

If $p = 4$: $\frac{a_1}{a_2} = \frac{b_1}{b_2} = 2$ but $\frac{c_1}{c_2} = 4$. The lines are parallel, so there is no solution and the system is inconsistent. The assertion is false.

If $p \neq 4$, then $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$, so there is exactly one solution: consistent. So the system is consistent for every p except 4.

The reason states the standard condition for infinitely many solutions, and it is true.

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

Common mistake: Reading "consistent" as "infinitely many solutions only". A system with a unique solution is consistent too.

Section B: Very short answer

5 questions, 2 marks each.

Q21 · LINEAR EQUATIONS · 2 MARKS

Solve the following system of equations for x and y : $\frac{x}{2} + \frac{2y}{3} = -1$ and $x - \frac{y}{3} = 3$.

SOLUTION

Clear the fractions. Multiply the first equation by 6: $3x + 4y = -6$ (i)

Multiply the second by 3: $3x - y = 9$ (ii)

Subtract (ii) from (i): $5y = -15$, so $y = -3$.

Put $y = -3$ in (ii): $3x + 3 = 9$, so $x = 2$.

Check in the first equation: $\frac{2}{2} + \frac{2(-3)}{3} = 1 - 2 = -1 \checkmark$.

Answer: $x = 2$, $y = -3$

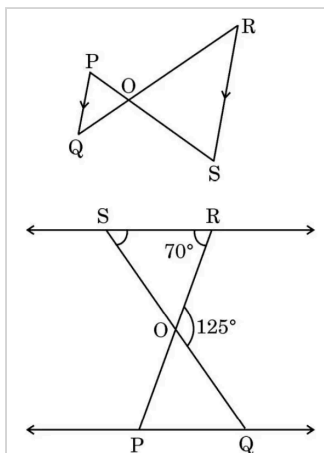
Common mistake: Multiplying only one side when clearing fractions.

Q22 · TRIANGLES · 2 MARKS

(a) In the given figure, if $PQ \parallel RS$, then prove that $\triangle POQ \sim \triangle SOR$.

OR

(b) In the given figure, $\triangle OSR \sim \triangle OQP$, $\angle ROQ = 125^\circ$ and $\angle ORS = 70^\circ$. Find the measures of $\angle OSR$ and $\angle OQP$.



SOLUTION

(a) $PQ \parallel RS$ with transversal QR , so $\angle PQO = \angle SRO$ (alternate interior angles).

$\angle POQ = \angle SOR$ (vertically opposite angles).

Two pairs of equal angles, so $\triangle POQ \sim \triangle SOR$ by AA similarity.

(b) $\angle ROQ$ is an exterior angle of $\triangle OSR$ (side SO is extended to Q). An exterior angle equals the sum of the two opposite interior angles: $\angle ROQ = \angle OSR + \angle ORS$.

$125^\circ = \angle OSR + 70^\circ$, so $\angle OSR = 55^\circ$.

$\triangle OSR \sim \triangle OQP$ (with $S \leftrightarrow Q$), so corresponding angles are equal: $\angle OQP = \angle OSR = 55^\circ$.

Answer: (a) $\triangle POQ \sim \triangle SOR$ shown by AA (b) $\angle OSR = 55^\circ$, $\angle OQP = 55^\circ$

Common mistake: Using 125° as an angle inside the triangle. It is outside: the straight line SOQ makes the inside angle $\angle OSR = 55^\circ$.

Q23 · CIRCLES · 2 MARKS

Two concentric circles are of radii 6 cm and 10 cm. Find the length of the chord of the larger circle which touches the smaller circle.

SOLUTION

Let the chord AB of the larger circle touch the smaller circle at C . The radius $OC = 6$ cm is perpendicular to the tangent AB , and it bisects the chord.

In right triangle OCB : $OB = 10$ (radius of the larger circle), $OC = 6$. So $CB^2 = 10^2 - 6^2 = 100 - 36 = 64$ and $CB = 8$ cm.

The chord $AB = 2 \times 8 = 16$ cm.

Answer: 16 cm

Common mistake: Stopping at 8 cm, which is only half the chord.

Q24 · TRIGONOMETRY · 2 MARKS

(a) Find the values of A and B ($0^\circ \leq A < 90^\circ$, $0^\circ \leq B < 90^\circ$), if $\tan(A + B) = 1$ and $\tan(A - B) = \frac{1}{\sqrt{3}}$.

OR

(b) Prove that $\tan 45^\circ = 1$ geometrically.

SOLUTION

(a) $\tan(A + B) = 1 = \tan 45^\circ$, so $A + B = 45^\circ$ (i)

$\tan(A - B) = \frac{1}{\sqrt{3}} = \tan 30^\circ$, so $A - B = 30^\circ$ (ii)

Add (i) and (ii): $2A = 75^\circ$, so $A = 37.5^\circ$. Then $B = 45^\circ - 37.5^\circ = 7.5^\circ$.

(b) Take a right triangle ABC with the right angle at B and $AB = BC = x$ (an isosceles right triangle).

Equal sides have equal angles opposite them, so $\angle A = \angle C$. The angles add to 90° , so $\angle A = \angle C = 45^\circ$.

$\tan 45^\circ = \tan A = \frac{BC}{AB} = \frac{x}{x} = 1$.

Answer: (a) $A = 37.5^\circ$, $B = 7.5^\circ$ (b) $\tan 45^\circ = 1$

Q25 · AREAS RELATED TO CIRCLES · 2 MARKS

A chord of a circle of diameter 20 cm subtends an angle of 60° at the centre of the circle. Find the area of the corresponding minor segment of the circle. (Use $\pi = 3.14$ and $\sqrt{3} = 1.73$)

SOLUTION

Radius $r = 10$ cm. In $\triangle OAB$, $OA = OB = 10$ and $\angle AOB = 60^\circ$, so the other two angles are 60° too: the triangle is equilateral.

Area of the sector = $\frac{60}{360} \times \pi r^2 = \frac{1}{6} \times 3.14 \times 100 = 52.33 \text{ cm}^2$.

Area of the equilateral triangle = $\frac{\sqrt{3}}{4} r^2 = \frac{1.73}{4} \times 100 = 43.25 \text{ cm}^2$.

Area of the minor segment = sector - triangle = $52.33 - 43.25 = 9.08 \text{ cm}^2$ (exactly $\frac{109}{12} \text{ cm}^2$).

Answer: $\approx 9.08 \text{ cm}^2$

Common mistake: Giving the sector area. The segment is what is left after removing the triangle.

Section C: Short answer

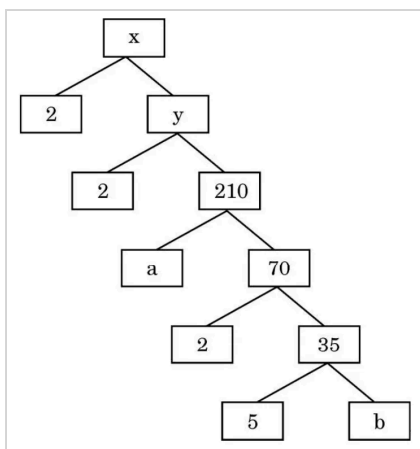
6 questions, 3 marks each.

Q26 · REAL NUMBERS · 3 MARKS

(a) Prove that $\sqrt{3}$ is an irrational number.

OR

(b) The factor tree of a number x is shown below. Find the values of x , y , a and b . Hence, write the product of the prime factors of the number x so obtained.



SOLUTION

(a) Suppose $\sqrt{3}$ is rational. Then $\sqrt{3} = \frac{p}{q}$ with integers p, q ($q \neq 0$) that have no common factor.

Squaring: $3q^2 = p^2$. So 3 divides p^2 , and since 3 is prime, 3 divides p . Write $p = 3m$.

Then $3q^2 = 9m^2$, so $q^2 = 3m^2$. So 3 divides q^2 , and hence 3 divides q .

Now 3 divides both p and q , which contradicts "no common factor". So $\sqrt{3}$ is irrational.

(b) Work upwards from the bottom. $35 = 5 \times b$, so $b = 7$. Then $70 = 2 \times 35 \checkmark$.

$210 = a \times 70$, so $a = 3$. Then $y = 2 \times 210 = 420$ and $x = 2 \times 420 = 840$.

The prime factors of x : $840 = 2 \times 2 \times 2 \times 3 \times 5 \times 7$, that is $x = 2^3 \times 3 \times 5 \times 7$.

Answer: (a) $\sqrt{3}$ is irrational (b) $b = 7$, $a = 3$, $y = 420$, $x = 840 = 2^3 \times 3 \times 5 \times 7$

Common mistake: In the proof, forgetting to say why 3 dividing p squared means 3 divides p (because 3 is prime).

Q27 · POLYNOMIALS · 3 MARKS

Find a quadratic polynomial whose sum and product of zeroes are 0 and -9 , respectively. Also, find the zeroes of the polynomial so obtained.

SOLUTION

A quadratic polynomial with zeroes whose sum is S and product is P is $x^2 - Sx + P$.

Here $S = 0$ and $P = -9$, so the polynomial is $x^2 - 0x - 9 = x^2 - 9$.

Zeroes: $x^2 - 9 = (x + 3)(x - 3) = 0$, so $x = -3$ or $x = 3$.

Check: sum $= -3 + 3 = 0 \checkmark$, product $= (-3)(3) = -9 \checkmark$.

Answer: Polynomial $x^2 - 9$; zeroes -3 and 3

Common mistake: Writing $x^2 + Sx + P$. The middle term is $-S$.

Q28 · LINEAR EQUATIONS · 3 MARKS

(a) Solve the following system of equations graphically: $x + 3y = 6$; $2x - 3y = 12$.

OR

(b) x and y are complementary angles such that $x : y = 1 : 2$. Express the given information as a system of linear equations in two variables and hence solve it.

SOLUTION

(a) Line 1, $x + 3y = 6$: points $(0, 2)$, $(3, 1)$, $(6, 0)$.

Line 2, $2x - 3y = 12$: points $(0, -4)$, $(3, -2)$, $(6, 0)$.

Plot both lines on the same axes. They meet at the single point $(6, 0)$, so $x = 6$ and $y = 0$.

Check: $6 + 0 = 6 \checkmark$ and $12 - 0 = 12 \checkmark$.

(b) Complementary angles add to 90° : $x + y = 90$ (i)

$x : y = 1 : 2$ means $y = 2x$, i.e. $2x - y = 0$ (ii)

Add (i) and (ii): $3x = 90$, so $x = 30$ and $y = 60$.

Answer: (a) $x = 6$, $y = 0$ (b) $x + y = 90$, $y = 2x$; $x = 30^\circ$, $y = 60^\circ$

Common mistake: Plotting with a wrong scale or too few points. Two correct points define a line, but a third point is a free check.

Q29 · CIRCLES · 3 MARKS

Prove that a rectangle circumscribing a circle is a square.

SOLUTION

Let rectangle $ABCD$ circumscribe a circle, touching the sides AB, BC, CD, DA at P, Q, R, S .

Tangents from an outside point are equal: $AP = AS$, $BP = BQ$, $CR = CQ$, $DR = DS$.

Add the four equalities: $(AP + BP) + (CR + DR) = (AS + DS) + (BQ + CQ)$, that is $AB + CD = AD + BC$.

In a rectangle opposite sides are equal: $AB = CD$ and $AD = BC$. So $2AB = 2AD$, giving $AB = AD$.

A rectangle whose adjacent sides are equal is a square.

Answer: The circumscribed rectangle is a square

Common mistake: Skipping the labelled figure with the four points of contact. It is worth marks.

Q30 · TRIGONOMETRY · 3 MARKS

Prove that: $\frac{1 + \cot^2 A}{1 + \tan^2 A} = \left(\frac{1 - \cot A}{1 - \tan A} \right)^2$

SOLUTION

Left side: $1 + \cot^2 A = \operatorname{cosec}^2 A$ and $1 + \tan^2 A = \sec^2 A$, so $\text{LHS} = \frac{\operatorname{cosec}^2 A}{\sec^2 A} = \frac{\cos^2 A}{\sin^2 A} = \cot^2 A$.

Right side: $1 - \cot A = \frac{\sin A - \cos A}{\sin A}$ and $1 - \tan A = \frac{\cos A - \sin A}{\cos A}$.

$\frac{1 - \cot A}{1 - \tan A} = \frac{\sin A - \cos A}{\sin A} \times \frac{\cos A}{\cos A - \sin A} = -\frac{\cos A}{\sin A} = -\cot A$.

Squaring: $(-\cot A)^2 = \cot^2 A$.

So $\text{LHS} = \cot^2 A = \text{RHS}$.

Answer: Proved

Common mistake: Working on both sides at once. Simplify the left side and the right side separately, and show they meet at the same expression.

Q31 · PROBABILITY · 3 MARKS

A lot consists of 200 pens of which 180 are good and the rest are defective. A customer will buy a pen if it is not defective. The shopkeeper draws a pen at random and gives it to the customer. What is the probability that the customer will not buy it? Another lot of 100 pens containing 80 good pens is mixed with the previous lot of 200 pens. The shopkeeper now draws one pen at random from the entire lot and gives it to the customer. What is the probability that the customer will buy the pen?

SOLUTION

Defective pens in the first lot: $200 - 180 = 20$.

The customer does not buy a defective pen. $P(\text{not buy}) = \frac{20}{200} = \frac{1}{10}$.

After mixing: total pens = $200 + 100 = 300$ and good pens = $180 + 80 = 260$.

The customer buys a good pen. $P(\text{buy}) = \frac{260}{300} = \frac{13}{15}$.

Answer: $\frac{1}{10}$ and $\frac{13}{15}$

Common mistake: Answering the first part with the probability of a good pen. The question asks for the chance the customer will NOT buy.

Section D: Long answer

4 questions, 5 marks each.

Q32 · QUADRATIC EQUATIONS · 5 MARKS

(a) The difference of the squares of two positive numbers is 180. The square of the smaller number is 8 times the greater number. Find the two numbers.

OR

(b) Find the value(s) of k for which the equation $2x^2 + kx + 3 = 0$ has real and equal roots. Hence, find the roots of the equations so obtained.

SOLUTION

(a) Let the greater number be x and the smaller be y . Then $x^2 - y^2 = 180$ and $y^2 = 8x$.

Put $y^2 = 8x$ in the first: $x^2 - 8x = 180$, so $x^2 - 8x - 180 = 0$.

Factorise: $(x - 18)(x + 10) = 0$, so $x = 18$ or $x = -10$.

The numbers are positive, so $x = 18$. Then $y^2 = 8 \times 18 = 144$ and $y = 12$.

Check: $18^2 - 12^2 = 324 - 144 = 180 \checkmark$.

(b) Equal roots need the discriminant to be zero: $k^2 - 4(2)(3) = 0$, so $k^2 = 24$ and $k = \pm 2\sqrt{6}$.

For $k = 2\sqrt{6}$: $2x^2 + 2\sqrt{6}x + 3 = 0$. The equal roots are $x = \frac{-b}{2a} = \frac{-2\sqrt{6}}{4} = -\frac{\sqrt{6}}{2}$.

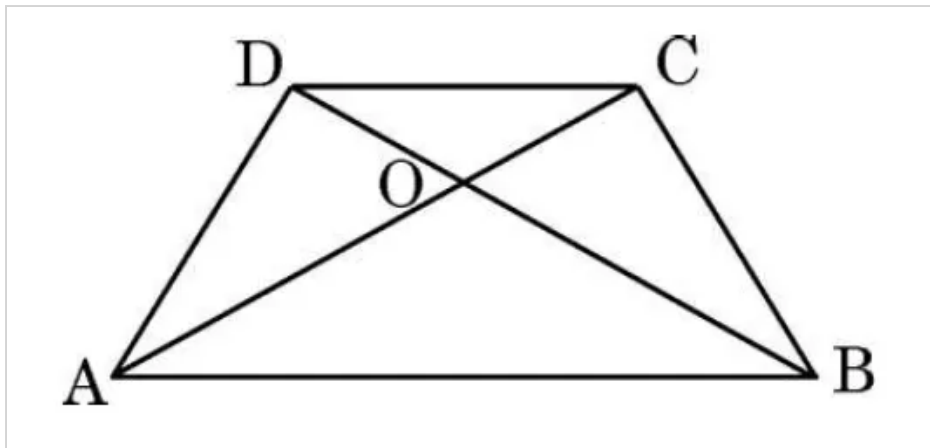
For $k = -2\sqrt{6}$: $2x^2 - 2\sqrt{6}x + 3 = 0$. The equal roots are $x = \frac{2\sqrt{6}}{4} = \frac{\sqrt{6}}{2}$.

Answer: (a) 18 and 12 (b) $k = \pm 2\sqrt{6}$; roots $-\frac{\sqrt{6}}{2}$ (twice) for $k = 2\sqrt{6}$ and $\frac{\sqrt{6}}{2}$ (twice) for $k = -2\sqrt{6}$

Common mistake: Keeping $x = -10$. The question says the numbers are positive, so say clearly why it is rejected.

Q33 · TRIANGLES · 5 MARKS

State "Basic Proportionality Theorem" and use it to prove the following: In a quadrilateral $ABCD$, diagonals AC and BD intersect each other at O such that $\frac{AO}{BO} = \frac{CO}{DO}$ as shown in the given figure. Prove that $ABCD$ is a trapezium.



SOLUTION

Basic Proportionality Theorem: if a line is drawn parallel to one side of a triangle to meet the other two sides at distinct points, it divides those two sides in the same ratio.

Given: $\frac{AO}{BO} = \frac{CO}{DO}$. To prove: $AB \parallel CD$.

Construction: through O draw $OE \parallel AB$, meeting AD at E .

In $\triangle DAB$, $OE \parallel AB$, so by the theorem $\frac{DE}{EA} = \frac{DO}{OB}$ (i)

From the given condition, cross-multiplying: $AO \times DO = CO \times BO$, so $\frac{DO}{BO} = \frac{CO}{AO}$ (ii)

From (i) and (ii): $\frac{DE}{EA} = \frac{CO}{AO}$.

In $\triangle ADC$, this says E and O divide AD and AC in the same ratio, so by the converse of the theorem $OE \parallel DC$.

Now $OE \parallel AB$ and $OE \parallel DC$, so $AB \parallel DC$. A quadrilateral with one pair of parallel sides is a trapezium. Hence $ABCD$ is a trapezium.

Answer: $ABCD$ is a trapezium

Common mistake: Writing the theorem but not naming the triangle each time you use it, or using the converse without saying so.

Q34 · SURFACE AREAS AND VOLUMES · 5 MARKS

(a) A toy is in the form of a cone surmounted on a hemisphere. The cone and hemisphere have the same radii. The height of the conical part of the toy is equal to the diameter of its base. If the radius of the conical part is 5 cm, find the volume of the toy.

OR

(b) A cubical block is surmounted by a hemisphere of radius 3.5 cm. What is the smallest possible length of the edge of the cube so that the hemisphere can totally lie on the cube? Find the total surface area of the solid so formed.

SOLUTION

(a) Radius $r = 5$ cm. The height of the cone is the diameter: $h = 2r = 10$ cm. Use $\pi = \frac{22}{7}$.

$$\text{Volume of the hemisphere} = \frac{2}{3}\pi r^3 = \frac{2}{3} \times \frac{22}{7} \times 125 = \frac{5500}{21} \text{ cm}^3.$$

$$\text{Volume of the cone} = \frac{1}{3}\pi r^2 h = \frac{1}{3} \times \frac{22}{7} \times 25 \times 10 = \frac{5500}{21} \text{ cm}^3.$$

$$\text{Volume of the toy} = \frac{5500}{21} + \frac{5500}{21} = \frac{11000}{21} \approx 523.81 \text{ cm}^3.$$

(b) For the hemisphere to lie fully on the cube, the cube's face must hold the circular base. The smallest edge equals the diameter: $a = 2 \times 3.5 = 7 \text{ cm}$.

The solid's surface is the five exposed faces plus the top face with the circle removed, plus the curved surface of the hemisphere. So the total surface area $= 6a^2 - \pi r^2 + 2\pi r^2 = 6a^2 + \pi r^2$.

$$= 6 \times 49 + \frac{22}{7} \times 3.5 \times 3.5 = 294 + 38.5 = 332.5 \text{ cm}^2.$$

Answer: (a) $\frac{11000}{21} \approx 523.81 \text{ cm}^3$ **(b) edge 7 cm, total surface area 332.5 cm²**

Common mistake: In (b), using $6a^2 + 2\pi r^2$ and forgetting that the circle covered by the hemisphere is no longer exposed.

Q35 · STATISTICS · 5 MARKS

The following data gives the information on the observed lifetime (in hours) of 200 electrical components. Find the mean lifetime (in hours) of the electrical components.

Lifetime (in hours)	Number of electrical components
0 – 20	10
20 – 40	35
40 – 60	50
60 – 80	60
80 – 100	30
100 – 120	15

SOLUTION

Class marks x_i : 10, 30, 50, 70, 90, 110. Frequencies f_i : 10, 35, 50, 60, 30, 15, with $\sum f_i = 200$.

Products $f_i x_i$: 100, 1050, 2500, 4200, 2700, 1650. Their sum is $\sum f_i x_i = 12200$.

$$\text{Mean} = \frac{\sum f_i x_i}{\sum f_i} = \frac{12200}{200} = 61.$$

(Step-deviation check with $a = 50$, $h = 20$: $u_i = -2, -1, 0, 1, 2, 3$ and $\sum f_i u_i = -20 - 35 + 0 + 60 + 60 + 45 = 110$, so mean $= 50 + \frac{110}{200} \times 20 = 61 \checkmark$.)

Answer: Mean lifetime = 61 hours

Common mistake: Using the class limits instead of the class marks (midpoints) in the products.

Section E: Case studies

3 case studies, 4 marks each.

Q36 · APPLICATIONS OF TRIGONOMETRY · 4 MARKS

Case study 1. An injured bird was found on the roof of a building. The building is 15 m high. A fireman was called to rescue the bird. The fireman used an adjustable ladder to reach the roof. He placed the ladder in such a way that the ladder makes an angle of 60° with the ground in order to reach the roof.

- (i) Find the length of the ladder used by the fireman to reach the roof. [1]
- (ii) Find the distance of the point on the ground at which the ladder was fixed from the bottom of the building. [1]
- (iii) In order to avoid skidding, the fireman placed the ladder in such a way that the bottom of the ladder touches the base of the wall which is opposite to the building, making an angle of 30° with the ground.
- (a) Draw a neat diagram to represent the above situation and hence find the width of the road between the building and the wall. [2]

OR

- (b) Find the length of the ladder used by the fireman in this case. [2]

Figure: A photo of a fireman with a ladder against a roof, and a sketch of the same: a vertical building wall, the ground, and a ladder leaning from the ground to the roof.

SOLUTION

(i) The building is 15 m high and the ladder makes 60° with the ground. The ladder L is the hypotenuse: $\sin 60^\circ = \frac{15}{L}$,
so $L = \frac{15}{\sin 60^\circ} = \frac{15}{\frac{\sqrt{3}}{2}} = 10\sqrt{3}$ m.

(ii) Distance x from the building: $\tan 60^\circ = \frac{15}{x}$, so $x = \frac{15}{\tan 60^\circ} = 5\sqrt{3}$ m.

(iii)(a) Diagram: a vertical line for the building (height 15 m) on the left, the ground as a horizontal line of width y (the road) to the base of the opposite wall on the right, and the ladder from that point up to the roof of the building, making 30° with the ground. This forms a right triangle with height 15, base y and the ladder as hypotenuse.

$\tan 30^\circ = \frac{15}{y}$, so $y = 15 \times \sqrt{3} = 15\sqrt{3}$ m.

(iii)(b) In the same triangle: $\sin 30^\circ = \frac{15}{l}$, so $\frac{1}{2} = \frac{15}{l}$ and $l = 30$ m.

Answer: (i) $10\sqrt{3}$ m (ii) $5\sqrt{3}$ m (iii)(a) $15\sqrt{3}$ m (iii)(b) 30 m

Common mistake: Using $\tan$ for the ladder length. The ladder is the hypotenuse, so use $\sin$ with the height.

Q37 · ARITHMETIC PROGRESSIONS · 4 MARKS

Case study 2. In a garden, saplings of rose flowers were planted at equal intervals to form a spiral pattern. The spiral is made up of successive semicircles, with centres alternately at A and B, starting with centre at A, of radii 50 cm, 100 cm, 150 cm, ... Spiral 1 has 10 flowers, Spiral 2 has 20 flowers, Spiral 3 has 30 flowers and so on.

- (i) What is the radius of the 13th spiral? [1]
- (ii) If the radius of the n th spiral is 500 cm, find the value of n . [1]
- (iii) (a) Find the total number of saplings till the 11th spiral. [2]

OR

- (iii) (b) Till which spiral, will there be a total of 450 saplings? [2]

Figure: A spiral made of successive semicircles with centres alternately at the points A and B, which are very close together on a horizontal line. The semicircles are labelled I1, I2, I3, I4, each larger than the one before.

SOLUTION

The radii 50, 100, 150, ... form an AP with first term $a = 50$ and common difference $d = 50$, so the n th radius is $a_n = 50 + (n - 1) \times 50 = 50n$.

(i) $a_{13} = 50 \times 13 = 650$ cm.

(ii) $50n = 500$, so $n = 10$.

The numbers of flowers 10, 20, 30, ... form a different AP, with $a = 10$ and $d = 10$.

(iii)(a) $S_{11} = \frac{11}{2} [2 \times 10 + (11 - 1) \times 10] = \frac{11}{2} \times 120 = 660$ saplings.

(iii)(b) $S_n = \frac{n}{2} [20 + (n - 1) \times 10] = 450$, so $5n(n + 1) = 450$, i.e. $n^2 + n - 90 = 0$.

$(n - 9)(n + 10) = 0$, and n cannot be negative, so $n = 9$. There are 450 saplings till the 9th spiral.

Answer: (i) 650 cm (ii) $n = 10$ (iii)(a) 660 (iii)(b) 9th spiral

Common mistake: Mixing the two progressions: the radii go up by 50 cm and the flowers go up by 10 per spiral.

Q38 · COORDINATE GEOMETRY · 4 MARKS

Case study 3. In a society, there is a circular park having two gates. The gates are placed at points A(10, 20) and B(50, 50), as shown in the figure below. Two fountains are installed at points P and Q on AB such that $AP = PQ = QB$.

(i) Find the coordinates of the centre C. [1]

(ii) Find the radius of the circular park. [1]

(iii) (a) Find the coordinates of the point P. [2]

OR

(iii) (b) Find the distance of the fountain at Q from gate A. [2]

Figure: A circle with a diameter AB drawn across it. On AB, from A to B, the points P, C (the centre) and Q lie in that order. $AP = PQ = QB$.

SOLUTION

AB is a diameter, so the centre C is the mid-point of A(10, 20) and B(50, 50).

(i) $C = \left(\frac{10 + 50}{2}, \frac{20 + 50}{2} \right) = (30, 35)$.

(ii) Radius = $CA = \sqrt{(30 - 10)^2 + (35 - 20)^2} = \sqrt{400 + 225} = \sqrt{625} = 25$ units.

(iii)(a) $AP = PQ = QB$, so P divides AB in the ratio 1 : 2. By the section formula, $P = \left(\frac{1 \times 50 + 2 \times 10}{3}, \frac{1 \times 50 + 2 \times 20}{3} \right) = \left(\frac{70}{3}, 30 \right)$.

(iii)(b) $AB = 2 \times 25 = 50$ units. Q is two-thirds of the way from A to B: $AQ = \frac{2}{3} \times 50 = \frac{100}{3}$ units.

Answer: (i) (30, 35) (ii) 25 units (iii)(a) $\left(\frac{70}{3}, 30 \right)$ (iii)(b) $\frac{100}{3}$ units

Common mistake: Using the ratio 2 : 1 for P. P is the point nearer to A, so the ratio AP : PB is 1 : 2.

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