

**Mathematics (Basic) 2025, Set 430/5/1**

Q.P. Code 430/5/1 · Series EH5GF · 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.

Free paper, 1-minute analysis and quiz: [cognicraftedu.com/cbse-class-10-papers/maths-basic/2025/430-5-1](https://cognicraftedu.com/cbse-class-10-papers/maths-basic/2025/430-5-1)

**Section A: Multiple choice**

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

**Q1 · REAL NUMBERS · 1 MARK**

$(2 - 5\sqrt{3})^2$  is:

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

**SOLUTION**

$(2 - 5\sqrt{3})^2 = 4 - 20\sqrt{3} + 75 = 79 - 20\sqrt{3}$ . Since  $\sqrt{3}$  is irrational, this is irrational.

**Answer: (B) an irrational number**

**Q2 · QUADRATIC EQUATIONS · 1 MARK**

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

- (A) 0  
(B)  $\frac{3}{4}$   
(C)  $-\frac{3}{2}$   
(D)  $\frac{2}{3}$

**SOLUTION**

Equal roots need  $D = (4k)^2 - 4(6)(k) = 16k^2 - 24k = 8k(2k - 3) = 0$ , so  $k = 0$  or  $k = \frac{3}{2}$ .

Only  $k = 0$  is among the options (then  $6x^2 = 0$  has the equal roots 0, 0).

**Answer: (A) 0**

**Q3 · COORDINATE GEOMETRY · 1 MARK**

The distance between the points  $(2, 3)$  and  $(-2, -3)$  is:

- (A)  $4\sqrt{13}$   
(B)  $\sqrt{40}$   
(C)  $2\sqrt{13}$   
(D) 5

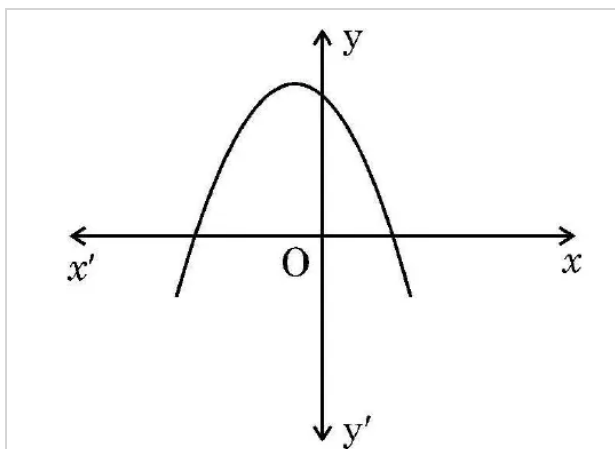
**SOLUTION**

$d = \sqrt{(2 + 2)^2 + (3 + 3)^2} = \sqrt{16 + 36} = \sqrt{52} = 2\sqrt{13}$ .

**Answer: (C)  $2\sqrt{13}$**

**Q4 · POLYNOMIALS · 1 MARK**

Observe the given graph of polynomial  $p(x)$ . The number of zeroes of  $p(x)$  is:



(A) 0

(B) 1

(C) 3

(D) 2

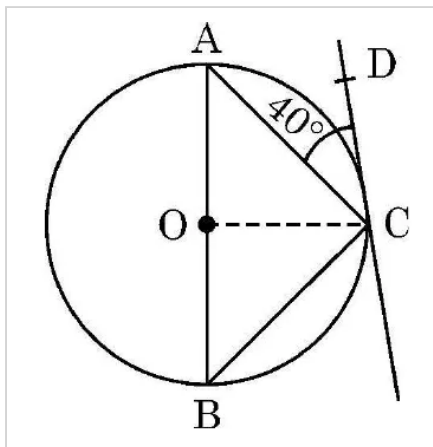
**SOLUTION**

The zeroes are the points where the graph meets the  $x$ -axis. The parabola crosses it twice, so  $p(x)$  has 2 zeroes.

**Answer: (D) 2**

**Q5 · CIRCLES · 1 MARK**

In the given figure,  $AB$  is diameter of the circle with centre  $O$ .  $CD$  is tangent to the circle so that  $\angle ACD = 40^\circ$ . The value of  $\angle CBA$  is:



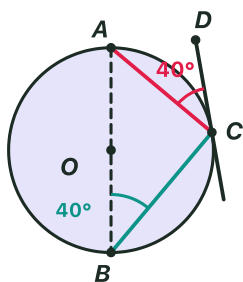
(A)  $50^\circ$

(B)  $40^\circ$

(C)  $80^\circ$

(D)  $45^\circ$

**SOLUTION**



tangent–chord angle = alternate segment angle

The angle between the tangent  $CD$  and the chord  $CA$  equals the angle in the alternate segment:  $\angle CBA = \angle ACD = 40^\circ$ .

(Check:  $\angle ACB = 90^\circ$  (angle in a semicircle), so  $\angle CAB = 50^\circ$  and  $\angle OCA = 50^\circ$ , giving  $\angle OCD = 90^\circ = 50^\circ + 40^\circ$  ✓.)

**Answer: (B)  $40^\circ$**

#### Q6 · ARITHMETIC PROGRESSIONS · 1 MARK

$10^{\text{th}}$  term of the A.P.:  $-12, -19, -26, \dots$  is:

- (A)  $-75$  (B)  $-65$   
(C)  $51$  (D)  $-82$

#### SOLUTION

$a = -12$  and  $d = -7$ .  $a_{10} = -12 + 9(-7) = -75$ .

**Answer: (A)  $-75$**

#### Q7 · QUADRATIC EQUATIONS · 1 MARK

The roots of the equation  $x^2 - 8 = 0$  are:

- (A) rational and distinct (B) irrational and distinct  
(C) real and equal (D) not real

#### SOLUTION

$x^2 = 8$  gives  $x = \pm 2\sqrt{2}$ : two different irrational numbers. ( $D = 32 > 0$ , not a perfect square.)

**Answer: (B) irrational and distinct**

#### Q8 · COORDINATE GEOMETRY · 1 MARK

The point  $(x, 0)$  divides the line segment joining the points  $(-4, 5)$  and  $(0, -10)$  in the ratio:

- (A)  $1 : 3$  (B)  $2 : 1$   
(C)  $1 : 1$  (D)  $1 : 2$

#### SOLUTION

Let the ratio be  $k : 1$ . The  $y$ -coordinate is  $0$ :  $\frac{-10k + 5}{k + 1} = 0$ , so  $k = \frac{1}{2}$ . The ratio is  $1 : 2$ .

**Answer: (D)  $1 : 2$**

**Q9 · PROBABILITY · 1 MARK**

A black card is lost from a deck of 52 playing cards. Rest of the cards are shuffled and one card is drawn at random from the available cards. The probability that drawn card is 'king of hearts', is:

(A)  $\frac{1}{52}$   
(C)  $\frac{1}{51}$

(B)  $\frac{1}{4}$   
(D)  $\frac{1}{26}$

**SOLUTION**

51 cards remain. The king of hearts is red, so it is still there:  $P = \frac{1}{51}$ .

**Answer: (C)  $\frac{1}{51}$**

**Q10 · SURFACE AREAS AND VOLUMES · 1 MARK**

The largest possible cone is just fitted inside a hollow cube of edge 25 cm. The radius of the base of the cone is:

(A) 5 cm  
(C) 25 cm

(B) 12.5 cm  
(D) 10 cm

**SOLUTION**

The biggest cone has its base circle inscribed in a face of the cube, so its diameter is 25 cm and the radius is 12.5 cm.

**Answer: (B) 12.5 cm**

**Q11 · PROBABILITY · 1 MARK**

If  $E$  is an event such that  $P(E) = 0.1$ , then  $P(\bar{E})$  is equal to:

(A) 0.9  
(C) 0.99

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

**SOLUTION**

$$P(\bar{E}) = 1 - 0.1 = 0.9.$$

**Answer: (A) 0.9**

**Q12 · TRIGONOMETRY · 1 MARK**

If  $\tan A = 1$ , then  $3 \sin A + \cos A$  is equal to:

(A)  $4\sqrt{2}$   
(C)  $2\sqrt{2}$

(B) 4  
(D)  $4 \times 45^\circ$

**SOLUTION**

$$\tan A = 1 \text{ gives } A = 45^\circ, \text{ so } \sin A = \cos A = \frac{1}{\sqrt{2}}. \quad 3 \sin A + \cos A = \frac{4}{\sqrt{2}} = 2\sqrt{2}.$$

**Answer: (C)  $2\sqrt{2}$**

**Q13 · POLYNOMIALS · 1 MARK**

A quadratic polynomial having only zero  $(-2)$  is:

(A)  $(x - 2)^2$

(B)  $x^2 - 2$

(C)  $x^2 + 2x$

(D)  $(x + 2)^2$

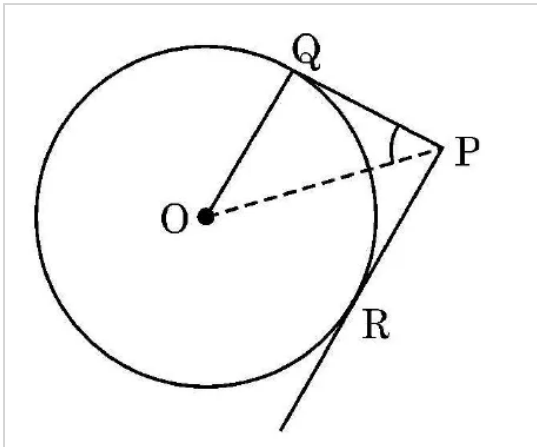
**SOLUTION**

$(x + 2)^2 = (x + 2)(x + 2)$  has the repeated zero  $-2$  and no other. ( $x^2 + 2x$  has the zeroes  $0$  and  $-2$ .)

**Answer: (D)**  $(x + 2)^2$

**Q14 · CIRCLES · 1 MARK**

$PQ$  and  $PR$  are tangents to a circle with centre  $O$  such that  $OQ = QP$ . The value of  $\angle OPQ$  is equal to:

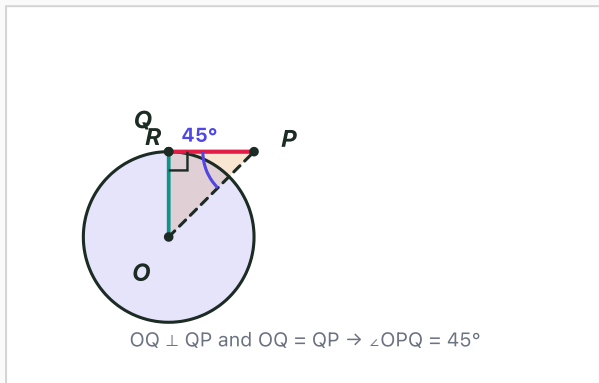


(A)  $45^\circ$

(B)  $30^\circ$

(C)  $60^\circ$

(D)  $90^\circ$

**SOLUTION**

$OQ \perp PQ$ , so  $\triangle OQP$  is right-angled at  $Q$  with  $OQ = QP$ . The two base angles are equal and add to  $90^\circ$ :  $\angle OPQ = 45^\circ$ .

**Answer: (A)**  $45^\circ$

**Q15 · STATISTICS · 1 MARK**

Which of the following depends on all observations of a given data?

(A) Median

(B) Mean

(C) Range

(D) Mode

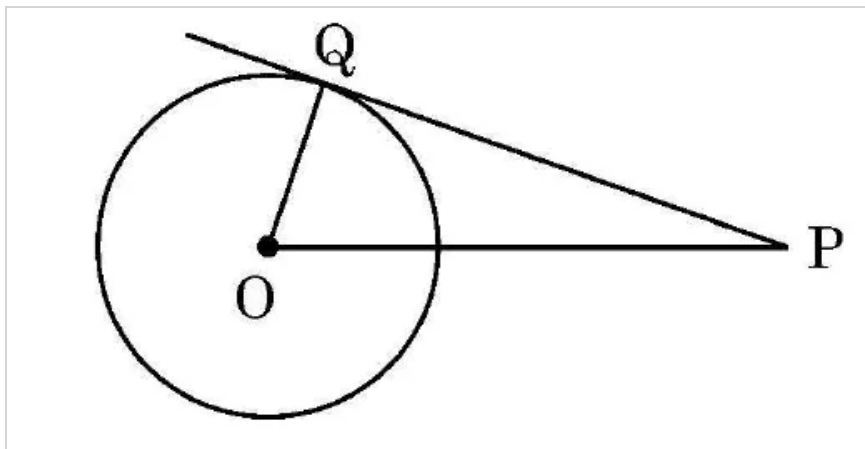
**SOLUTION**

The mean uses every value (sum divided by the number of values). The median and mode depend on the position and frequency, and the range on only the largest and smallest values.

**Answer: (B) Mean**

**Q16 · CIRCLES · 1 MARK**

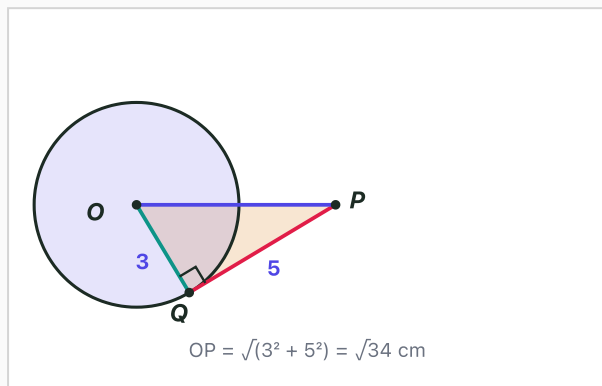
$PQ$  is tangent to the circle centred at  $O$ . If  $OQ = 3$  cm,  $PQ = 5$  cm, then  $OP$  is equal to:



- (A) 5 cm  
(C)  $\sqrt{15}$  cm

- (B) 4 cm  
(D)  $\sqrt{34}$  cm

**SOLUTION**



$OQ \perp PQ$ , so  $OP = \sqrt{OQ^2 + PQ^2} = \sqrt{9 + 25} = \sqrt{34}$  cm.

**Answer: (D)  $\sqrt{34}$  cm**

**Q17 · PROBABILITY · 1 MARK**

Two dice are rolled together. The probability that only one die shows number 4, is:

- (A)  $\frac{11}{36}$   
(C)  $\frac{5}{18}$

- (B)  $\frac{1}{3}$   
(D)  $\frac{1}{4}$

**SOLUTION**

Exactly one 4: the first die shows 4 and the second does not (5 ways) or the other way round (5 ways), 10 outcomes in 36.  $P = \frac{10}{36} = \frac{5}{18}$ .

Answer: (C)  $\frac{5}{18}$

**Q18 · AREAS RELATED TO CIRCLES · 1 MARK**

An arc of length 22 cm subtends an angle of  $x^\circ$  at the centre of the circle. If radius of circle is 36 cm, the value of  $x$  is:

- (A) 35 (B) 40  
(C) 60 (D) 30

**SOLUTION**

$$22 = \frac{x}{360} \times 2 \times \frac{22}{7} \times 36, \text{ so } x = \frac{22 \times 360 \times 7}{2 \times 22 \times 36} = 35.$$

Answer: (A) 35

**Q19 · SURFACE AREAS AND VOLUMES · 1 MARK**

Assertion (A): When a hemisphere of same radius ( $r$ ) is carved out from one side of a solid wooden cylinder, the total surface area of remaining solid is increased by  $2\pi r^2$ .

Reason (R): Curved surface area of hemisphere is  $2\pi r^2$ .

- (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**

(R) The curved surface area of a hemisphere is  $2\pi r^2$ . True.

(A) Carving out the hemisphere removes the flat circle  $\pi r^2$  of the cylinder's top and adds the hollow of area  $2\pi r^2$ . The net increase is  $2\pi r^2 - \pi r^2 = \pi r^2$ , not  $2\pi r^2$ . False.

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

**Q20 · TRIGONOMETRY · 1 MARK**

Assertion (A): In a right angle triangle  $ABC$ ,  $\angle B = 90^\circ$ . Therefore the value of  $\cos(A + C)$  is equal to 0.

Reason (R):  $A + B + C = 180^\circ$  and  $\cos 90^\circ = 0$ .

- (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**

(R) The angle sum is  $180^\circ$  and  $\cos 90^\circ = 0$ . True.

(A)  $A + C = 180^\circ - 90^\circ = 90^\circ$ , so  $\cos(A + C) = \cos 90^\circ = 0$ . True, and R is exactly this reasoning.

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

## Section B: Very short answer

5 questions, 2 marks each.

**Q21 · REAL NUMBERS · 2 MARKS**

Check whether  $15^n \times 2^n$ ,  $n$  being a natural number, ends with the digit zero.

**SOLUTION**

$15^n \times 2^n = (3 \times 5)^n \times 2^n = 3^n \times 5^n \times 2^n$ . Both 2 and 5 are prime factors.

A number divisible by both 2 and 5 is divisible by 10, so it ends with the digit 0. (Indeed,  $15^n \times 2^n = 30^n$ .)

**Answer: Yes, it ends with 0**

**Q22 · TRIGONOMETRY · 2 MARKS**

(a) Evaluate:  $2 \tan^2 45^\circ + \cos^2 30^\circ - \sin^2 90^\circ$ .

OR

(b) Verify that  $\cos 2A = \frac{1 - \tan^2 A}{1 + \tan^2 A}$  for  $A = 30^\circ$ .

**SOLUTION**

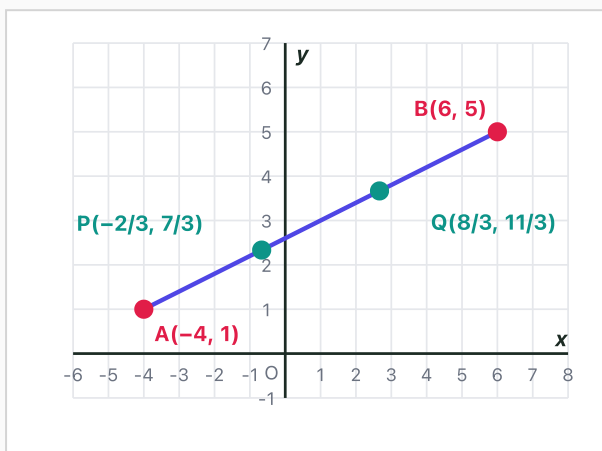
$$(a) 2(1)^2 + \left(\frac{\sqrt{3}}{2}\right)^2 - (1)^2 = 2 + \frac{3}{4} - 1 = \frac{7}{4}.$$

$$(b) \text{LHS} = \cos 60^\circ = \frac{1}{2}. \text{RHS} = \frac{1 - \frac{1}{3}}{1 + \frac{1}{3}} = \frac{2/3}{4/3} = \frac{1}{2}. \text{LHS} = \text{RHS} \checkmark.$$

**Answer: (a)  $\frac{7}{4}$  (b) verified**

**Q23 · COORDINATE GEOMETRY · 2 MARKS**

Find the coordinates of the points of trisection of line segment joining the points  $(-4, 1)$  and  $(6, 5)$ .

**SOLUTION**

Let  $A(-4, 1)$  and  $B(6, 5)$ . The point  $P$  with  $AP : PB = 1 : 2$  is  $\left(\frac{1(6) + 2(-4)}{3}, \frac{1(5) + 2(1)}{3}\right) = \left(-\frac{2}{3}, \frac{7}{3}\right)$ .

The point  $Q$  with  $AQ : QB = 2 : 1$  is  $\left(\frac{2(6) + 1(-4)}{3}, \frac{2(5) + 1(1)}{3}\right) = \left(\frac{8}{3}, \frac{11}{3}\right)$ .

**Answer:  $\left(-\frac{2}{3}, \frac{7}{3}\right)$  and  $\left(\frac{8}{3}, \frac{11}{3}\right)$**

**Q24 · PROBABILITY · 2 MARKS**

(a) A bag contains 40 marbles out of which some are white and others are black. If the probability of drawing a black marble is  $\frac{3}{5}$ , then find the number of white marbles.

OR

(b) In a pre-primary class, a teacher put cards numbered 20 to 59 in a bowl. A student picked up a card at random and read the number. Find the probability that the number read was (i) a prime number (ii) a perfect square.

**SOLUTION**

(a) Black marbles =  $\frac{3}{5} \times 40 = 24$ , so white marbles =  $40 - 24 = 16$ .

(b) The cards 20 to 59 number  $59 - 20 + 1 = 40$ . (i) Primes: 23, 29, 31, 37, 41, 43, 47, 53, 59, which is 9:  $P = \frac{9}{40}$ .

(ii) Perfect squares: 25, 36, 49, which is 3:  $P = \frac{3}{40}$ .

**Answer: (a) 16 (b) (i)  $\frac{9}{40}$  (ii)  $\frac{3}{40}$**

**Q25 · COORDINATE GEOMETRY · 2 MARKS**

Using distance formula, prove that the points (1, 5), (2, 3) and (3, 1) are collinear.

**SOLUTION**

Let  $A(1, 5)$ ,  $B(2, 3)$ ,  $C(3, 1)$ .  $AB = \sqrt{1^2 + (-2)^2} = \sqrt{5}$ ,  $BC = \sqrt{1^2 + (-2)^2} = \sqrt{5}$  and  $AC = \sqrt{2^2 + (-4)^2} = \sqrt{20} = 2\sqrt{5}$ .

$AB + BC = \sqrt{5} + \sqrt{5} = 2\sqrt{5} = AC$ , so the three points lie on one straight line.

**Answer: Proved**

**Section C: Short answer**

6 questions, 3 marks each.

**Q26 · POLYNOMIALS · 3 MARKS**

(a) If  $\alpha, \beta$  are zeroes of the polynomial  $3x^2 - 8x + 4$ , then form a quadratic polynomial in  $x$  whose zeroes are  $\frac{1}{\alpha}$  and  $\frac{1}{\beta}$ .

OR

(b) Find zeroes of the polynomial  $6x^2 - 7x - 3$  and verify the relationship between zeroes and its coefficients.

**SOLUTION**

(a)  $\alpha + \beta = \frac{8}{3}$  and  $\alpha\beta = \frac{4}{3}$ . The new sum =  $\frac{1}{\alpha} + \frac{1}{\beta} = \frac{\alpha + \beta}{\alpha\beta} = \frac{8/3}{4/3} = 2$  and the new product =  $\frac{1}{\alpha\beta} = \frac{3}{4}$ .

The polynomial is  $x^2 - 2x + \frac{3}{4}$ , or  $k(4x^2 - 8x + 3)$  for any non-zero  $k$ .

(b)  $6x^2 - 7x - 3 = (2x - 3)(3x + 1)$ , so the zeroes are  $\frac{3}{2}$  and  $-\frac{1}{3}$ .

Sum =  $\frac{3}{2} - \frac{1}{3} = \frac{7}{6} = -\frac{-7}{6} \checkmark$ . Product =  $\frac{3}{2} \times \left(-\frac{1}{3}\right) = -\frac{1}{2} = \frac{-3}{6} \checkmark$ .

**Answer: (a)  $x^2 - 2x + \frac{3}{4}$  (b) zeroes  $\frac{3}{2}, -\frac{1}{3}$ ; relations verified**

**Q27 · QUADRATIC EQUATIONS · 3 MARKS**

The sum of the squares of two consecutive even numbers is 452. Find the numbers.

**SOLUTION**

Let the numbers be  $x$  and  $x + 2$ .  $x^2 + (x + 2)^2 = 452$  gives  $2x^2 + 4x - 448 = 0$ , so  $x^2 + 2x - 224 = 0$  and  $(x + 16)(x - 14) = 0$ .

$x = 14$  gives 14 and 16. (Check:  $196 + 256 = 452$  ✓. The root  $x = -16$  gives the pair  $-16, -14$ , which also fits the words; the key lists 14 and 16.)

**Answer: 14 and 16**

**Q28 · TRIGONOMETRY · 3 MARKS**

Prove that:  $(\operatorname{cosec} A + \sin A)^2 + (\sec A + \cos A)^2 = 7 + \tan^2 A + \cot^2 A$ .

**SOLUTION**

LHS =  $\operatorname{cosec}^2 A + 2 \operatorname{cosec} A \sin A + \sin^2 A + \sec^2 A + 2 \sec A \cos A + \cos^2 A$ .

Since  $\operatorname{cosec} A \sin A = 1$  and  $\sec A \cos A = 1$ : LHS =  $(\sin^2 A + \cos^2 A) + (1 + \cot^2 A) + (1 + \tan^2 A) + 2 + 2$ .  
 $= 1 + 1 + \cot^2 A + 1 + \tan^2 A + 4 = 7 + \tan^2 A + \cot^2 A = \text{RHS}$ .

**Answer: Proved**

**Q29 · REAL NUMBERS · 3 MARKS**

The traffic lights at three different road crossings change after every 45 seconds, 75 seconds and 60 seconds respectively. If they change together at 5.00 a.m., then at what time they will change together next?

**SOLUTION**

They change together again after the LCM of 45, 75 and 60 seconds.  $45 = 3^2 \times 5$ ,  $75 = 3 \times 5^2$ ,  $60 = 2^2 \times 3 \times 5$ .  
 $\text{LCM} = 2^2 \times 3^2 \times 5^2 = 900$  seconds = 15 minutes. They next change together at 5:15 a.m.

**Answer: At 5:15 a.m.**

**Q30 · SURFACE AREAS AND VOLUMES · 3 MARKS**

(a) A spherical glass vessel has a cylindrical neck 7 cm long and 8 cm in diameter. The radius of the spherical part is 10 cm. Find the volume of the vessel.

OR

(b) From each end of a solid cylinder of height 20 cm and base radius 7 cm, a cone of base radius 2.1 cm and height 5 cm is scooped out. Find the volume of the remaining solid.

**SOLUTION**

(a) Sphere:  $\frac{4}{3} \times \frac{22}{7} \times 10^3 \approx 4190.48 \text{ cm}^3$ . Neck (a cylinder of radius 4 and length 7):  $\frac{22}{7} \times 4 \times 4 \times 7 = 352 \text{ cm}^3$ .

Volume =  $4190.48 + 352 = 4542.48 \text{ cm}^3$ .

(b) Cylinder:  $\frac{22}{7} \times 7 \times 7 \times 20 = 3080 \text{ cm}^3$ . The two cones:  $2 \times \frac{1}{3} \times \frac{22}{7} \times 2.1 \times 2.1 \times 5 = 46.2 \text{ cm}^3$ .

Remaining volume =  $3080 - 46.2 = 3033.8 \text{ cm}^3$ .

**Answer: (a)  $\approx 4542.48 \text{ cm}^3$  (b)  $3033.8 \text{ cm}^3$**

**Q31 · TRIANGLES · 3 MARKS**

Point  $E$  lies on the extended side  $AD$  of parallelogram  $ABCD$ .  $BE$  intersects  $CD$  at  $F$ . Show that (i)  $\triangle DFE \sim \triangle CFB$  (ii)  $\triangle AEB \sim \triangle CBF$ .

**SOLUTION**

(i) In  $\triangle DFE$  and  $\triangle CFB$ :  $\angle DFE = \angle CFB$  (vertically opposite angles) and  $\angle EDF = \angle BCF$  (alternate angles, since  $AD \parallel BC$  and  $DC$  is a transversal... with  $E$  on  $AD$  produced and  $DF \subset DC$ ). So  $\triangle DFE \sim \triangle CFB$  by AA.

(ii) In  $\triangle AEB$  and  $\triangle CBF$ :  $\angle AEB = \angle CBF$  (alternate angles,  $AE \parallel BC$  with transversal  $BE$ ) and  $\angle EAB = \angle BCF$  (opposite angles of the parallelogram  $ABCD$ ).

So  $\triangle AEB \sim \triangle CBF$  by AA.

**Answer: Shown**

**Section D: Long answer**

4 questions, 5 marks each.

**Q32 · LINEAR EQUATIONS · 5 MARKS**

Determine graphically whether the following pair of linear equations  $2x + 3y = 12$  and  $x - y = 1$  has unique solution or infinitely many solutions.

**SOLUTION**

$2x + 3y = 12$ : points  $(0, 4)$ ,  $(6, 0)$ ,  $(3, 2)$ .  $x - y = 1$ : points  $(0, -1)$ ,  $(1, 0)$ ,  $(3, 2)$ .

The two lines are drawn on the same axes and intersect at exactly one point,  $(3, 2)$ . (Check:  $6 + 6 = 12 \checkmark$  and  $3 - 2 = 1 \checkmark$ .)

Since the lines intersect at a single point, the pair has a unique solution,  $x = 3, y = 2$ .

**Answer: Unique solution:  $x = 3, y = 2$**

**Q33 · TRIANGLES · 5 MARKS**

(a) If a line is drawn parallel to one side of a triangle to intersect the other two sides in distinct points, then prove that the other two sides are divided in the same ratio.

OR

(b) It is given that sides  $AB$  and  $AC$  and median  $AD$  of  $\triangle ABC$  are respectively proportional to sides  $PQ$  and  $PR$  and median  $PM$  of another  $\triangle PQR$ . Show that  $\triangle ABC \sim \triangle PQR$ .

**SOLUTION**

(a) \*\*Given:\*\*  $DE \parallel BC$  in  $\triangle ABC$ . \*\*To prove:\*\*  $\frac{AD}{DB} = \frac{AE}{EC}$ . \*\*Construction:\*\* join  $BE$  and  $DC$ ; draw  $DG \perp AC$  and  $EF \perp AB$ .

$$\frac{\text{ar}(\triangle ADE)}{\text{ar}(\triangle BDE)} = \frac{\frac{1}{2} \cdot AD \cdot EF}{\frac{1}{2} \cdot DB \cdot EF} = \frac{AD}{DB} \text{ and } \frac{\text{ar}(\triangle ADE)}{\text{ar}(\triangle CDE)} = \frac{\frac{1}{2} \cdot AE \cdot DG}{\frac{1}{2} \cdot EC \cdot DG} = \frac{AE}{EC}.$$

$\triangle BDE$  and  $\triangle CDE$  are on the same base  $DE$  and between the same parallels, so their areas are equal. Hence

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

(b) Given  $\frac{AB}{PQ} = \frac{AD}{PM} = \frac{AC}{PR}$ . Extend  $AD$  to  $E$  with  $DE = AD$  and  $PM$  to  $N$  with  $MN = PM$ ; join  $CE$  and  $RN$ .

$\triangle DAB \cong \triangle DEC$  (SAS:  $BD = DC$ ,  $AD = DE$ , vertically opposite angles), so  $CE = AB$ . Likewise  $\triangle MPQ \cong \triangle MNR$  and  $RN = PQ$ .

Then  $\frac{CE}{NR} = \frac{AB}{PQ} = \frac{AD}{PM} = \frac{AE}{PN}$  (as  $AE = 2AD$ ,  $PN = 2PM$ )  $= \frac{AC}{PR}$ . So  $\triangle CAE \sim \triangle RPN$  (SSS) and  $\angle 1 = \angle 2$ . In the same way  $\angle 3 = \angle 4$ .

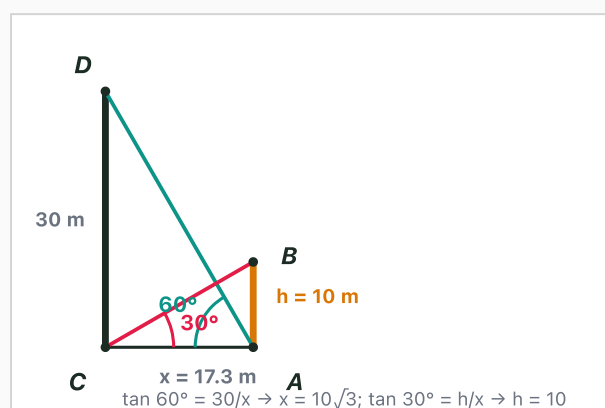
Adding,  $\angle 1 + \angle 3 = \angle 2 + \angle 4$ , that is  $\angle BAC = \angle QPR$ . With  $\frac{AB}{PQ} = \frac{AC}{PR}$ , we get  $\triangle ABC \sim \triangle PQR$  by SAS.

**Answer: Proved (both parts)**

#### Q34 · TRIGONOMETRY · 5 MARKS

The angle of elevation of the top of a building from the foot of the tower is  $30^\circ$  and the angle of elevation of the top of the tower from the foot of the building is  $60^\circ$ . If the tower is 30 m high, find the height of the building and distance between the building and the tower. (Use  $\sqrt{3} = 1.73$ )

#### SOLUTION



Let the building be  $AB = h$  and the tower  $CD = 30$  m, with  $AC = x$ .

From the foot  $A$  of the building, the top of the tower is at  $60^\circ$ :  $\tan 60^\circ = \frac{30}{x}$ , so  $x = 10\sqrt{3}$ . (i)

From the foot  $C$  of the tower, the top of the building is at  $30^\circ$ :  $\tan 30^\circ = \frac{h}{x}$ , so  $x = h\sqrt{3}$ . (ii)

From (i) and (ii),  $h\sqrt{3} = 10\sqrt{3}$ , so  $h = 10$  m.  $x = 10 \times 1.73 = 17.3$  m.

**Answer: Building height = 10 m; distance = 17.3 m**

#### Q35 · STATISTICS · 5 MARKS

(a) Find 'mean' and 'mode' of the following data (classes 10 – 25, 25 – 40, 40 – 55, 55 – 70, 70 – 85, 85 – 100 with 12, 10, 15, 13, 8, 12 students).

OR

(b) The following table shows the ages of patients admitted in a hospital during a year (ages 5 – 15, 15 – 25, 25 – 35, 35 – 45, 45 – 55, 55 – 65 with 7, 10, 21, 22, 15, 5 patients). Find 'mode' and 'median' of the above data.

| Class              | 10–25 | 25–40 | 40–55 | 55–70 | 70–85 | 85–100 |
|--------------------|-------|-------|-------|-------|-------|--------|
| Number of Students | 12    | 10    | 15    | 13    | 8     | 12     |

#### SOLUTION

(a)  $N = 70$ . Take  $a = 47.5$  and  $h = 15$ :  $u = -2, -1, 0, 1, 2, 3$  for the class marks 17.5, 32.5, 47.5, 62.5, 77.5, 92.5.  
 $\sum f_i u_i = -24 - 10 + 0 + 13 + 16 + 36 = 31$ .

Mean =  $47.5 + \frac{31}{70} \times 15 \approx 54.14$ . Modal class 40 – 55 ( $f_1 = 15, f_0 = 10, f_2 = 13$ ): Mode =  $40 + \frac{15 - 10}{30 - 10 - 13} \times 15 = 40 + \frac{75}{7} \approx 50.71$ .

(b) Cumulative frequencies: 7, 17, 38, 60, 75, 80.  $N = 80$  and  $\frac{N}{2} = 40$  lies in 35 – 45:  $l = 35, cf = 38, f = 22, h = 10$ . Median =  $35 + \frac{40 - 38}{22} \times 10 \approx 35.91$ .

The modal class is 35 – 45 (frequency 22):  $f_1 = 22, f_0 = 21, f_2 = 15$ . Mode =  $35 + \frac{22 - 21}{44 - 21 - 15} \times 10 = 35 + 1.25 = 36.25$ .

**Answer: (a) mean  $\approx 54.14$ , mode  $\approx 50.71$  (b) median  $\approx 35.91$ , mode = 36.25**

## Section E: Case studies

3 case studies, 4 marks each.

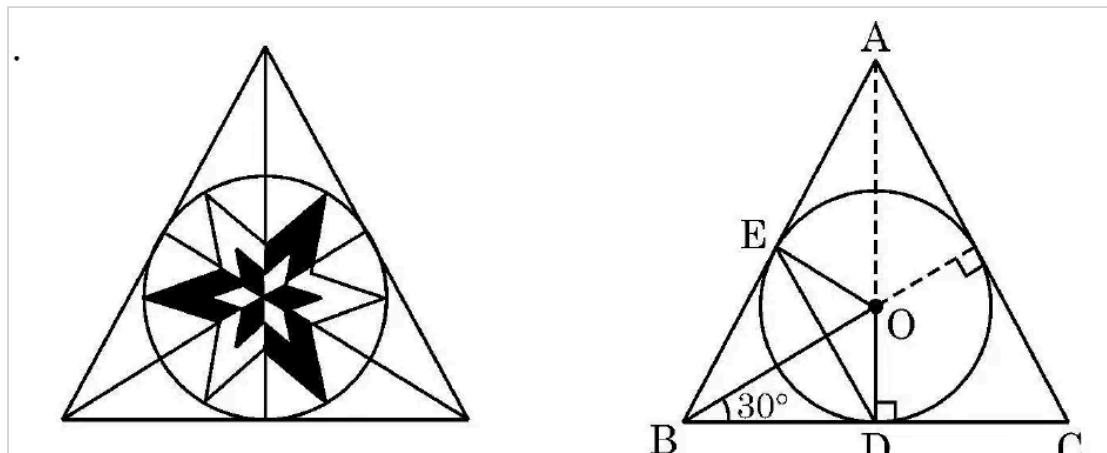
### Q36 · CIRCLES · 4 MARKS

Case study 1. In a Fine Arts class, students were asked to design triangular tiles in geometric pattern. Neelima made a circular design inside an equilateral triangle ABC. The radius of the circle is 4 cm. Observe the diagram and answer the following questions:

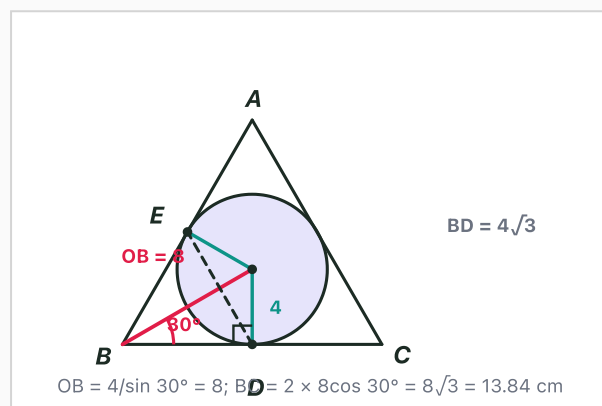
- Determine the length OB. [1]
- Is DE || CA? Give reason for your answer. [1]
- (a) Write all angles of quadrilateral OEBD and show that it is a cyclic quadrilateral. [2]

OR

- (b) Find the perimeter of  $\triangle ABC$ . (Use  $\sqrt{3} = 1.73$ ) [2]



### SOLUTION



(i)  $O$  is the centre of the circle inscribed in the equilateral triangle, so  $OB$  bisects  $\angle B = 60^\circ$ :  $\angle OBD = 30^\circ$ . In the right triangle  $ODB$  ( $OD = 4$ ):  $\sin 30^\circ = \frac{4}{OB}$ , so  $OB = 8$  cm.

(ii) Yes,  $DE \parallel CA$ .  $ABC$  is equilateral and  $AD \perp BC$ , so  $D$  is the mid-point of  $BC$ . In the same way  $E$  is the mid-point of  $AB$ , and the line joining the mid-points of two sides is parallel to the third side:  $DE \parallel CA$ .

(iii)(a)  $\angle EBD = 60^\circ$ . The radii to the points of contact are perpendicular to the tangents:  $\angle OEB = \angle ODB = 90^\circ$ . So  $\angle EOD = 360^\circ - 60^\circ - 90^\circ - 90^\circ = 120^\circ$ .  $\angle OEB + \angle ODB = 180^\circ$  (opposite angles supplementary), so  $OEBD$  is a cyclic quadrilateral.

(iii)(b)  $\cos 30^\circ = \frac{BD}{OB}$ , so  $BD = 8 \times \frac{\sqrt{3}}{2} = 4\sqrt{3} = 6.92$  cm.  $BC = 2BD = 13.84$  cm. Perimeter  $= 3 \times 13.84 = 41.52$  cm.

**Answer: (i) 8 cm (ii) yes (mid-point theorem) (iii)(a)  $60^\circ, 90^\circ, 120^\circ, 90^\circ$ ; cyclic (iii)(b) 41.52 cm**

### Q37 · AREAS RELATED TO CIRCLES · 4 MARKS

Case study 2. A farmer has put up a decorative windmill in his farm in which there are eight blades of equal width and equally placed in a circular arrangement. A circular wire goes through them. The diagram shows two blades  $OAB$  and  $OPQ$  in a quarter circle with centre  $O$ .  $\angle AOB = \angle POQ = 30^\circ$ ,  $OA = 28$  cm,  $OC = 21$  cm.  $O$  is the centre of both the circles. Based on the above information, answer the following questions:

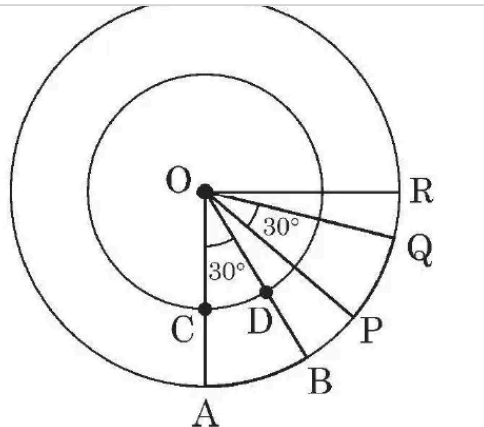
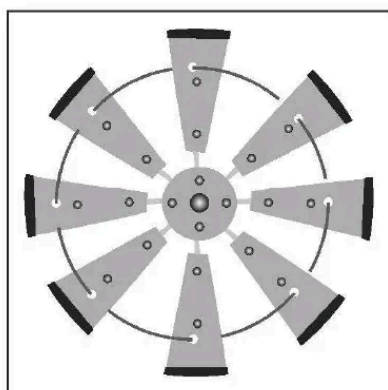
(i) Determine the measure of  $\angle BOP$ . [1]

(ii) Find length of arc  $CD$ . [1]

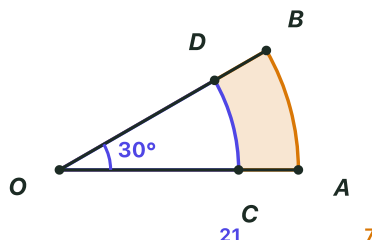
(iii) (a) Find the area of region  $CABD$ . [2]

OR

(iii) (b) Find perimeter of region  $CABD$ . [2]



### SOLUTION



$$\text{area} = \frac{30}{360} \times \frac{22}{7} \times (28^2 - 21^2) = 89.83 \text{ cm}^2$$

(i) The blades are equally placed in the quarter circle ( $\angle AOR = 90^\circ$ ), and two blades of  $30^\circ$  each leave  $90^\circ - 60^\circ = 30^\circ$  for the gaps, shared equally:  $\angle BOP = \frac{30^\circ}{2} = 15^\circ$ .

(ii) Arc  $CD = \frac{30}{360} \times 2 \times \frac{22}{7} \times 21 = 11$  cm.

(iii)(a) Area  $CABD = \frac{30}{360} \times \frac{22}{7} \times (28^2 - 21^2) = \frac{1}{12} \times \frac{22}{7} \times 343 = \frac{539}{6} \approx 89.8$  cm<sup>2</sup>.

(iii)(b) Arc  $AB = \frac{30}{360} \times 2 \times \frac{22}{7} \times 28 = \frac{44}{3} \approx 14.67$  cm. Perimeter =  $AB$  arc +  $CD$  arc +  $CA$  +  $DB$  =  $14.67 + 11 + 2 \times (28 - 21) = 39.67$  cm.

**Answer: (i)  $15^\circ$  (ii) 11 cm (iii)(a)  $\approx 89.8$  cm<sup>2</sup> (iii)(b)  $\approx 39.67$  cm**

### Q38 · ARITHMETIC PROGRESSIONS · 4 MARKS

Case study 3. A tent house owner provides furniture on rent. He stacks chairs in his shop to save space. In the diagram, the height of seat of chair from ground is represented by  $h_1, h_2, h_3, \dots$ . The height of first seat is 44 cm from ground level and gap between every two seats is 10 cm.

Based on the above information, answer the following questions:

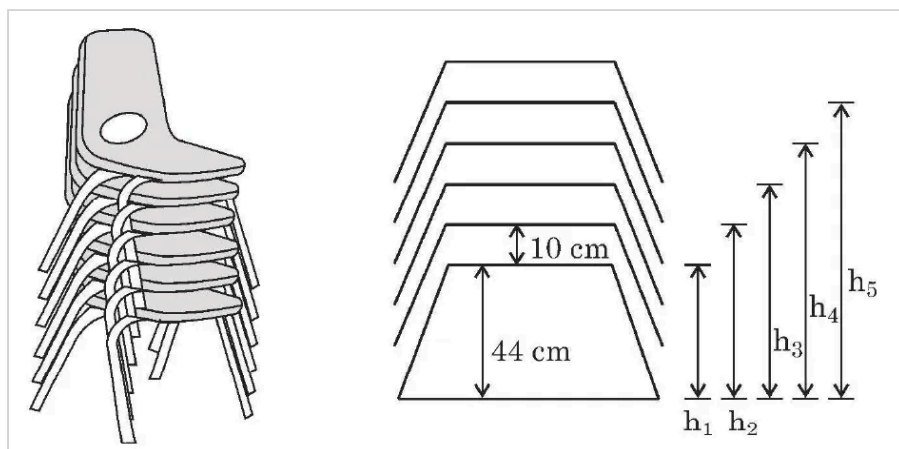
(i) Write the values of  $h_1, h_2, h_3, h_4$  and  $h_5$  in this order only. [1]

(ii) Show that the above values form an A.P. Write its first term and common difference. [1]

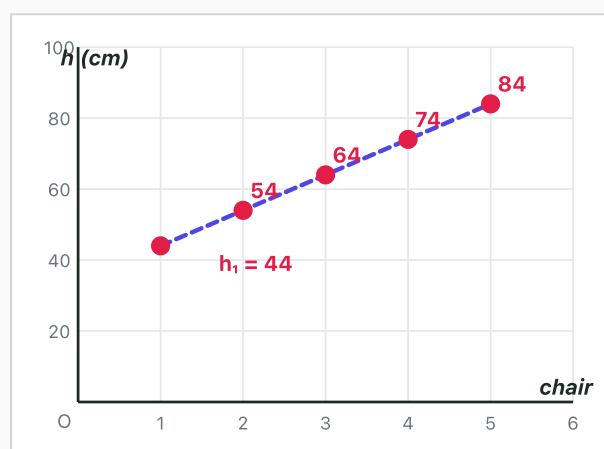
(iii) (a) If chairs can be stacked up to the maximum height of 160 cm, then find the maximum number of chairs in a stack. [2]

OR

(iii) (b) Is it possible to stack 15 chairs if maximum height of the stack can not be more than 180 cm? Justify your answer. [2]



### SOLUTION



(i)  $h_1 = 44$ ,  $h_2 = 44 + 10 = 54$ ,  $h_3 = 64$ ,  $h_4 = 74$ ,  $h_5 = 84$ .

(ii) The difference between consecutive heights is always 10 ( $54 - 44 = 64 - 54 = 74 - 64 = 84 - 74 = 10$ ), so they form an A.P. with first term  $a = 44$  and common difference  $d = 10$ .

(iii)(a)  $h_n = 44 + (n - 1) \times 10 \leq 160$  gives  $(n - 1) \times 10 \leq 116$ , so  $n \leq 12.6$ . The maximum number of chairs is 12.

(iii)(b)  $h_{15} = 44 + 14 \times 10 = 184$  cm, and  $184 > 180$ . So 15 chairs cannot be stacked within 180 cm.

**Answer: (i) 44, 54, 64, 74, 84    (ii) A.P.,  $a = 44$ ,  $d = 10$     (iii)(a) 12 chairs    (iii)(b) no,  $h_{15} = 184 > 180$**

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