

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

Q.P. Code 30/1/1 · 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 · POLYNOMIALS · 1 MARK

If α and β are the zeroes of the polynomial $3x^2 + 6x + k$ such that $\alpha + \beta + \alpha\beta = -\frac{2}{3}$, then the value of k is:

- (A) -8 (B) 8
(C) -4 (D) 4

SOLUTION

For $3x^2 + 6x + k$: sum of zeroes $\alpha + \beta = -\frac{6}{3} = -2$, and product $\alpha\beta = \frac{k}{3}$.

Put these in the given condition: $-2 + \frac{k}{3} = -\frac{2}{3}$.

So $\frac{k}{3} = 2 - \frac{2}{3} = \frac{4}{3}$, which gives $k = 4$.

Answer: (D) 4

Common mistake: Writing $\alpha + \beta = +\frac{b}{a}$ (forgetting the minus sign) gives $k = -8$.

Q2 · LINEAR EQUATIONS · 1 MARK

If $x = 1$ and $y = 2$ is a solution of the pair of linear equations $2x - 3y + a = 0$ and $2x + 3y - b = 0$, then:

- (A) $a = 2b$ (B) $2a = b$
(C) $a + 2b = 0$ (D) $2a + b = 0$

SOLUTION

Put $x = 1$, $y = 2$ in the first equation: $2 - 6 + a = 0$, so $a = 4$.

Put $x = 1$, $y = 2$ in the second: $2 + 6 - b = 0$, so $b = 8$.

Compare: $b = 8 = 2 \times 4 = 2a$, so $2a = b$.

Answer: (B) $2a = b$

Q3 · COORDINATE GEOMETRY · 1 MARK

The mid-point of the line segment joining the points $P(-4, 5)$ and $Q(4, 6)$ lies on:

- (A) x-axis (B) y-axis
(C) origin (D) neither x-axis nor y-axis

SOLUTION

Mid-point = $\left(\frac{-4+4}{2}, \frac{5+6}{2}\right) = \left(0, \frac{11}{2}\right)$.

The x-coordinate is 0 and the y-coordinate is not, so the point is on the y-axis (it is not the origin).

Answer: (B) y-axis

Common mistake: Calling it the origin. The origin needs both coordinates to be 0.

Q4 · TRIGONOMETRY · 1 MARK

If θ is an acute angle and $7 + 4 \sin \theta = 9$, then the value of θ is:

- (A) 90° (B) 30°
(C) 45° (D) 60°

SOLUTION

$$4 \sin \theta = 9 - 7 = 2, \text{ so } \sin \theta = \frac{1}{2}.$$

$$\sin 30^\circ = \frac{1}{2} \text{ and } \theta \text{ is acute, so } \theta = 30^\circ.$$

Answer: (B) 30°

Q5 · TRIGONOMETRY · 1 MARK

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

- (A) 1 (B) 0
(C) -1 (D) 2

SOLUTION

$$\frac{1}{\cos \theta} = \sec \theta, \text{ so the bracket is } \sec \theta \times \sec \theta = \sec^2 \theta.$$

$$\text{The expression is } \tan^2 \theta - \sec^2 \theta.$$

$$\text{Since } \sec^2 \theta = 1 + \tan^2 \theta, \text{ we get } \tan^2 \theta - (1 + \tan^2 \theta) = -1.$$

Answer: (C) -1

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

Q6 · REAL NUMBERS · 1 MARK

If $\text{HCF}(98, 28) = m$ and $\text{LCM}(98, 28) = n$, then the value of $n - 7m$ is:

- (A) 0 (B) 28
(C) 98 (D) 198

SOLUTION

$$98 = 2 \times 7^2 \text{ and } 28 = 2^2 \times 7. \text{ HCF} = 2 \times 7 = 14, \text{ so } m = 14.$$

$$\text{LCM} = 2^2 \times 7^2 = 196, \text{ so } n = 196. (\text{Check: } 14 \times 196 = 2744 = 98 \times 28.)$$

$$n - 7m = 196 - 98 = 98.$$

Answer: (C) 98

Q7 · CIRCLES · 1 MARK

The tangents drawn at the extremities of the diameter of a circle are always:

- (A) parallel (B) perpendicular
(C) equal (D) intersecting

SOLUTION

A tangent is perpendicular to the radius at the point of contact.

The two ends of a diameter lie on one straight line through the centre, so both tangents are perpendicular to that same line.

Two lines perpendicular to the same line are parallel.

Answer: (A) parallel

Q8 · TRIANGLES · 1 MARK

In triangles ABC and DEF , $\angle B = \angle E$, $\angle F = \angle C$ and $AB = 3 DE$. Then the two triangles are:

- (A) congruent but not similar (B) congruent as well as similar
(C) neither congruent nor similar (D) similar but not congruent

SOLUTION

Two pairs of equal angles ($\angle B = \angle E$ and $\angle C = \angle F$) give similarity by the AA criterion.

AB and DE are corresponding sides and $AB = 3 DE$, so the ratio of sides is 3 : 1, not 1 : 1.

Triangles of equal size would be congruent. These are not the same size.

Answer: (D) similar but not congruent

Common mistake: Treating "similar" as "congruent". Congruent needs equal sides, similar only needs equal angles.

Q9 · REAL NUMBERS · 1 MARK

If $(-1)^n + (-1)^8 = 0$, then n is:

- (A) any positive integer (B) any negative integer
(C) any odd number (D) any even number

SOLUTION

$(-1)^8 = 1$ because 8 is even.

So $(-1)^n + 1 = 0$, which means $(-1)^n = -1$.

(-1) raised to a power is -1 only when the power is odd.

Answer: (C) any odd number

Q10 · POLYNOMIALS · 1 MARK

Two polynomials are shown in the graph below. The number of distinct zeroes of both the polynomials is:

Figure: Two parabolas on the same axes: one opens upward, the other opens downward. They cross each other exactly on the x-axis, at the same two points.

- (A) 3 (B) 5
(C) 2 (D) 4

SOLUTION

A zero of a polynomial is where its graph meets the x-axis.

Each parabola meets the x-axis at two points, and both parabolas meet it at the same two points.

So the distinct zeroes are only 2, not 4.

Answer: (C) 2

Common mistake: Adding the zeroes of the two graphs ($2 + 2 = 4$). The question asks for distinct zeroes, and they share both.

Q11 · ARITHMETIC PROGRESSIONS · 1 MARK

If the sum of the first m terms of an AP is $2m^2 + 3m$, then its second term is:

- (A) 10 (B) 9
(C) 12 (D) 4

SOLUTION

$$S_1 = 2 + 3 = 5, \text{ so } a_1 = 5.$$

$$S_2 = 2(4) + 3(2) = 14.$$

$$\text{Second term} = S_2 - S_1 = 14 - 5 = 9.$$

Answer: (B) 9

Common mistake: Answering 14, which is the sum of two terms, not the second term.

Q12 · STATISTICS · 1 MARK

Mode and Mean of a data are $15x$ and $18x$, respectively. Then the median of the data is:

- (A) x (B) $11x$
(C) $17x$ (D) $34x$

SOLUTION

Use the empirical relation: $\text{Mode} = 3 \times \text{Median} - 2 \times \text{Mean}$.

$$15x = 3 \text{ Median} - 36x, \text{ so } 3 \text{ Median} = 51x.$$

$$\text{Median} = 17x.$$

Answer: (C) $17x$

Common mistake: Swapping the mean and the mode in the relation.

Q13 · PROBABILITY · 1 MARK

A card is selected at random from a deck of 52 playing cards. The probability of it being a red face card is:

- (A) $\frac{3}{13}$ (B) $\frac{2}{13}$
(C) $\frac{1}{2}$ (D) $\frac{3}{26}$

SOLUTION

Face cards are Jack, Queen and King: 3 in each of the 4 suits.

Red suits are hearts and diamonds, so red face cards = $3 \times 2 = 6$.

$$\text{Probability} = \frac{6}{52} = \frac{3}{26}.$$

Answer: (D) $\frac{3}{26}$

Common mistake: Counting all 12 face cards and answering $\frac{3}{13}$.

Q14 · REAL NUMBERS · 1 MARK

Which of the following is a rational number between $\sqrt{3}$ and $\sqrt{5}$?

- (A) 1.4142387954012... (B) $2.32\overline{6}$
(C) π (D) 1.857142

SOLUTION

$\sqrt{3} \approx 1.732$ and $\sqrt{5} \approx 2.236$, so we need a rational number between 1.732 and 2.236.

Option A never ends and never repeats, so it is irrational (and it is below 1.732 anyway).

Option B is a repeating decimal, so it is rational, but $2.32\overline{6} \dots$ is bigger than 2.236.

π is irrational. Option D, 1.857142, is a terminating decimal, so it is rational, and $1.732 < 1.857142 < 2.236$.

Answer: (D) 1.857142

Common mistake: Picking B because it is rational, without checking that it lies between the two roots.

Q15 · AREAS RELATED TO CIRCLES · 1 MARK

If a sector of a circle has an area of 40π sq. units and a central angle of 72° , the radius of the circle is:

- (A) 200 units (B) 100 units
(C) 20 units (D) $10\sqrt{2}$ units

SOLUTION

$$\text{Area of sector} = \frac{\theta}{360} \times \pi r^2 = \frac{72}{360} \times \pi r^2 = \frac{\pi r^2}{5}.$$

$$\frac{\pi r^2}{5} = 40\pi, \text{ so } r^2 = 200.$$

$$r = \sqrt{200} = 10\sqrt{2} \text{ units.}$$

Answer: (D) $10\sqrt{2}$ units

Common mistake: Stopping at $r^2 = 200$ and picking 200.

Q16 · CIRCLES · 1 MARK

In the given figure, PA is a tangent from an external point P to a circle with centre O . If $\angle POB = 115^\circ$, then $\angle APO$ is equal to:

Figure: A circle with centre O . AB is a diameter (A at the top, B at the bottom). P is outside the circle on the left, PA is a tangent touching the circle at A , and PO is joined. Angle POB is marked 115 degrees.

- (A) 25° (B) 65°
(C) 90° (D) 35°

SOLUTION

A, O, B lie on one straight line, so $\angle POA + \angle POB = 180^\circ$, giving $\angle POA = 180^\circ - 115^\circ = 65^\circ$.

The tangent PA is perpendicular to the radius OA , so $\angle PAO = 90^\circ$.

In $\triangle APO$: $\angle APO = 180^\circ - 90^\circ - 65^\circ = 25^\circ$.

Answer: (A) 25°

Common mistake: Using 115° as $\angle POA$ and getting $\angle APO = 90^\circ - 115^\circ$, which is impossible. Use the straight line AOB first.

Q17 · APPLICATIONS OF TRIGONOMETRY · 1 MARK

A kite is flying at a height of 150 m from the ground. It is attached to a string inclined at an angle of 30° to the horizontal. The length of the string is:

- (A) $100\sqrt{3}$ m (B) 300 m
(C) $150\sqrt{2}$ m (D) $150\sqrt{3}$ m

SOLUTION

The height is opposite to the 30° angle, and the string is the hypotenuse.

$$\sin 30^\circ = \frac{\text{height}}{\text{string}}, \text{ so } \frac{1}{2} = \frac{150}{L}.$$

$$L = 300 \text{ m.}$$

Answer: (B) 300 m

Common mistake: Using $\cos 30^\circ$ or $\tan 30^\circ$, which would need the horizontal distance.

Q18 · AREAS RELATED TO CIRCLES · 1 MARK

A piece of wire 20 cm long is bent into the form of an arc of a circle of radius $\frac{60}{\pi}$ cm. The angle subtended by the arc at the centre of the circle is:

- (A) 30° (B) 60°
(C) 90° (D) 50°

SOLUTION

$$\text{Arc length} = \frac{\theta}{360} \times 2\pi r.$$

$$20 = \frac{\theta}{360} \times 2\pi \times \frac{60}{\pi} = \frac{\theta}{360} \times 120.$$

$$\theta = \frac{20 \times 360}{120} = 60^\circ.$$

Answer: (B) 60°

Q19 · PROBABILITY · 1 MARK

Assertion (A): The probability of selecting a number at random from the numbers 1 to 20 is 1.

Reason (R): For any event E , if $P(E) = 1$, then E is called a sure event.

- (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

Picking a number from 1 to 20 means you will certainly get some number from 1 to 20. Every outcome is favourable, so the probability is $\frac{20}{20} = 1$. The assertion is true.

An event with probability 1 is called a sure event. The reason is true.

The reason is exactly why the assertion holds: the event is certain, so its probability is 1. So R explains A.

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

Common mistake: Reading the assertion as "the probability of picking one particular number" (which is $\frac{1}{20}$). It says selecting a number from 1 to 20, which is certain.

Q20 · SURFACE AREAS AND VOLUMES · 1 MARK

Assertion (A): If we join two hemispheres of the same radius along their bases, then we get a sphere.

Reason (R): Total surface area of a sphere of radius r is $3\pi r^2$.

- (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

Two hemispheres of the same radius, joined flat face to flat face, make a full sphere. The assertion is true.

The total surface area of a sphere is $4\pi r^2$, not $3\pi r^2$. ($3\pi r^2$ is the total surface area of a solid hemisphere.) The reason is false.

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

Common mistake: Confusing the sphere's $4\pi r^2$ with the solid hemisphere's $3\pi r^2$.

Section B: Very short answer

5 questions, 2 marks each.

Q21 · TRIGONOMETRY · 2 MARKS

(a) If $x \cos 60^\circ + y \cos 0^\circ + \sin 30^\circ - \cot 45^\circ = 5$, find the value of $x + 2y$.

OR

(b) Evaluate: $\frac{\tan^2 60^\circ}{\sin^2 60^\circ + \cos^2 30^\circ}$

SOLUTION

(a) Standard values: $\cos 60^\circ = \frac{1}{2}$, $\cos 0^\circ = 1$, $\sin 30^\circ = \frac{1}{2}$, $\cot 45^\circ = 1$.

So $\frac{x}{2} + y + \frac{1}{2} - 1 = 5$, which gives $\frac{x}{2} + y = \frac{11}{2}$.

Multiply by 2: $x + 2y = 11$.

(b) $\tan 60^\circ = \sqrt{3}$, so $\tan^2 60^\circ = 3$. $\sin 60^\circ = \cos 30^\circ = \frac{\sqrt{3}}{2}$, so $\sin^2 60^\circ + \cos^2 30^\circ = \frac{3}{4} + \frac{3}{4} = \frac{3}{2}$.

The value is $3 \div \frac{3}{2} = 2$.

Answer: (a) $x + 2y = 11$ (b) 2

Q22 · POLYNOMIALS · 2 MARKS

Find the zeroes of the polynomial $p(x) = x^2 + \frac{4}{3}x - \frac{4}{3}$.

SOLUTION

Multiply by 3 to clear the fractions: $3x^2 + 4x - 4 = 0$.

Split the middle term: $3x^2 + 6x - 2x - 4 = 3x(x + 2) - 2(x + 2) = (3x - 2)(x + 2)$.

Set each factor to zero: $x = \frac{2}{3}$ or $x = -2$.

Answer: Zeroes: $\frac{2}{3}$ and -2

Common mistake: Giving the factors instead of the zeroes, or flipping the sign of a zero.

Q23 · COORDINATE GEOMETRY · 2 MARKS

The coordinates of the centre of a circle are $(2a, a - 7)$. Find the value(s) of a if the circle passes through the point $(11, -9)$ and has diameter $10\sqrt{2}$ units.

SOLUTION

Radius = $\frac{10\sqrt{2}}{2} = 5\sqrt{2}$, so $r^2 = 50$.

The distance from the centre $(2a, a - 7)$ to $(11, -9)$ equals the radius: $(11 - 2a)^2 + (-9 - a + 7)^2 = 50$.

That is $(11 - 2a)^2 + (a + 2)^2 = 50$. Expand: $121 - 44a + 4a^2 + a^2 + 4a + 4 = 50$.

$5a^2 - 40a + 75 = 0$, so $a^2 - 8a + 15 = 0$, i.e. $(a - 3)(a - 5) = 0$.

Answer: $a = 3$ or $a = 5$

Common mistake: Stopping after one value. The question asks for value(s), and both work.

Q24 · TRIANGLES · 2 MARKS

(a) If $\triangle ABC \sim \triangle PQR$ in which $AB = 6$ cm, $BC = 4$ cm, $AC = 8$ cm and $PR = 6$ cm, find the length of $(PQ + QR)$.

OR

(b) In the given figure, $\frac{QR}{QS} = \frac{QT}{PR}$ and $\angle 1 = \angle 2$. Show that $\triangle PQS \sim \triangle TQR$.

Figure: For part (b): T, P and Q lie on one straight line. Q, S and R lie on another line from Q. Angle 1 is the angle at Q and angle 2 is the angle at R (angle PRQ). P is joined to S and to R.

SOLUTION

(a) Corresponding sides are in the same ratio, with $A \leftrightarrow P$, $B \leftrightarrow Q$, $C \leftrightarrow R$. AC corresponds to PR , so the ratio is $\frac{PR}{AC} = \frac{6}{8} = \frac{3}{4}$.

$$PQ = AB \times \frac{3}{4} = 4.5 \text{ cm and } QR = BC \times \frac{3}{4} = 3 \text{ cm.}$$

$$PQ + QR = 4.5 + 3 = 7.5 \text{ cm.}$$

(b) In $\triangle PQR$, $\angle 1 = \angle 2$ means $\angle PQR = \angle PRQ$, so the sides opposite them are equal: $PR = PQ$.

Replace PR by PQ in the given ratio: $\frac{QR}{QS} = \frac{QT}{PQ}$, which can be written $\frac{QS}{QR} = \frac{PQ}{QT}$.

In $\triangle PQS$ and $\triangle TQR$: $\frac{PQ}{QT} = \frac{QS}{QR}$, and $\angle PQS = \angle TQR$ (the same angle at Q).

So $\triangle PQS \sim \triangle TQR$ by the SAS similarity criterion.

Answer: (a) 7.5 cm (b) shown by SAS similarity

Common mistake: Matching the wrong sides in part (a). Write the similarity in vertex order first (A to P, B to Q, C to R).

Q25 · CIRCLES · 2 MARKS

A person is standing at P outside a circular ground at a distance of 26 m from the centre of the ground. He found that his distances from the points A and B on the ground are 10 m each (PA and PB are tangents to the circle). Find the radius of the circular ground.

Figure: Circle with centre O. P is outside, 26 m from O. PA and PB are tangents, each 10 m long. OA and OB are radii.

SOLUTION

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

$$OA^2 = OP^2 - PA^2 = 26^2 - 10^2 = 676 - 100 = 576.$$

$$OA = 24 \text{ m.}$$

Answer: Radius = 24 m

Common mistake: Adding instead of subtracting: $OP^2 + PA^2$ treats OP as a leg, but OP is the hypotenuse.

Section C: Short answer

6 questions, 3 marks each.

Q26 · CIRCLES · 3 MARKS

(a) In the given figure, O is the centre of the circle and BCD is a tangent to it at C . Prove that $\angle BAC + \angle ACD = 90^\circ$.

OR

(b) Prove that opposite sides of a quadrilateral circumscribing a circle subtend supplementary angles at the centre of the circle.

Figure: For part (a): B, P, O, A lie along one line, and BCD is a tangent at C , with C directly below O . OC is drawn (dotted) and AC is joined.

SOLUTION

(a) BCD is a tangent at C and OC is a radius, so $OC \perp BD$. Hence $\angle OCD = 90^\circ$, i.e. $\angle OCA + \angle ACD = 90^\circ$.
... (1)

In $\triangle OAC$, $OA = OC$ (radii), so $\angle OAC = \angle OCA$ (angles opposite equal sides).

O lies on line BA , so $\angle BAC$ is the same angle as $\angle OAC$. Put $\angle OCA = \angle BAC$ in (1): $\angle BAC + \angle ACD = 90^\circ$.

(b) Let $ABCD$ circumscribe a circle with centre O , touching AB, BC, CD, DA at P, Q, R, S . Join O to A, B, C, D and to P, Q, R, S .

Tangents from an outside point are equal: $AP = AS$. Also $OP = OS$ (radii) and OA is common, so $\triangle OAP \cong \triangle OAS$ (SSS). Hence $\angle AOP = \angle AOS$; call it $\angle 1$.

In the same way $\angle BOP = \angle BOQ = \angle 2$, $\angle COQ = \angle COR = \angle 3$, $\angle DOR = \angle DOS = \angle 4$.

The angles around O add up to 360° : $2(\angle 1 + \angle 2 + \angle 3 + \angle 4) = 360^\circ$, so $\angle 1 + \angle 2 + \angle 3 + \angle 4 = 180^\circ$.

$\angle AOB = \angle 1 + \angle 2$ and $\angle COD = \angle 3 + \angle 4$, so $\angle AOB + \angle COD = 180^\circ$. Likewise $\angle AOD + \angle BOC = \angle 1 + \angle 4 + \angle 2 + \angle 3 = 180^\circ$.

Answer: (a) $\angle BAC + \angle ACD = 90^\circ$ (b) opposite sides subtend supplementary angles

Common mistake: Drawing the radius to the point of contact is the step most answers skip. Without OC , there is nothing to connect the tangent to the angle.

Q27 · TRIGONOMETRY · 3 MARKS

(a) Prove that: $\frac{\tan \theta}{1 - \cot \theta} + \frac{\cot \theta}{1 - \tan \theta} = 1 + \sec \theta \operatorname{cosec} \theta$

OR

(b) Prove that: $\frac{\sin A + \cos A}{\sin A - \cos A} + \frac{\sin A - \cos A}{\sin A + \cos A} = \frac{2}{2 \sin^2 A - 1}$

SOLUTION

(a) Write everything in $\sin$ and $\cos$. $\frac{\tan \theta}{1 - \cot \theta} = \frac{\sin \theta / \cos \theta}{(\sin \theta - \cos \theta) / \sin \theta} = \frac{\sin^2 \theta}{\cos \theta (\sin \theta - \cos \theta)}$.

$\frac{\cot \theta}{1 - \tan \theta} = \frac{\cos \theta / \sin \theta}{(\cos \theta - \sin \theta) / \cos \theta} = \frac{\cos^2 \theta}{\sin \theta (\cos \theta - \sin \theta)} = -\frac{\cos^2 \theta}{\sin \theta (\sin \theta - \cos \theta)}$.

Add them: $\frac{1}{\sin \theta - \cos \theta} \left[\frac{\sin^2 \theta}{\cos \theta} - \frac{\cos^2 \theta}{\sin \theta} \right] = \frac{1}{\sin \theta - \cos \theta} \cdot \frac{\sin^3 \theta - \cos^3 \theta}{\sin \theta \cos \theta}$.

Use $a^3 - b^3 = (a - b)(a^2 + ab + b^2)$: this becomes $\frac{\sin^2 \theta + \sin \theta \cos \theta + \cos^2 \theta}{\sin \theta \cos \theta} = \frac{1 + \sin \theta \cos \theta}{\sin \theta \cos \theta}$.

$= \frac{1}{\sin \theta \cos \theta} + 1 = 1 + \sec \theta \operatorname{cosec} \theta = \text{RHS}$.

(b) Take the common denominator $(\sin A - \cos A)(\sin A + \cos A) = \sin^2 A - \cos^2 A$.

Numerator: $(\sin A + \cos A)^2 + (\sin A - \cos A)^2 = 2(\sin^2 A + \cos^2 A) = 2$.

Denominator: $\sin^2 A - \cos^2 A = \sin^2 A - (1 - \sin^2 A) = 2\sin^2 A - 1$. So $\text{LHS} = \frac{2}{2\sin^2 A - 1} = \text{RHS}$.

Answer: Both identities proved

Common mistake: Starting from both sides at once. Work on the left side only and arrive at the right side.

Q28 · COORDINATE GEOMETRY · 3 MARKS

Find the ratio in which the y-axis divides the line segment joining the points $(5, -6)$ and $(-1, -4)$. Also find the point of intersection.

SOLUTION

Let the y-axis divide the segment in the ratio $k : 1$ at the point $(0, y)$.

Section formula for the x-coordinate: $\frac{k \times (-1) + 1 \times 5}{k + 1} = 0$, so $-k + 5 = 0$ and $k = 5$.

The ratio is $5 : 1$.

$$y = \frac{5 \times (-4) + 1 \times (-6)}{5 + 1} = \frac{-26}{6} = -\frac{13}{3}.$$

Answer: Ratio $5 : 1$, point of intersection $(0, -\frac{13}{3})$

Common mistake: Using the x-coordinate for the y-axis condition the wrong way round. On the y-axis, x is 0.

Q29 · REAL NUMBERS · 3 MARKS

Prove that $\frac{1}{\sqrt{5}}$ is an irrational number.

SOLUTION

Suppose $\frac{1}{\sqrt{5}}$ is rational. Then $\frac{1}{\sqrt{5}} = \frac{p}{q}$ for integers p, q with $q \neq 0$, and p, q have no common factor.

Flip both sides: $\sqrt{5} = \frac{q}{p}$. So $\sqrt{5}$ would be rational.

But $\sqrt{5}$ is irrational. To see this, suppose $\sqrt{5} = \frac{a}{b}$ in lowest terms. Then $5b^2 = a^2$, so 5 divides a^2 . Since 5 is prime, 5 divides a . Write $a = 5c$: $5b^2 = 25c^2$, so $b^2 = 5c^2$, and 5 divides b . Now 5 divides both a and b , which contradicts "lowest terms".

So our assumption was wrong, and $\frac{1}{\sqrt{5}}$ is irrational.

Answer: Proved by contradiction

Common mistake: Writing "so it is irrational" without showing the contradiction with the common factor.

Q30 · SURFACE AREAS AND VOLUMES · 3 MARKS

A room is in the form of a cylinder surmounted by a hemispherical dome. The base radius of the hemisphere is half of the height of the cylindrical part. If the room contains $\frac{1408}{21} \text{ m}^3$ of air, find the height of the cylindrical part. (Use $\pi = \frac{22}{7}$)

SOLUTION

Let the common radius be r . The height of the cylinder is twice that, $h = 2r$.

$$\text{Volume of air} = \text{cylinder} + \text{hemisphere} = \pi r^2 h + \frac{2}{3} \pi r^3 = \pi r^2 (2r) + \frac{2}{3} \pi r^3 = \frac{8}{3} \pi r^3.$$

$$\frac{8}{3} \times \frac{22}{7} \times r^3 = \frac{1408}{21}, \text{ which is } \frac{176}{21} r^3 = \frac{1408}{21}.$$

$$r^3 = \frac{1408}{176} = 8, \text{ so } r = 2 \text{ m.}$$

Height of the cylindrical part = $2r = 4 \text{ m}$.

Answer: Height = 4 m

Common mistake: Answering $r = 2 \text{ m}$. The question asks for the height of the cylinder, which is $2r$.

Q31 · PROBABILITY · 3 MARKS

Two dice are thrown at the same time. Determine the probability that the difference of the numbers on the two dice is 2.

SOLUTION

Total outcomes when two dice are thrown = $6 \times 6 = 36$.

Pairs with difference 2: $(1, 3), (3, 1), (2, 4), (4, 2), (3, 5), (5, 3), (4, 6), (6, 4)$. That is 8 pairs.

$$\text{Probability} = \frac{8}{36} = \frac{2}{9}.$$

Answer: $P = \frac{2}{9}$

Common mistake: Counting only 4 pairs, e.g. $(1, 3)$ but not $(3, 1)$. The two dice are different, so both orders count.

Section D: Long answer

4 questions, 5 marks each.

Q32 · LINEAR EQUATIONS · 5 MARKS

Vijay invested certain amounts of money in two schemes A and B , which offer interest at the rate of 8% per annum and 9% per annum, respectively. He received ₹1,860 as the total annual interest. However, had he interchanged the amounts of investments in the two schemes, he would have received ₹20 more as annual interest. How much money did he invest in each scheme?

SOLUTION

Let ₹ x be invested in A (8%) and ₹ y in B (9%).

First case: $\frac{8x}{100} + \frac{9y}{100} = 1860$, so $8x + 9y = 186000$ (i)

Interchanged: $\frac{9x}{100} + \frac{8y}{100} = 1860 + 20 = 1880$, so $9x + 8y = 188000$ (ii)

Add (i) and (ii): $17x + 17y = 374000$, so $x + y = 22000$ (iii)

Subtract (i) from (ii): $x - y = 2000$ (iv)

Add (iii) and (iv): $2x = 24000$, so $x = 12000$. Then $y = 22000 - 12000 = 10000$.

Check: $8 \times 12000 + 9 \times 10000 = 96000 + 90000 = 186000$ ✓.

Answer: ₹12,000 in scheme A and ₹10,000 in scheme B

Common mistake: Forgetting to divide by 100, or using ₹20 less instead of ₹20 more in the second equation.

Q33 · TRIANGLES · 5 MARKS

(a) The diagonal BD of a parallelogram $ABCD$ intersects the line segment AE at the point F , where E is any point on the side BC . Prove that $DF \times EF = FB \times FA$.

OR

(b) In $\triangle ABC$, if $AD \perp BC$ and $AD^2 = BD \times DC$, then prove that $\angle BAC = 90^\circ$.

Figure: For part (a): parallelogram $ABCD$ with E on side BC . Segment AE crosses diagonal BD at F . For part (b): triangle ABC with AD drawn perpendicular to BC , D on BC .

SOLUTION

(a) In a parallelogram $AD \parallel BC$, so $AD \parallel BE$. Consider $\triangle ADF$ and $\triangle EBF$.

$\angle AFD = \angle EFB$ (vertically opposite angles).

$\angle ADF = \angle FBE$ (alternate angles, since $AD \parallel BE$ with transversal BD).

So $\triangle ADF \sim \triangle EBF$ by AA similarity. Corresponding sides are proportional: $\frac{DF}{FB} = \frac{FA}{EF}$.

Cross-multiply: $DF \times EF = FB \times FA$.

(b) $AD^2 = BD \times DC$ gives $\frac{AD}{DC} = \frac{BD}{AD}$, i.e. $\frac{BD}{AD} = \frac{AD}{DC}$.

In $\triangle DBA$ and $\triangle DAC$: $\angle BDA = \angle ADC = 90^\circ$, and $\frac{BD}{AD} = \frac{AD}{DC}$. So $\triangle DBA \sim \triangle DAC$ by SAS similarity.

Hence $\angle DBA = \angle DAC$ and $\angle BAD = \angle DCA$.

In right triangle ADB : $\angle DBA + \angle BAD = 90^\circ$. Replace $\angle DBA$ by $\angle DAC$: $\angle DAC + \angle BAD = 90^\circ$.

But $\angle BAD + \angle DAC = \angle BAC$. So $\angle BAC = 90^\circ$.

Answer: (a) $DF \times EF = FB \times FA$ (b) $\angle BAC = 90^\circ$

Common mistake: Skipping the figure. A clear, labelled figure is worth marks in proof questions.

Q34 · QUADRATIC EQUATIONS · 5 MARKS

(a) The perimeter of a right triangle is 60 cm and its hypotenuse is 25 cm. Find the lengths of the other two sides of the triangle.

OR

(b) A train travels a distance of 480 km at a uniform speed. If the speed had been 8 km/h less, then it would have taken 3 hours more to cover the same distance. Find the speed of the train.

SOLUTION

(a) Let the other two sides be x cm and y cm. Perimeter: $x + y + 25 = 60$, so $y = 35 - x$.

Pythagoras: $x^2 + y^2 = 25^2 = 625$, so $x^2 + (35 - x)^2 = 625$.

$x^2 + 1225 - 70x + x^2 = 625$, so $2x^2 - 70x + 600 = 0$, i.e. $x^2 - 35x + 300 = 0$.

$(x - 15)(x - 20) = 0$, so $x = 15$ or 20 , and the other side is 20 or 15 . The sides are 15 cm and 20 cm.

(b) Let the speed be x km/h. At speed $(x - 8)$ the time is $\frac{480}{x - 8}$, which is 3 hours more than $\frac{480}{x}$.

$\frac{480}{x - 8} - \frac{480}{x} = 3$. Combine: $\frac{480 \times 8}{x(x - 8)} = 3$, so $x(x - 8) = 1280$.

$x^2 - 8x - 1280 = 0$. Factorise: $(x - 40)(x + 32) = 0$, so $x = 40$ or $x = -32$.

Speed cannot be negative, so $x = 40$.

Answer: (a) 15 cm and 20 cm (b) 40 km/h

Common mistake: Leaving the negative root in (b). Say clearly why it is rejected.

Q35 · STATISTICS · 5 MARKS

Find the missing frequency f in the following table, if the mean of the given data is 18. Hence find the mode.

Daily allowance (₹)	Number of children
11 – 13	7
13 – 15	6
15 – 17	9
17 – 19	13
19 – 21	f
21 – 23	5
23 – 25	4

SOLUTION

Class marks x_i : 12, 14, 16, 18, 20, 22, 24. Products $f_i x_i$: 84, 84, 144, 234, $20f$, 110, 96.

$$\sum f_i = 7 + 6 + 9 + 13 + f + 5 + 4 = 44 + f \text{ and } \sum f_i x_i = 752 + 20f.$$

$$\text{Mean} = \frac{\sum f_i x_i}{\sum f_i} = 18, \text{ so } 752 + 20f = 18(44 + f) = 792 + 18f.$$

$$2f = 40, \text{ so } f = 20.$$

The highest frequency is 20, so the modal class is 19 – 21. Here $l = 19$, $f_1 = 20$, $f_0 = 13$, $f_2 = 5$, class width $h = 2$.

$$\text{Mode} = l + \frac{f_1 - f_0}{2f_1 - f_0 - f_2} \times h = 19 + \frac{20 - 13}{40 - 13 - 5} \times 2 = 19 + \frac{7}{22} \times 2 = 19 + \frac{7}{11} \approx 19.64.$$

Answer: $f = 20$ and **Mode** ≈ 19.64

Common mistake: Using the wrong class width. Here every class is 2 wide (21 – 19).

About CBSE's key: CBSE's published marking scheme multiplies by 3 and prints 19.95. The class 19 – 21 is 2 wide, so the multiplier is 2 and the mode is 19.64. Show $h = 2$ in your working.

Section E: Case studies

3 case studies, 4 marks each.

Q36 · ARITHMETIC PROGRESSIONS · 4 MARKS

Case study 1. A school organises a charity run as a series of rounds around a track. The first round is 300 metres, and each next round is 50 metres longer than the one before: the second round is 350 m, the third 400 m, and so on. There are 10 rounds in all.

- (i) Write the fourth, fifth and sixth terms of the AP so formed. [1]
- (ii) Determine the distance of the 8th round. [1]
- (iii) (a) Find the total distance run after completing all 10 rounds. [2]

OR

- (iii) (b) If a runner completes only the first 6 rounds, what is the total distance run? [2]

SOLUTION

The distances form an AP with first term $a = 300$ and common difference $d = 50$.

(i) $a_4 = 300 + 3 \times 50 = 450$, $a_5 = 500$, $a_6 = 550$.

(ii) $a_8 = 300 + 7 \times 50 = 650$ m.

(iii)(a) $S_{10} = \frac{10}{2} [2 \times 300 + 9 \times 50] = 5 \times (600 + 450) = 5 \times 1050 = 5250$ m.

(iii)(b) $S_6 = \frac{6}{2} [2 \times 300 + 5 \times 50] = 3 \times (600 + 250) = 3 \times 850 = 2550$ m.

Answer: (i) 450, 500, 550 (ii) 650 m (iii)(a) 5250 m (iii)(b) 2550 m

Common mistake: Using $9d$ for the sum of 6 terms. The sum formula for n terms needs $(n - 1)d$, so for 6 terms it is $5d$.

About CBSE's key: CBSE's published marking scheme prints 2250 m for part (iii)(b). 3×850 is 2550, which is what the working gives.

Q37 · AREAS RELATED TO CIRCLES · 4 MARKS

Case study 2. A brooch is made with silver wire in the form of a circle of diameter 35 mm. The wire is also used to make 5 diameters, which divide the circle into 10 equal sectors.

(i) Find the central angle of each sector. [1]

(ii) Find the length of the arc ACB. [1]

(iii) (a) Find the area of each sector of the brooch. [2]

OR

(iii) (b) Find the total length of the silver wire used. [2]

Figure: A circle divided into 10 equal sectors by 5 diameters. Points A, C, B lie on the rim at the top right: A and B are the ends of one sector, and C is the point marked between them.

SOLUTION

Radius $r = \frac{35}{2}$ mm = 17.5 mm. Use $\pi = \frac{22}{7}$.

(i) 10 equal sectors fill 360° , so each central angle is $\frac{360^\circ}{10} = 36^\circ$.

(ii) The arc ACB is the rim of one sector (A and B are the ends of one sector), so it is $\frac{1}{10}$ of the circumference:
 $\frac{1}{10} \times 2 \times \frac{22}{7} \times 17.5 = \frac{1}{10} \times 110 = 11$ mm.

(iii)(a) Area of one sector = $\frac{1}{10} \pi r^2 = \frac{1}{10} \times \frac{22}{7} \times 17.5 \times 17.5 = \frac{1}{10} \times 962.5 = 96.25$ mm².

(iii)(b) Wire = circumference + 5 diameters = $110 + 5 \times 35 = 110 + 175 = 285$ mm.

Answer: (i) 36° (ii) 11 mm (iii)(a) 96.25 mm² (iii)(b) 285 mm

Common mistake: Using the diameter 35 mm as the radius, or forgetting the 5 diameters when finding the total wire.

Q38 · APPLICATIONS OF TRIGONOMETRY · 4 MARKS

Case study 3. Amrita stands near the base of a lighthouse and measures the angle of elevation of its top as 60° . She then climbs an observation deck 40 metres higher than her original position and finds the angle of elevation of the top is 45° .

- (i) If $CD = h$ metres, find the distance BD in terms of h . [1]
 (ii) Find the distance BC in terms of h . [1]
 (iii) (a) Find the height CE of the lighthouse. [Use $\sqrt{3} = 1.73$] [2]

OR

- (iii) (b) Find the distance AE , if $AC = 100$ m. [2]

Figure: Right triangles on one picture. A is on the ground, E is the foot of the lighthouse, C is the top. B is 40 m directly above A. D is the point on CE level with B, so BD is horizontal and $BD = AE$. Angle $CBD = 45^\circ$ and angle $CAE = 60^\circ$. $CD = h$.

SOLUTION

(i) In right triangle BDC (right angle at D): $\tan 45^\circ = \frac{CD}{BD} = \frac{h}{BD}$. $\tan 45^\circ = 1$, so $BD = h$ metres.

(ii) $\sin 45^\circ = \frac{CD}{BC} = \frac{h}{BC}$. $\sin 45^\circ = \frac{1}{\sqrt{2}}$, so $BC = \sqrt{2}h$ metres.

(iii)(a) The total height $CE = CD + DE = h + 40$ ($DE = AB = 40$ m). Also $AE = BD = h$.

In right triangle AEC : $\tan 60^\circ = \frac{CE}{AE}$, so $\sqrt{3} = \frac{h + 40}{h}$, giving $\sqrt{3}h = h + 40$, so $h(\sqrt{3} - 1) = 40$.

$$h = \frac{40}{\sqrt{3} - 1} = \frac{40(\sqrt{3} + 1)}{2} = 20(\sqrt{3} + 1) = 20 \times 2.73 = 54.6 \text{ m.}$$

$$CE = 54.6 + 40 = 94.6 \text{ m.}$$

(iii)(b) In right triangle AEC with $AC = 100$ m: $\cos 60^\circ = \frac{AE}{AC}$, so $\frac{1}{2} = \frac{AE}{100}$ and $AE = 50$ m.

Answer: (i) h m (ii) $\sqrt{2}h$ m (iii)(a) ≈ 94.6 m (iii)(b) 50 m

Common mistake: Forgetting to add the 40 m: h is only the part of the lighthouse above the deck, so $CE = h + 40$.

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

Mock quiz, 1-minute analysis and more papers: cognicraftedu.com/cbse-class-10-papers/maths-standard/2025/30-1-1

Questions are from the official CBSE paper. Solutions are written by CogniGuru.