

Mathematics (Standard) 2026, Set 30/5/1

Q.P. Code 30/5/1 · Series 5LMKN · 80 marks · 3 hours · 2026. 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 · QUADRATIC EQUATIONS · 1 MARK

The value of k for which the equation $kx^2 - 6x - 4 = 0$ has real and equal roots, is:

- (A) $\frac{9}{4}$ (B) -4
 (C) $-\frac{9}{4}$ (D) -2

SOLUTION

Equal roots need $D = 0$: $(-6)^2 - 4(k)(-4) = 36 + 16k = 0$, so $k = -\frac{36}{16} = -\frac{9}{4}$.

Answer: (C) $-\frac{9}{4}$

Q2 · COORDINATE GEOMETRY · 1 MARK

The line segment joining the points $P(-4, -2)$ and $Q(10, 4)$ is divided by y -axis in the ratio:

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

SOLUTION

A point on the y -axis has $x = 0$. Let it divide PQ in the ratio $k : 1$: $\frac{10k + (-4)}{k + 1} = 0$.

$10k = 4$, so $k = \frac{2}{5}$. The ratio is 2 : 5.

Answer: (A) 2 : 5

Q3 · POLYNOMIALS · 1 MARK

If the zeroes of a polynomial $p(x)$ are -3 and 8 , then $p(x)$ equals:

- (A) $x^2 + 5x - 4$ (B) $(x + 3)(-x + 8)$
 (C) $a(x^2 + 5x - 24)$ (D) $x^2 - 24$

SOLUTION

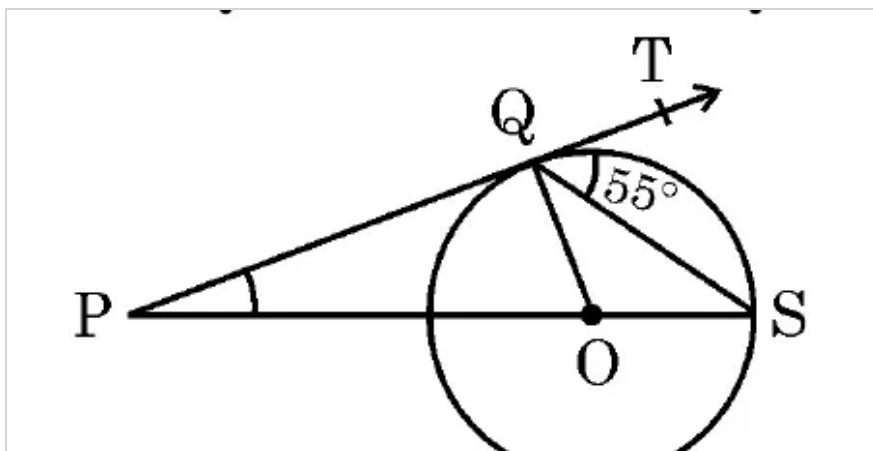
A polynomial with zeroes -3 and 8 has the form $k(x + 3)(x - 8)$ with $k \neq 0$.

Option (B) $(x + 3)(-x + 8) = -(x + 3)(x - 8)$ is of this form with $k = -1$. The others have different zeroes: $x^2 + 5x - 24 = (x + 8)(x - 3)$ has zeroes -8 and 3 .

Answer: (B) $(x + 3)(-x + 8)$

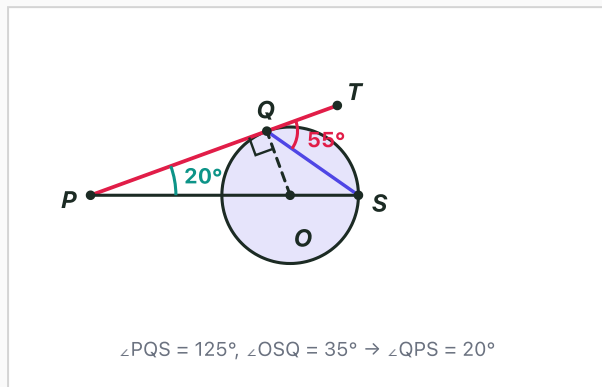
Q4 · CIRCLES · 1 MARK

In the given figure, PQ is tangent to the circle with centre O . S is a point on the circle such that $\angle SQT = 55^\circ$. The $m\angle QPS$ is:



- (A) 55° (B) 20°
(C) 35° (D) 70°

SOLUTION



P, Q, T are on a tangent line, so $\angle PQS = 180^\circ - 55^\circ = 125^\circ$. $OQ \perp PQ$ gives $\angle PQO = 90^\circ$, so $\angle OQS = 125^\circ - 90^\circ = 35^\circ$.

$OQ = OS$, so $\angle OSQ = \angle OQS = 35^\circ$.

In $\triangle PQS$ (with P, O, S in a line): $\angle QPS = 180^\circ - 125^\circ - 35^\circ = 20^\circ$.

Answer: (B) 20°

Q5 · TRIANGLES · 1 MARK

Devansh proved that $\triangle ABC \sim \triangle PQR$ using SAS similarity criteria. If he found $\angle C = \angle R$, then which of the following was proved true?

- (A) $\frac{AC}{AB} = \frac{PR}{PQ}$ (B) $\frac{BC}{AC} = \frac{PR}{QR}$
(C) $\frac{AC}{BC} = \frac{PR}{PQ}$ (D) $\frac{AC}{BC} = \frac{PR}{QR}$

SOLUTION

For SAS with the equal angles at C and R , the two sides that include them must be in proportion: the sides of $\angle C$ are CA and CB , and of $\angle R$ are RP and RQ .

$\frac{CA}{RP} = \frac{CB}{RQ}$, that is $\frac{AC}{BC} = \frac{PR}{QR}$.

Answer: (D) $\frac{AC}{BC} = \frac{PR}{QR}$

Q6 · STATISTICS · 1 MARK

While calculating mean of a grouped frequency distribution, step deviation method was used $\left(\frac{x-a}{h} = u\right)$. It was found that $\bar{x} = 64$, $h = 5$ and $a = 62.5$. The value of $\bar{u}$ is:

- (A) 0.5 (B) 1.5
(C) 0.3 (D) 7.5

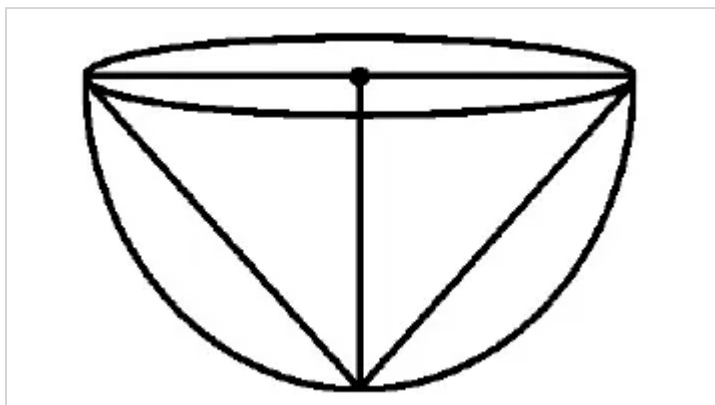
SOLUTION

$$\bar{x} = a + h\bar{u}, \text{ so } \bar{u} = \frac{\bar{x} - a}{h} = \frac{64 - 62.5}{5} = \frac{1.5}{5} = 0.3.$$

Answer: (C) 0.3

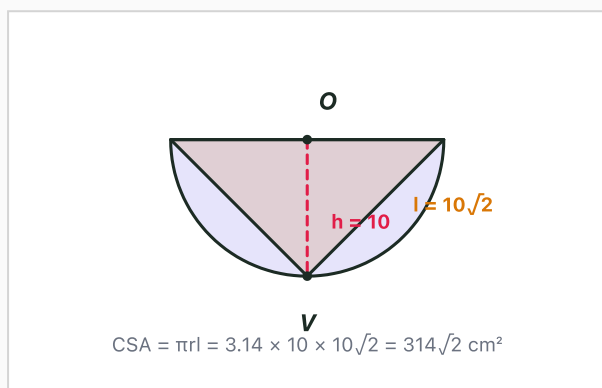
Q7 · SURFACE AREAS AND VOLUMES · 1 MARK

A conical cavity of maximum volume is carved out from a wooden solid hemisphere of radius 10 cm. Curved surface area of the cavity carved out is (use $\pi = 3.14$):



- (A) $314\sqrt{2} \text{ cm}^2$ (B) 314 cm^2
(C) $\frac{3140}{3} \text{ cm}^2$ (D) $3140\sqrt{2} \text{ cm}^2$

SOLUTION



The largest cone has the base of the hemisphere as its base and its tip on the pole: radius $r = 10$ and height $h = 10$. Slant height $l = \sqrt{10^2 + 10^2} = 10\sqrt{2}$. Curved surface area $= \pi rl = 3.14 \times 10 \times 10\sqrt{2} = 314\sqrt{2} \text{ cm}^2$.

Answer: (A) $314\sqrt{2} \text{ cm}^2$

Q8 · ARITHMETIC PROGRESSIONS · 1 MARK

If a_n represents n^{th} term of the A.P. $-\frac{15}{4}, -\frac{10}{4}, -\frac{5}{4}, \dots$, then value of $a_{16} - a_{12}$ is:

(A) 4

(B) $\frac{5}{4}$

(C) 5

(D) $\frac{25}{4}$

SOLUTION

$$d = -\frac{10}{4} + \frac{15}{4} = \frac{5}{4}. a_{16} - a_{12} = (16 - 12)d = 4 \times \frac{5}{4} = 5.$$

Answer: (C) 5

Q9 · QUADRATIC EQUATIONS · 1 MARK

The value of p for which roots of the quadratic equation $x^2 - px + 6 = 0$ are rational, is:

(A) 1

(B) -5

(C) 25

(D) $\sqrt{5}$

SOLUTION

The roots are rational when $D = p^2 - 24$ is a perfect square.

Check: $p = 1$ gives -23 (no real roots), $p = 25$ gives 601 (not a square), $p = \sqrt{5}$ gives -19 . $p = -5$ gives $25 - 24 = 1$, a perfect square: $x^2 + 5x + 6 = (x + 2)(x + 3)$ with roots -2 and -3 .

Answer: (B) -5

Q10 · PROBABILITY · 1 MARK

Which of the following can not be the probability of an event?

(A) $\frac{39}{100}$

(B) $\frac{0.001}{20}$

(C) $\frac{10}{0.2}$

(D) 10%

SOLUTION

A probability must lie between 0 and 1.

$\frac{10}{0.2} = 50 > 1$, so it cannot be a probability. The others are 0.39, 0.00005 and 0.1, all between 0 and 1.

Answer: (C) $\frac{10}{0.2}$

Q11 · PROBABILITY · 1 MARK

A card is drawn at random from a well shuffled deck of 52 playing cards. The probability that it is either a ten or a king is:

(A) $\frac{1}{26}$

(B) $\frac{2}{13}$

(C) $\frac{1}{13}$

(D) $\frac{8}{26}$

SOLUTION

There are 4 tens and 4 kings, 8 cards in all. $P = \frac{8}{52} = \frac{2}{13}$.

Answer: (B) $\frac{2}{13}$

Q12 · SURFACE AREAS AND VOLUMES · 1 MARK

A camping tent in hemispherical shape of radius 1.4 m, has a door opening of area 0.50 m². Outer surface area of the tent is:

- (A) 11.78 m² (B) 12.32 m²
(C) 11.82 m² (D) 12.86 m²

SOLUTION

Curved surface of the hemisphere = $2\pi r^2 = 2 \times \frac{22}{7} \times 1.4 \times 1.4 = 12.32$ m².

The door is an opening, so subtract it: $12.32 - 0.50 = 11.82$ m².

Answer: (C) 11.82 m²

Q13 · AREAS RELATED TO CIRCLES · 1 MARK

An arc of length 2.2 cm subtends an angle θ at the centre of the circle with radius 2.8 cm. The value of θ is:

- (A) 50° (B) 60°
(C) 45° (D) 30°

SOLUTION

Arc = $\frac{\theta}{360} \times 2\pi r$: $2.2 = \frac{\theta}{360} \times 2 \times \frac{22}{7} \times 2.8 = \frac{\theta}{360} \times 17.6$, so $\theta = \frac{2.2 \times 360}{17.6} = 45^\circ$.

Answer: (C) 45°

Q14 · TRIGONOMETRY · 1 MARK

For an acute angle θ , if $\sin \theta = \frac{1}{9}$, then value of $\frac{9 \operatorname{cosec} \theta + 1}{9 \operatorname{cosec} \theta - 1}$ is:

- (A) 0 (B) $\frac{80}{81}$
(C) 1 (D) $\frac{82}{80}$

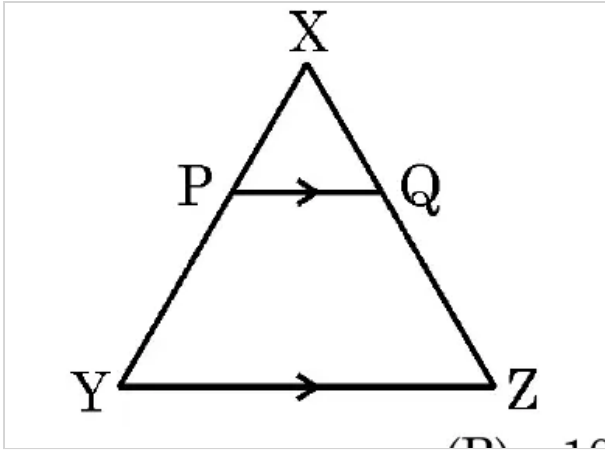
SOLUTION

$\operatorname{cosec} \theta = \frac{1}{\sin \theta} = 9$, so $9 \operatorname{cosec} \theta = 81$. The expression is $\frac{81 + 1}{81 - 1} = \frac{82}{80}$.

Answer: (D) $\frac{82}{80}$

Q15 · TRIANGLES · 1 MARK

In the given figure, $PQ \parallel YZ$ such that $XP : PY = 2 : 3$. If $PQ = 5$ cm, then YZ equals:



(A) 12.5 cm

(B) 10 cm

(C) 15 cm

(D) 7.5 cm

SOLUTION

$PQ \parallel YZ$, so $\triangle XPQ \sim \triangle XYZ$ and $\frac{PQ}{YZ} = \frac{XP}{XY}$.

$XP : PY = 2 : 3$ gives $XP : XY = 2 : 5$. $\frac{5}{YZ} = \frac{2}{5}$, so $YZ = 12.5$ cm.

Answer: (A) 12.5 cm

Q16 · PROBABILITY · 1 MARK

Meena calculates that the probability of her winning the first prize in a lottery is 0.08. If total 800 tickets were sold, the number of tickets bought by her is:

(A) 64

(B) 640

(C) 100

(D) 10

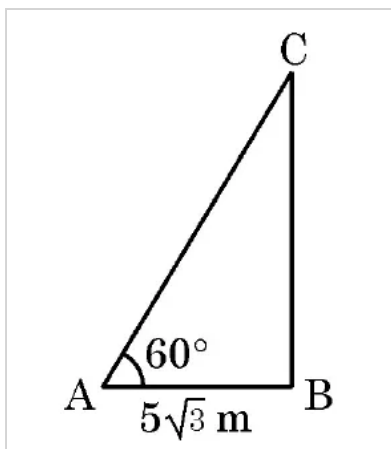
SOLUTION

$P = \frac{\text{her tickets}}{800} = 0.08$, so her tickets = $0.08 \times 800 = 64$.

Answer: (A) 64

Q17 · TRIGONOMETRY · 1 MARK

A wire is attached from a point A on the ground to the top of a pole BC , making an angle of elevation as 60° . If $AB = 5\sqrt{3}$ m, then length of the wire is:



- (A) 10 m
(B) $10\sqrt{3}$ m
(C) 15 m
(D) $\frac{5}{2}\sqrt{3}$ m

SOLUTION

In the right triangle ABC : $\cos 60^\circ = \frac{AB}{AC}$, so $AC = \frac{5\sqrt{3}}{1/2} = 10\sqrt{3}$ m.

Answer: (B) $10\sqrt{3}$ m

Q18 · TRIGONOMETRY · 1 MARK

Simplest form of $\frac{\sec A}{\sqrt{\sec^2 A - 1}}$ is:

- (A) $\sin A$
(B) $\tan A$
(C) $\operatorname{cosec} A$
(D) $\cos A$

SOLUTION

$\sec^2 A - 1 = \tan^2 A$, so $\sqrt{\sec^2 A - 1} = \tan A$. $\frac{\sec A}{\tan A} = \frac{1/\cos A}{\sin A/\cos A} = \frac{1}{\sin A} = \operatorname{cosec} A$.

Answer: (C) $\operatorname{cosec} A$

Q19 · LINEAR EQUATIONS · 1 MARK

Assertion (A): The system of linear equations $3x - 5y + 7 = 0$ and $-6x + 10y + 14 = 0$ is inconsistent.

Reason (R): When two linear equations don't have unique solution, they always represent parallel lines.

- (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) $\frac{a_1}{a_2} = \frac{3}{-6} = -\frac{1}{2}$, $\frac{b_1}{b_2} = \frac{-5}{10} = -\frac{1}{2}$ and $\frac{c_1}{c_2} = \frac{7}{14} = \frac{1}{2}$. The first two are equal and the third is different: parallel lines, inconsistent. True.

(R) Without a unique solution the lines may also be coincident (infinitely many solutions), not only parallel. False.

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

Q20 · REAL NUMBERS · 1 MARK

Assertion (A): H.C.F. $(36m^2, 18m) = 18m$, where m is a prime number.

Reason (R): H.C.F. of two numbers is always less than or equal to the smaller number.

(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) $36m^2 = 2 \times 18 \times m \times m$ and $18m$ divides $36m^2$ (as $36m^2 = 18m \times 2m$). So the HCF is $18m$. True.

(R) The HCF divides both numbers, so it cannot exceed the smaller one. True. But it does not tell us that the HCF is $18m$ here, so it is not the explanation.

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

Section B: Very short answer

5 questions, 2 marks each.

Q21 · REAL NUMBERS · 2 MARKS

Prove that $2 - 5\sqrt{3}$ is an irrational number given that $\sqrt{3}$ is irrational.

SOLUTION

Suppose $2 - 5\sqrt{3} = \frac{a}{b}$ with integers a, b and $b \neq 0$.

Then $\sqrt{3} = \frac{2b - a}{5b}$, a ratio of integers, so $\sqrt{3}$ would be rational. That contradicts the given fact, so $2 - 5\sqrt{3}$ is irrational.

Answer: Proved

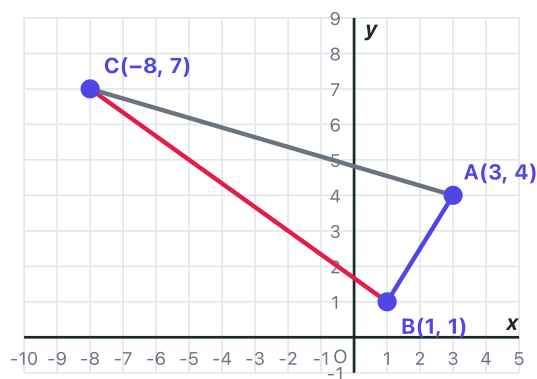
Q22 · COORDINATE GEOMETRY · 2 MARKS

(a) Vertices of a right triangle ABC with $\angle B = 90^\circ$ are $A(3, 4)$, $B(1, 1)$ and $C(-8, 7)$. Find the value of $\tan A$.

OR

(b) Using distance formula, prove that the points $A(2, 3)$, $B(-7, 0)$ and $C(-1, 2)$ are collinear.

SOLUTION



(a) $BC = \sqrt{(-8-1)^2 + (7-1)^2} = \sqrt{117} = 3\sqrt{13}$ and $AB = \sqrt{(3-1)^2 + (4-1)^2} = \sqrt{13}$.

$\tan A = \frac{BC}{AB} = \frac{3\sqrt{13}}{\sqrt{13}} = 3$ (opposite over adjacent, as the right angle is at B).

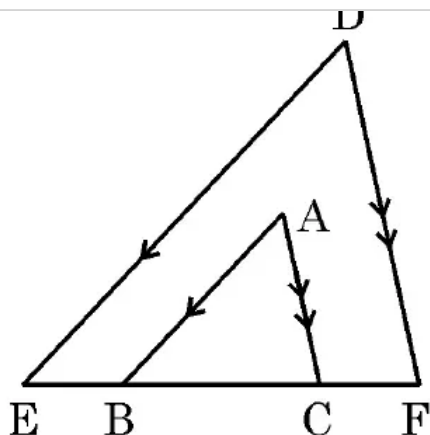
(b) $AB = \sqrt{81+9} = \sqrt{90} = 3\sqrt{10}$, $BC = \sqrt{36+4} = \sqrt{40} = 2\sqrt{10}$ and $AC = \sqrt{9+1} = \sqrt{10}$.

$AC + BC = \sqrt{10} + 2\sqrt{10} = 3\sqrt{10} = AB$, so the points are collinear.

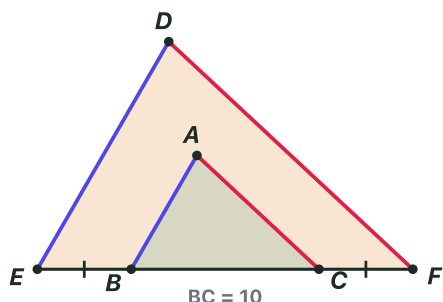
Answer: (a) $\tan A = 3$ (b) collinear

Q23 · TRIANGLES · 2 MARKS

In the given figure, $AB \parallel DE$ and $AC \parallel DF$. Show that $\triangle ABC \sim \triangle DEF$. If $BC = 10$ cm, $EB = CF = 5$ cm and $AB = 7$ cm, then find the length DE .



SOLUTION



$EF = 5 + 10 + 5 = 20 = 2 \times BC \rightarrow DE = 2 \times AB = 14$ cm

$AB \parallel DE$, so $\angle DEF = \angle ABC$ (corresponding angles). $AC \parallel DF$, so $\angle DFE = \angle ACB$. By AA, $\triangle ABC \sim \triangle DEF$.

$$EF = EB + BC + CF = 5 + 10 + 5 = 20 \text{ cm. } \frac{BC}{EF} = \frac{AB}{DE}; \frac{10}{20} = \frac{7}{DE}, \text{ so } DE = 14 \text{ cm.}$$

Answer: $DE = 14 \text{ cm}$

Q24 · TRIGONOMETRY · 2 MARKS

(a) Evaluate: $\frac{\sin^3 60^\circ - \tan 30^\circ}{\cos^2 45^\circ}$

OR

(b) For acute angles A and B , $A + 2B$ and $2A + B$ are acute if $\tan(A + 2B) = \sqrt{3}$ and $\sin(2A + B) = \frac{1}{\sqrt{2}}$, then find the measures of angles A and B .

SOLUTION

(a) $\sin 60^\circ = \frac{\sqrt{3}}{2}$, so $\sin^3 60^\circ = \frac{3\sqrt{3}}{8}$. $\tan 30^\circ = \frac{1}{\sqrt{3}} = \frac{\sqrt{3}}{3}$. $\cos^2 45^\circ = \frac{1}{2}$.

$$\frac{\frac{3\sqrt{3}}{8} - \frac{\sqrt{3}}{3}}{\frac{1}{2}} = 2 \times \sqrt{3} \left(\frac{9 - 8}{24} \right) = \frac{\sqrt{3}}{12} \text{ (which is the same as } \frac{1}{4\sqrt{3}}).$$

(b) $A + 2B = 60^\circ$ and $2A + B = 45^\circ$. Adding: $3(A + B) = 105^\circ$, so $A + B = 35^\circ$. Then $B = 60^\circ - 35^\circ = 25^\circ$ and $A = 10^\circ$.

Answer: (a) $\frac{\sqrt{3}}{12}$ (b) $A = 10^\circ, B = 25^\circ$

Q25 · PROBABILITY · 2 MARKS

A bag contains 25 balls. Some of them are yellow and others are green. One ball is drawn at random. If probability of getting a green ball is $\frac{3}{5}$, then find the number of yellow balls.

SOLUTION

$$P(\text{yellow}) = 1 - P(\text{green}) = 1 - \frac{3}{5} = \frac{2}{5}.$$

$$\text{Yellow balls} = \frac{2}{5} \times 25 = 10.$$

Answer: 10 yellow balls

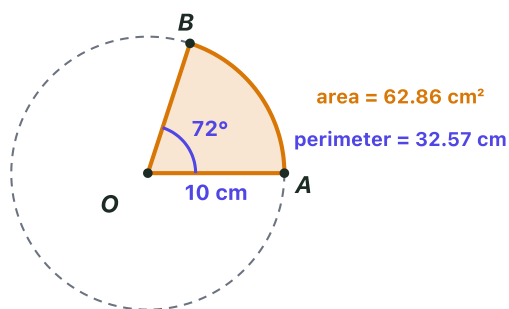
Section C: Short answer

6 questions, 3 marks each.

Q26 · AREAS RELATED TO CIRCLES · 3 MARKS

A circle of diameter 20 cm is equally divided into five sectors. Find the area and perimeter of one of the sectors.

SOLUTION



$$72/360 \times \pi \times 10^2 = 440/7; \text{ arc } 44/7 \times 2 + 20 = 228/7$$

Radius = 10 cm. Each sector has central angle $\frac{360^\circ}{5} = 72^\circ$.

$$\text{Area} = \frac{72}{360} \times \frac{22}{7} \times 10 \times 10 = \frac{440}{7} \approx 62.86 \text{ cm}^2.$$

$$\text{Perimeter} = \text{arc} + 2r = \frac{72}{360} \times 2 \times \frac{22}{7} \times 10 + 10 + 10 = \frac{88}{7} + 20 = \frac{228}{7} \approx 32.57 \text{ cm}.$$

$$\text{Answer: Area} = \frac{440}{7} \approx 62.86 \text{ cm}^2; \text{ perimeter} = \frac{228}{7} \approx 32.57 \text{ cm}$$

Q27 · ARITHMETIC PROGRESSIONS · 3 MARKS

(a) In an A.P., 15th term exceeds the 8th term by 21. If sum of first 10 terms is 55, then form the A.P.

OR

(b) The sum of first n terms of an A.P. is $2n^2 + 13n$. Find its n^{th} term and hence 10th term.

SOLUTION

$$(a) a_{15} - a_8 = 7d = 21, \text{ so } d = 3. S_{10} = \frac{10}{2}[2a + 9 \times 3] = 55 \text{ gives } 2a + 27 = 11 \text{ and } a = -8.$$

The A.P. is $-8, -5, -2, 1, \dots$

$$(b) a_1 = S_1 = 2 + 13 = 15. S_2 = 8 + 26 = 34, \text{ so } a_2 = 34 - 15 = 19 \text{ and } d = 4.$$

$$a_n = 15 + (n - 1) \times 4 = 4n + 11. a_{10} = 40 + 11 = 51.$$

$$\text{Answer: (a) } -8, -5, -2, \dots \quad (b) a_n = 4n + 11, a_{10} = 51$$

Q28 · TRIGONOMETRY · 3 MARKS

Prove that: $\frac{\tan \theta}{1 - \cot \theta} + \frac{\cot \theta}{1 - \tan \theta} = 1 + \tan \theta + \cot \theta$.

SOLUTION

$$\text{LHS} = \frac{\frac{\sin \theta}{\cos \theta}}{1 - \frac{\cos \theta}{\sin \theta}} + \frac{\frac{\cos \theta}{\sin \theta}}{1 - \frac{\sin \theta}{\cos \theta}} = \frac{\sin^2 \theta}{\cos \theta(\sin \theta - \cos \theta)} + \frac{\cos^2 \theta}{\sin \theta(\cos \theta - \sin \theta)}.$$

$$= \frac{1}{\sin \theta - \cos \theta} \left[\frac{\sin^2 \theta}{\cos \theta} - \frac{\cos^2 \theta}{\sin \theta} \right] = \frac{\sin^3 \theta - \cos^3 \theta}{\sin \theta \cos \theta(\sin \theta - \cos \theta)}.$$

$$\sin^3 \theta - \cos^3 \theta = (\sin \theta - \cos \theta)(\sin^2 \theta + \sin \theta \cos \theta + \cos^2 \theta) = (\sin \theta - \cos \theta)(1 + \sin \theta \cos \theta).$$

$$\text{LHS} = \frac{1 + \sin \theta \cos \theta}{\sin \theta \cos \theta} = \frac{1}{\sin \theta \cos \theta} + 1 = \frac{\sin^2 \theta + \cos^2 \theta}{\sin \theta \cos \theta} + 1 = \tan \theta + \cot \theta + 1 = \text{RHS}.$$

Answer: Proved

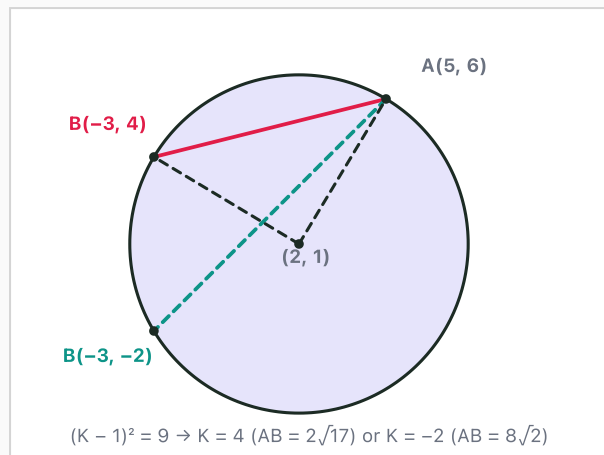
Q29 · COORDINATE GEOMETRY · 3 MARKS

(a) A circle centered at $(2, 1)$ passes through the points $A(5, 6)$ and $B(-3, K)$. Find the value(s) of K . Hence find length of chord AB .

OR

(b) Prove that the point P dividing the line segment joining the points $A(-1, 7)$ and $B(4, -3)$ in the ratio $3 : 2$, lies on the line $x - 3y = -1$. Also find length of PA and PB .

SOLUTION



(a) The centre $O(2, 1)$ is equidistant from A and B : $OA = OB$, so $(5 - 2)^2 + (6 - 1)^2 = (-3 - 2)^2 + (K - 1)^2$.
 $34 = 25 + (K - 1)^2$, so $(K - 1)^2 = 9$ and $K = 4$ or $K = -2$.

For $K = -2$: $AB = \sqrt{(5 + 3)^2 + (6 + 2)^2} = \sqrt{128} = 8\sqrt{2}$. For $K = 4$: $AB = \sqrt{64 + 4} = \sqrt{68} = 2\sqrt{17}$.

(b) $P = \left(\frac{3(4) + 2(-1)}{5}, \frac{3(-3) + 2(7)}{5} \right) = (2, 1)$. On the line: $x - 3y = 2 - 3 = -1$ ✓.

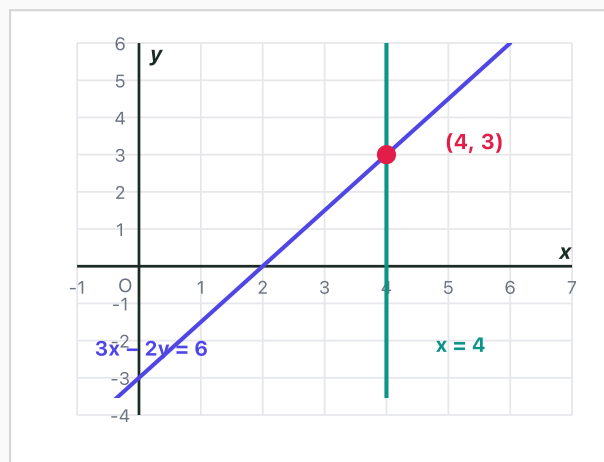
$PA = \sqrt{(2 + 1)^2 + (1 - 7)^2} = \sqrt{45} = 3\sqrt{5}$ and $PB = \sqrt{(2 - 4)^2 + (1 + 3)^2} = \sqrt{20} = 2\sqrt{5}$ (ratio $3 : 2$ ✓).

Answer: (a) $K = 4$ ($AB = 2\sqrt{17}$) or $K = -2$ ($AB = 8\sqrt{2}$) (b) $P(2, 1)$ on the line, $PA = 3\sqrt{5}$, $PB = 2\sqrt{5}$

Q30 · LINEAR EQUATIONS · 3 MARKS

Solve the system of linear equations: $x = 4$ and $3x - 2y = 6$ graphically.

SOLUTION



$x = 4$ is a vertical line through $(4, 0)$.

$3x - 2y = 6$: when $x = 2$, $y = 0$; when $x = 4$, $y = 3$; when $x = 0$, $y = -3$.

The lines meet at $(4, 3)$, so $x = 4$ and $y = 3$.

Answer: $x = 4, y = 3$

Q31 · REAL NUMBERS · 3 MARKS

The dimensions of a window are $156 \text{ cm} \times 216 \text{ cm}$. Arjun wants to put grill on the window creating complete squares of maximum size. Determine the side length of the square and hence find the number of squares formed.

SOLUTION

$156 = 2^2 \times 3 \times 13$ and $216 = 2^3 \times 3^3$. The largest square side that fits an exact number of times along both is the HCF $= 2^2 \times 3 = 12 \text{ cm}$.

$$\text{Number of squares} = \frac{156}{12} \times \frac{216}{12} = 13 \times 18 = 234.$$

Answer: Side 12 cm; 234 squares

Section D: Long answer

4 questions, 5 marks each.

Q32 · QUADRATIC EQUATIONS · 5 MARKS

Venkat can row a boat in still water at the speed of 12 km/h. He ferries tourists 15 km upstream and 18 km downstream in 3 hours. Find the speed of the stream.

SOLUTION

Let the stream go at $x \text{ km/h}$. Upstream speed $= 12 - x$ and downstream speed $= 12 + x$. $\frac{15}{12 - x} + \frac{18}{12 + x} = 3$.

$15(12 + x) + 18(12 - x) = 3(144 - x^2)$, so $396 - 3x = 432 - 3x^2$ and $3x^2 - 3x - 36 = 0$, that is $x^2 - x - 12 = 0$.

$(x - 4)(x + 3) = 0$. A speed cannot be negative, so $x = 4$. (Check: $\frac{15}{8} + \frac{18}{16} = 1.875 + 1.125 = 3 \checkmark$.)

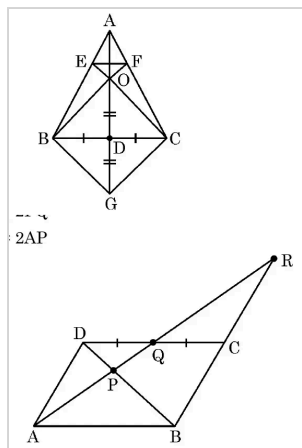
Answer: 4 km/h

Q33 · TRIANGLES · 5 MARKS

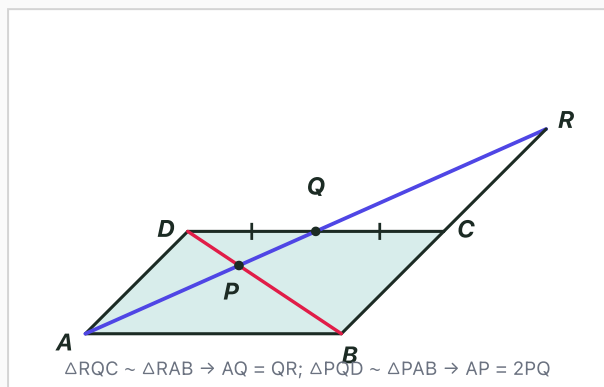
(a) D is the mid-point of side BC of $\triangle ABC$. CE and BF intersect at O , a point on AD . AD is produced to G such that $OD = DG$. Prove that (i) $OBGC$ is a parallelogram (ii) $EF \parallel BC$ (iii) $\triangle AEF \sim \triangle ABC$.

OR

(b) Through the mid-point Q of side CD of a parallelogram $ABCD$, the line AR is drawn which intersects BD at P and produced BC at R . Prove that (i) $AQ = QR$ (ii) $AP = 2PQ$ (iii) $PR = 2AP$.



SOLUTION



(a)(i) D is the mid-point of BC and $OD = DG$, so the diagonals OG and BC of $OBGC$ bisect each other. So $OBGC$ is a parallelogram.

(ii) $CO \parallel GB$, so $CE \parallel GB$. In $\triangle AGB$, $OE \parallel GB$, so $\frac{AO}{OG} = \frac{AE}{EB}$. In the same way in $\triangle AGC$, $\frac{AO}{OG} = \frac{AF}{FC}$.

Hence $\frac{AE}{EB} = \frac{AF}{FC}$, so $EF \parallel BC$ (converse of the basic proportionality theorem).

(iii) In $\triangle AEF$ and $\triangle ABC$: $\angle AEF = \angle ABC$ (corresponding angles, $EF \parallel BC$) and $\angle A$ is common. So $\triangle AEF \sim \triangle ABC$.

(b)(i) $QC \parallel AB$ (as $ABCD$ is a parallelogram), so $\triangle RQC \sim \triangle RAB$ and $\frac{QR}{AR} = \frac{QC}{AB} = \frac{1}{2}$ (Q is the mid-point of CD and $CD = AB$). So $AR = 2QR$ and $AQ = QR$.

(ii) $DQ \parallel AB$, so $\triangle PQD \sim \triangle PAB$ and $\frac{PQ}{AP} = \frac{DQ}{AB} = \frac{1}{2}$. So $AP = 2PQ$.

(iii) $AQ = QR$ gives $AP + PQ = PR - PQ$. With $PQ = \frac{1}{2}AP$: $AP + \frac{1}{2}AP = PR - \frac{1}{2}AP$, so $PR = 2AP$.

Answer: Proved (both parts)

Q34 · STATISTICS · 5 MARKS

(a) The mean of the following frequency distribution is 28. If sum of all frequencies is 100, then find the values of p and q :

OR

(b) Find median and mode of the following distribution (classes 0 – 15, 15 – 30, 30 – 45, 45 – 60, 60 – 75, 75 – 90, 90 – 105 with frequencies 15, 10, 12, 9, 8, 10, 6).

Class Interval	0–10	10–20	20–30	30–40	40–50	50–60
Frequency	12	p	27	20	q	6

SOLUTION

(a) The sum of frequencies: $12 + p + 27 + 20 + q + 6 = 65 + p + q = 100$, so $p + q = 35$.

Class marks: 5, 15, 25, 35, 45, 55. $\sum f_i x_i = 60 + 15p + 675 + 700 + 45q + 330 = 1765 + 15p + 45q$. Mean = 28: $1765 + 15p + 45q = 2800$, so $p + 3q = 69$.

Subtracting: $2q = 34$, so $q = 17$ and $p = 18$.

(b) Cumulative frequencies: 15, 25, 37, 46, 54, 64, 70. $\frac{N}{2} = 35$ lies in 30 – 45: $l = 30$, $cf = 25$, $f = 12$, $h = 15$.

Median = $30 + \frac{35 - 25}{12} \times 15 = 30 + 12.5 = 42.5$.

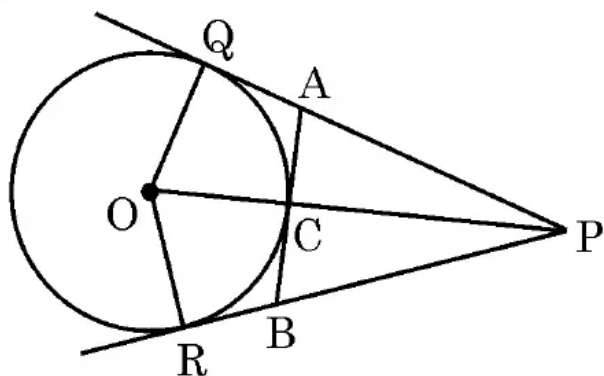
Modal class 0 – 15 (the highest frequency 15): $f_1 = 15$, $f_0 = 0$, $f_2 = 10$. Mode = $0 + \frac{15 - 0}{30 - 0 - 10} \times 15 = \frac{225}{20} = 11.25$.

Answer: (a) $p = 18$, $q = 17$ (b) median = 42.5, mode = 11.25

Q35 · CIRCLES · 5 MARKS

PQ and PR are two tangents to a circle with centre O and radius 5 cm. AB is another tangent to the circle at C which lies on OP . If $OP = 13$ cm, then find the length AB and PA .

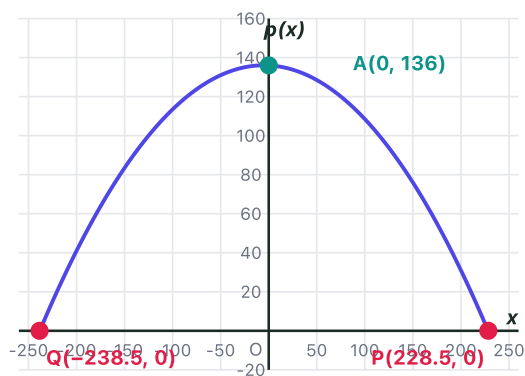
B and PA.



SOLUTION



Answer: $AB = \frac{20}{3}$ cm, $PA = \frac{26}{3}$ cm



(i) A is on the y -axis ($x = 0$): $p(0) = 136$. So $A = (0, 136)$.

(ii) $Q = (-238.5, 0)$ and $P = (228.5, 0)$, so the span $= 228.5 + 238.5 = 467$ units.

(iii)(a) From the diagram the zeroes are 228.5 and -238.5 . Sum $= -10$. For $p(x) = -0.0025x^2 - 0.025x + 136$ the sum of zeroes is $-\frac{b}{a} = -\frac{-0.025}{-0.0025} = -10$ ✓ (the product relation $\frac{c}{a}$ agrees with the diagram only approximately, as the figure's readings are rounded).

(iii)(b) $p(100) = -25 - 2.5 + 136 = 108.5$ and $p(-100) = -25 + 2.5 + 136 = 113.5$. They are not the same, since the $-0.025x$ term changes sign with x .

Answer: (i) $(0, 136)$ (ii) 467 units (iii)(a) zeroes 228.5 and -238.5 , sum -10 (iii)(b) 108.5 and 113.5, not the same

Q37 · SURFACE AREAS AND VOLUMES · 4 MARKS

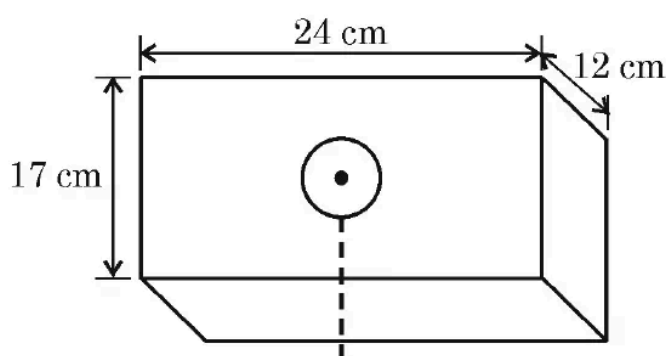
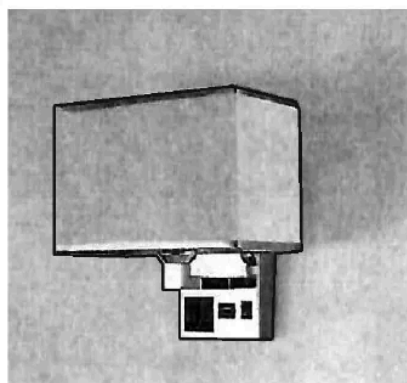
Case study 2. A wall mounted lamp, made of fabric, is shown below. Lamp has cuboidal shape, open from top and bottom. A spherical bulb of diameter 7 cm is latched with a very thin rod. (Ignore the rod while making calculations.) Dimensions of the cuboid are 24 cm $\times$ 12 cm $\times$ 17 cm.

Based on the above information, answer the following questions:

- Find the surface area of the bulb. [1]
- What could be the maximum diameter of the bulb if at least 1 cm space is left from each side? [1]
- (a) Find the area of the fabric used if there is a fold of 2 cm on top and bottom edges. [2]

OR

- (b) Find the space available inside the lamp. [2]



SOLUTION

(i) Surface area of a sphere of diameter 7 cm $= 4\pi r^2 = 4 \times \frac{22}{7} \times \frac{7}{2} \times \frac{7}{2} = 154$ cm².

(ii) The smallest dimension of the lamp is 12 cm. Leaving at least 1 cm on each side takes 2 cm off, so the maximum diameter is $12 - 2 = 10$ cm.

(iii)(a) The fabric forms the four vertical faces (open top and bottom). With 2 cm folded over at the top and the bottom, the height becomes $17 + 2 + 2 = 21$ cm. Area = $2 \times 21 \times (24 + 12) = 1512$ cm².

(iii)(b) Space inside = volume of the cuboid – volume of the bulb = $24 \times 12 \times 17 - \frac{4}{3} \times \frac{22}{7} \times \left(\frac{7}{2}\right)^3 = 4896 - \frac{539}{3} = \frac{14149}{3} \approx 4716.3$ cm³.

Answer: (i) 154 cm² (ii) 10 cm (iii)(a) 1512 cm² (iii)(b) $\frac{14149}{3} \approx 4716.3$ cm³

Q38 · TRIGONOMETRY · 4 MARKS

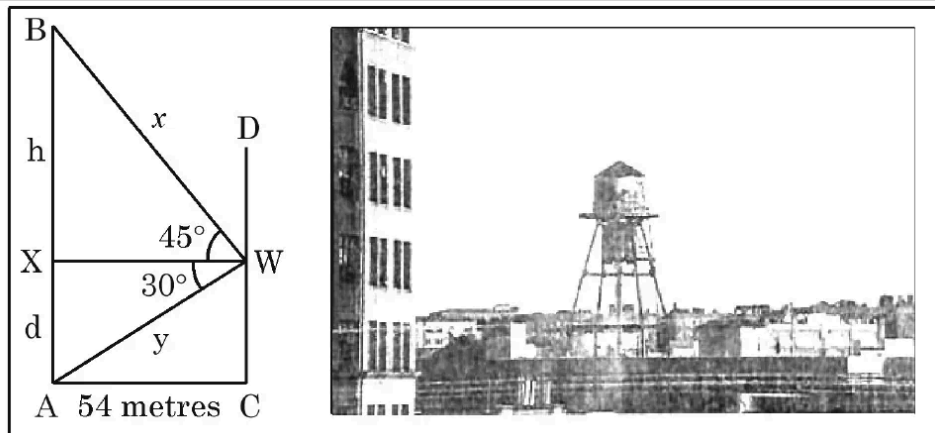
Case study 3. Elevated water storage tanks are built to store and supply water to nearby colonies. In the diagram given above, AB is an elevated water tank and CD is a nearby multistorey building. The building is 54 metres away from the water tank. From a window (W) of the building, the angle of elevation of top of the tank is 45° and angle of depression of its foot is 30°.

Based on the above information, answer the following questions:

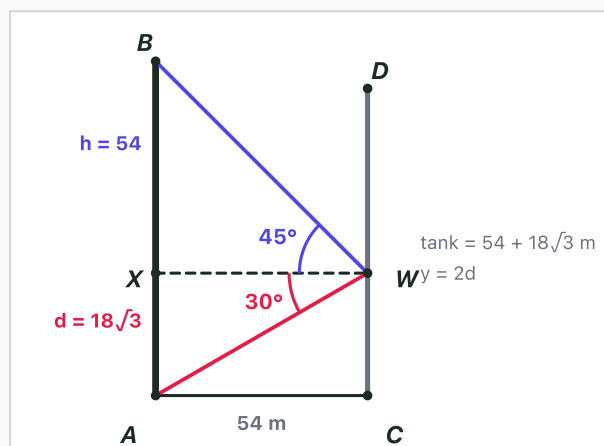
- Write a relation between d (the height of window) and y. [1]
- Determine the value of h. [1]
- (a) Determine height of the water tank. [2]

OR

- (b) Find the value of x and height of the window above ground level. [2]



SOLUTION



(i) The angle of depression of A from W is 30° , so $\angle XWA = 30^\circ$ in the right triangle AXW , and $\sin 30^\circ = \frac{d}{y} = \frac{1}{2}$.

So $y = 2d$.

(ii) $\tan 45^\circ = \frac{h}{WX}$, so $1 = \frac{h}{54}$ and $h = 54$ m.

(iii)(a) $\tan 30^\circ = \frac{d}{54}$, so $d = \frac{54}{\sqrt{3}} = 18\sqrt{3}$ m. Height of the tank $= h + d = 54 + 18\sqrt{3}$ m ≈ 85.2 m.

(iii)(b) The window is d above the ground, which is $WC = 18\sqrt{3}$ m ≈ 31.2 m. $\sin 45^\circ = \frac{h}{x}$, so $x = 54\sqrt{2}$ m ≈ 76.4 m.

Answer: (i) $y = 2d$ (ii) $h = 54$ m (iii)(a) $54 + 18\sqrt{3}$ m (iii)(b) $x = 54\sqrt{2}$ m; window height $18\sqrt{3}$ m

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