Sample Paper 1

Class- X Exam - 2022-23

Mathematics - Standard

Time Allowed: 3 Hours **Maximum Marks : 80**

General Instructions :

1. This Question Paper has 5 Sections A-E.
2. Section A has 20 MCQs carrying 1 mark each
3. Section B has 5 questions carrying 02 marks each.
4. Section C has 6 questions carrying 03 marks each.
5. Section D has 4 questions carrying 05 marks each.
6. Section E has 3 case based integrated units of assessment (04 marks each) with sub-parts of the values of 1, 1 and 2 marks each respectively.
7. All Questions are compulsory. However, an internal choice in 2 Qs of 5 marks, 2 Qs of 3 marks and 2 Questions of 2 marks has been provided. An internal choice has been provided in the 2marks questions of Section E
8. Draw neat figures wherever required. Take $\pi = \frac{22}{7}$ wherever required if not stated.

Section - A

Section A consists of 20 questions of 1 mark each.

1. The maximum number of zeroes a cubic polynomial can have, is

(a) 1 (b) 4

(c) 2 (d) 3

2. **Assertion :** $(2-\sqrt{3})$ is one zero of the quadratic polynomial then other zero will be $(2+\sqrt{3})$.

Reason : Irrational zeros (roots) always occurs in pairs.

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).

(c) Assertion (A) is true but reason (R) is false.

(d) Assertion (A) is false but reason (R) is true.

3. A fraction becomes 4 when 1 is added to both the numerator and denominator and it becomes 7 when 1 is subtracted from both the numerator and denominator. The numerator of the given fraction is

(a) 2 (b) 3

(c) 5 (d) 15

4. The pair of linear equations $2kx+5y=7$, $6x-5y=11$ has a unique solution, if

(a) $k \neq -3$ (b) $k \neq \frac{2}{3}$

(c) $k \neq 5$ (d) $k \neq \frac{2}{9}$

5. **Assertion :** The equation $x^2+3x+1=(x-2)^2$ is a quadratic equation.
Reason : Any equation of the form $ax^2+bx+c=0$ where $a \neq 0$, is called a quadratic equation.
(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).
(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).
(c) Assertion (A) is true but reason (R) is false.
(d) Assertion (A) is false but reason (R) is true.

6. The linear factors of the quadratic equation $x^2+kx+1=0$ are
(a) $k \geq 2$
(b) $k \leq 2$
(c) $k \geq -2$
(d) $2 \leq k \leq -2$

7. In an AP, if $d=-4$, $n=7$ and $a_n=4$, then a is equal to
(a) 6
(b) 7
(c) 20
(d) 28

8. The 4th term from the end of an AP $-11, -8, -5$, ..., 49 is
(a) 37
(b) 40
(c) 43
(d) 58

9. In a right angled ΔABC right angled at B, if P and Q are points on the sides AB and BC respectively, then
(a) $AQ^2+CP^2=2(AC^2+PQ^2)$
(b) $2(AQ^2+CP^2)=AC^2+PQ^2$
(c) $AQ^2+CP^2=AC^2+PQ^2$
(d) $AQ+CP=\frac{1}{2}(AC+PQ)$

10. A chord of a circle of radius 10 cm, subtends a right angle at its centre. The length of the chord (in cm) is
(a) $\frac{5}{\sqrt{2}}$
(b) $5\sqrt{2}$
(c) $10\sqrt{2}$
(d) $10\sqrt{3}$

11. If ΔABC is right angled at C, then the value of$\cos(A+B)$ is
(a) 0
(b) 1
(c) $\frac{1}{2}$
(d) $\frac{\sqrt{3}}{2}$

12. A circle artist is climbing a 20 m long rope, which is tightly stretched and tied from the top of a vertical pole to the ground, then the height of pole, if the angle made by the rope with the ground level is 30°, is
(a) 5 m
(b) 10 m
(c) 15 m
(d) 20 m

13. If the area of a semi-circular field is 15400 sq m, then perimeter of the field is

(a) $160\sqrt{2}$ m (b) $260\sqrt{2}$ m

(c) $360\sqrt{2}$ m (d) $460\sqrt{2}$ m

14. Ratio of lateral surface areas of two cylinders with equal height is

(a) 1 : 2 (b) $H:h$

(c) $R:r$ (d) None of these

15. For finding the popular size of readymade garments, which central tendency is used?

(a) Mean

(b) Median

(c) Mode

(d) Both Mean and Mode

16. When a die is thrown, the probability of getting an odd number less than 3 is

(a) $\frac{1}{6}$ (b) $\frac{1}{3}$

(c) $\frac{1}{2}$ (d) 0

17. If the point P (6, 2) divides the line segment joining $A(6,5)$ and $B(4,y)$ in the ratio $3:1$ then the value of y is

(a) 4

(b) 3

(c) 2

(d) 1

18. If $x-2y+k=0$ is a median of the triangle whose vertices are at points $A(-1,3)$, $B(0,4)$ and $C(-5,2)$,then the value of k is

(a) 2 (b) 4

(c) 6 (d) 8

19. The ratio in which the point $(2,y)$ divides the join of $(-4,3)$ and (6, 3), hence the value of y is

(a) $2:3, y=3$

(b) $3:2, y=4$

(c) $3:2, y=3$

(d) $3:2, y=2$

20. The sum of exponents of prime factors in the prime-factorisation of 196 is

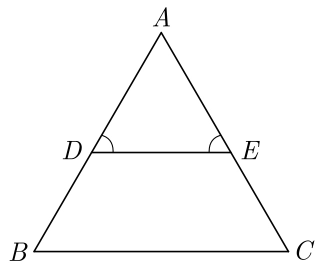
(a) 3 (b) 4

(c) 5 (d) 2

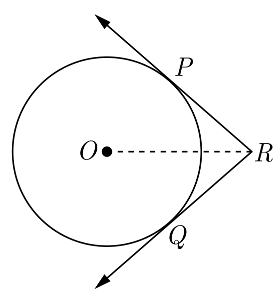
Section - B

Section B consists of 5 questions of 2 marks each.

21. In Figure $\angle D = \angle E$ and $\frac{AD}{DB} = \frac{AE}{EC}$, prove that ΔBAC is an isosceles triangle.



22. In figure, two tangents RQ and RP are drawn from an external point R to the circle with centre O. If $\angle PRQ = 120^\circ$, then prove that $OR = PR + RQ$.



23. If $\sqrt{3}\sin\theta - \cos\theta = 0$ and $0^\circ < \theta < 90^\circ$, find the value of θ.

24. Find the value of λ, if the mode of the following data is 20 :
15, 20, 25, 18, 13, 15, 25, 15, 18, 17, 20, 25, 20, λ, 18.

OR

The mean and median of 100 observation are 50 and 52 respectively. The value of the largest observation is 100. It was later found that it is 110. Find the true mean and median.

25. Prove that $3 + \sqrt{5}$ is an irrational number.

OR

Show that any positive even integer can be written in the form $6q, 6q + 2$ or $6q + 4$, where q is an integer.

Section - C

Section C consists of 6 questions of 3 marks each.

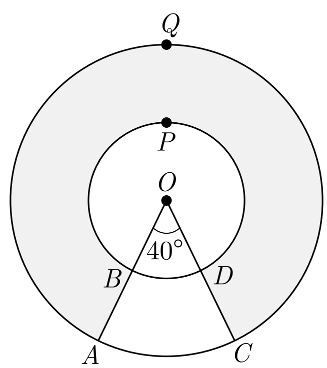
26. Show that the sum of all terms of an AP whose first term is a, the second term is b and last term is c, is equal to $\dfrac{(a+c)(b+c-2a)}{2(b-a)}$

27. Prove that $(1+\cot A-\operatorname{cosec} A)(1+\tan A+\sec A)=2$

28. Sides of a right triangular field are 25 m, 24 m and 7 m. At the three corners of the field, a cow, a buffalo and a horse are tied separately with ropes of 3.5 m each to graze in the field. Find the area of the field that cannot be grazed by these animals.

OR

In the given figure, find the area of the shaded region, enclosed between two concentric circles of radii 7 cm and 14 cm where $\angle AOC=40^\circ$. Use $\pi=\frac{22}{7}$.



29. The mean of the following distribution is 48 and sum of all the frequency is 50. Find the missing frequencies x and y.

Class	20-30	30-40	40-50	50-60	60-70
Frequency	8	6	x	11	y

30. If the co-ordinates of points A and B are $(-2,-2)$ and $(2,-4)$ respectively, find the co-ordinates of P such that $AP=\frac{3}{7}AB$, where P lies on the line segment AB.

OR

Find the co-ordinates of the points of trisection of the line segment joining the points $A(1,-2)$ and $B(-3,4)$.

31. Three bells toll at intervals of 9, 12, 15 minutes respectively. If they start tolling together, after what time will they next toll together?

Section - D

Section D consists of 4 questions of 5 marks each.

32. Aftab tells his daughter, '7 years ago, I was seven times as old as you were then. Also, 3 years from now, I shall be three times as old as you will be.' Represent this situation algebraically and graphically.

OR

Solve the following pair of linear equations graphically:
$x - y = 1$, $2x + y = 8$
Also find the co-ordinates of the points where the lines represented by the above equation intersect $y-$ axis.

33. From a point T outside a circle of centre O, tangents TP and TQ are drawn to the circle. Prove that OT is the right bisector of line segment PQ.

34. From a point on the ground, the angles of elevation of the bottom and the top of a tower fixed at the top of a 20 m high building are 45° and 60° respectively. Find the height of the tower.

OR

The angle of elevation of the top B of a tower AB from a point X on the ground is 60°. At point Y, 40 m vertically above X, the angle of elevation of the top is 45°. Find the height of the tower AB and the distance XB.

35. Water is flowing through a cylindrical pipe, of internal diameter 2 cm, into a cylindrical tank of base radius 40 cm, at the rate of 0.4 m/s. Determine the rise in level of water in the tank in half an hour.

Section - E

Case study based questions are compulsory.

36. John and Priya went for a small picnic. After having their lunch Priya insisted to travel in a motor boat. The speed of the motor boat was 20 km/hr. Priya being a Mathematics student wanted to know the speed of the current. So she noted the time for upstream and downstream.

She found that for covering the distance of 15 km the boat took 1 hour more for upstream than downstream.

(i) Let speed of the current be x km/hr. then speed of the motorboat in upstream will be

(ii) What is the relation between speed distance and time?

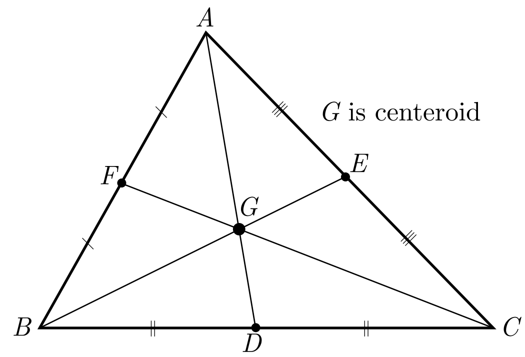
(iii) Write the correct quadratic equation for the speed of the current ?

OR

(iv) What is the speed of current ?

37. The centroid is the centre point of the object. It is also defined as the point of intersection of all the three medians. The median is a line that joins the midpoint of a side and the opposite vertex of the triangle. The centroid of the triangle separates the median in the ratio of 2 : 1. It can be found by taking the average of x- coordinate points and y-coordinate points of all the vertices of the triangle.

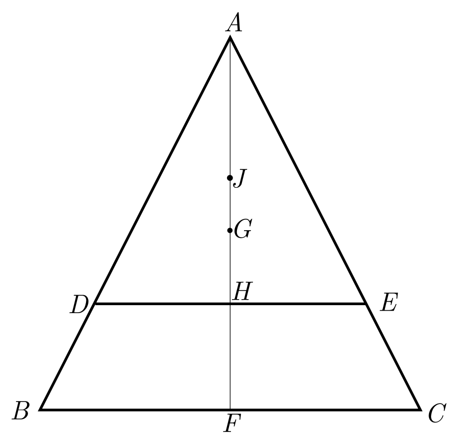
See the figure given below



Here D, E and F are mid points of sides BC, AC and AB in same order. G is centroid, the centroid divides the median in the ratio 2 : 1 with the larger part towards the vertex. Thus $AG:GD = 2:1$

On the basis of above information read the question below.

If G is Centroid of $\triangle ABC$ with height h and J is centroid of $\triangle ADE$. Line DE parallel to BC, cuts the $\triangle ABC$ at a height $\frac{h}{4}$ from BC. $HF = \frac{h}{4}$.



(i) What is the length of AH ?

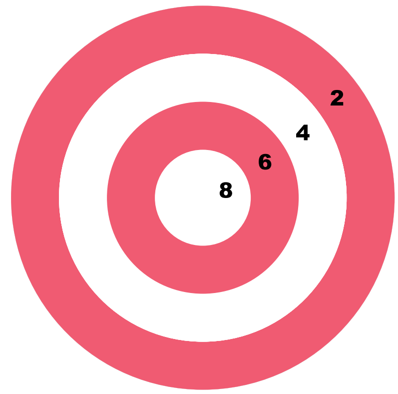
(ii) What is the distance of point A from point G?

(iii) What is the distance of point A from point J?

OR

(iv) What is the distance GJ ?

38. Abhinav Bindra is retired sport shooter and currently India's only individual Olympic gold medalist. His gold in the 10-meter air rifle event at the 2008 Summer Olympics was also India's first Olympic gold medal since 1980. He is the first Indian to have held concurrently the world and Olympic titles for the men's 10-meter air rifle event, having earned those honors at the 2008 Summer Olympics and the 2006 ISSF World Shooting Championships. Bindra has also won nine medals at the Commonwealth Games and three gold medals at the Asian Games.



A circular dartboard has a total radius of 8 inch, with circular bands that are 2 inch wide, as shown in figure. Abhinav is still skilled enough to hit this board 100% of the time so he always score at least two points each time he throw a dart. Assume the probabilities are related to area, on the next dart that he throw.

(i) What is the probability that he score at least 4 ?

(ii) What is the probability that he score at least 6 ?

(iii) What is the probability that he hit bull's eye ?

OR

(iv) What is the probability that he score exactly 4 points ?

□□□□□□□

Sample Paper 1 Solutions

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Mathematics - Standard

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7. All Questions are compulsory. However, an internal choice in 2 Qs of 5 marks, 2 Qs of 3 marks and 2 Questions of 2 marks has been provided. An internal choice has been provided in the 2marks questions of Section E
8. Draw neat figures wherever required. Take $\pi = \frac{22}{7}$ wherever required if not stated.

Section - A

Section A consists of 20 questions of 1 mark each.

1. The maximum number of zeroes a cubic polynomial can have, is

(a) 1 (b) 4

(c) 2 (d) 3

Ans :

A cubic polynomial has maximum 3 zeroes because its degree is 3.

Thus (d) is correct option.

2. **Assertion :** $(2-\sqrt{3})$ is one zero of the quadratic polynomial then other zero will be $(2+\sqrt{3})$.

Reason : Irrational zeros (roots) always occurs in pairs.

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).

(c) Assertion (A) is true but reason (R) is false.

(d) Assertion (A) is false but reason (R) is true.

Ans :

As irrational roots/zeros always occurs in pairs therefore, when one zero is $(2-\sqrt{3})$ then other will be $2+\sqrt{3}$. So, both A and R are correct and R explains A.

Thus (a) is correct option.

3. A fraction becomes 4 when 1 is added to both the numerator and denominator and it becomes 7 when 1 is subtracted from both the numerator and denominator. The numerator of the given fraction is

(a) 2 (b) 3

(c) 5 (d) 15

Ans :

Let the fraction be $\frac{x}{y}$,

$$\frac{x+1}{y+1} = 4 \Rightarrow x = 4y+3 \qquad ...(1)$$

and

$$\frac{x-1}{y-1} = 7 \Rightarrow x = 7y-6 \qquad ...(2)$$

Solving (1) and (2), we have $x = 15$, $y = 3$,

Thus (d) is correct option.

4. The pair of linear equations $2kx+5y=7$, $6x-5y=11$ has a unique solution, if

(a) $k \neq -3$ (b) $k \neq \frac{2}{3}$

(c) $k \neq 5$ (d) $k \neq \frac{2}{9}$

Ans :

Given the pair of linear equations are

$$2kx + 5y - 7 = 0$$

and $$6x - 5y - 11 = 0$$

On comparing with

$$a_1 x + b_1 y + c_1 = 0$$

and $$a_2 x + b_2 y + c_2 = 0$$

we get, $$a_1 = 2k,\ b_1 = 5,\ c_1 = -7$$

and $$a_2 = 6,\ b_2 = -5,\ c_2 = -11$$

For unique solution,

$$\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$$

$$\frac{2k}{6} \neq \frac{5}{-5}$$

$$\frac{k}{3} = \neq -1$$

$$k \neq -3$$

Thus (a) is correct option.

5. **Assertion :** The equation $x^2 + 3x + 1 = (x-2)^2$ is a quadratic equation.

Reason : Any equation of the form $ax^2 + bx + c = 0$ where $a \neq 0$, is called a quadratic equation.

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).

(c) Assertion (A) is true but reason (R) is false.

(d) Assertion (A) is false but reason (R) is true.

Ans :

We have, $x^2 + 3x + 1 = (x-2)^2 = x^2 - 4x$

$$x^2 + 3x + 1 = x^2 - 4x + 4$$

$$7x - 3 = 0$$

It is not of the form $ax^2 + bx + c = 0$

(d) Assertion (A) is false but reason (R) is true.

Thus (d) is correct option.

6. The linear factors of the quadratic equation $x^2 + kx + 1 = 0$ are

(a) $k \geq 2$ (b) $k \leq 2$

(c) $k \geq -2$ (d) $2 \leq k \leq -2$

Ans :

We have, $$x^2 + kx + 1 = 0$$

Comparing with $ax^2 + bx + c = 0$ we get $a = 1$, $b = k$ and $c = 1$.

For linear factors, $$b^2 - 4ac \geq 0$$

$$k^2 - 4 \times 1 \times 1 \geq 0$$

$$(k^2 - 2^2) \geq 0$$

$$(k-2)(k+2) \geq 0$$

$$k \geq 2 \text{ and } k \leq -2$$

Thus (d) is correct option.

7. In an AP, if $d = -4$, $n = 7$ and $a_n = 4$, then a is equal to

(a) 6 (b) 7

(c) 20 (d) 28

Ans :

In an AP, $$a_n = a + (n-1)\,d$$

$$4 = a + (7-1)(-4$$

$$4 = a + 6(-4)$$

$$4 + 24 = a \Rightarrow a = 28$$

Thus (d) is correct option.

8. The 4th term from the end of an AP $-11, -8, -5$, ..., 49 is

(a) 37 (b) 40

(c) 43 (d) 58

Ans :

Common difference,

$$d = -8 - (-11) = -8 + 11 = 3$$

Last term, $$l = 49$$

nth term of an AP from the end is

$$a_n = l - (n-1)\,d$$

, $$a_4 = 49 - (4-1) \times 3$$

$$= 49 - 9 = 40$$

9. In a right angled ΔABC right angled at B, if P and Q are points on the sides AB and BC respectively, then

(a) $AQ^2 + CP^2 = 2(AC^2 + PQ^2)$

(b) $2(AQ^2 + CP^2) = AC^2 + PQ^2$

(c) $AQ^2 + CP^2 = AC^2 + PQ^2$

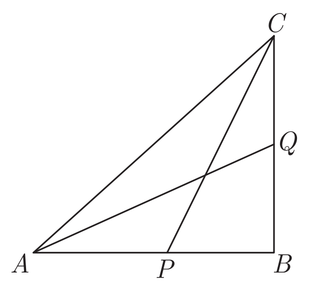
(d) $AQ + CP = \frac{1}{2}(AC + PQ)$

Ans :

In right angled ΔABQ and ΔCPB,

$$CP^2 = CB^2 + BP^2$$

and $$AQ^2 = AB^2 + BQ^2$$



$$CP^2 + AQ^2 = CB^2 + BP^2 + AB^2 + BQ^2$$
$$= CB^2 + AB^2 + BP^2 + BQ^2$$
$$= AC^2 + PQ^2$$

Thus (c) is correct option.

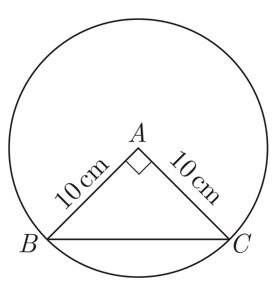
10. A chord of a circle of radius 10 cm, subtends a right angle at its centre. The length of the chord (in cm) is

(a) $\frac{5}{\sqrt{2}}$ (b) $5\sqrt{2}$

(c) $10\sqrt{2}$ (d) $10\sqrt{3}$

Ans :

As per given information we have drawn the figure below.



Using Pythagoras theorem in ΔABC, we get

$$BC^2 = AB^2 + AC^2$$
$$= 10^2 + 10^2$$
$$= 100 + 100 = 200$$
$$BC = 10\sqrt{2} \text{ cm}$$

Thus (c) is correct option.

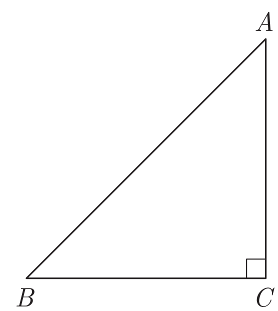
11. If ΔABC is right angled at C, then the value of $\cos(A + B)$ is

(a) 0 (b) 1

(c) $\frac{1}{2}$ (d) $\frac{\sqrt{3}}{2}$

Ans :

We know that in ΔABC,



$$\angle A + \angle B + \angle C = 180^\circ$$

But right angled at C i.e., $\angle C = 90^\circ$, thus

$$\angle A + \angle B + 90^\circ = 180^\circ$$
$$A + B = 90^\circ$$
$$\cos(A + B) = \cos 90^\circ = 0$$

Thus (a) is correct option.

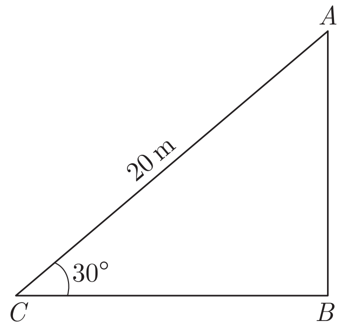
12. A circle artist is climbing a 20 m long rope, which is tightly stretched and tied from the top of a vertical pole to the ground, then the height of pole, if the angle made by the rope with the ground level is 30°, is

(a) 5 m (b) 10 m

(c) 15 m (d) 20 m

Ans :

Let AB be the vertical pole and CA be the 20 m long rope such that its one end A is tied from the top of the vertical pole AB and the other end C is tied to a point C on the ground.



In $\triangle ABC$, we have

$$\sin 30^\circ = \frac{AB}{AC}$$

$$\frac{1}{2} = \frac{AB}{AC}$$

$$\frac{1}{2} = \frac{AB}{20} \Rightarrow AB = 10\text{ m}$$

Hence, the height of the pole is 10 m.
Thus (b) is correct option.

13. If the area of a semi-circular field is 15400 sq m, then perimeter of the field is

(a) $160\sqrt{2}$ m
(b) $260\sqrt{2}$ m
(c) $360\sqrt{2}$ m
(d) $460\sqrt{2}$ m

Ans :

Let the radius of the field be r.

Then, $$\frac{\pi r^2}{2} = 15400$$

$$\frac{1}{2} \times \frac{22}{7} \times r^2 = 15400$$

$$r^2 = 15400 \times 2 \times \frac{7}{22} = 9800$$

$$r = 70\sqrt{2}\text{ m}$$

Thus, perimeter of the field

$$\pi r + 2r = \frac{22}{7} \times 70\sqrt{2} + 2 \times 70\sqrt{2}$$

$$= 220\sqrt{2} + 140\sqrt{2}$$

$$= \sqrt{2}(220 + 140)$$

$$= 360\sqrt{2}\text{ m}$$

Thus (c) is correct option.

14. Ratio of lateral surface areas of two cylinders with equal height is

(a) 1 : 2
(b) $H:h$
(c) $R:r$
(d) None of these

Ans :

$$2\pi Rh : 2\pi rh = R:r$$

Thus (c) is correct option.

15. For finding the popular size of readymade garments, which central tendency is used?

(a) Mean
(b) Median
(c) Mode
(d) Both Mean and Mode

Ans :

For finding the popular size of ready made garments, mode is the best measure of central tendency.
Thus (c) is correct option.

16. When a die is thrown, the probability of getting an odd number less than 3 is

(a) $\frac{1}{6}$
(b) $\frac{1}{3}$
(c) $\frac{1}{2}$
(d) 0

Ans :

Odd number less than 3 is 1 only.

$$n(S) = 6$$

$$n(E) = 1$$

So, probability of getting an odd number less than 3,

$$P(E) = \frac{n(E)}{n(S)} = \frac{1}{6}$$

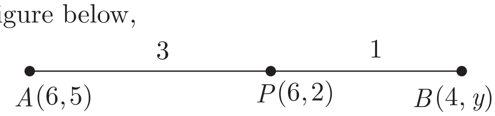
Thus (a) is correct option.

17. If the point P (6, 2) divides the line segment joining $A(6, 5)$ and $B(4, y)$ in the ratio $3:1$ then the value of y is

(a) 4
(b) 3
(c) 2
(d) 1

Ans :

As per given information in question we have drawn the figure below,



Here, $x_1 = 6,\ y_1 = 5$

and $x_2 = 4\ \ y_2 = y$

Now $y = \frac{my_2 + ny_1}{m+n}$

$$2 = \frac{3 \times y + 1 \times 5}{3+1}$$

$$2 = \frac{3y+5}{4}$$

$$3y + 5 = 8$$

$$3y = 8 - 5 = 3 \Rightarrow y = 1$$

Thus (d) is correct option.

18. If $x - 2y + k = 0$ is a median of the triangle whose vertices are at points $A(-1, 3)$, $B(0, 4)$ and $C(-5, 2)$, then the value of k is

(a) 2 (b) 4

(c) 6 (d) 8

Ans :

Coordinate of the centroid G of ΔABC

$$= \left(\frac{-1+0-5}{2}, \frac{3+4+2}{3}\right)$$

$$= (-2, 3)$$

Since, G lies on the median, $x - 2y + k = 0$, it must satisfy the equation,

$$-2 - 6 + k = 0 \Rightarrow k = 8$$

Thus (d) is correct option.

19. The ratio in which the point $(2, y)$ divides the join of $(-4, 3)$ and (6, 3), hence the value of y is

(a) $2:3, y = 3$ (b) $3:2, y = 4$

(c) $3:2, y = 3$ (d) $3:2, y = 2$

Ans :

Let the required ratio be $k:1$

Then, $2 = \frac{6k - 4(1)}{k+1}$

or $k = \frac{3}{2}$

The required ratio is $\frac{3}{2}:1$ or 3 : 2

Also, $y = \frac{3(3) + 2(3)}{3+2} = 3$

Thus (c) is correct option.

20. The sum of exponents of prime factors in the prime-factorisation of 196 is

(a) 3 (b) 4

(c) 5 (d) 2

Ans :

Prime factors of 196,

$$196 = 4 \times 49$$

$$= 2^2 \times 7^2$$

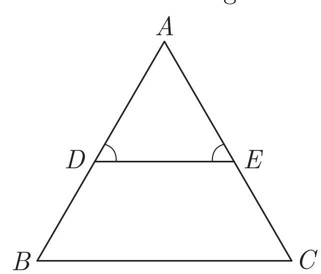
The sum of exponents of prime factor is $2 + 2 = 4$.

Thus (b) is correct option.

Section - B

Section B consists of 5 questions of 2 marks each.

21. In Figure $\angle D = \angle E$ and $\frac{AD}{DB} = \frac{AE}{EC}$, prove that ΔBAC is an isosceles triangle.



Ans :

We have, $\angle D = \angle E$

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

By converse of BPT, $DE \parallel BC$

Due to corresponding angles we have

$$\angle ADE = \angle ABC \text{ and}$$

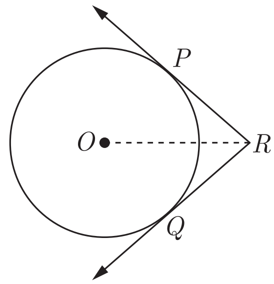
$$\angle AED = \angle ACB$$

Given $\angle ADE = \angle AED$

Thus $\angle ABC = \angle ACB$

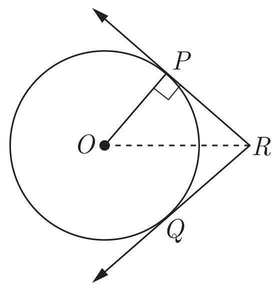
Therefore BAC is an isosceles triangle.

22. In figure, two tangents RQ and RP are drawn from an external point R to the circle with centre O. If $\angle PRQ = 120^\circ$, then prove that $OR = PR + RQ$.



Ans :

We redraw the given figure by joining O to P as shown below.



$$\angle PRO = \tfrac{1}{2}\angle PRQ$$

$$= \frac{120^\circ}{2} = 60^\circ$$

Here ΔOPR is right angle triangle, thus

$$\angle POR = 90^\circ - \angle PRO = 90^\circ - 60^\circ = 30^\circ$$

Now $$\frac{PR}{OR} = \sin 30^\circ = \frac{1}{2}$$

$$OR = 2PR = PR + PR$$

Since $PR = QR$,

$$OR = PR + QR$$ Hence Proved

23. If $\sqrt{3}\sin\theta - \cos\theta = 0$ and $0^\circ < \theta < 90^\circ$, find the value of θ.

Ans :

We have

$$\sqrt{3}\sin\theta - \cos\theta = 0 \text{ and } 0^\circ < \theta <$$

$$\sqrt{3}\sin\theta = \cos\theta$$

$$\frac{\sin\theta}{\cos\theta} = \frac{1}{\sqrt{3}}$$

$$\tan\theta = \frac{1}{\sqrt{3}} = \tan 30^\circ \quad \left[\tan\theta = \frac{\sin\theta}{\cos\theta}\right]$$

$$\theta = 30^\circ$$

24. Find the value of λ, if the mode of the following data is 20 :

15, 20, 25, 18, 13, 15, 25, 15, 18, 17, 20, 25, 20, λ, 18.

Ans :

First we prepare the following table as discrete frequency distribution.

x_i	f_i
13	1
15	3
17	1
18	3
20	3
λ	1
25	3

Frequency of 20 must be highest to be mode of the frequency distribution, $\lambda = 20$.

or

The mean and median of 100 observation are 50 and 52 respectively. The value of the largest observation is 100. It was later found that it is 110. Find the true mean and median.

Ans :

Mean, $$M = \frac{\sum fx}{\sum f}$$

$$50 = \frac{\sum fx}{100}$$

$$\sum fx = 5000$$

Correct, $$\sum fx' = 5000 - 100 + 110$$

$$= 5010$$

Correct Mean $$= \frac{5010}{100} = 50.1$$

Median will remain same i.e. median is 52.

25. Prove that $3+\sqrt{5}$ is an irrational number.

Ans :

Assume that $3+\sqrt{5}$ is a rational number, then we have

$$3+\sqrt{5} = \frac{p}{q}, \quad q \neq 0$$

$$\sqrt{5} = \frac{p}{q} - 3$$

$$\sqrt{5} = \frac{p-3q}{q}$$

Here $\sqrt{5}$ is irrational and $\frac{p-3q}{q}$ is rational. But rational number cannot be equal to an irrational number. Hence $3+\sqrt{5}$ is an irrational number.

or

Show that any positive even integer can be written in the form $6q, 6q+2$ or $6q+4$, where q is an integer.

Ans :

Let a be any positive integer, then by Euclid's division algorithm, a can be written as

$$= = bq + r$$

Take $b = 6$, then $0 \leq r < 6$ because $0 \leq r < b$,

Thus $\quad a = 6q, 6q+1, 6q+2, 6q+3, 6q+4, 6q+5$

Here $6q$, , $6q+2$ and $6q+4$ are divisible by 2 and so $6q$, $6q+2$ and $6q+4$ are even positive integers.

Hence a is always an even integer if

$$a = 6q,\ 6q+2,\ 6q+4$$

Section - C

Section C consists of 6 questions of 3 marks each.

26. Show that the sum of all terms of an AP whose first term is a, the second term is b and last term is c, is equal to $\frac{(a+c)(b+c-2a)}{2(b-a)}$

Ans :

Given, first term, $\quad A = a$

and second term $\quad A_2 = b$

Common difference, $\quad D = b - a$

Last term, $\quad A_n = c$

$$A + (n-1)d = c$$

$$a + (n-1)(b-a) = c$$

$$(b-a)(n-1) = c - a$$

$$n - 1 = \frac{c-a}{b-a}$$

$$n = \frac{c-a}{b-a} + 1 = \frac{c-a+b-a}{b-a}$$

$$n = \frac{b+c-2a}{b-a}$$

Now sum of all terms

$$S_n = \frac{n}{2}[A + A_n] = \frac{(b+c-2a)}{2(b-a)}[a+c]$$

$$= \frac{(a+c)(b+c-2a)}{2(b-a)} \qquad \text{Hence Proved}$$

27. Prove that $(1+\cot A - \operatorname{cosec} A)(1+\tan A + \sec A) = 2$

Ans :

$$\text{LHS} = (1+\cot A - \operatorname{cosec} A)(1+\tan A + \sec A)$$

$$= \left(1 + \frac{\cos A}{\sin A} - \frac{1}{\sin A}\right)\left(1 + \frac{\sin A}{\cos A} + \frac{1}{\cos A}\right)$$

$$= \left(\frac{\sin A + \cos A - 1}{\sin A}\right)\left(\frac{\cos A + \sin A}{\cos A}\right.$$

$$= \frac{(\sin A + \cos A - 1)(\cos A + \sin A}{\sin A \cos A}$$

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

$$= \frac{\sin^2 A + \cos^2 A + 2\sin A \cos A - 1}{\sin A \cos A}$$

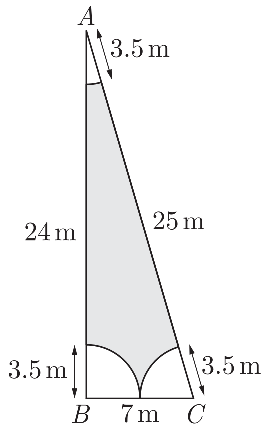
$$= \frac{1 + 2\sin A \cos A - 1}{\sin A \cos A}$$

$$= 2 = \text{RHS}$$

28. Sides of a right triangular field are 25 m, 24 m and 7 m. At the three corners of the field, a cow, a buffalo and a horse are tied separately with ropes of 3.5 m each to graze in the field. Find the area of the field that cannot be grazed by these animals.

Ans :

As per information given in question we have drawn the figure below.



Let $\angle A = \theta_1$, $\angle B = \theta_2$ and $\angle C = \theta_3$.

Now, area which can be grazed by the animals is the sum of the areas of three sectors with central angles θ_1, θ_2 and θ_3 each with radius $r = 3.5$ m.

$$\frac{\pi r^2 \theta_1}{360^\circ} + \frac{\pi r^2 \theta_2}{360^\circ} + \frac{\pi r^2 \theta_3}{360^\circ} = \frac{\pi r^2}{360^\circ}(\theta_1 + \theta_2 + \theta_3) \qquad ...(1)$$

From angle sum property of a triangle we have

$$\theta_1 + \theta_2 + \theta_3 = 180^\circ$$

Substituting above in equation (1) we have

$$\frac{\pi r^2 \theta_1}{360^\circ} + \frac{\pi r^2 \theta_2}{360^\circ} + \frac{\pi r^2 \theta_3}{360^\circ} = \frac{\pi r^2}{360^\circ} \times 180^\circ = \frac{\pi r^2}{2}$$

$$= \frac{22}{7} \times \frac{1}{2} \times (3.5)^2$$

$$= 19.25$$

Hence, the area grazed by the horses is $19.25\,\text{m}^2$.

$$\text{Area of } \Delta ABC = \frac{1}{2} \times AB \times BC$$

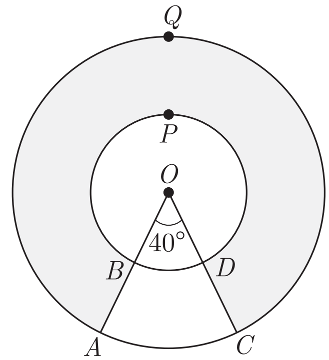
$$= \frac{1}{2} \times 24 \times 7 = 84\,\text{m}^2$$

Area of the field that cannot be grazed by these animals = Area of triangle − Area of three sectors

$$= 84 - 1925 = 64.75\,\text{m}^2$$

or

In the given figure, find the area of the shaded region, enclosed between two concentric circles of radii 7 cm and 14 cm where $\angle AOC = 40^\circ$. Use $\pi = \frac{22}{7}$.



Ans :

Radii of two concentric circle is 7 cm and 14 cm.

Angle $\angle AOC = 40^\circ$,

Angle $\angle AOC = 360^\circ - 40^\circ = 320^\circ$

Area of shaded region,

$$\frac{\theta}{360^\circ}\pi[R^2 - r^2] = \frac{320^\circ}{360^\circ} \times \frac{22}{7}[14^2 - 7^2]$$

$$= \frac{8}{9} \times 22 \times (14 \times 2 - 7)$$

$$= \frac{8}{9} \times 22 \times 21 = \frac{8}{3} \times 22 \times 7$$

$$= \frac{8 \times 154}{3}\ \text{cm}^2$$

Required area, $= \frac{1232}{3}\ \text{cm}^2$

$$= 410.67\ \text{cm}^2$$

29. The mean of the following distribution is 48 and sum of all the frequency is 50. Find the missing frequencies x and y.

Class	20-30	30-40	40-50	50-60	60-70
Frequency	8	6	x	11	y

Ans :

We prepare following table to find mean.

C.I.	f_i	x_i	$u_i = \frac{x_i - a}{h}$	$f_i u_i$
20-30	8	25	-2	-16
30-40	6	35	-1	-6
40-50	x	$45 = a$	0	0
50-60	11	55	1	11
60-70	y	65	2	$2y$

Total	$\sum f_i =$ $25+x+y$			$\sum f_i u_i =$ $2y-11$

Mean,
$$M = a + \frac{\sum f_i u_i}{\sum f_i} \times h$$

$$48 = 45 + \frac{2y-11}{50} \times 10$$

$$48 - 45 = \frac{2y-11}{5}$$

$$3 \times 5 = 2y - 11$$

$$15 = 2y - 11 \Rightarrow y = 13$$

Also
$$\sum f_i = 25 + x + y = 50$$

$$x + y = 25$$

$$x = 25 - 13 = 12$$

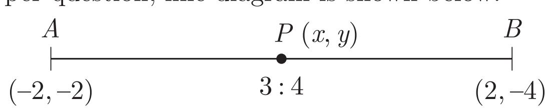
Thus $x = 12$ and $y = 13$

30. If the co-ordinates of points A and B are $(-2,-2)$ and $(2,-4)$ respectively, find the co-ordinates of P such that $AP = \frac{3}{7}AB$, where P lies on the line segment AB.

Ans :

We have
$$AP = \frac{3}{7}AB \Rightarrow AP:PB = 3:4$$

As per question, line diagram is shown below.



Section formula :

$$x = \frac{mx_2 + nx_1}{m+n} \text{ and } y = \frac{my_2 + ny_1}{m+n}$$

Applying section formula we get

$$x = \frac{3 \times 2 + 4 \times (-2)}{3+4} = -\frac{2}{7}$$

$$y = \frac{3 \times (-4) + 4 \times (-2)}{3+4} = -\frac{20}{7}$$

Hence P is $\left(-\frac{2}{7}, -\frac{20}{7}\right)$.

or

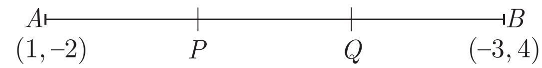
Find the co-ordinates of the points of trisection of the line segment joining the points $A(1,-2)$ and $B(-3,4)$.

Ans :

Let $P(x_1, y_1), Q(x_2, y_2)$ divides AB into 3 equal parts.

Thus P divides AB in the ratio of 1:2.

As per question, line diagram is shown below.



Now
$$x_1 = \frac{1(-3) + 2(1)}{1+3} = \frac{-3+2}{3} = \frac{-1}{3}$$

$$y_1 = \frac{1(4) + 2(-2)}{1+2} = \frac{4-4}{3} = 0$$

Co-ordinates of P is $\left(-\frac{1}{3}, 0\right)$.

Here Q is mid-point of PB.

Thus
$$x_2 = \frac{-\frac{1}{3} + (-3)}{2}$$

$$= \frac{-10}{6} = \frac{-5}{3}$$

$$y_2 = \frac{0+4}{2} = 2$$

Thus co-ordinates of Q is $\left(-\frac{5}{2}, 2\right)$.

31. Three bells toll at intervals of 9, 12, 15 minutes respectively. If they start tolling together, after what time will they next toll together?

Ans :

The required answer is the LCM of 9, 12, and 15 minutes.

Finding prime factor of given number we have,

$$9 = 3 \times 3 = 3^2$$

$$12 = 2 \times 2 \times 3 \quad 2^2 \times$$

$$15 = 3 \times 5$$

$$\text{LCM}(9, 12, 15) = 2^2 \times 3^2 \times 5$$

$$= 150 \text{ minutes}$$

The bells will toll next together after 180 minutes.

Section - D

Section D consists of 4 questions of 5 marks each.

32. Aftab tells his daughter, '7 years ago, I was seven times as old as you were then. Also, 3 years from now, I shall be three times as old as you will be.' Represent this situation algebraically and graphically.

Ans :

Let the present age of Aftab be x years and the age of daughter be y years.

$$7 \text{ years ago father's(Aftab) age} = (x-7)\text{years}$$

$$7 \text{ years ago daughter's age} = (y-7) \text{ years}$$

According to the question,

$$(x-7) = 7(y-7)$$

or, $$(x-7y) = -42 \quad (1)$$

$$\text{After 3 years father's(Aftab) age} = (x+3) \text{ years}$$

$$\text{After 3 years daughter's age} = (y+3) \text{ years}$$

According to the condition,

$$x+3 = 3(y+3)$$

or, $$x-3y = 6 \quad (2)$$

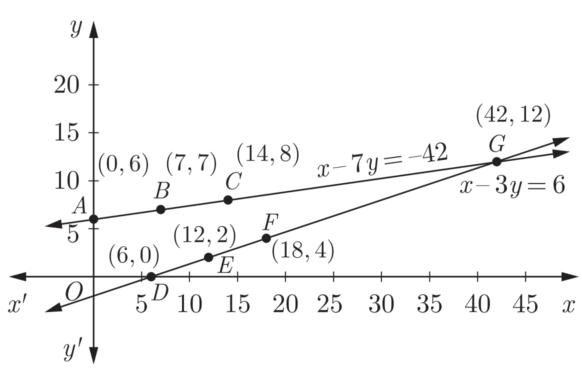
From equation(1) $\quad x-7y = -42$

x	0	7	14
$y = \frac{x+42}{7}$	6	7	8

From equation (2) $x-3y = 6$

x	6	12	18
$y = \frac{x-6}{3}$	0	2	4

Plotting the above points and drawing lines joining them, we get the following graph.



Two lines obtained intersect each other at $(42, 12)$

Hence, $\quad$ father's age $= 42$ years

and $\quad$ daughter's age $= 12$ years

or

Solve the following pair of linear equations graphically:
$x - y = 1,\ 2x + y = 8$
Also find the co-ordinates of the points where the lines represented by the above equation intersect $y-$ axis.

Ans :

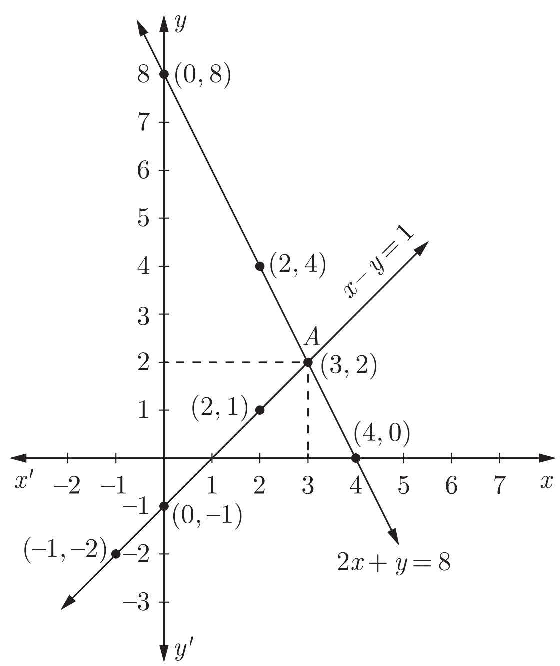
We have $\quad x - y = 1 \Rightarrow y = x - 1$

x	2	3	-1
y	1	2	-2

and $\quad 2x + y = 8 \Rightarrow y = 8 - 2x$

x	2	4	0
y	4	0	8

Plotting the above points and drawing lines joining them, we get the following graph.



The two lines intersect each other at point $A(3,2)$. Thus solution of given equations is $x = 3, y = 2$.

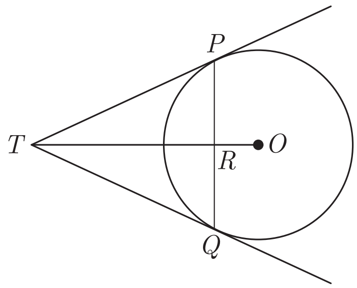
Again, $x - y = 1$ intersects $y-$ axis at $(0, -1)$

and $\quad 2x + y = 8$ $y-$ axis at $(0,8)$.

33. From a point T outside a circle of centre O, tangents TP and TQ are drawn to the circle. Prove that OT is the right bisector of line segment PQ.

Ans :

A circle with centre O. Tangents TP and TQ are drawn from a point T outside a circle as shown in figure below.



Since length of tangents from an external point to a circle are equal,

$$TP = TQ$$

Angle $\angle TPR$ and $\angle TQR$ are opposite angle of equal sides, thus

$$\angle TPR = \angle TQR$$

Now in ΔPTR and ΔQTR

$$TP = TQ$$

$$TR = TR \quad \text{(Common)}$$

$$\angle TPR = \angle TQR$$

Thus $\Delta PTR \cong \Delta QTR$

and $PR = QR$

and $\angle PRT = \angle QRT$

But $\angle PRT + QRT = 180^\circ$ as PQ is line segment,

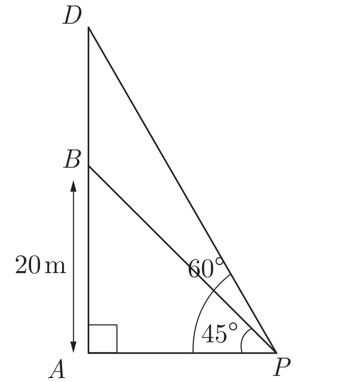
$$\angle PRT = \angle QRT = 90^\circ$$

Therefore TR or OT is the right bisector of line segment PQ. Hence proved.

34. From a point on the ground, the angles of elevation of the bottom and the top of a tower fixed at the top of a 20 m high building are 45° and 60° respectively. Find the height of the tower.

Ans :

As per given information in question we have drawn the figure below. Here AB is the building and BD is tower on building.



In ΔPAB, $\tan 45^\circ = \dfrac{AB}{AP}$

$$1 = \frac{20}{AP} \Rightarrow AP = 20 \text{ m}$$

In ΔPAD, $\tan 60^\circ = \dfrac{AD}{AP} = \dfrac{20 + BD}{20}$

$$\sqrt{3} = \frac{20 + BD}{20}$$

$$20 + BD = 20\sqrt{3}$$

$$BD = 20\sqrt{3} - 20 = 20(\sqrt{3} - 1)$$

$$= 20(1.732 - 1)$$

$$= 20 \times 0.732 = 14.64 \text{ cm}.$$

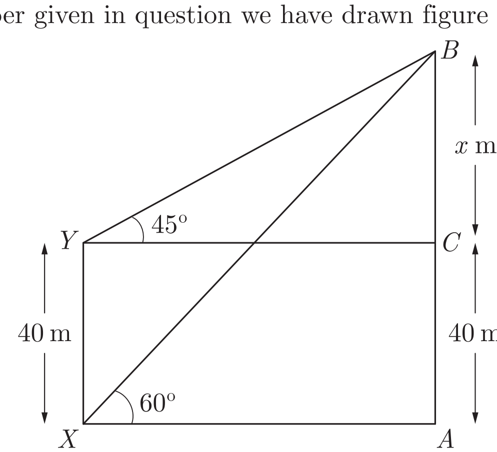
Hence, height of the tower is 14.64 m.

or

The angle of elevation of the top B of a tower AB from a point X on the ground is 60°. At point Y, 40 m vertically above X, the angle of elevation of the top is 45°. Find the height of the tower AB and the distance XB.

Ans :

As per given in question we have drawn figure below.



In right ΔYCB, we have

$$\tan 45^\circ = \frac{BC}{YC}$$

$$1 = \frac{x}{YC}$$

$$YC = x = XA$$

In right ΔXAB we have

$$\tan 60^\circ = \frac{AB}{XA}$$

$$\sqrt{3} = \frac{x+40}{x}$$

$$\sqrt{3}x = x+40$$

$$x\sqrt{3} - x = 40$$

$$x = \frac{40}{\sqrt{3}-1} \times \frac{\sqrt{3}+1}{\sqrt{3}+1}$$

$$= 20(\sqrt{3}+1) = 20\sqrt{3}+20$$

Thus height of the tower,

$$AB = x+40$$

$$= 20\sqrt{3}+20+40$$

$$= 20\sqrt{3}+60 = 20(\sqrt{3}+3)$$

In right ΔXAB we have,

$$\sin 60^\circ = \frac{AB}{BX}$$

$$\frac{\sqrt{3}}{2} = \frac{AB}{BX}$$

$$BX = \frac{2AB}{\sqrt{3}} = \frac{20 \times 2(\sqrt{3}+3)}{\sqrt{3}}$$

$$= 40(1+\sqrt{3})$$

$$= 40 \times 2.73 = 109.20$$

35. Water is flowing through a cylindrical pipe, of internal diameter 2 cm, into a cylindrical tank of base radius 40 cm, at the rate of 0.4 m/s. Determine the rise in level of water in the tank in half an hour.

Ans :

Radius of pipe $\quad r = \frac{2}{2} = 1$

Water flow rate $\quad = 0.4 \text{ m/s} = 40 \text{ cm/s}$

Volume of water flowing through pipe in 1 sec.

$$\pi r^2 h = \pi \times (1)^2 \times 40 = 40\pi \text{ cm}^3$$

Volume of water flowing in 30 min $(30 \times 60 \text{ sec})$

$$= 40\pi \times 30 \times 60 = 72000\pi$$

Volume of water in cylindrical tank in 30 min,

Now $\quad \pi R^2 H = \pi(40)^2 \times H$

$$\pi(40)^2 \times H = 72000\pi$$

$$40 \times 40 \times H = 72000\pi$$

Rise in water level

$$H = \frac{72000}{40 \times 40} = 45 \text{ cm.}$$

Thus level of water in the tank is 45 cm.

Section - E

Case study based questions are compulsory.

36. John and Priya went for a small picnic. After having their lunch Priya insisted to travel in a motor boat. The speed of the motor boat was 20 km/hr. Priya being a Mathematics student wanted to know the speed of the current. So she noted the time for upstream and downstream.

She found that for covering the distance of 15 km the boat took 1 hour more for upstream than downstream.

(i) Let speed of the current be x km/hr. then speed of the motorboat in upstream will be

(ii) What is the relation between speed distance and time?

(iii) Write the correct quadratic equation for the speed of the current ?

or

What is the speed of current ?

Ans :

(i) In this case speed of the motorboat in upstream

will be $(20-x)$ km/hr.
(ii) distance = (speed)/time
(iii) As per question,

$$\begin{aligned} \frac{15}{20-x} &= \frac{15}{20+x}+1 \\ 15(20+x) &= 15(20-x)+(20-x)(20+x) \\ 15x &= -15x+(20^2-x^2) \\ 30x &= -x^2+400 \\ x^2+30x-400 &= 0 \end{aligned}$$

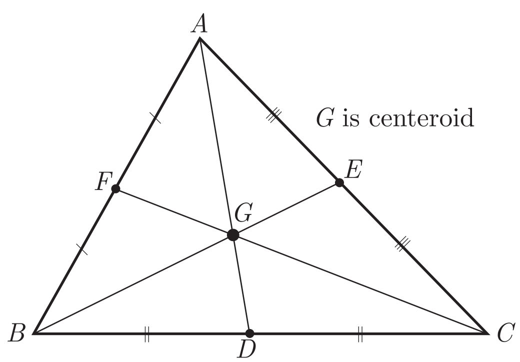
(iv) We have $x^2+30x-400=0$

$$\begin{aligned} x^2+40x-10x-400 &= 0 \\ x(x+40)-10x(x+40) &= 0 \\ (x+40)(x-10) &= 0 \\ x &= 10, -40 \end{aligned}$$

Here $x=10$ is only possible.

37. The centroid is the centre point of the object. It is also defined as the point of intersection of all the three medians. The median is a line that joins the midpoint of a side and the opposite vertex of the triangle. The centroid of the triangle separates the median in the ratio of 2 : 1. It can be found by taking the average of x- coordinate points and y-coordinate points of all the vertices of the triangle.

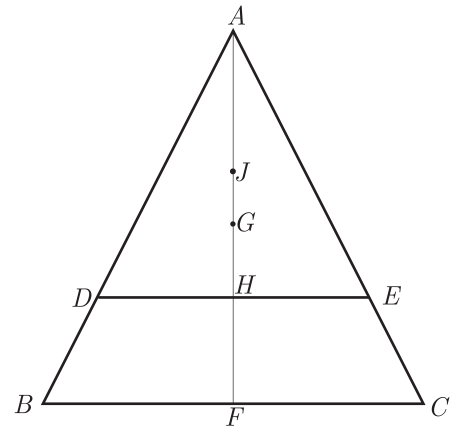
See the figure given below



Here D, E and F are mid points of sides BC, AC and AB in same order. G is centroid, the centroid divides the median in the ratio 2 : 1 with the larger part towards the vertex. Thus $AG:GD=2:1$

On the basis of above information read the question below.

If G is Centroid of $\triangle ABC$ with height h and J is centroid of $\triangle ADE$. Line DE parallel to BC, cuts the $\triangle ABC$ at a height $\frac{h}{4}$ from BC. $HF=\frac{h}{4}$.



(i) What is the length of AH ?
(ii) What is the distance of point A from point G?
(iii) What is the distance of point A from point J?

or

What is the distance GJ ?

Ans :

(i)
$$\begin{aligned} AF &= h \\ HF &= \frac{h}{4} \\ AH &= AF-HF = h-\frac{h}{4} = \frac{3h}{4} \end{aligned}$$

(ii) Here AF is the median to BC from A in $\triangle ABC$ and G is centroid Thus $AG=\frac{2}{3}AF$

(iii) From part (ii)

$$AG = \frac{2}{3}AF$$

$$AF = \frac{3}{2}AG$$

Now AH is median to DE from A in $\triangle ADE$

Thus $AJ = \frac{2}{3}AH$ Since $DE \parallel BC$,

From part (i) $AH = \frac{3}{4}AF$

Thus
$$\begin{aligned} AJ &= \frac{2}{3}\times\frac{3}{4}AF \\ &= \frac{2}{3}\times\frac{3}{4}\times\frac{3}{2}AG = \frac{3}{4}AG \end{aligned}$$

(iv)
$$\begin{aligned} GJ &= AG-AJ \\ &= AG-\frac{3}{4}AG = \frac{1}{4}AG \end{aligned}$$

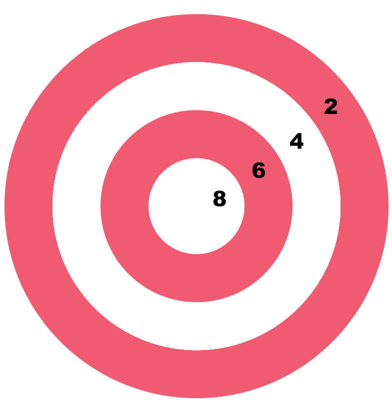
38. Abhinav Bindra is retired sport shooter and currently India's only individual Olympic gold medalist. His gold in the 10-meter air rifle event at the 2008 Summer Olympics was also India's first Olympic gold medal since 1980. He is the first Indian to have held concurrently the world and Olympic titles for the men's 10-meter air rifle event, having earned those honors at the 2008 Summer Olympics and the 2006 ISSF World Shooting Championships. Bindra has also won nine medals at the Commonwealth Games and three gold medals at the Asian Games.

A circular dartboard has a total radius of 8 inch, with circular bands that are 2 inch wide, as shown in figure. Abhinav is still skilled enough to hit this board 100% of the time so he always score at least two points each time he throw a dart. Assume the probabilities are related to area, on the next dart that he throw.

(i) What is the probability that he score at least 4 ?
(ii) What is the probability that he score at least 6 ?
(iii) What is the probability that he hit bull's eye ?

or

What is the probability that he score exactly 4 points ?



Ans :

Here sample space is area of circle of 8 inch.

Thus $n(S) = \pi 8^2 \text{ in}^2$

(i) The probability that you score at least 4,

Let E_1 be the event that she hit the circle in the radius of 6 inch to score 4. Favourable outcome will be area of this 6 inch circle.

Favourable outcome, $n(E_1) = \pi 6^2 \text{ in}^2$

Probability, $P(E_1) = \dfrac{n(E_1)}{n(S)} = \dfrac{\pi 6^2}{\pi 8^2} = \dfrac{9}{16}$

(ii) The probability that you score at least 6,

Let E_2 be the event that she hit the circle in the radius of 4 inch to score 6. Favourable outcome will be area of this 4 inch circle.

Favourable outcome, $n(E_2) = \pi 4^2 \text{ in}^2$

Probability, $P(E_2) = \dfrac{n(E_2)}{n(S)} = \dfrac{\pi 4^2}{\pi 8^2} = \dfrac{1}{4}$

(iii) The probability that you hit the bull's eye,

Let E_3 be the event that she hit the bulls eye. Favourable outcome will be area of 2 inch circle.

Favourable outcome, $n(E_3) = \pi 2^2 \text{ in}^2$

Probability, $P(E_3) = \dfrac{n(E_4)}{n(S)} = \dfrac{\pi 2^2}{\pi 8^2} = \dfrac{1}{16}$

(iv) The probability that you score exactly 4 points,

Let E_4 be the event that she hit the circular band in the radius of 4 inch to 6 inch. Favourable outcome will be area of this circular band.

Favourable outcome, $n(E_4) = \pi(6^2 - 4^2) \text{ in}^2$

Probability, $P(E_4) = \dfrac{n(E_4)}{n(S)} = \dfrac{\pi(6^2 - 4^2)}{\pi 8^2}$

$= \dfrac{20}{64} = \dfrac{5}{16}$