

---

# CBSE MATH

## Made Simple

---

G. V. V. Sharma



Copyright ©2023 by G. V. V. Sharma.

<https://creativecommons.org/licenses/by-sa/3.0/>

and

<https://www.gnu.org/licenses/fdl-1.3.en.html>

# Contents

Introduction	iii
<b>1 Vectors</b>	<b>1</b>
1.1 2023 . . . . .	1
1.1.1 10 . . . . .	1
1.1.2 10 . . . . .	2
1.1.3 12 . . . . .	4
1.2 2022 . . . . .	5
1.2.1 10 . . . . .	5
1.2.2 12 . . . . .	6
1.3 2021 . . . . .	15
1.3.1 10 . . . . .	15
1.3.2 12 . . . . .	20
<b>2 Linear Forms</b>	<b>21</b>
2.1 2023 . . . . .	21
2.1.1 10 . . . . .	21
2.1.2 12 . . . . .	22
2.2 2022 . . . . .	23

2.3	2021	30
2.3.1	10	30
2.3.2	12	30
3	Circles	33
3.1	2023	33
3.1.1	10	33
3.2	2022	43
3.3	2021	47
3.3.1	10	47
4	Intersection of Conics	53
4.1	2022	53
4.2	2021	54
4.2.1	12	54
5	Probability	57
5.1	2021	57
5.1.1	10	57
5.1.2	12	62
5.2	2023	64
5.2.1	10	64
5.2.2	12	67
5.3	2022	70

5.3.1	12	70
6	Construction	79
6.1	2022	82
6.1.1	10	82
6.2	2021	84
6.2.1	10	84
7	Optimization	89
7.1	2023	89
7.2	2021	91
7.2.1	12	91
8	Algebra	99
8.1	2023	99
8.1.1	10	99
9	Geometry	107
9.1	2023	107
9.1.1	10	107
10	Discrete	115
10.1	2023	115
10.1.1	10	115

<b>11 Differentiation</b>	<b>119</b>
11.1 2023 . . . . .	119
11.1.1 12 . . . . .	119
<b>12 Integration</b>	<b>123</b>
12.1 2023 . . . . .	123
12.1.1 12 . . . . .	123
<b>13 Functions</b>	<b>125</b>
13.1 2023 . . . . .	125
13.1.1 12 . . . . .	125
<b>14 Matrices</b>	<b>127</b>
14.1 2023 . . . . .	127
14.1.1 10 . . . . .	127
14.1.2 12 . . . . .	130



# Introduction

This book links high school coordinate geometry to linear algebra and matrix analysis through solved problems.





# Chapter 1

## Vectors

### 1.1. 2023

#### 1.1.1. 10

1.1.1 In what ratio, does  $x$ -axis divide the line segment joinin the points  $\mathbf{A}(3, 6)$  and  $\mathbf{B}(-12, -3)$  ?

(a) 1 : 2

(b) 1 : 4

(c) 4 : 1

(d) 2 : 1

1.1.2 The distance between the point  $(0, 2\sqrt{5})$  and  $(-2\sqrt{5}, 0)$  is

(a)  $2\sqrt{10}$  units

(b)  $4\sqrt{10}$  units

(c)  $2\sqrt{20}$  units

(d) 0 units

1.1.3 If  $(-5, 3)$  and  $(5, 3)$  are two vertices of an equilateral triangle, then coordinates of the third vertex, given that origin lies inside the triangle (*take*  $\sqrt{3} = 1.7$ )

1.1.4 Show that the points  $(-2, 3)$ ,  $(8, 3)$  and  $(6, 7)$  are the vertices of right-angled triangle

1.1.5 If  $\mathbf{Q} = (0, 1)$  is equidistant from  $\mathbf{P} = (5, -3)$  and  $\mathbf{R} = (x, 6)$ , find the value of  $x$ .

1.1.6 The distance of the point  $(-6, 8)$  from origin is :

- (a) 6
- (b)  $-6$
- (c) 8
- (d) 10

1.1.7 The points  $(-4, 0)$ ,  $(4, 0)$  and  $(0, 3)$  are the vertices of a :

- (a) right triangle
- (b) isosceles triangle
- (c) equilateral triangle
- (d) scalene triangle

## 1.1.2. 10

1. The area of the triangle formed by the line  $\frac{x}{a} + \frac{y}{b} = 1$  with the coordinate axes is :

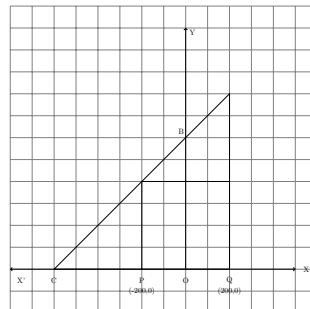
(a)  $ab$

(b)  $\frac{1}{2}ab$

(c)  $\frac{1}{4}ab$

(d)  $2ab$

2. Jagdish has a field which is in the shape of a right angled triangle AQC. He wants to leave a space in the form of a square PQRS inside the field for growing wheat and remaining for growing vegetables as shown in figure. 2.1 . In the field , there is a pole marked as O .



1

Figure 2.1: Image

Based on the above information, answer the following equations:

- (a) Taking O as origin , coordinates of P are (-200,0) and of Q are (200,0). PQRS being a square, what are the coordinates of R and S?
- (b)
  - i. What is the area of square PQRS?
  - ii. What is the length of diagonal PR in PQRS?
- (c) If S divides CA in the ratio K:1, what is the value of K, where point A is (200,800)?

### 1.1.3. 12

1.1.1. Unit vector along  $\mathbf{PQ}$ , where coordinates of  $\mathbf{P}$  and  $\mathbf{Q}$  respectively are (2,1,-1) and (4,4,-7), is

- (a)  $2\hat{i} + 3\hat{j} - 6\hat{k}$
- (b)  $-2\hat{i} - 3\hat{j} + 6\hat{k}$
- (c)  $-\frac{2\hat{i}}{7} - \frac{3\hat{j}}{7} + \frac{6\hat{k}}{7}$
- (d)  $\frac{2\hat{i}}{7} + \frac{3\hat{j}}{7} - \frac{6\hat{k}}{7}$

1.1.2. If in  $\triangle ABC$ ,  $\overrightarrow{BA} = 2\vec{a}$  and  $\overrightarrow{BC} = 3\vec{b}$ , then  $\overrightarrow{AC}$  is

- (a)  $2\vec{a} + 3\vec{b}$
- (b)  $2\vec{a} - 3\vec{b}$
- (c)  $3\vec{b} - 2\vec{a}$
- (d)  $-2\vec{a} - 3\vec{b}$

1.1.3. Equation of line passing through origin and making  $30^\circ$ ,  $60^\circ$  and  $90^\circ$  with x, y, z axes respectively is

(a)  $\frac{2x}{\sqrt{3}} = \frac{y}{2} = \frac{z}{0}$

(b)  $\frac{2x}{\sqrt{3}} = \frac{2y}{1} = \frac{z}{0}$

(c)  $2x = \frac{2y}{\sqrt{3}} = \frac{z}{1}$

(d)  $\frac{2x}{\sqrt{3}} = \frac{2y}{1} = \frac{z}{1}$

1.1.4. If  $\vec{a}$ ,  $\vec{b}$ ,  $\vec{c}$  are three non-zero unequal vectors such that  $\vec{a} \cdot \vec{b} = \vec{a} \cdot \vec{c}$ , then find the angle between  $\vec{a}$  and  $\vec{b} - \vec{c}$ .

1.1.5. If the equation of a line is

$$x = ay + b, z = cy + d, \quad (1.1.5.1)$$

then find the direction ratios of the line and a point on the line.

1.1.6. Using Integration, find the area of triangle whose vertices are  $(-1, 1)$ ,  $(0, 5)$  and  $(3, 2)$ .

## 1.2. 2022

### 1.2.1. 10

1.2.1. The distance between the points  $(0, 0)$  and  $(a - b, a + b)$  is

(a)  $2\sqrt{ab}$

(b)  $\sqrt{2a^2 + ab}$

(c)  $2\sqrt{a^2 + b^2}$

(d)  $\sqrt{2a^2 + 2b^2}$

1.2.2. The value of  $m$  which makes the point  $(0, 0)$ ,  $(2m, -4)$  and  $(3, 6)$  collinear, is \_\_\_\_\_

1.2.3. A circle has its center at  $(4, 4)$ . If one end of a diameter is  $(4, 0)$ , then find the coordinates of other end.

1.2.4. Find the area of the quadrilateral ABCD whose vertices are  $\mathbf{A}(-4, -3)$ ,  $\mathbf{B}(3, -1)$ ,  $\mathbf{C}(0, 5)$  and  $\mathbf{D}(-4, 2)$

1.2.5. If the points  $\mathbf{A}(2, 0)$ ,  $\mathbf{B}(6, 1)$ , and  $\mathbf{C}(p, q)$  form a triangle of area 12sq. units (positive only) and

$$2p + q = 10 \quad (1.2.5.1)$$

, then find the values of  $p$  and  $q$ .

## 1.2.2. 12

1.2.1.  $\vec{a}$  and  $\vec{b}$  are two unit vectors such that

$$\left| 2\vec{a} + 3\vec{b} \right| = \left| 3\vec{a} - 2\vec{b} \right|. \quad (1.2.1.1)$$

Find the angle between  $\vec{a}$  and  $\vec{b}$ .

1.2.2. If  $\vec{a}$  and  $\vec{b}$  are two vectors such that

$$\vec{a} = \hat{i} - \hat{j} + \hat{k} \quad (1.2.2.1)$$

and

$$\vec{b} = 2\hat{i} - \hat{j} - 3\hat{k} \quad (1.2.2.2)$$

then find the vector  $\vec{c}$ , given that

$$\vec{a} \times \vec{c} = \vec{b} \quad (1.2.2.3)$$

and

$$\vec{a} \cdot \vec{c} = 4. \quad (1.2.2.4)$$

1.2.3. If

$$\left| \vec{a} \times \vec{b} \right|^2 + \left| \vec{a} \cdot \vec{b} \right|^2 = 400 \quad (1.2.3.1)$$

and

$$\left| \vec{b} \right| = 5 \quad (1.2.3.2)$$

find the value of  $|\vec{a}|$ .



1.2.4. If

$$\vec{a} = \hat{i} + \hat{j} + \hat{k}, \vec{a} \cdot \vec{b} = 1 \quad (1.2.4.1)$$

and

$$\vec{a} \times \vec{b} = \hat{j} - \hat{k} \quad (1.2.4.2)$$

, then find  $|\vec{b}|$

1.2.5. If

$$|\vec{a}| = 3, |\vec{b}| = 2\sqrt{3} \quad (1.2.5.1)$$

and

$$\vec{a} \cdot \vec{b} = 6, \quad (1.2.5.2)$$

then find the value of  $|\vec{a} \times \vec{b}|$ .

1.2.6.  $|\vec{a}| = 8, |\vec{b}| = 3$  and  $\vec{a} \cdot \vec{b} = 12\sqrt{3}$ , then the value of  $|\vec{a} \times \vec{b}|$  is

(a) 24

(b) 144

(c) 2

(d) 12

1.2.7. If

$$\vec{a} = 2\hat{i} + \hat{j} + 3\hat{k}, \vec{b} = -\hat{i} + 2\hat{j} + \hat{k} \quad (1.2.7.1)$$

and

$$\vec{c} = 3\hat{i} + \hat{j} + 2\hat{k} \quad (1.2.7.2)$$

, then find  $\vec{a} \cdot (\vec{b} \times \vec{c})$ .

1.2.8.  $\vec{a}, \vec{b}, \vec{c}$  and  $\vec{d}$  are four non-zero vectors such that

$$\vec{a} \times \vec{b} = \vec{c} \times \vec{d} \quad (1.2.8.1)$$

and

$$\vec{a} \times \vec{c} = 4\vec{b} \times \vec{d} \quad (1.2.8.2)$$

, then show that  $(\vec{a} - 2\vec{d})$  is parallel to  $(2\vec{b} - \vec{c})$  where

$$\vec{a} \neq 2\vec{d}, \vec{c} \neq 2\vec{b} \quad (1.2.8.3)$$

1.2.9. If

$$\vec{a} = \hat{i} + \hat{j} + \hat{k}, \vec{a} \cdot \vec{b} = 1 \quad (1.2.9.1)$$

and

$$\vec{a} \times \vec{b} = \hat{j} - \hat{k}, \quad (1.2.9.2)$$

then find  $|\vec{b}|$

1.2.10. If  $\vec{a}$  and  $\vec{b}$  are two vectors such that

$$|\vec{a} + \vec{b}| = |\vec{b}|, \quad (1.2.10.1)$$

then prove that  $(\vec{a} + 2\vec{b})$  is perpendicular to  $\vec{a}$ .

1.2.11. If  $\vec{a}$  and  $\vec{b}$  are unit vectors and  $\theta$  is the angle between them, then prove that  $\sin$

$$\frac{\theta}{2} = \frac{1}{2} |\vec{a} - \vec{b}| \quad (1.2.11.1)$$

1.2.12. If  $\vec{a}$  and  $\vec{b}$  are two unit vectors such that and  $\theta$  is the angle between them, then prove that

$$\sin \frac{\theta}{2} = \frac{1}{2} |\vec{a} - \vec{b}| \quad (1.2.12.1)$$

1.2.13. If

$$\vec{a} = 2\hat{i} + y\hat{j} + \hat{k} \quad (1.2.13.1)$$

and

$$\vec{b} = \hat{i} + 2\hat{j} + 3\hat{k} \quad (1.2.13.2)$$

are two vectors for which the vector  $(\vec{a} + \vec{b})$  is perpendicular to the vector  $(\vec{a} - \vec{b})$  then find all the possible values of  $y$ .

1.2.14. Write the projection of the vector  $(\vec{b} + \vec{c})$  on the vector  $\vec{a}$ , where

$$\vec{a} = 2\hat{i} - 2\hat{j} + \hat{k}, \vec{b} = \hat{i} + 2\hat{j} - 2\hat{k} \quad (1.2.14.1)$$

and

$$\vec{c} = 2\hat{i} - \hat{j} + 4\hat{k}. \quad (1.2.14.2)$$

1.2.15. If

$$\vec{a} = 2\hat{i} - \hat{j} + \hat{k}, \vec{b} = \hat{i} + \hat{j} - 2\hat{k} \quad (1.2.15.1)$$

and

$$\vec{c} = \hat{i} + 3\hat{j} - \hat{k} \quad (1.2.15.2)$$

and the projection of vector  $\vec{c} + \lambda\vec{b}$  on vector  $\vec{a}$  is  $2\sqrt{6}$ , find the value of  $\lambda$ .

1.2.16. If

$$\vec{a} = 2\hat{i} + \hat{j} + 3\hat{k}, \hat{b} = -\hat{i} + 2\hat{j} + \hat{k} \quad (1.2.16.1)$$

and

$$\vec{c} = 3\hat{i} + \hat{j} + 2\hat{k} \quad (1.2.16.2)$$

, then find  $\vec{a} \cdot (\vec{b} \times \vec{c})$ .

1.2.17. If

$$\vec{a} = 2\hat{i} - \hat{j} + 2\hat{k} \quad (1.2.17.1)$$

and

$$\vec{b} = 5\hat{i} - 3\hat{j} - 4\hat{k} \quad (1.2.17.2)$$

, then find the ratio  $\frac{\text{projection of vector } \vec{a} \text{ on vector } \vec{b}}{\text{projection of vector } \vec{b} \text{ on vector } \vec{a}}$

1.2.18. Show that the three vectors  $2\hat{i} - \hat{j} + \hat{k}$ ,  $\hat{i} - 3\hat{j} - 5\hat{k}$ , and  $3\hat{i} - 4\hat{j} - 4\hat{k}$  form the vertices of a right-angled triangle. If

$$\vec{a} = 2\hat{i} + 2\hat{j} + 3\hat{k}, \vec{b} = -\hat{i} + 2\hat{j} + \hat{k} \quad (1.2.18.1)$$

and

$$\vec{c} = 3\hat{i} + \hat{j} \quad (1.2.18.2)$$

are such that the vector  $(\vec{a} + \lambda \vec{b})$  is perpendicular to vector  $\vec{c}$ , then find the value of  $\lambda$ .

1.2.19. If  $\vec{a}$ ,  $\vec{b}$  and  $\vec{c}$  are the position vectors of the points  $\mathbf{A}(2, 3, -4)$ ,  $\mathbf{B}(3, -4, -5)$  and  $\mathbf{C}(3, 2, -3)$  and respectively, then  $|\vec{a} + \vec{b} + \vec{c}|$  is equal to

(a)  $\sqrt{113}$

(b)  $\sqrt{185}$

(c)  $\sqrt{203}$

(d)  $\sqrt{209}$

1.2.20. Find the values  $\lambda$ , for which the distance of point  $(2, 1, \lambda)$  from plane

$$3x + 5y + 4z = 11 \quad (1.2.20.1)$$

is  $2\sqrt{2}$  units.

1.2.21. Find the coordinates of the point where the line through  $(3, 4, 1)$  crosses the ZX-plane

1.2.22. Using vectors, find the area of the triangle with vertices  $\mathbf{A}(-1, 0, -2)$ ,  $\mathbf{B}(0, 2, 1)$  and  $\mathbf{C}(-1, 4, 1)$

1.2.23. Using integration, find the area of triangle region whose vertices are  $(2, 0)$  ,  $(4, 5)$  and  $(1, 4)$ .

1.2.24. If a line makes  $60^\circ$  and  $45^\circ$  angles with the positive directions of X-axis and z-axis respectively, then find the angle that it makes with the positive direction of y-axis. Hence, write the direction cosines of the line.

1.2.25. The Cartesian equation of a line  $AB$  is :

$$\frac{2x - 1}{12} = \frac{y + 2}{2} = \frac{z - 3}{3} \quad (1.2.25.1)$$

.

1.2.26. Find the directions cosines of a line parallel to line  $AB$ .

1.2.27. Find the direction cosines of a line whose cartesian equation is given as

$$3x + 1 = 6y - 2 = 1 - z. \quad (1.2.27.1)$$

1.2.28. A vector of magnitude 9 units in the direction of the vector  $-2\hat{i} - \hat{j} + 2\hat{k}$  is \_\_\_\_\_

1.2.29. The two adjacent sides of a parallelogram are represented by  $2\hat{i} - 4\hat{j} - 5\hat{k}$  and  $\hat{i} + 2\hat{j} + 3\hat{k}$ . Find the unit vectors parallel to its diagonals. Using the diagonal vectors, find the area of the parallelogram also.

1.2.30. The two adjacent sides of a parallelogram are represented by vectors

$2\hat{i} - 4\hat{j} + 5\hat{k}$  and  $\hat{i} - 2\hat{j} - 3\hat{k}$ . Find the unit vector parallel to one of its diagonals. Also, find the area of the parallelogram.

1.2.31. If

$$\vec{a} = \vec{i} + 2\vec{j} + 3\vec{k} \quad (1.2.31.1)$$

and

$$\vec{b} = 2\hat{i} + 4\hat{j} - 5\hat{k} \quad (1.2.31.2)$$

represent two adjacent sides of a parallelogram, then find the unit vector parallel to the diagonal of the parallelogram.

## 1.3. 2021

### 1.3.1. 10

1.3.1.1. Find the distance between the points  $\mathbf{A}(-\frac{7}{3}, 5)$  and  $\mathbf{B}(\frac{2}{3}, 5)$ .

1.3.1.2. Check whether 13cm, 12cm, 5cm can be the sides of a right triangle.

1.3.1.3. (a) If  $PL$  and  $PM$  are two tangents to a circle with centre  $\mathbf{O}$  from an external point  $\mathbf{P}$  and  $PL = 4$  cm, find the length of  $OP$ , where radius of the circle is 3 cm.

(b) Find the distance between two parallel tangents of a circle of radius 2.5 cm.



1.3.1.4. Find the coordinates of the points which divides the line segment joining the points  $\mathbf{A}(7, -1)$  and  $\mathbf{B}(-3, -4)$  in the ratio  $2 : 3$ .

1.3.1.5. To divide a line segment  $QP$  internally in the ratio  $2 : 3$ , we draw a ray  $QY$  such that  $\angle PQY$  is acute. What will be the minimum number of points to be located at equal distances on the ray  $QY$  ?

1.3.1.6. Answer any four of the following questions :

(i) The point which divides the line segment joining the points  $(7, -6)$  and  $(3, 4)$  in the ratio  $1 : 2$  lies in

- (A) I quadrant
- (B) II quadrant
- (C) III quadrant
- (D) IV quadrant

(ii) If the  $\mathbf{A}(1, 2)$ ,  $\mathbf{O}(0, 0)$  and  $\mathbf{C}(a, 6)$  are collinear, then the value of  $a$  is

- (A) 6
- (B)  $\frac{3}{2}$
- (C) 3
- (D) 12

(iii) The distance between the points  $\mathbf{A}(0, 6)$  and  $\mathbf{B}(0, -2)$  is

- (A) 6 units
- (B) 8 units
- (C) 4 units

(D) 2 units

(iv) If  $(\frac{a}{3}, 4)$  is the mid-point of the line segment joining the points  $(-6, 5)$  and  $(-2, 3)$ , then the value of 'a' is

(A) -4

(B) 4

(C) -12

(D) 12

(v) What kind of triangle is formed with vertices **A**(0, 2), **B**(-3, 0) and **C**(3, 0) ?

(A) A right triangle

(B) An equilateral triangle

(C) An isosceles triangle

(D) A scalene triangle

1.3.1.7. (a) If the distance between the points  $(k, -2)$  and  $(3, -6)$  is 10 units, find the positive value of k.

(b) Find the length of the segment joining **A**(-6, 7) and **B**(-1, -5). Also, find the mid-point of  $AB$ .

1.3.1.8. A man goes 5 metres due to West and then 12 metres due North. How far is he from the starting point ?

1.3.1.9. Students of a school are standing in rows and columns in their school playground to celebrate their annual sports day. **A**, **B**, **C** and **D** are the positions of four students as shown in the figure.

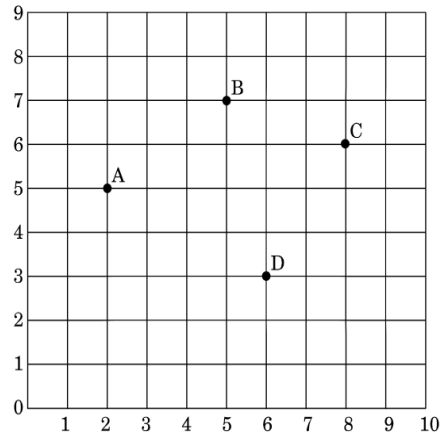


Figure 1.3.1.9.1: Based on the above, answer the following question :

- (i) The figure formed by the points **A**, **B**, **C** and **D** is a
  - (A) square
  - (B) parallelogram
  - (C) rhombus
  - (D) quadrilateral
- (ii) If the sports teacher is sitting at the origin, then which of the four students is closest to him ?
  - (A) **A**
  - (B) **B**
  - (C) **C**
  - (D) **D**
- (iii) The distance between **A** and **C** is
  - (A)  $\sqrt{37}$  units
  - (B)  $\sqrt{35}$  units

(C) 6 units

(D) 5 units

(iv) The coordinates of the mid-point of line segment  $AC$  are

(v) If a point  $\mathbf{P}$  divides the line segment  $AD$  in the ratio  $1 : 2$ , then coordinates of  $\mathbf{P}$  are

(A)  $(\frac{8}{3}, \frac{8}{3})$

(B)  $(\frac{10}{3}, \frac{13}{3})$

(C)  $(\frac{13}{3}, \frac{10}{3})$

(D)  $(\frac{16}{3}, \frac{11}{3})$

1.3.1.10. (a) Check whether the points  $\mathbf{P}(5, -2)$ ,  $\mathbf{Q}(6, 4)$  and  $\mathbf{R}(7, -2)$  are the vertices of an isosceles triangle  $PQR$ .

(b) Find the ratio in which  $\mathbf{P}(4, 5)$  divides the join of  $\mathbf{A}(2, 3)$  and  $\mathbf{B}(7, 8)$ .

1.3.1.11. The coordinates of the three consecutive vertices of a parallelogram  $ABCD$  are  $\mathbf{A}(1, 3)$ ,  $\mathbf{B}(-1, 2)$ , and  $\mathbf{C}(2, 5)$ . Find the coordinates of the fourth vertex  $\mathbf{D}$ .

1.3.1.12. (a) If  $\mathbf{P}(2, 2)$ ,  $\mathbf{Q}(-4, -4)$  and  $\mathbf{R}(5, -8)$  are the vertices of a  $\triangle PQR$ , then find the length of the median through  $\mathbf{R}$ .

(b) Find the ratio in which  $y$ -axis divides the line segment joining the points  $\mathbf{A}(5, -6)$  and  $\mathbf{B}(-1, -4)$ . Also, find the coordinates of the point of intersection.

1.3.1.13. (a) Find the ratio in which the line segment joining the points  $\mathbf{A}(1, -5)$

and  $\mathbf{B}(-4, 5)$  is divided by the  $ax$ -axis. Also, find coordinates of the point of division.

- (b) The points  $\mathbf{A}(0, 3)$ ,  $\mathbf{B}(-2, a)$  and  $\mathbf{C}(-1, 4)$  are the vertices of a right triangle, right-angled at  $\mathbf{A}$ . Find the value of  $a$ .

### 1.3.2. 12

- If  $\mathbf{a}, \mathbf{b}, \mathbf{c}$  are position vectors of the points  $A(2, 3, -4)$ ,  $B(3, -4, -5)$  and  $C(3, 2, -3)$  respectively, then  $|\mathbf{a} + \mathbf{b} + \mathbf{c}|$  is equal to
  - $\sqrt{113}$
  - $\sqrt{185}$
  - $\sqrt{203}$
  - $\sqrt{209}$
- Find the distance of the point  $(a, b, c)$  from the  $x$ -axis
- If  $\mathbf{a} = 2\hat{i} - \hat{j} + 2\hat{k}$  and  $\mathbf{b} = 5\hat{i} - 3\hat{j} - 4\hat{k}$ , then find the ratio  $\frac{\text{projection of vector } \mathbf{a} \text{ on } \mathbf{b}}{\text{projection of vector } \mathbf{b} \text{ on vector } \mathbf{a}}$
- Let  $\hat{a}$  and  $\hat{b}$  be two unit vectors. If the vectors  $\mathbf{c} = \hat{a} + 2\hat{b}$  and  $\mathbf{d} = 5\hat{a} - 4\hat{b}$  are perpendicular to each other, then find the angle between the vectors  $\hat{a}$  and  $\hat{b}$ .
- Show that  $|\mathbf{a}||\mathbf{b}| + |\mathbf{b}||\mathbf{a}|$  is perpendicular to  $|\mathbf{a}\mathbf{b}| - |\mathbf{b}||\mathbf{a}|$ , for any two non-zero vectors  $\mathbf{a}$  and  $\mathbf{b}$ .
- Prove that three points  $A, B$  and  $C$  with position vectors  $\mathbf{a}, \mathbf{b}$  and  $\mathbf{c}$  respectively are collinear if and only if  $(\mathbf{b} \times \mathbf{c}) + (\mathbf{c} \times \mathbf{a}) + (\mathbf{a} \times \mathbf{b}) = \mathbf{0}$ .

## Chapter 2

# Linear Forms

## 2.1. 2023

### 2.1.1. 10

2.1.1. **Assertion (A):** Point  $\mathbf{P}(0,2)$  is the point of intersection of  $y - axis$  with the line  $3x + 2y = 4$ .

**Reason (R):** The distance of point  $\mathbf{P}(0,2)$  from  $x - axis$  is 2 units.

2.1.2. If the pair of equations  $3x - y + 8 = 0$  and  $6x - ry + 16 = 0$  represent coincident lines, then the value of ' $r$ ' is:

(a)  $-\frac{1}{2}$

(b)  $\frac{1}{2}$

(c) -2

(d) 2

2.1.3. The of linear equations  $2x = 5y + 6$  and  $15y = 6x - 18$  represents two lines which are:

- (a) intersecting
- (b) parallel
- (c) coincident
- (d) either intersecting or parallel

2.1.4. Find the equations of the diagonals of the parallelogram **PQRS** whose vertices are **P**(4,2,-6), **Q**(5,-3,1), **R**(12,4,5) and **S**(11,9,-2). Use these equations to find the point of intersection of diagonals.

2.1.5. A line  $l$  passes through point  $(-1,3,-2)$  and is perpendicular to both the lines  $\frac{x}{1} = \frac{y}{2} = \frac{z}{3}$  and  $\frac{x+2}{-3} = \frac{y-1}{2} = \frac{z+1}{5}$ . Find the vector equation of the line  $l$ . Hence, obtain its distance from origin.

## 2.1.2. 12

1. Equation of line passing through origin and making  $30^\circ$ ,  $60^\circ$  and  $90^\circ$  with  $x, y, z$  axes respectively is

- (a)  $\frac{2x}{\sqrt{3}} = \frac{y}{2} = \frac{z}{0}$
- (b)  $\frac{2x}{\sqrt{3}} = \frac{2y}{1} = \frac{z}{0}$
- (c)  $2x = \frac{2y}{\sqrt{3}} = \frac{z}{1}$
- (d)  $\frac{2x}{\sqrt{3}} = \frac{2y}{1} = \frac{z}{1}$

2. If the equation of a line is  $x = ay + b, z = cy + d$ , then find the direction ratios of the line and a point on the line.

3. (a) Find the equations of the diagonals of the parallelogram  $PQRS$  whose vertices are  $P(4, 2, -6)$ ,  $Q(5, -3, 1)$ ,  $R(12, 4, 5)$ ,  $S(11, 9, -2)$ . Use these equations to find the point of intersection of diagonals.
- (b) A line  $l$  passes through point  $(-1, 3, -2)$  and is perpendicular to both the lines  $\frac{x}{1} = \frac{y}{2} = \frac{z}{3}$  and  $\frac{x+2}{-3} = \frac{y-1}{2} = \frac{z+1}{5}$ . Find the vector equation of the line  $l$ . Hence, obtain its distance from origin.

## 2.2. 2022

2.2.1. Solve the equations  $x + 2y = 6$  and  $2x - 5y = 12$  graphically.

2.2.2. Solve the following equations for  $x$  and  $y$  using cross-multiplication method:

$$(ax - by) + (a + 4b) = 0 \quad (2.2.2.1)$$

$$(bx + ay) + (b - 4a) = 0 \quad (2.2.2.2)$$

2.2.3. Find the co-ordinates of the point where the line  $\frac{x-3}{-1} = \frac{y+4}{1} = \frac{z+5}{6}$  crosses the plane passing through the points  $\left(\frac{7}{2}, 0, 0\right)$ ,  $(0, 7, 0)$ ,  $(0, 0, 7)$ .

2.2.4. Electrical transmission wires which are laid down in winters are stretched tightly to accommodate expansion in summers.



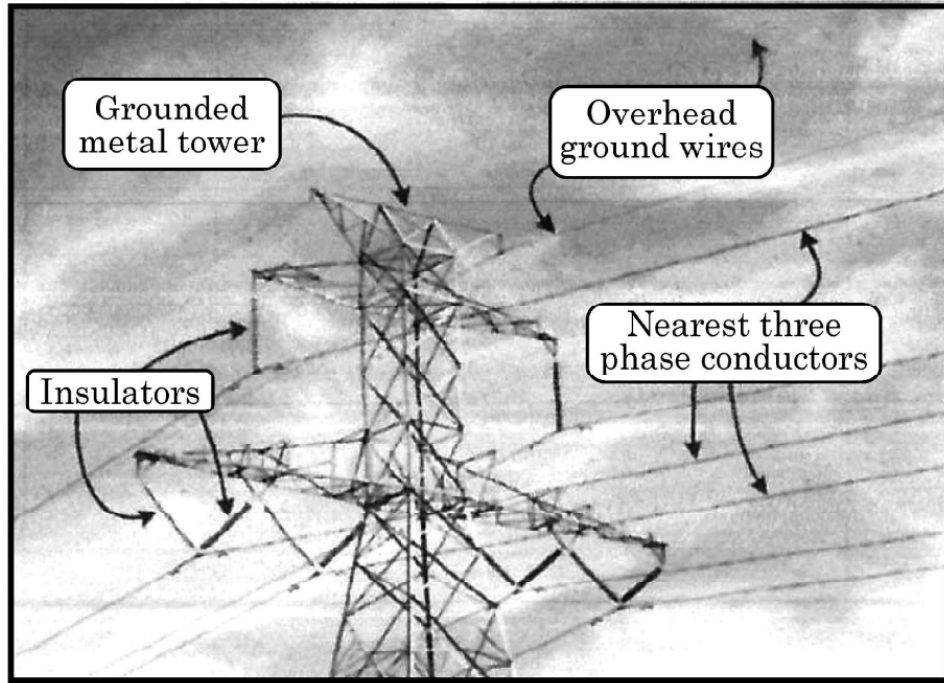


Figure 2.2.4.1: Electrical transmission wires connected to a transmission tower.

Two such wires in the figure 2.2.4.1 lie along the following lines:

$$l_1 : \frac{x+1}{3} = \frac{y-3}{-2} = \frac{z+2}{-1} \quad (2.2.4.1)$$

$$l_2 : \frac{x}{-1} = \frac{y-7}{3} = \frac{z+7}{-2} \quad (2.2.4.2)$$

Based on the given information, answer the following questions:

- (a) Are the  $l_1$  and  $l_2$  coplanar? Justify your answer.
- (b) Find the point of intersection of lines  $l_1$  and  $l_2$ .

2.2.5. Write the cartesian equation of the line PQ passing through points

P(2, 2, 1) and Q(5, 1, -2). Hence, find the y-coordinate of the point on the line PQ whose z-coordinate is -2.

2.2.6. Find the distance between the lines  $x = \frac{y-1}{2} = \frac{z-2}{3}$  and  $x+1 = \frac{y+2}{2} = \frac{z-1}{3}$ .

2.2.7. Find the shortest distance between the following lines:

$$\mathbf{r} = 3\hat{i} + 5\hat{j} + 7\hat{k} + \lambda(\hat{i} - 2\hat{j} + \hat{k}) \quad (2.2.7.1)$$

$$\mathbf{r} = (-\hat{i} - \hat{j} - \hat{k}) + \mu(7\hat{i} - 6\hat{j} + \hat{k}) \quad (2.2.7.2)$$

2.2.8. Two motorcycles A and B are running at a speed more than the allowed speed on the road (as shown in figure 2.2.8.1) represented by the following lines

$$\mathbf{r} = \lambda(\hat{i} + 2\hat{j} - \hat{k}) \quad (2.2.8.1)$$

$$\mathbf{r} = (3\hat{i} + 3\hat{j}) + \mu(2\hat{i} + \hat{j} + \hat{k}) \quad (2.2.8.2)$$

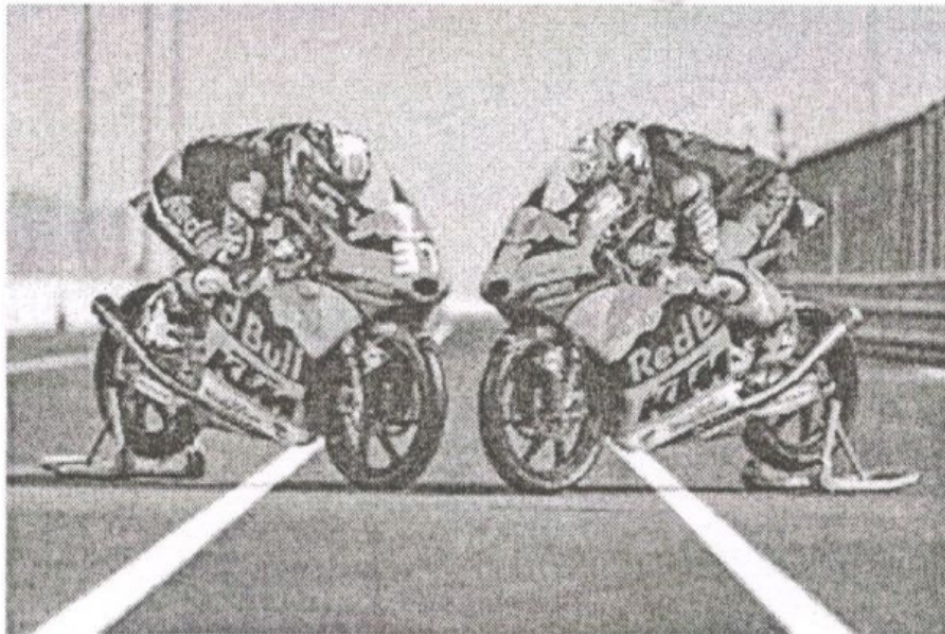


Figure 2.2.8.1: Two motorcycles moving along the road in a straight line.

Based on the following information, answer the following questions:

- (a) Find the shortest distance between the given lines.
- (b) Find a point at which the motorcycles may collide.

2.2.9. Find the shortest distance between the following lines

$$\mathbf{r} = (\lambda + 1)\hat{i} + (\lambda + 4)\hat{j} - (\lambda - 3)\hat{k} \quad (2.2.9.1)$$

$$\mathbf{r} = (3 - \mu)\hat{i} + (2\mu + 2)\hat{j} + (\mu + 6)\hat{k} \quad (2.2.9.2)$$

2.2.10. Find the shortest distance between the following lines and hence write

whether the lines are intersecting or not.

$$\frac{x-1}{2} = \frac{y+1}{3} = z, \frac{x+1}{5} = \frac{y-2}{1}, z = 2 \quad (2.2.10.1)$$

2.2.11. Find the equation of the plane passing through the points  $(2, 1, 0)$ ,  $(3, -2, -2)$  and  $(1, 1, 7)$ . Also, obtain its distance from the origin.

2.2.12. The foot of a perpendicular drawn from the point  $(-2, -1, -3)$  on a plane is  $(1, -3, 3)$ . Find the equation of the plane.

2.2.13. Find the cartesian and the vector equation of a plane which passes through the point  $(3, 2, 0)$  and contains the line  $\frac{x-3}{1} = \frac{y-6}{5} = \frac{z-4}{4}$ .

2.2.14. The distance between the planes  $4x-4y+2z+5=0$  and  $2x-2y+z+6=0$  is

- (a)  $\frac{1}{6}$
- (b)  $\frac{7}{6}$
- (c)  $\frac{11}{6}$
- (d)  $\frac{16}{6}$

2.2.15. Find the equation of the plane through the line of intersection of the planes

$$\mathbf{r} \cdot (\hat{i} + 3\hat{j}) + 6 = 0 \quad (2.2.15.1)$$

$$\mathbf{r} \cdot (3\hat{i} - \hat{j} - 4\hat{k}) = 0 \quad (2.2.15.2)$$

which is at a unit distance from the origin.

2.2.16. If the distance of the point  $(1, 1, 1)$  from the plane  $x - y + z + \lambda = 0$  is  $\frac{5}{\sqrt{3}}$ , find the value(s) of  $\lambda$ .

2.2.17. Find the distance of the point  $(2, 3, 4)$  measured along the line  $\frac{x-4}{3} = \frac{y+5}{6} = \frac{z+1}{2}$  from the plane  $3x + 2y + 2z + 5 = 0$ .

2.2.18. Find the distance of the point  $P(4, 3, 2)$  from the plane determined by the points  $A(-1, 6, -5)$ ,  $B(-5, -2, 3)$  and  $C(2, 4, -5)$ .

2.2.19. The distance of the line

$$\mathbf{r} = (\hat{i} - \hat{j}) + \lambda(\hat{i} + 5\hat{j} + \hat{k}) \quad (2.2.19.1)$$

from the plane

$$\mathbf{r} \cdot (\hat{i} - \hat{j} + 4\hat{k}) = 5 \quad (2.2.19.2)$$

is

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

2.2.20. Find a unit vector perpendicular to each of the vectors  $(\mathbf{a} + \mathbf{b})$  and

$(\mathbf{a} - \mathbf{b})$  where

$$\mathbf{a} = \hat{i} + \hat{j} + \hat{k} \quad (2.2.20.1)$$

$$\mathbf{b} = \hat{i} + 2\hat{j} + 3\hat{k} \quad (2.2.20.2)$$

2.2.21. Find the distance of the point  $(1, -2, 9)$  from the point of intersection of the line

$$\mathbf{r} = 4\hat{i} + 2\hat{j} + 7\hat{k} + \lambda(3\hat{i} + 4\hat{j} + 2\hat{k}) \quad (2.2.21.1)$$

and the plane

$$\mathbf{r} \cdot (\hat{i} - \hat{j} + \hat{k}) = 10. \quad (2.2.21.2)$$

2.2.22. Find the area bounded by the curves  $y = |x - 1|$  and  $y = 1$ , using integration.

2.2.23. Find the coordinates of the point where the line through  $(4, -3, -4)$  and  $(3, -2, 2)$  crosses the plane  $2x + y + z = 6$ .

2.2.24. Fit a straight line trend by the method of least squares and find the trend value for the year 2008 using the data from Table 2.2.24.1:

Table 2.2.24.1: Table showing yearly trend of production of goods in lakh tonnes

Year	Production (in lakh tonnes)
2001	30
2002	35
2003	36
2004	32
2005	37
2006	40

## 2.3. 2021

### 2.3.1. 10

2.3.1. If the graph of a pair of lines  $x - 2y + 3 = 0$  and  $2x - 4y = 5$  be drawn, that what type of lines are drawn ?

### 2.3.2. 12

1. If the two lines

$$L_1 : x = 5, \frac{y}{3 - \alpha} = \frac{z}{-2} \quad (1.1)$$

$$L_1 : x = 2, \frac{y}{-1} = \frac{z}{z - \alpha} \quad (1.2)$$

are perpendicular, then the value of  $\alpha$

(a)  $\frac{2}{3}$

(b) 3

(c) 4

(d)  $\frac{7}{3}$

2. Find the shortest distance between the following lines and hence write whether the lines are intersecting or not.

$$\frac{x-1}{2} = \frac{y+1}{3} = z \quad (2.1)$$

$$\frac{x+1}{5} = \frac{y-2}{1}, z = 2 \quad (2.2)$$

3. Find the equation of the plane through the line of intersection of the planes

$$\mathbf{r} \cdot (i + 3j) + 6 = 0 \quad (3.1)$$

$$\mathbf{r} \cdot (3i - j - 4k) = 0 \quad (3.2)$$

which is at a unit distance from the origin.

4. If segment of the line intercepted between the co-ordinate-axes is bi-



sected at the point  $M(2, 3)$ , then the equation of this line is

$$2x + 3y = 13 \quad (4.1)$$

$$x + y = 5 \quad (4.2)$$

$$2x + y = 7 \quad (4.3)$$

$$3x + 2y = 12 \quad (4.4)$$

5. The equation of a line through  $(2, -4)$  and parallel to x-axis is \_\_\_\_\_.
6. Find the equation of the median through vertex  $A$  of the triangle  $ABC$ , having vertices  $A(2, 5)$ ,  $B(-4, 9)$  and  $C(-2, -1)$ .
7. Solve the system of linear equations, using matrix method :

$$7x + 2y = 11 \quad (7.1)$$

$$4x - y = 2 \quad (7.2)$$

## Chapter 3

# Circles

### 3.1. 2023

#### 3.1.1. 10

3.1.1. In the given figure Fig. 3.1.1.1,  $PQ$  is tangent to the circle centred at

**O.** If  $\angle AOB = 95^\circ$ , then measure of  $\angle ABQ$  will be

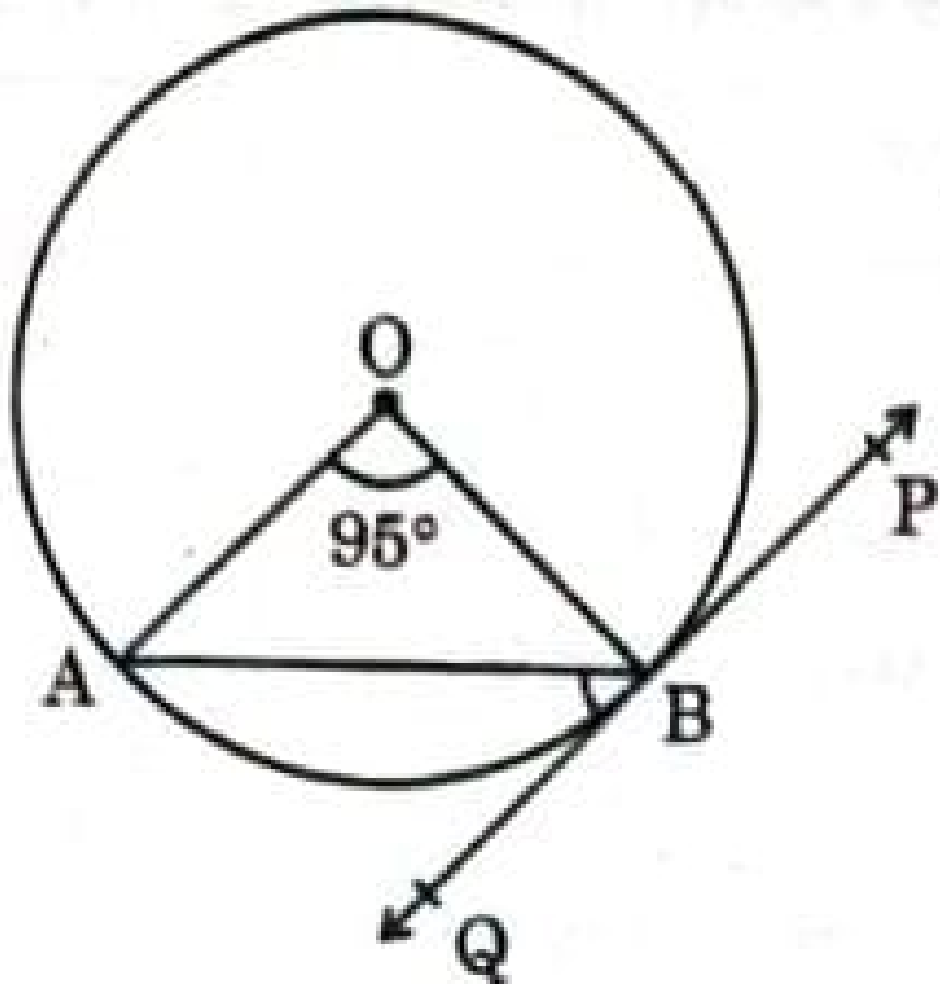


Figure 3.1.1.1:

- (a)  $47.5^\circ$
- (b)  $42.5^\circ$
- (c)  $85^\circ$
- (d)  $95^\circ$

3.1.2. (a) In the given figure Fig. 3.1.2.1, two tangents  $TP$  and  $TQ$  are

drawn to be a circle with centre **O** from an external point **T**.

Prove that  $\angle PTQ = 2\angle OPQ$ .

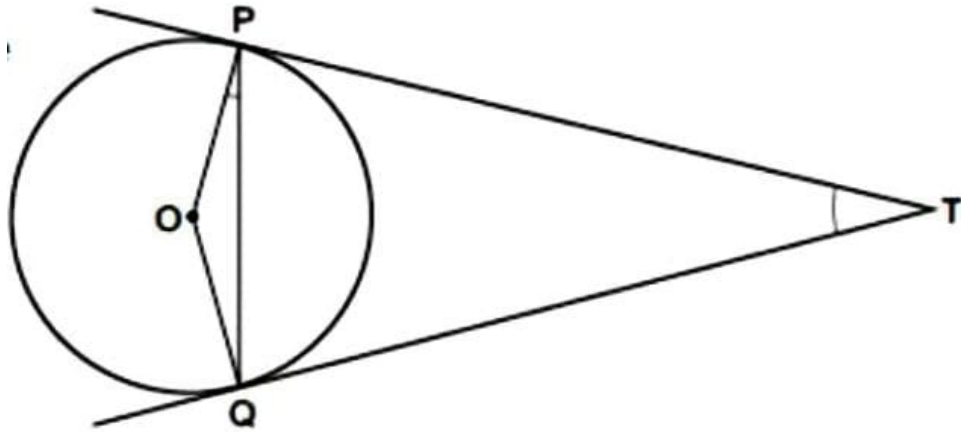


Figure 3.1.2.1:

- (b) In the given figure Fig. 3.1.2.2, a circle is inscribed in a quadrilateral  $ABCD$  in which  $\angle B = 90^\circ$ . If  $AD = 17cm$ ,  $AB = 20cm$  and  $DS = 3cm$ , then find the radius of the circle.

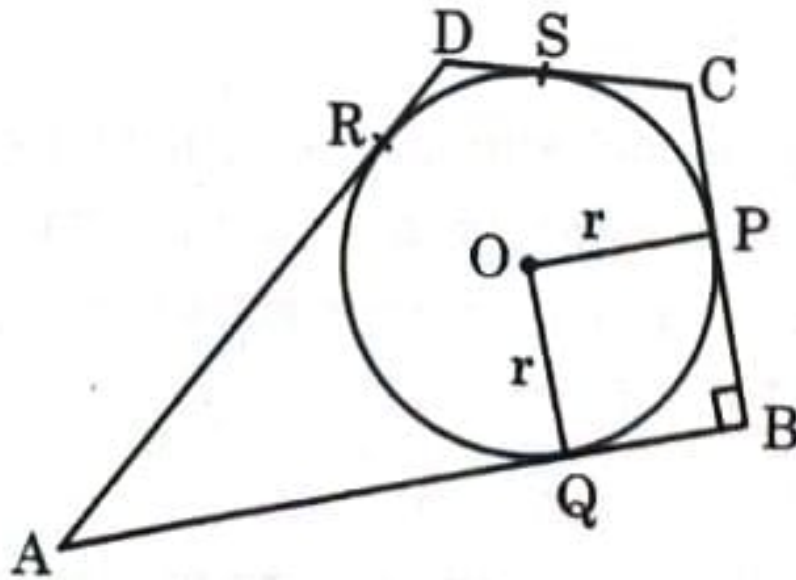


Figure 3.1.2.2:

3.1.3. The discus throw is an event in which an athlete attempts to throw a discus. The athlete spins anti-clockwise around one and a half times through a circle as shown in Fig. 3.1.3.1 below, then releases the throw. When released, the discus travels along tangent to the circular spin orbit.



Figure 3.1.3.1:

In the given figure Fig. 3.1.3.2,  $AB$  is one such tangent to a circle of radius 75 cm. Point  $O$  is centre of the circle and  $\angle ABO = 30^\circ$ .  $PQ$  is parallel to  $OA$ .

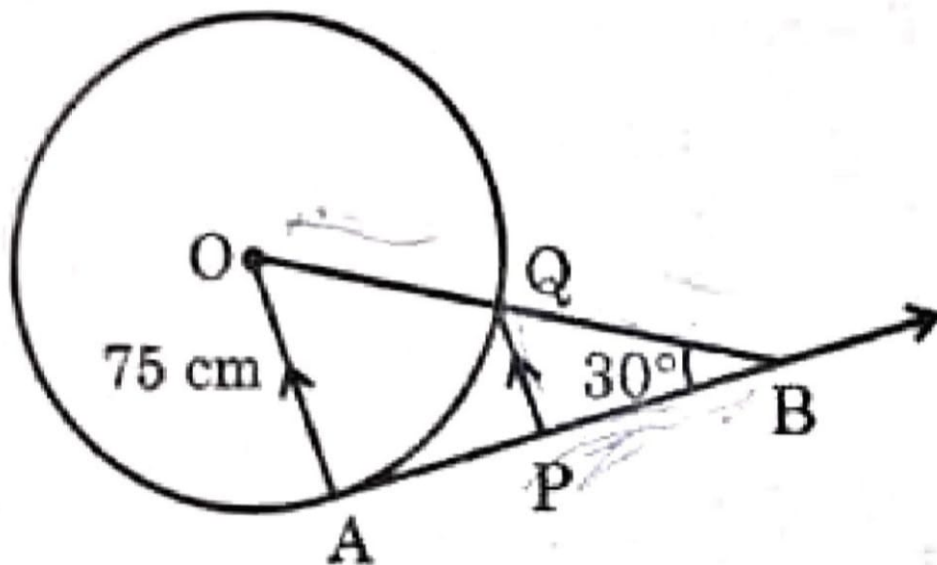


Figure 3.1.3.2:

Based on above information :

- (a) find the length of  $AB$ .
- (b) find the length of  $OB$ .
- (c) find the length of  $AP$ .
- (d) find the length of  $PQ$ .

3.1.4. In the given figure Fig. 3.1.4.1, the quadrilateral  $PQRS$  circumscribes a circle. Here  $PA + CS$  is equal to :

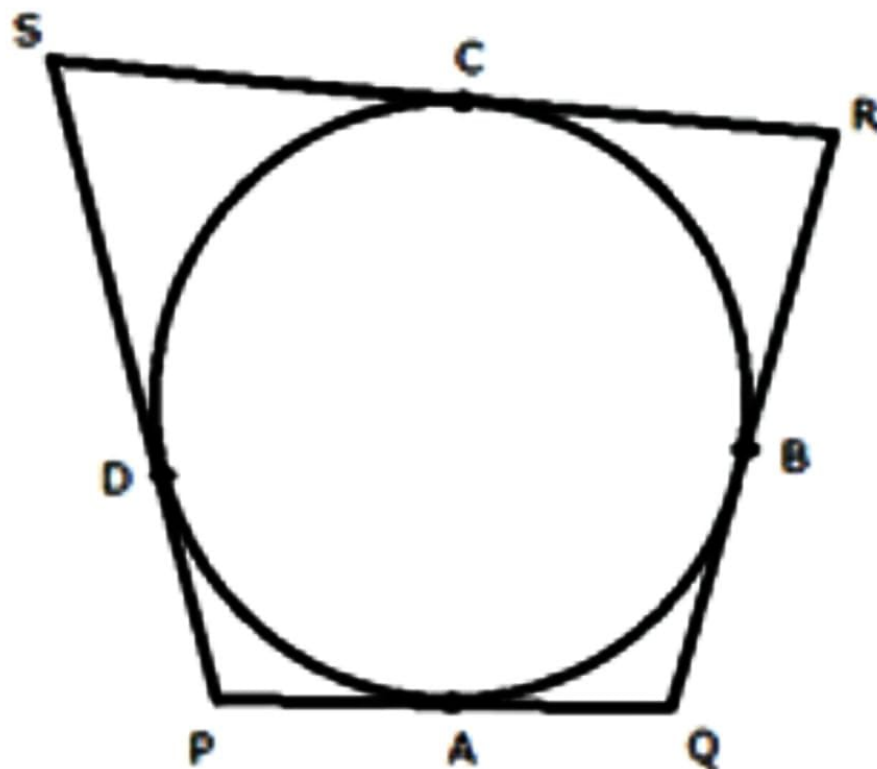


Figure 3.1.4.1:

- (a)  $QR$
- (b)  $PR$
- (c)  $PS$
- (d)  $PQ$

3.1.5. In the given figure Fig. 3.1.5.1,  $\mathbf{O}$  is the centre of the circle.  $AB$  and  $AC$  are tangents drawn to the circle from point  $\mathbf{A}$ . If  $\angle BAC = 65^\circ$ , then find the measure of  $\angle BOC$ .



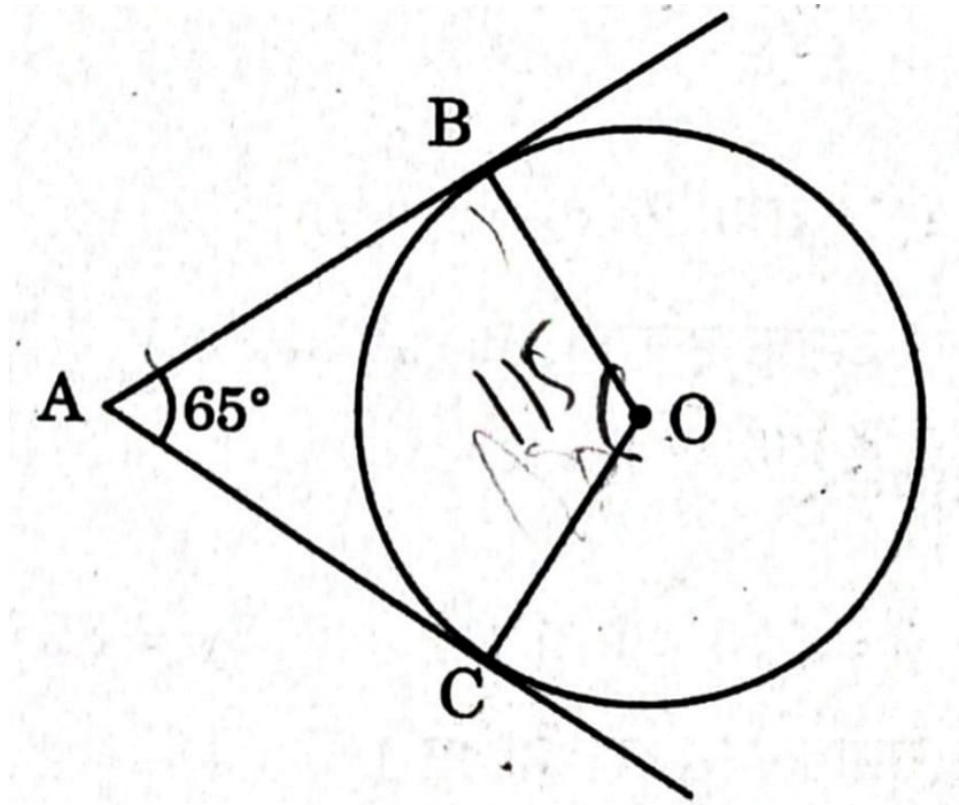


Figure 3.1.5.1:

3.1.6. In the given figure Fig. 3.1.6.1,  $O$  is the centre of the circle and  $QPR$  is the tangent to it at  $P$ . Prove that  $\angle QAP + \angle APR = 90^\circ$ .

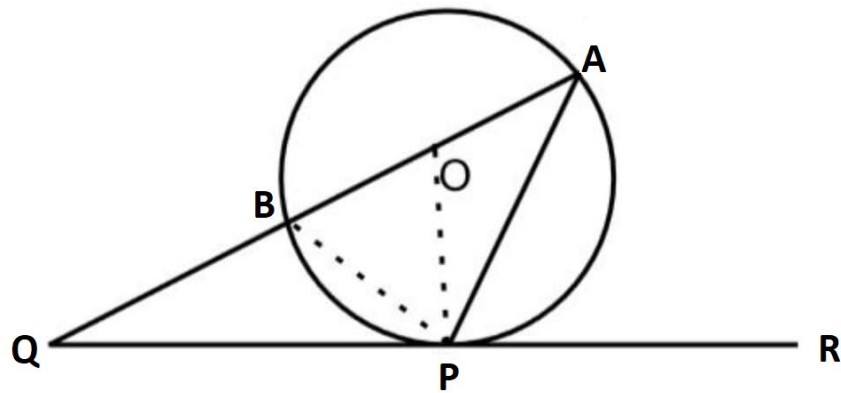


Figure 3.1.6.1:

3.1.7. In the given figure Fig. 3.1.7.1,  $TA$  is a tangent to the circle with centre  $O$  such that  $OT = 4\text{cm}$ ,  $\angle OTA = 30^\circ$ , then length of  $TA$  is :

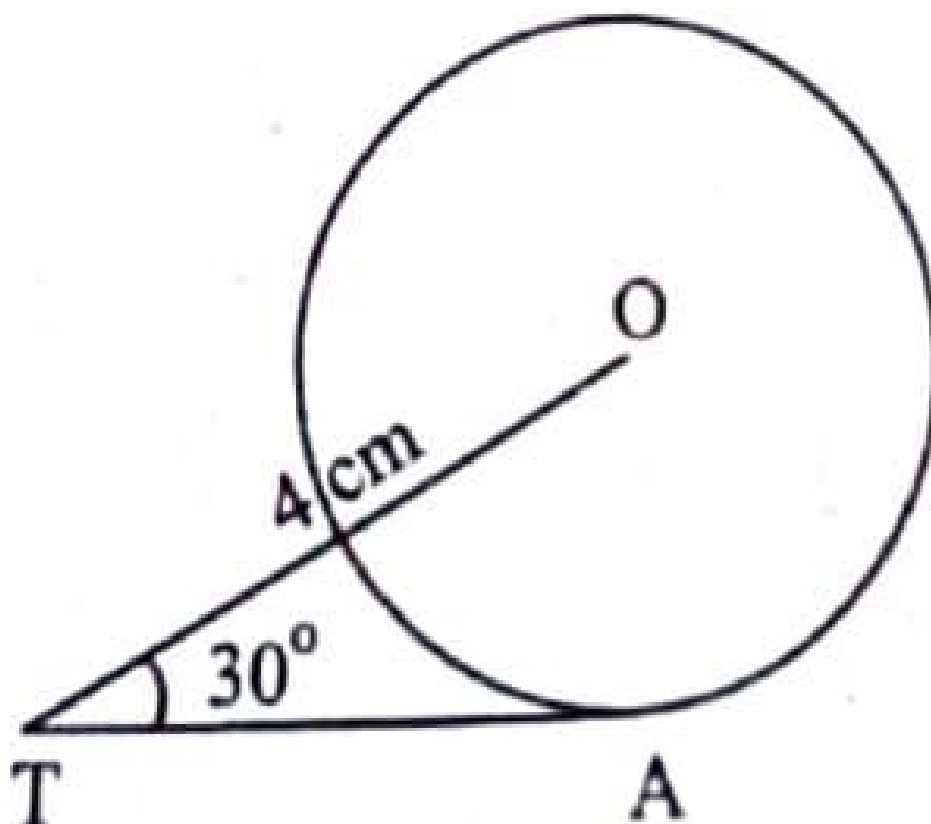


Figure 3.1.7.1:

- (a)  $2\sqrt{3}cm$
- (b)  $2cm$
- (c)  $2\sqrt{2}cm$
- (d)  $\sqrt{3}cm$

3.1.8. In the given figure Fig. 3.1.8.1,  $PT$  is a tangent at  $T$  to the circle with centre  $O$ . If  $\angle TPO = 25^\circ$ , then  $x$  is equal to :

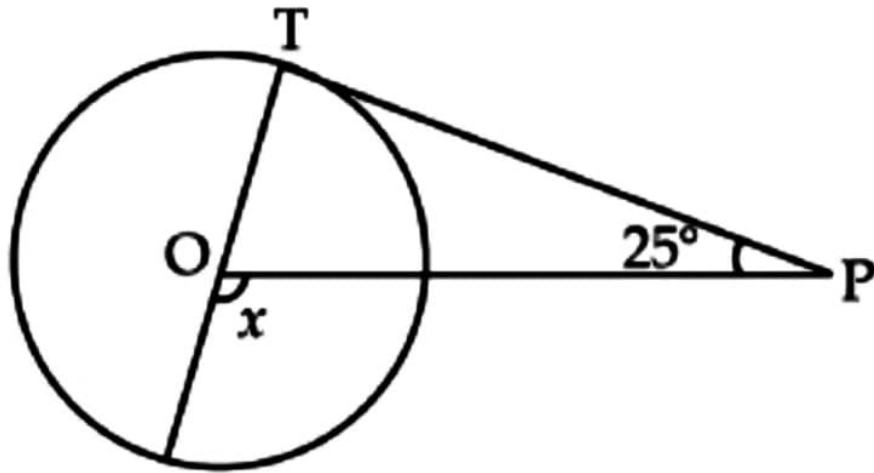


Figure 3.1.8.1:

- (a)  $25^\circ$
- (b)  $65^\circ$
- (c)  $90^\circ$
- (d)  $115^\circ$

3.1.9. Two concentric circles are of radii 5 cm and 3 cm. Find the length of the chord of the larger circle which touches the smaller circle.

## 3.2. 2022

3.2.1. Draw a circle of radius 2.5 cm. Take a point **P** outside the circle at a distance of 7 cm from the center. Then construct a pair of tangents to the circle from point **P**.

3.2.2. Write the steps of construction for constructing a pair of tangents to a circle of radius 4 cm from a point **P**, at a distance of 7 cm from its center **O**.

3.2.3. In Figure 3.2.3.1, there are two concentric circles with centre **O**. If  $ARC$  and  $AQB$  are tangents to the smaller circle from the point **A** lying on the larger circle, find the length of  $AC$ , if  $AQ = 5$  cm.

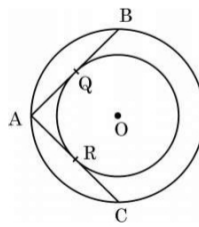


Figure 3.2.3.1: Two concentric circles with **O** as centre

3.2.4. In Figure 3.2.4.1, if a circle touches the side  $QR$  of  $\triangle PQR$  at **S** and extended sides  $PQ$  and  $PR$  at **M** and **N**, respectively,

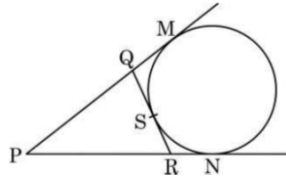


Figure 3.2.4.1: Two tangents are drawn from point **P** to the circle

prove that  $PM = \frac{1}{2}(PQ + QR + PR)$

3.2.5. In Figure 3.2.5.1, a triangle  $ABC$  is drawn to circumscribe a circle of radius 4 cm such that the segments  $BD$  and  $DC$  into which  $BC$  is divided by the point of contact **D** are of lengths 6 cm and 8 cm

respectively. If the area of  $\triangle ABC$  is  $84 \text{ cm}^2$ , find the lengths of sides  $AB$  and  $AC$ .

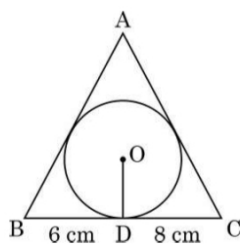


Figure 3.2.5.1: Circle with **O** as center circumscribed in triangle  $ABC$

3.2.6. In Figure 3.2.6.1,  $PQ$  and  $PR$  are tangents to the circle centered at **O**. If  $\angle OPR = 45^\circ$ , then prove that  $ORPQ$  is a square.

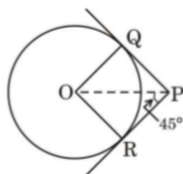


Figure 3.2.6.1: Two tangents drawn from point **P** to a circle whose centre is **O**

3.2.7. In Figure 3.2.7.1, **O** is the centre of a circle of radius 5 cm.  $PA$  and  $BC$  are tangents to the circle at **A** and **B** respectively. If  $OP$  is 13 cm, then find the length of tangents  $PA$  and  $BC$ .

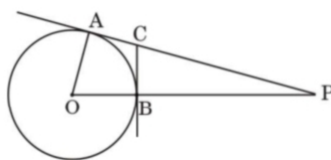


Figure 3.2.7.1: Two tangents drawn from point **C** to a circle whose centre is **O**

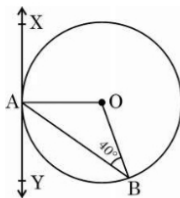


Figure 3.2.9.1: The line  $XAY$  is tangent to the circle centered at  $\mathbf{O}$

- 3.2.8. In Figure 3.2.8.1,  $AB$  is diameter of a circle centered at  $\mathbf{O}$ .  $BC$  is tangent to the circle at  $\mathbf{B}$ . If  $OP$  bisects the chord  $AD$  and  $\angle AOP = 60^\circ$ , then find  $m\angle C$ .

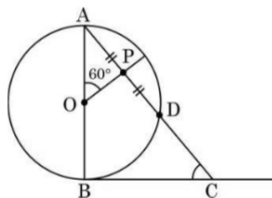


Figure 3.2.8.1: Tangent  $BC$  is drawn from point  $\mathbf{C}$  to a circle whose centre is  $\mathbf{O}$

- 3.2.9. In Figure 3.2.9.1,  $XAY$  is a tangent to the circle centered at  $\mathbf{O}$ . If  $\angle ABO = 60^\circ$ , then find  $m\angle BAY$  and  $m\angle AOB$ .
- 3.2.10. Two concentric circles are of radii 4cm and 3 cm. Find the length of the chord of the larger circle which touches the smaller circle.
- 3.2.11. In Figure 3.2.11.1, a triangle  $ABC$  with  $\angle B = 90^\circ$  is shown. Taking  $AB$  as diameter, a circle has been drawn intersecting  $AC$  at point  $\mathbf{P}$ . Prove that the tangent drawn at point  $\mathbf{P}$  bisects  $BC$ .

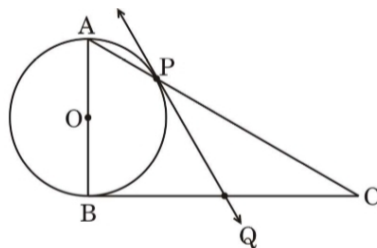


Figure 3.2.11.1:  $PQ$  is tangent to the circle centered at  $\mathbf{O}$ .  $AB$  is the diameter and  $\angle B = 90^\circ$

- 3.2.12. Find the equation of tangent to the curve  $y = x^2 + 4x + 1$  at the point  $(3, 22)$ .

## 3.3. 2021

### 3.3.1. 10

1. A quadrilateral  $ABCD$  is drawn to circumscribe a circle (see Figure-1).  
Prove that  $AB + CD = AD + BC$ .
2. Draw a pair of tangents to a circle of radius  $4\text{cm}$  which are inclined to each other at an angle of  $45^\circ$ .
3. A point  $\mathbf{T}$  is  $13\text{cm}$  away from the centre of a circle. The length of the tangent drawn from  $\mathbf{T}$  to the circle is  $12\text{cm}$ . Find the radius of the circle.
4. Two tangents  $TP$  and  $PQ$  are drawn to a circle with centre  $\mathbf{O}$  from an external point  $\mathbf{T}$ . Prove that  $\angle PTQ = 2\angle OPQ$ .



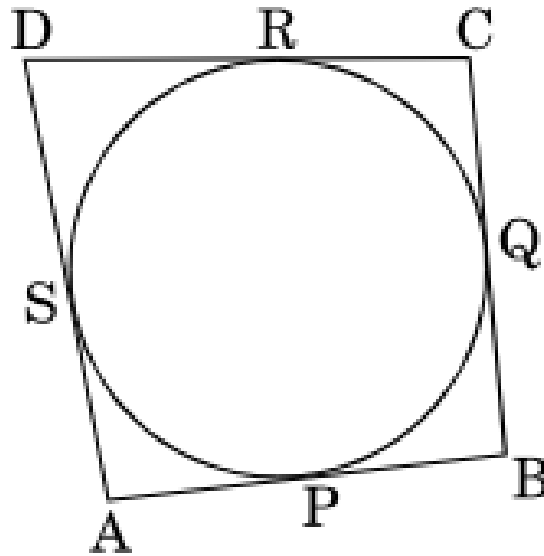


Figure 1.1:

5.  $PQ$  is a tangent to a circle with centre  $\mathbf{O}$  at the point  $\mathbf{P}$  on the circle.  
If  $\triangle OPQ$  is an isosceles triangle, then find  $\angle OQP$ .
6. Two concentric circles have radii  $10\text{cm}$  and  $6\text{cm}$ . Find the length of the chord of the larger circle which touches the smaller circle.
7. If tangents  $PA$  and  $PB$  from an external point  $\mathbf{P}$  to a circle with centre  $\mathbf{O}$  are inclined to each other at an angle of  $70^\circ$ , then find  $\angle POA$ .
8.  $ABC$  is right triangle, right-angled at  $\mathbf{B}$  with  $BC = 6\text{cm}$  and  $AB = 8\text{cm}$ . A circle with centre  $\mathbf{O}$  and radius  $r$  cm has been inscribed in  $\triangle ABC$  as shown in the figure. Find the value of  $r$ .

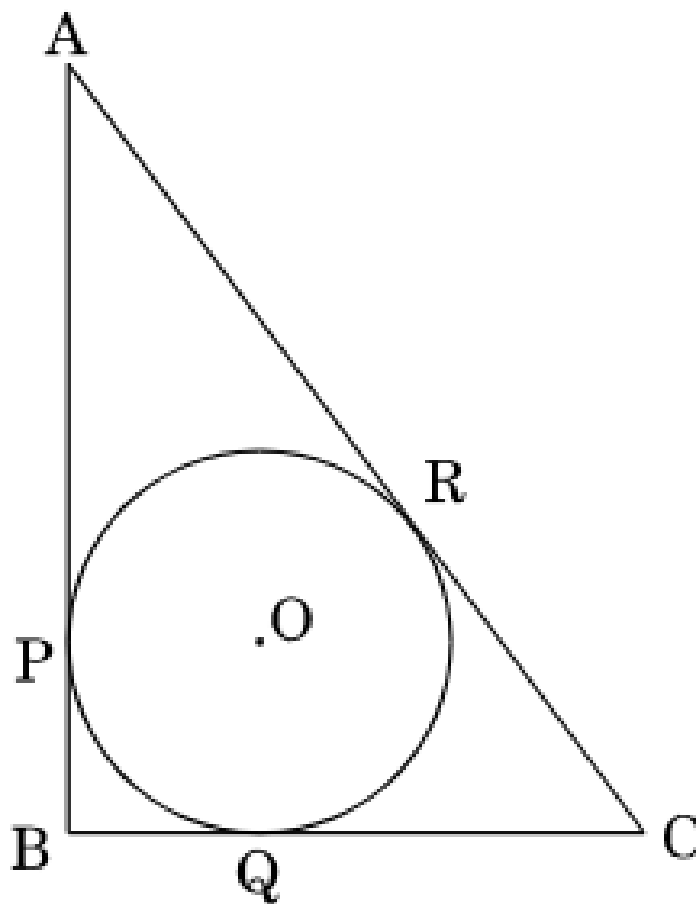


Figure 8.1:

9. Draw a circle of radius  $5\text{cm}$ . From a point  $8\text{cm}$  away from its centre, construct a pair of tangents to the circle.
10. In the given figure,  $PT$  and  $PS$  are tangents to a circle with centre  $O$ , from a point  $P$ , such that  $PT = 4\text{cm}$  and  $\angle TPS = 60^\circ$ . Find the length of the chord  $TS$ . Also, find the radius of the circle.

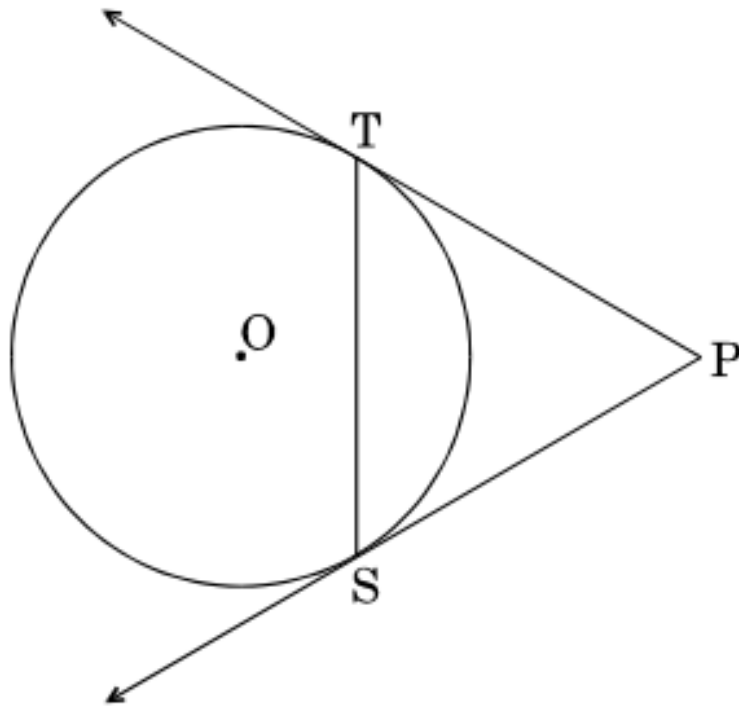


Figure 10.1:

11. (a) In a right triangle  $ABC$ , right-angled at  $B$ ,  $BC = 6\text{cm}$  and  $AB = 8\text{cm}$ . A circle is inscribed in the  $\triangle ABC$ . Find the radius of the incircle.
- (b) Two circles touch externally at  $P$  and  $AB$  is a common tangent, touching one circle at  $A$  and the other at  $B$ . Find the measure of  $\angle APB$ .
12. From an external point  $P$ , tangents  $PQ$  and  $PR$  are drawn to a circle with centre  $O$ , touching the circle at  $Q$  and  $R$ . If  $\angle QOR = 140^\circ$ , find the measure of  $\angle QPR$ .

13. A circle touches all the sides of a quadrilateral  $ABCD$ . Prove that  $AB + CD = DA + BC$ .
14. Write the steps of construction of a circle of diameter  $6\text{cm}$  and drawing of a pair of tangents to the circle from a point  $5\text{cm}$  away from the centre.



## Chapter 4

# Intersection of Conics

### 4.1. 2022

4.1.1. Using integration, find the area of the region enclosed by the curve  $y = x^2$ , the x-axis and the ordinates  $x = -2$  and  $x = 1$ .

4.1.2. Using integration, find the area of the region enclosed by line  $y = \sqrt{3}x$  semi-circle  $y = \sqrt{4 - x^2}$  and x-axis in first quadrant.

4.1.3. Using integration, find the area of the smaller region enclosed by the curve  $4x^2 + 4y^2 = 9$  and the line  $2x + 2y = 3$ .

4.1.4. If the area of the region bounded by the curve  $y^2 = 4ax$  and the line  $x = 4a$  is  $\frac{256}{3}$  sq. units, then using integration, find the value of  $a$ , where  $a > 0$ .

4.1.5. Find the area of the region enclosed by the curves  $y^2 = x$ ,  $x = \frac{1}{4}$ ,  $y = 0$  and  $x = 1$ , using integration.

4.1.6. If the area of the region bounded by the line  $y = mx$  and the curve  $x^2 = y$  is  $\frac{32}{3}$  sq. units, then find the positive value of  $m$ , using integration.

4.1.7. If the area between the curves  $x = y^2$  and  $x = 4$  is divided into two equal parts by the line  $x = a$ , then find the value of  $a$ , using integration.

4.1.8. Find the area bounded by the ellipse  $x^2 + 4y^2 = 16$  and the ordinates  $x = 0$  and  $x = 2$ , using integration.

4.1.9. Find the area of the region  $\{(x, y) : x^2 \leq y \leq x\}$ , using integration

## 4.2. 2021

### 4.2.1. 12

1. The point at which the normal to the curve

$$y = x + \frac{1}{x}, x > 0 \quad (1.1)$$

is perpendicular to the line

$$3x - 4y - 7 = 0 \quad (1.2)$$

(a)  $(2, \frac{5}{2})$

(b)  $(\pm 2, \frac{5}{2})$

(c)  $(-\frac{1}{2}, \frac{5}{2})$

(d)  $(\frac{1}{2}, \frac{5}{2})$

2. The points on the curve

$$\frac{x^2}{9} + \frac{y^2}{16} = 1 \quad (2.1)$$

at which the tangents are parallel to  $y$ -axis are:

(a)  $(0, \pm 4)$

(b)  $(\pm 4, 0)$

(c)  $(\pm 3, 0)$

(d)  $(0, \pm 3)$

3. For which value of  $m$  is the line

$$y = mx + 1 \quad (3.1)$$

a tangent to the curve

$$y^2 = 4x \quad (3.2)$$

(a)  $\frac{1}{2}$

(b) 1

(c) 2

(d) 3





## Chapter 5

# Probability

### 5.1. 2021

#### 5.1.1. 10

5.1.1. During the lockdown period, many families got bored of watching TV all the time. Out of these families, one family of 6 members decided to play a card game. 17 cards numbered 1, 2, 3, 4, ..., 17 are put in a box and mixed thoroughly. One card is drawn by one member at random and other family members bet for the chances of drawing the number either prime, odd or even etc.



Figure 5.1.1.1: Family of six

Based on the above, answer the following questions:

- (i) The first member of the family draws a card at random and another member bets that it is an even prime number. What is the probability of his winning the bet?
- (A)  $\frac{2}{17}$
- (B)  $\frac{3}{17}$
- (C)  $\frac{1}{17}$
- (D)  $\frac{4}{17}$

(ii) The second member of the family draws a card at random and some other member bets that it is an even number. What is the probability of his winning the bet ?

(A)  $\frac{7}{17}$

(B)  $\frac{8}{17}$

(C)  $\frac{9}{17}$

(D)  $\frac{10}{17}$

(iii) What is the probability that the number on the card drawn at random is divisible by 5 ?

(A)  $\frac{5}{17}$

(B)  $\frac{4}{17}$

(C)  $\frac{3}{17}$

(D)  $\frac{2}{17}$

(iv) What is the probability that the number on the card drawn at random is a multiple of 3 ?

(A)  $\frac{5}{17}$

(B)  $\frac{6}{17}$

(C)  $\frac{7}{17}$

(D)  $\frac{8}{17}$

5.1.2. (a) Two different coins are tossed simultaneously. Write all the possible outcomes.

(b) A die is thrown once. Write the probability of getting a number less than 7.

- 5.1.3. If the probability of occurrence of event  $E$ ,  $\Pr(E)=0.99$ , what is the probability of non-occurrence of the event  $E$ ,  $\Pr(notE)$ ?
- 5.1.4. (a) A bag contains 5 white balls and 7 red balls. A ball is drawn at random from the bag. What is the probability that it is either a white or a red ball?
- (b) Two coins are tossed together once. What is the probability of getting at least one head?
- 5.1.5. Cards marked with numbers 1, 2, 3, 4, ..., 100 are placed in a bag and mixed together thoroughly. A card is randomly drawn from the bag. Find the probability that the numbers on the card is
- (i) an even number,
- (ii) a 2-digit number,
- (iii) a perfect square.
- 5.1.6. (a) How many outcomes are possible when three dice are thrown together?
- (b) if  $\Pr(E)=0.015$ , then find  $\Pr(notE)$ .
- 5.1.7. During summer break, Harish wanted to play with his friends but it was too hot outside, so he decided to play some indoor game with his friends. He collects 20 identical cards and writes the numbers 1 to 20 on them (one number on one card). He puts them in a box. He and his friends make a bet for the chances of drawing various cards out of the box. Ench was given a chance to tell the probability of picking one card out of the box.

Based on the above,answer the following questions:

- (i) The probability that the number on the card drawn is an odd prime number,is

(A)  $\frac{3}{5}$

(B)  $\frac{2}{5}$

(C)  $\frac{9}{20}$

(D)  $\frac{7}{20}$

- (ii) The probability that the number on the card drawn is a composite number is

(A)  $\frac{11}{20}$

(B)  $\frac{3}{5}$

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

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

- (iii) The probability that the number on the card drawn is a multiple of 3,6 and 9 is

(A)  $\frac{1}{20}$

(B)  $\frac{1}{20}$

(C)  $\frac{3}{20}$

(D) 0

- (iv) The probability that the number on the card drawn is a multiple of 3 and 7is

(A)  $\frac{3}{10}$

(B)  $\frac{1}{10}$

(C) 0

(D)  $\frac{2}{5}$

- (v) If all cards having odd numbers written on them are removed from the box and then one card is drawn from the remaining cards, the probability of getting a card having a prime number is

(A)  $\frac{1}{20}$

(B)  $\frac{1}{10}$

(C) 0

(D)  $\frac{1}{5}$

- 5.1.8. (a) In a single throw of a pair of dice, find the probability that both dice have the same number.

- (b) A card is drawn from a well-shuffled pack of 52 cards. Find the probability that it is not an ace.

### 5.1.2. 12

1. The probability of solving a specific question independently by  $A$  and  $B$  are  $\frac{1}{3}$  and  $\frac{1}{5}$  respectively. If both try to solve the question independently, the probability that the question is solved is

(a)  $\frac{7}{15}$

(b)  $\frac{8}{15}$

(c)  $\frac{2}{15}$

(d)  $\frac{14}{15}$

2. From a pack of 52 cards, 3 cards are drawn at random (without replacement). The probability that they are two red cards and one black card is\_\_\_\_\_.
3. A bag contains 19 tickets, numbered 1 to 19. A ticket is drawn at random and then another ticket is drawn without replacing the first one in the bag. Find the probability distribution of the number of even numbers on the ticket.
4. Find the probability distribution of the number of successes in two tosses of a die, when a success is defined as "number greater than 5".
5. A bag contains 5 red and 4 black balls, a second bag contains 3 red and 6 black balls. One of the two bags is selected at random and two balls are drawn at random (without replacement), both of which are found to be red. Find the probability that these two balls are drawn from the second bag.
6. An unbiased die is thrown. What is the probability of getting an odd number or a multiple of 3 ?
- (a)  $\frac{3}{4}$
- (b)  $\frac{1}{2}$
- (c)  $\frac{2}{3}$
- (d)  $\frac{1}{3}$
7. A card is drawn from an ordinary pack of 52 cards and a gambler bets that it is a heart or a king card. What are the odds against his winning



this bet ?

(a) 4 : 9

(b) 1 : 4

(c) 4 : 1

(d) 9 : 4

8. In a lottery of 25 tickets, numbered 1 to 25, two tickets are drawn simultaneously. Find the probability that none of the tickets has prime number.
9. If  $E_1$  and  $E_2$  are two events, where  $E_1$  is a subset of  $E_2$ , then evaluate  $P(E_2 | E_1)$ .
10. Two dice are thrown simultaneously. Find the probability of getting a multiple of 3 on one dice and a multiple of 2 on the other dice.
11. An urn contains 4 white, 7 green and 9 blue balls. If two balls are drawn at random, find the probability that the drawn balls are of the same colour.

## 5.2. 2023

### 5.2.1. 10

- 5.2.1. Probability of happening of an event is denoted by  $p$  and probability of non-happening of the event is denoted by  $q$ . Relation between  $p$  and  $q$  is

- (a)  $p+q=1$
- (b)  $p=1, q=1$
- (c)  $p=q-1$
- (d)  $p+q+1=0$

5.2.2. A girl calculates that the probability of her winning the first prize in a lottery is 0.08. If 6000 tickets are sold, how many tickets has she bought ?

- (a) 40
- (b) 240
- (c) 480
- (d) 750

5.2.3. In a group of 20 people, 5 can't swim. If one person is selected at random, then the probability that he/sh can swim, is

- (a)  $\frac{3}{4}$
- (b)  $\frac{1}{3}$
- (c) 1
- (d)  $\frac{1}{4}$

5.2.4. A bag contain 4 red, 3 blue and 2 yellow balls. One ball is drawn at random from the bag. Find the probability that drawn ball is

- (a) red
- (b) yellow

5.2.5. A bag contain 100 cards numbered 1 to 100. A card is drawn at random from the bag. What is the probability that the number on the card is a perfect cube ?

(a)  $\frac{1}{20}$

(b)  $\frac{3}{50}$

(c)  $\frac{1}{25}$

(d)  $\frac{7}{100}$

5.2.6. If three coins are tossed simultaneously, what is the probability of getting at most one tail ?

(a)  $\frac{3}{8}$

(b)  $\frac{4}{8}$

(c)  $\frac{5}{8}$

(d)  $\frac{7}{8}$

5.2.7. Two dice are thrown together. The probability of getting the difference of numbers on their upper faces equals to 3 is :

(a)  $\frac{1}{9}$

(b)  $\frac{2}{9}$

(c)  $\frac{1}{6}$

(d)  $\frac{1}{12}$

5.2.8. A card is drawn at random from a well-shuffled pack of 52 cards. The probability that the card drawn is not an ace is :

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

(b)  $\frac{9}{13}$

(c)  $\frac{4}{13}$

(d)  $\frac{12}{13}$

5.2.9. **Assertion (A) :** The probability that a leap year has 53 Students is  $\frac{2}{7}$ .

**Reason (R) :** The probability that a non-leap year has 53 Sundays is  $\frac{5}{7}$ .

(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 and 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.

## 5.2.2. 12

5.2.1. If A and B are two events such that

$$\Pr(A|B) = 2 \times \Pr(B|A) \Pr(A) + \Pr(B) = \frac{2}{3} \quad (5.2.1.1)$$

then  $\Pr(B)$  is equal to

(a)  $\frac{2}{9}$

(b)  $\frac{7}{9}$

(c)  $\frac{4}{9}$

(d)  $\frac{5}{9}$

5.2.2. (a) Two balls are drawn at random one by one with replacement from an urn containing equal number of red balls and green balls. Find the probability distribution of number of red balls. Also, find the mean of the random variable.

(b) A and B throw a die alternately till one of them gets '6' and wins the game. Find their respective probabilities of winning, if A starts the game first.

5.2.3. Recent studies suggest that roughly 12% of the world population is left handed.

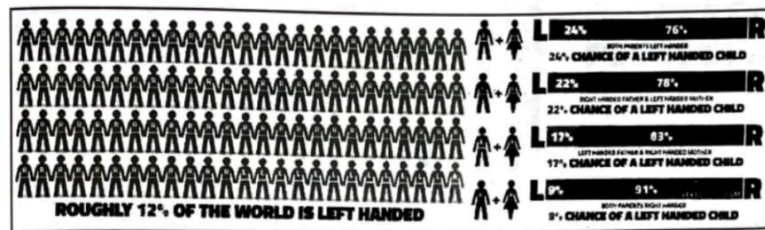


Figure 1: chance of left hand, depending upon parents

Figure 5.2.3.1: chance of left hand, depending upon parents

Depending upon the parents, the chances of having a left handed child are as follows :

- (a) When both father and mother are left handed : Chances of left handed child is 24%.
- (b) When father is right handed and mother is left handed : Chances of left handed child is 22%.
- (c) when father is left handed and mother is right handed : Chances of left handed child is 17%.
- (d) When both father and mother are right handed : Chances of left handed child is 9%.

Assuming that  $\Pr(A) = \Pr(B) = \Pr(C) = \Pr(D) = \frac{1}{4}$  and L denotes the event that child is left handed. Based on the above information, answer the following questions :

- (a) Find  $\Pr(L|C)$
- (b) Find  $\Pr(\bar{L}|A)$
- (c) Find  $\Pr(A|L)$
- (d) Find the probability that a randomly selected child is left handed given that exactly one of the parent is left handed.

## 5.3. 2022

### 5.3.1. 12

5.3.1. Let A and B be two events such that  $P(A) = \frac{5}{8}$ ,  $P(B) = \frac{1}{2}$  and  $P(A|B) = \frac{3}{4}$ . Find the value of  $P(B|A)$ .

5.3.2. Two balls are drawn at random from a bag containing 2 red balls and 3 blue balls, without replacement. Let the variable X denote the number of red balls. Find the probability distribution of X.

5.3.3. A card from a pack of 52 playing cards is lost. From the remaining cards, 2 cards are drawn at random without replacement, and are found to be both aces. Find the probability that the lost card was an ace.

5.3.4. Probabilities of A and B solving a specific problem are  $\frac{2}{3}$  and  $\frac{3}{5}$ , respectively. If both of them try independently to solve the problem, then find the probability that the problem is solved.

5.3.5. A pair of dice is thrown. It is given that the sum of numbers appearing on both dice is an even number. Find the probability that the number appearing on at least one die is 3.

5.3.6. At the start of a cricket match, a coin is tossed and the team winning the toss has the opportunity to choose to bat or bowl. Such a coin is unbiased with equal probabilities of getting head and tail Fig. 5.3.6.1

Based on the above information, answer the following question:

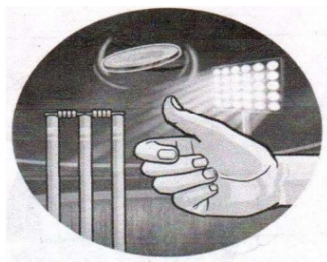


Figure 5.3.6.1: Toss before the match

- (a) If such a coin is tossed 2 times, then find the probability distribution of numbers of tails.
  - (b) Find the probability of getting at least one head in three tosses of such a coin.
- 5.3.7. Two cards are drawn successively with replacement from a well shuffled pack of 52 cards. Find the probability distribution of the number of spade cards.
- 5.3.8. A pair of dice is thrown and the sum of the numbers appearing on the dice is observed to be 7. Find the probability that the number 5 has appeared on at least one die.
- 5.3.9. The probability that A hits the target is  $\frac{1}{3}$  and the probability that B hits it, is  $\frac{2}{5}$ . If both try to hit the target independently, find the probability that the target is hit.
- 5.3.10. A shopkeeper sells three types of flower seeds  $A_1$ ,  $A_2$ ,  $A_3$ . They are sold in the form of a mixture, where the proportions of these seeds are 4 : 4 : 2, respectively. The germination rates of the three types of seeds are 45%, 60% and 35% respectively Fig. 5.3.10.1.



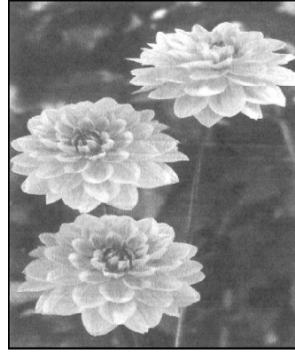


Figure 5.3.10.1: Three types of flowers

Based on the above information :

- (a) Calculate the probability that a randomly chosen seed will germinate.
- (b) Calculate the probability that the seed is of type  $A_2$ , given that a randomly chosen seed germinates.

5.3.11. Three friends A, B and C got their photograph clicked. Find the probability that B is standing at the central position, given that A is standing at the left corner.

5.3.12. In a game of Archery, each ring of the Archery target is valued. The centremost ring is worth 10 points and rest of the rings are allotted points 9 to 1 in sequential order moving outwards. Archer A is likely to earn 10 points with a probability of 0.8 and Archer B is likely to earn 10 points with a probability of 0.9 Fig. 5.3.12.1.

Based on the above information, answer the following questions :

- (a) exactly one of them earns 10 points .

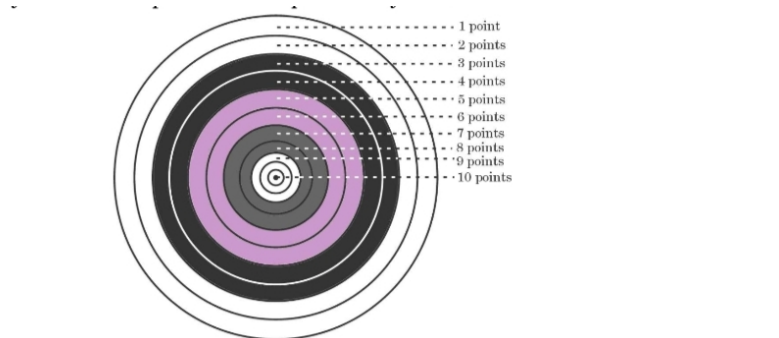


Figure 5.3.12.1: centermost ring

(b) both of them earn 10 point.

5.3.13. Event A and B are such that

$$P(A) = \frac{1}{2}, P(B) = \frac{7}{12} \quad (5.3.13.1)$$

and

$$P(\bar{A} \cup \bar{B}) = \frac{1}{4} \quad (5.3.13.2)$$

Find whether the events A and B are independent or not.

5.3.14. A box  $B_1$  contain 1 white ball and 3 red balls. Another box  $B_2$  contains 2 white balls and 3 red balls. If one ball is drawn at random from each of the boxes  $B_1$  and  $B_2$ , then find the probability that the two balls drawn are of the same colour.

5.3.15. Let X be random variable which assumes values  $x_1, x_2, x_3, x_4$  such

that

$$2P(X = x_1) = 3P(X = x_2) = P(X = x_3) = 5P(X = x_4). \quad (5.3.15.1)$$

Find the probability distribution of X.

5.3.16. There are two boxes, namely box-I and box-II. Box-I contains 3 red and 6 black balls. Box-II contains 5 red and 5 black balls. One of the two boxes, is selected at random and a ball is drawn at random. The ball drawn is found to be red. Find the probability that this red ball comes out from box-II.

5.3.17. In a toss of three different coins, find the probability of coming up of three heads, if it is known that at least one head comes up.

5.3.18. A laboratory blood test is 98% effective in detecting a certain disease when it is fact, present. However, the test also yeilds a false positive result for 0.4% of the healthy person tested. From a large population, it is given that 0.2% of the population actually has the diseases.

Based on the above, answer the following questtion :

(a) one person, from the population, is taken at random and given the test. Find the probabiliy of his getting a positive test result.

(b) what is the probability that the person actually has the disease, given that his test result is positive ?

5.3.19. Two cards are drawn from a well-shuffled pack of playing cards one-

by-one with replacement. The probability that the first card is a king and the second card is a queen is

(a)  $\frac{1}{13} + \frac{1}{13}$

(b)  $\frac{1}{13} \times \frac{4}{51}$

(c)  $\frac{4}{52} \times \frac{3}{51}$

(d)  $\frac{1}{13} \times \frac{1}{13}$

5.3.20. For two events A and B if  $P(A) = \frac{4}{10}$ ,  $P(B) = \frac{8}{10}$  and  $P(B|A) = \frac{6}{10}$  then find  $P(A \cup B)$ .

5.3.21. Bag I contain 4 red and 3 black balls. Bag II contains 3 red and 5 black balls. One of two bags is selected at random and a ball is drawn from the bag, which is found to be red. Find the probability that the ball is drawn from bag II.

5.3.22. Two cards are drawn successively without replacement from a well-shuffled pack of 52 cards. Find the probability distribution of the number of aces and hence find its mean.

5.3.23. The probability of solving a specific question independently by A and B are  $\frac{1}{3}$  and  $\frac{1}{5}$  respectively. If both try to solve the question independently, the probability that the question is solved is

(a)  $\frac{7}{15}$

(b)  $\frac{8}{15}$

(c)  $\frac{2}{15}$

(d)  $\frac{14}{15}$

- 5.3.24. A card is picked at random from a pack of 52 playing cards. Given that the picked up card is a queen, the probability of it being a queen of spades is \_\_\_\_\_.
- 5.3.25. A bag contains 19 tickets, numbered 1 to 19. A ticket is drawn at random and then another ticket is drawn without replacing the first one in the bag. Find the probability distribution of the number of even numbers on the ticket.
- 5.3.26. Find the probability distribution of the numbers of successes in two tosses of a die, when a success is defined as number greater than 5.
- 5.3.27. Ten cartoons are taken at random from an automatic packing machine. The mean net weight of the ten carton is 11.8 kg and standard deviation is 0.15 kg. Does the sample mean differ significantly from the intended mean of 12 kg ? [Given that for d.f. = 9,  $t_{0.05} = 2.26$ ]
- 5.3.28. A Coin is tossed twice. The following table 5.3.28.2 shows the probability distribution of numbers of tails:

X	0	1	2
P(X)	K	6K	9K

Table 5.3.28.2: Table shows the probability distribution of numbers of tails

- (a) Find the value of  $K$ .
- (b) Is the coin tossed biased or unbiased? Justify your answer.
- 5.3.29. If  $X$  is a random variable with probability distribution as given below

5.3.29.2:

X	0	1	2
P(X)	K	4K	K

Table 5.3.29.2: table shows the probability distribution

The value of K and the mean of the distribution respectively are

(a)  $\frac{1}{7}, 1$

(b)  $\frac{1}{6}, 2$

(c)  $\frac{1}{6}, 1$

(d)  $1, \frac{1}{6}$

5.3.30. The random variable X has a probability function  $P(x)$  as defined below, where K is some number :

$$P(X) = \begin{cases} K, & \text{if } x = 0 \\ 2K, & \text{if } x = 1 \\ 3K, & \text{if } x = 2 \\ 0, & \text{otherwise} \end{cases} \quad (5.3.30.1)$$

Find:

(a) The value of  $K$ .

(b)  $P(X < 2), P(X \leq 2), P(X \geq 2)$ .

5.3.31. Two rotten apples are mixed with 8 fresh apples. Find the probability distribution of number of rotten apples, if two apples are drawn at random, one-by-one without replacement.

## Chapter 6

### Construction

6.0.1. In the given figure,  $XZ$  is parallel to  $BC$ .  $AZ = 3\text{cm}$ ,  $ZC = 2\text{cm}$ ,  $BM = 3\text{cm}$  and  $MC = 5\text{cm}$ . Find the length of  $XY$ .

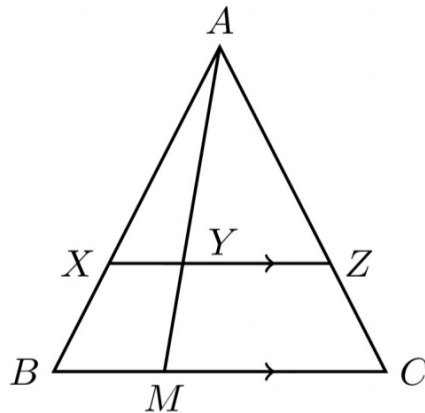


Figure 1: Isosceles Triangle

Figure 6.0.1.1: Isosceles Triangle

6.0.2. In the given figure,  $DE \parallel BC$ . If  $AD = 2\text{units}$ ,  $DB = AE = 3\text{units}$  and  $EC = x\text{units}$ , then find the value of  $x$  is:



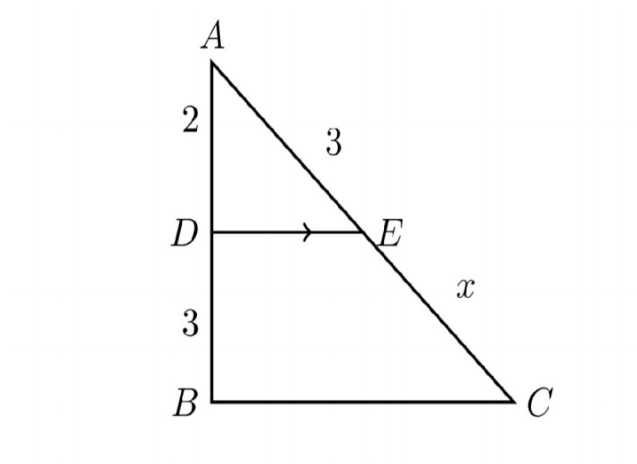


Figure 2: Right Angle Triangle

Figure 6.0.2.1: Right Angle Triangle

- (a) 2
- (b) 3
- (c) 5
- (d)  $\frac{9}{2}$

6.0.3. In the given figure,  $\triangle ABC$  and  $\triangle DBC$  are on the same base  $BC$ . If

$AD$  intersects  $BC$  at  $O$ , prove that  $\frac{ar(\triangle ABC)}{ar(\triangle DBC)} = \frac{AO}{DO}$ .

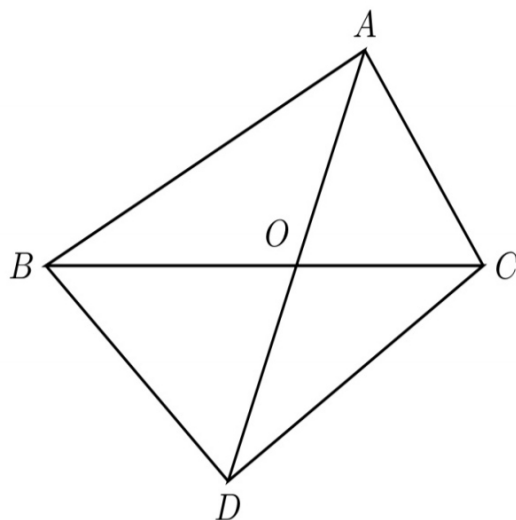


Figure 3: Triangles with same base

Figure 6.0.3.1: Triangles with same base

## 6.1. 2022

### 6.1.1. 10

6.1.1. In figure, Fig. 6.1.1.1 BN and CM are medians of a  $\triangle ABC$  right-angled at A. Prove that

$$4(BN^2 + CM^2) = 5BC^2 \quad (6.1.1.1)$$

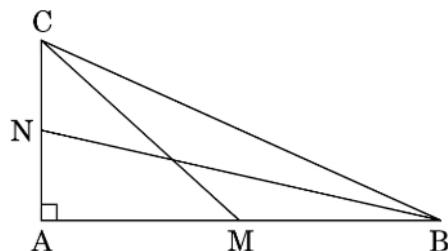


Figure 6.1.1.1: Right-angled triangle

#### 6.1.2. CaseStudy – 1 :

##### KiteFestival

Kite festival is celebrated in many countries at different times of the year. In India, every year 14th January is celebrated as International Kite Day. On this day many people visit India and participate in the festival by flying various kinds of kites.

The picture given below Fig. 6.1.2.1, three kites flying together.

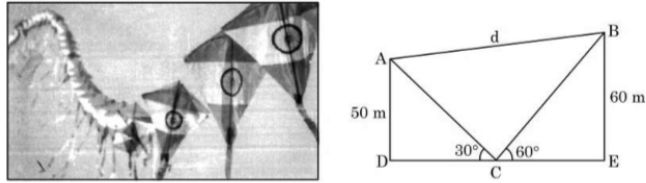


Figure 6.1.2.1: kites flying to gether

In Fig. 6.1.2.1, the angles of elevation of two kites (point C) are found to be  $^{\circ}30$  and  $^{\circ}60$  respectively. Taking

$$AD = 50m \quad (6.1.2.1)$$

and

$$BE = 60m \quad (6.1.2.2)$$

find

(a) The length of string used (take them straight) for kites A and B as shown in the figure.

(b) The distance 'd' between these two kites

## 6.2. 2021

### 6.2.1. 10

- 6.2.1. (a) **D** and **E** are points on the sides  $CA$  and  $CB$  respectively of a triangle  $ABC$ , right-angled at **C**.

Prove that  $AE^2 + BD^2 = AB^2 + DE^2$

- (b) Diagonals of a trapezium  $ABCD$  with  $AB \parallel DC$  intersect each other at the point **O**. If  $AB = 2CD$ , find the ratio of the areas of triangles  $AOB$  and  $COD$ .

- 6.2.2. Write the steps of construction of drawing a line segment  $AB = 4.8$  cm and finding a point **P** on it such that  $AP = \frac{1}{4}AB$ .

- 6.2.3. Answer any *four* of the following questions :

- (a) Given  $\triangle ABC \sim \triangle PQR$ . If  $\frac{AB}{PQ} = \frac{1}{3}$ , then  $\frac{ar(\triangle ABC)}{ar(\triangle PQR)}$  is

i.  $\frac{1}{3}$

ii. 3

iii.  $\frac{2}{3}$

iv.  $\frac{1}{9}$

- (b) The length of an altitude of an equilateral triangle of side 8 cm is

i. 4 cm

ii.  $4\sqrt{3}$  cm

iii.  $\frac{8}{3}$  cm

iv. 12 cm

- (c) In  $\triangle PQR$ ,  $PQ = 6\sqrt{3}$  cm,  $PR = 12$  cm and  $QR = 6$  cm. The measure of angle **Q** is
- $120^\circ$
  - $60^\circ$
  - $90^\circ$
  - $45^\circ$
- (d) If  $\triangle ABC \sim \triangle PQR$  and  $\angle B = 46^\circ$  and  $\angle R = 69^\circ$ , then the measure of  $\angle A$  is
- $65^\circ$
  - $111^\circ$
  - $44^\circ$
  - $115^\circ$
- (e) **P** and **Q** are the points on the sides  $AB$  and  $AC$  respectively of a  $\triangle ABC$  such that  $PQ \parallel BC$ . If  $AP : PB = 2 : 3$  and  $AQ = 4$  cm then  $AC$  is equal to
- 6 cm
  - 8 cm
  - 10 cm
  - 12 cm

6.2.4. Answer any *four* of the following questions :

- (a)  $ABC$  and  $BDE$  are two equilateral triangles such that **D** is the mid-point of  $BC$ . The ratio of the areas of the triangles  $ABC$  and  $BDE$  is

i. 2 : 1

ii. 1 : 2

iii. 4 : 1

iv. 1 : 4

(b) In  $\triangle ABC$ ,  $AB = 4\sqrt{3}$  cm,  $AC = 8$  cm and  $BC = 4$  cm. The angle **B** is

i.  $120^\circ$

ii.  $90^\circ$

iii.  $60^\circ$

iv.  $45^\circ$

(c) The perimeters of two similar triangles are 35 cm and 21 cm respectively. If one side of the first triangle is 9 cm, then the corresponding side of the second triangle is

i. 5.4 cm

ii. 4.5 cm

iii. 5.6 cm

iv. 15 cm

(d) In a  $\triangle ABC$ , **D** and **E** are points on the sides  $AB$  and  $AC$  respectively such that  $DE \parallel BC$  and  $AD : DB = 3 : 1$ . If  $AE = 3.3$  cm, then  $AC$  is equal to

i. 4 cm

ii. 1.1 cm

iii. 4.4 cm

iv. 5.5 cm

(e) In the isosceles triangle  $ABC$ , if  $AC = BC$  and  $AB^2 = 2AC^2$ , then  $\angle C$  is equal to

i.  $30^\circ$

ii.  $45^\circ$

iii.  $60^\circ$

iv.  $90^\circ$





## Chapter 7

# Optimization

### 7.1. 2023

1. The objective function  $Z = ax + by$  of an LLP has maximum value 42 at (4,6) and minimum value 19 at (3,2). Which of the following is true?

(a)  $a = 9, b = 1$

(b)  $a = 5, b = 2$

(c)  $a = 3, b = 5$

(d)  $a = 5, b = 3$

2. The corner point of the feasible region of a linear programming problem are (0,4), (8,0) and  $(\frac{20}{3}, \frac{4}{3})$ . if  $Z = 30x + 24y$  is the objective function, then ( maximum value of Z - minimum value of Z ) is equal to

(a) 40

(b) 96

(c) 120

(d) 136

3. Solve the following linear programming problem graphically :

$$\text{Maximum : } Z = x + 2y$$

$$\text{subject to constraints : } x + 2y \geq 100,$$

$$2x - y \leq 0,$$

$$2x + y \leq 200,$$

$$x \geq 0, y \geq 0.$$

4. Engine displacement is the measure of the cylinder volume swept by all the pistons engine. The piston move inside the cylinder bore



Figure 4.1: Engine

The cylinder bore in the form of circular cylinder open at the top is to be made from a metal sheet of area  $75\pi cm^2$

Based on the above information, answer the following questions:

- (a) if the radius of cylinder is  $r$  cm and height is  $h$  cm, then write the volume  $V$  of cylinder in terms of radius  $r$ .
- (b) Find  $\frac{dV}{dr}$ .
- (c) i. Find the radius of cylinder when its volume is maximum.  
 ii. For maximum volume,  $h > r$ . State true or false and justify.

## 7.2. 2021

### 7.2.1. 12

1. A company produces two types of goods,  $A$  and  $B$ , that require gold and silver. Each unit of type  $A$  requires  $3g$  of silver and  $1g$  of gold, while that of type  $B$  requires  $1g$  of silver and  $2g$  of gold. The company can use at the most  $9g$  of silver and  $8g$  of gold. If each unit of type  $A$  brings a profit of ₹ 120 and that of type  $B$  ₹ 150, then find the number of units of each type that the company should produce to maximise profit. Formulate the above LPP and solve it graphically. Also, find the maximum profit.
2. Find the maximum value of  $7x + 6y$  subject to the constraints:

$$x + y \geq 2 \quad (2.1)$$

$$2x + 3y \leq 6 \quad (2.2)$$

$$x \geq 0 \text{ and } y \geq 0 \quad (2.3)$$

3. A window is in the form of a rectangular mounted by a semi-circular opening. The total perimeter of the window to admit maximum light through the whole opening.
4. Divide the number 8 into two positive numbers such that the sum of the cube of one and the square of the other is maximum.
5. Find the maximum and the minimum values of

$$z = 5x + 2y \quad (5.1)$$

subject to the constraints:

$$-2x - 3y \leq -6 \quad (5.2)$$

$$x - 2y \leq 2 \quad (5.3)$$

$$6x + 4y \leq 24 \quad (5.4)$$

$$-3x + 2y \leq 3 \quad (5.5)$$

$$x \geq 0, y \geq 0 \quad (5.6)$$

6. A furniture dealer deals in only two items : chairs and tables. He has ₹ 5,000 to invest and a space to store at most 60 pieces. A table costs him ₹ 250 and a chair ₹ 50. He sells a table at a profit of ₹ 50 and a chair at a profit of ₹ 15. Assuming that he can sell all the items he buys, how should he invest his money in order that he may maximize his profit ? Formulate the above as a linear programming problem.

7. The least value of the function

$$f(x) = 2 \cos(x) + x \quad (7.1)$$

in the closed interval  $\left[0, \frac{\pi}{2}\right]$  is:

- (a) 2
- (b)  $\frac{\pi}{6} + \sqrt{3}$
- (c)  $\frac{\pi}{2}$
- (d) The least value does not exist.

8. A linear programming problem is as follows: Minimize

$$Z = 30x + 50y \quad (8.1)$$

subject to the constraints,

$$3x + 5y \geq 15 \quad (8.2)$$

$$2x + 3y \leq 18 \quad (8.3)$$

$$x \geq 0, y \geq 0 \quad (8.4)$$

In the feasible region, the minimum value of  $Z$  occurs at

- (a) a unique point
- (b) no point
- (c) infinitely many points
- (d) two points only

9. The area of a trapezium is defined by function  $f$  and given by

$$f(x) = (10 + x)\sqrt{100 - x^2} \quad (9.1)$$

, then the area when it is maximised is:

- (a)  $75cm^2$
- (b)  $7\sqrt{3}cm^2$
- (c)  $75\sqrt{3}cm^2$
- (d)  $5cm^2$

10. For an objective function

$$Z = ax + by \quad (10.1)$$

, where  $a, b > 0$ ; the corner points of the feasible region determined by a set of constraints (linear inequalities) are  $(0, 20)$ ,  $(10, 10)$ ,  $(30, 30)$ , and  $(0, 40)$ . The condition on  $a$  and  $b$  such that the maximum  $Z$  occurs at the points  $(30, 30)$  and  $(0, 40)$  is:

- (a)  $b - 3a = 0$
- (b)  $a = 3b$
- (c)  $a + 2b = 0$
- (d)  $2a - b = 0$

11. In a linear programming problem, the constraints on the decision variables  $x$  and  $y$  are  $x - 3y \geq 0, y \geq 0, 0 \leq x \leq 3$ . The feasible region

- (a) is not in the first quadrant
- (b) is bounded in the first quadrant
- (c) is unbounded in the first quadrant
- (d) does not exist

12. Based on the given shaded region in figure 12.1 as the feasible region in the graph, at which point(S) is the objective function

$$Z = 3x + 9y \quad (12.1)$$

maximum?

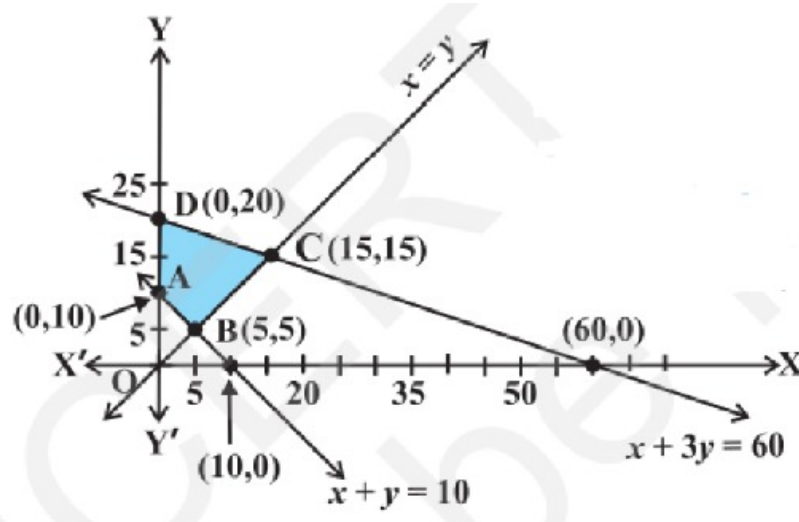


Figure 12.1: Optimization graph

- (a) point  $B$
- (b) point  $C$
- (c) point  $D$



(d) every point on the line segment  $CD$

13. In figure 13.1, the feasible region for a LPP is shaded. The objective function

$$Z = 2x - 3y \quad (13.1)$$

, will be minimum at:

(a)  $(4, 10)$

(b)  $(6, 8)$

(c)  $(0, 8)$

(d)  $(6, 5)$

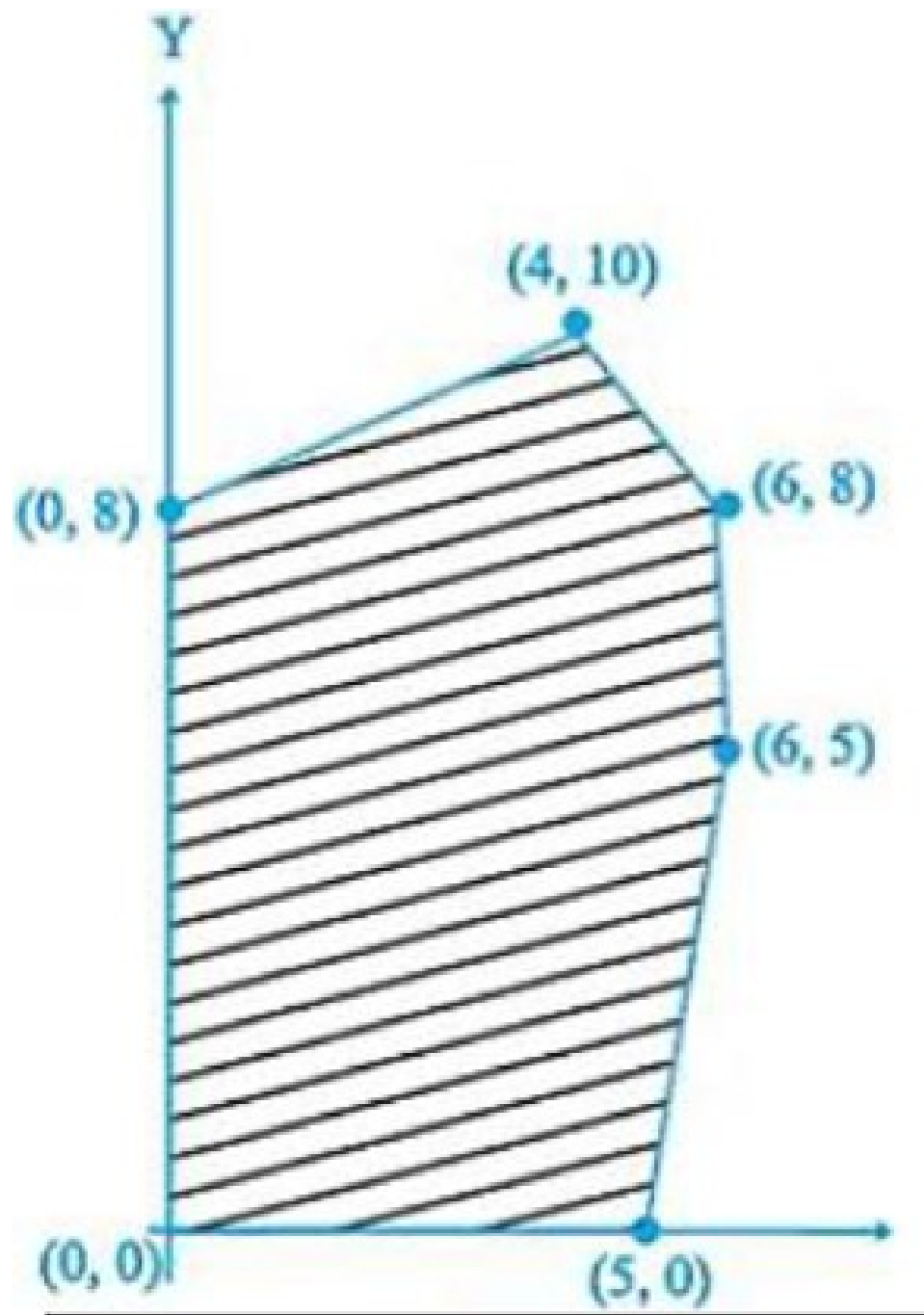


Figure 13.1: Optimization graph



## Chapter 8

# Algebra

## 8.1. 2023

### 8.1.1. 10

1. If one zero of the polynomial

$$p(x) = 6x^2 + 37x - (k - 2) \tag{1.1}$$

is reciprocal of the other, then find the value of  $k$ ?

2. Find the value of ' $p$ ' for which one root of the quadratic equation

$$px^2 - 14x + 18 = 0 \tag{2.1}$$

is 6 times the other?

3. (a) prove that

$$\frac{\sin A - 2 \sin^3 A}{2 \cos^3 A - \cos A} = \tan A \tag{3.1}$$

(b)

$$\sec A(1 - \sin A)(\sec A + \tan A) = 1 \quad (3.2)$$

4. Which of the following quadratic equations has sum of its roots as 4?

(a)  $2x^2 - 4x + 8 = 0$

(b)  $-x^2 + 4x + 4 = 0$

(c)  $\sqrt{2x^2} - \frac{4}{\sqrt{2}}x + 1 = 0$

(d)  $4x^2 - 4x + 4 = 0$

5. if one zero of the polynomial

$$6x^2 + 37x - (k - 2) \quad (5.1)$$

is reciprocal of the other, then what is the value of  $k$ ?

(a) -4

(b) -6

(c) 6

(d) 4

6. The zeroes of the polynomial

$$p(x) = x^2 + 4x + 3 \quad (6.1)$$

are given by:

- (a) 1,3
- (b) -1,3
- (c) 1,-3
- (d) -1,-3

7. If  $\alpha$  and  $\beta$  are the zeroes of the quadratic polynomial  $p(x) = x^2 - ax - b$ , then the value of  $\alpha^2 + \beta^2$  is:

- (a)  $a^2 - 2b$
- (b)  $a^2 + 2b$
- (c)  $b^2 - 2a$
- (d)  $b^2 + 2a$

8. The below is the Assertion and Reason based question. Two statements are given, one labelled as Assertion(A) and the other is labelled as Reason(R). Select the correct answer to these questions from the codes (a),(b),(c) and (d) as given below.

- (a) Both Assertion(A) and Reason(R) are true and Reason(R) is the correct explanation of the Assertion(A).
- (b) Both Assertion(A) and Reason(R) are true, but Reason(R) is not the correct explanation of the Assertion(A).
- (c) Assertion(A) is true, but Reason(R) is false.
- (d) Assertion(A) is false, but Reason(R) is true.

**Assertion(A):** The polynomial  $p(x) = x^2 + 3x + 3$  has two real zeroes.

**Reason(R):** A quadratic polynomial can have at most two real zeroes.

9. (a) If

$$4 \cot^2 45^\circ - \sec^2 60^\circ + \sin^2 60^\circ + p = \frac{3}{4}, \quad (9.1)$$

then find the value of  $p$ .

(b) If

$$\cos A + \cos^2 A = 1, \quad (9.2)$$

then find the value of

$$\sin^2 A + \sin^4 A. \quad (9.3)$$

10. Prove that:

$$\left( \frac{1}{\cos \theta} - \cos \theta \right) \left( \frac{1}{\sin \theta} - \sin \theta \right) = \frac{1}{\tan \theta + \cot \theta} \quad (10.1)$$

11. The value of  $k$  for which the pair of equations  $kx = y+2$  and  $6x = 2y+3$  has infinitely many solutions,

(a) is  $k = 3$

(b) does not exist

(c) is  $k = -3$

(d) is  $k = 4$

12. If  $2 \tan A = 3$ , then the value of  $\frac{4 \sin A + 3 \cos A}{4 \sin A - 3 \cos A}$  is

(a)  $\frac{7}{\sqrt{13}}$

(b)  $\frac{1}{\sqrt{13}}$

(c) 3

(d) does not exist

13. If  $\alpha, \beta$  are the zeroes of a polynomial  $p(x) = x^2 + x - 1$ , then  $\frac{1}{\alpha} + \frac{1}{\beta}$  equals to

(a) 1

(b) 2

(c) -1

(d)  $-\frac{1}{2}$

14.  $(\sec^2 \theta - 1)(\csc^2 \theta - 1)$  is equal to:

(a) -1

(b) 1

(c) 0

(d) 2

15. The roots of equation

$$x^2 + 3x - 10 = 0 \quad (15.1)$$

are:



(a)  $(2, -5)$

(b)  $(-2, 5)$

(c)  $(2, 5)$

(d)  $(-2, -5)$

16. If  $\alpha$  ,  $\beta$  are zeroes of the polynomial  $x^2 - 1$ , then value of  $(\alpha + \beta)$  is:

(a) 2

(b) 1

(c) 1

(d) 0

17. If  $\alpha, \beta$  are the zeroes of the polynomial

$$p(x) = 4x^2 - 3x - 7 \quad (17.1)$$

,then  $\left(\frac{1}{\alpha} + \frac{1}{\beta}\right)$  is equal to:

(a)  $\frac{7}{3}$

(b)  $\frac{-7}{3}$

(c)  $\frac{3}{7}$

(d)  $\frac{-3}{7}$

18. Find the sum and product of the roots of the quadratic equation

$$2x^2 - 9x + 4 = 0 \quad (18.1)$$

19. Find the discriminant of the quadratic equation

$$4x^2 - 5 = 0 \quad (19.1)$$

and hence comment on the nature of roots of the equation.

20. Evaluate  $2 \sec^2 \theta + 3 \csc^2 \theta - 2 \sin \theta \cos \theta$  if

$$\theta = 45^\circ \quad (20.1)$$

21. If

$$\sin \theta - \cos \theta = 0 \tag{21.1}$$

,then find the value of  $\sin^4 \theta + \cos^4 \theta$ .

## Chapter 9

# Geometry

### 9.1. 2023

#### 9.1.1. 10

1. The hour-hand of a clock is 6 cm long. The angle swept by it between 7 : 20 a.m. and 7 : 55 a.m. is:

(a)  $\left(\frac{35}{4}\right)^\circ$

(b)  $\left(\frac{35}{2}\right)^\circ$

(c)  $35^\circ$

(d)  $70^\circ$

2. In the given Fig. 2.1,  $AB \parallel PQ$ . If  $AB = 6$  cm,  $PQ = 2$  cm and  $OB = 3$  cm, then the length of  $OP$  is:

(a) 9cm

(b) 3cm

(c) 4cm

(d) 1cm

3. The length of the shadow of a tower on the plane ground is  $\sqrt{3}$  times the height of the tower. Find the angle of elevation of the sun.
4. The angle of elevation of the top of a tower from a point on the ground which is 30 m away from the foot of the tower, is  $30^\circ$ . Find the height of the tower.
5. A car has two wipers which do not overlap. Each wiper has a blade of length 21 cm sweeping through an angle of  $120^\circ$ . Find the total area cleaned at each sweep of the two blades.
6. As observed from the top of a 75 m high lighthouse from the sea-level, the angles of depression of two ships are  $30^\circ$  and  $60^\circ$ . If one ship is exactly behind the other on the same side of the lighthouse, find the distance between two ships. (Use  $\sqrt{3} = 1.73$ )
7. From a point on the ground, the angle of elevation of the bottom and top of a transmission tower fixed at the top of 30 m high building are  $30^\circ$  and  $60^\circ$ , respectively. Find the height of the transmission tower. (Use  $\sqrt{3} = 1.73$ )
8. Sides  $AB$  and  $BC$  and median  $AD$  of a triangle  $ABC$  are respectively proportional to sides  $PQ$  and  $QR$  and median  $PM$  of  $\triangle PQR$ . Show that  $\triangle ABC \sim \triangle PQR$ .
9. Through the mid-point  $M$  of the side  $CD$  of a parallelogram  $ABCD$ , the line  $BM$  is drawn intersecting  $AC$  in  $L$  and  $AD$  (produced) in  $E$ . Prove

that

$$EL = 2BL. \quad (9.1)$$

10. In an annual day function of a school, the organizers wanted to give a cash prize along with a memento to their best students. Each memento is made as shown in the Fig. 10.1 and its base  $ABCD$  is shown from the front side. The rate of silver plating is ₹ 20 *per*  $cm^2$ .

Based on the above, answer the following questions:

- (i) What is the area of the quadrant  $ODCO$ ?
  - (ii) Find the area of  $\triangle AOB$ .
  - (iii) What is the total cost of silver plating the shaded part  $ABCD$ ?
  - (iv) what is the length of arc  $CD$ ?
11. What is the length of the arc of the sector of a circle with radius 14 cm and of central angle  $90^\circ$ .
- (a) 22 cm
  - (b) 44 cm
  - (c) 88 cm
  - (d) 11 cm
12. if  $\triangle ABC \sim \triangle PQR$  with  $\angle A = 32^\circ$  and  $\angle R = 65^\circ$ , then the measure of  $\angle B$  is:

- (a)  $32^\circ$
- (b)  $65^\circ$
- (c)  $83^\circ$
- (d)  $97^\circ$

13. What is the total surface area of a solid hemisphere of diameter ' $d$ '?

- (a)  $3\pi d^2$
- (b)  $2\pi d^2$
- (c)  $\frac{1}{2}\pi d^2$
- (d)  $\frac{3}{4}\pi d^2$

14. In  $\triangle ABC$ ,  $DE \parallel BC$ .if  $AD = 2$  units, $DB = AE = 3$  units and  $EC = x$  units,then the value of  $x$  is :

- (a) 2
- (b) 3
- (c) 5
- (d)  $\frac{9}{2}$

15. A straight highway leads to the foot of a tower.A man standing on the top of the 75 m high tower observes two cars at angles of depression of  $30^\circ$  and  $60^\circ$ ,Which are approaching the foot of the tower.If one car is exactly behind the other on the same side of the tower,find the distance between the two cars.

16. From the top of a 7 m high building, the angle of elevation of the top of a cable tower is  $60^\circ$  and the angle of depression of its foot is  $30^\circ$ . Determine the height of the tower. (take  $\sqrt{3} = 1.73$ )
17. Governing council of local public development authority of Dehradun decided to build an adventurous playground on the top of a hill, which will have adequate space for parking. After survey, it was decided to build a rectangular playground, with a semi-circular area allocated for parking at one end of the playground. The length and breadth of the rectangular playground are 14 units and 7 units, respectively. There are two quadrants of radius 2 units on one side for special seats:
- What is the total perimeter of the parking area?
  - What is the total area of parking and the two quadrants?
  - What is the ratio of area of playground to the area of parking area?
  - Find the cost of fencing the playground and parking area at the rate of ₹2 per unit.
18. What is the total surface area of a solid hemisphere of diameter ' $d$ '?
- $3\pi d^2$
  - $2\pi d^2$
  - $\frac{1}{2}\pi d^2$
  - $\frac{3}{4}\pi d^2$



19. In the given Fig. 13.1,  $DE \parallel BC$ . If  $AD=2$  units,  $DB = AE = 3$  units and  $EC = x$  units, then the value of  $x$  is:

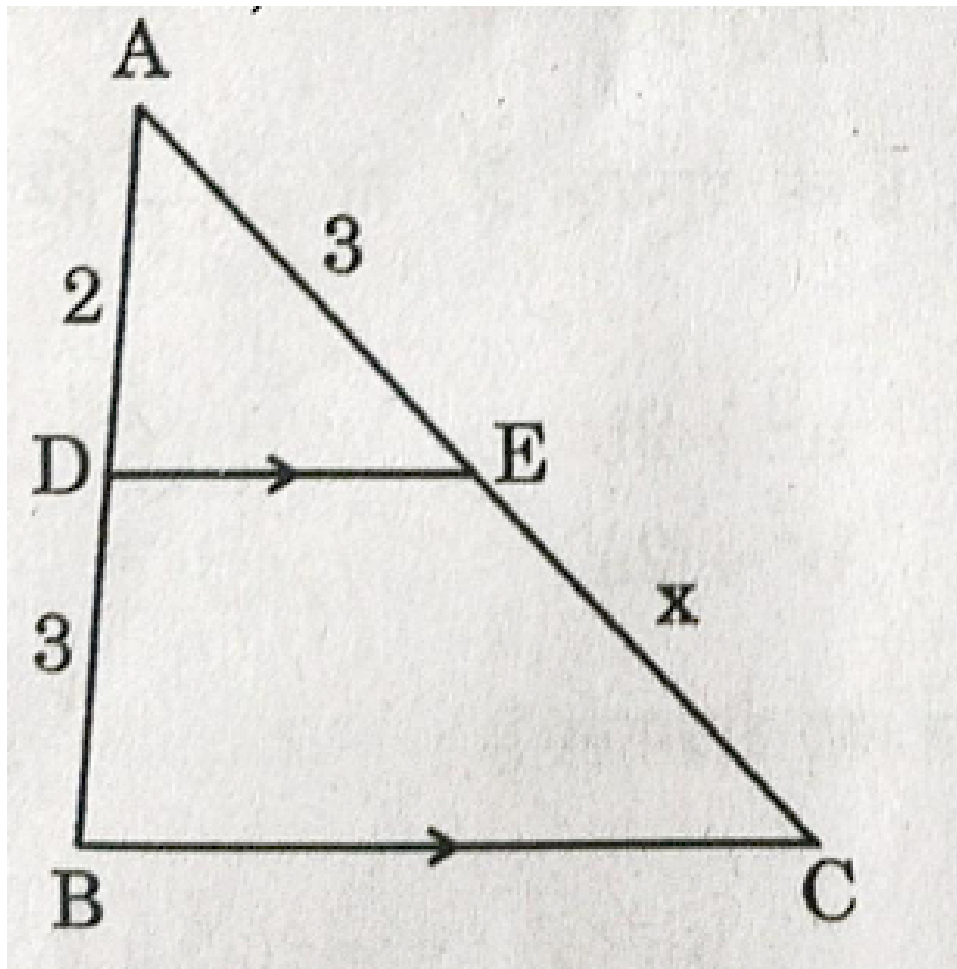


Figure 19.1:

- (a) 2
- (b) 3
- (c) 5
- (d)  $\frac{9}{2}$

20. In the given Fig. 17.1,  $XZ$  is parallel to  $BC$ .  $AZ = 3$  cm,  $ZC = 2$  cm,  $BM = 3$  cm, and  $MC = 5$  cm. Find the length of  $XY$ .

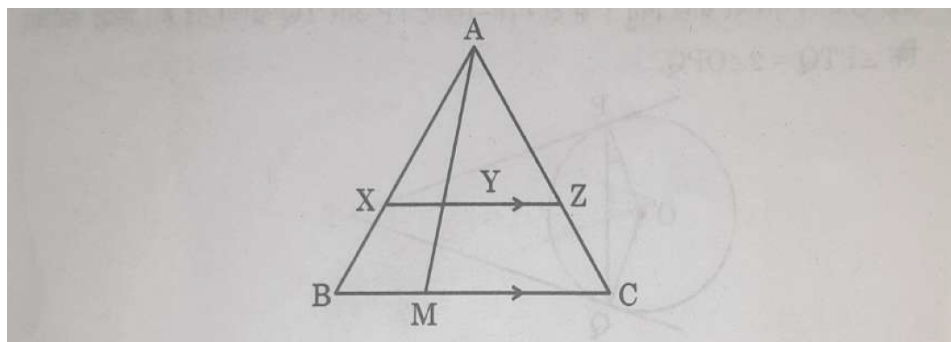


Figure 20.1:

21. A room is in the form of a cylinder surmounted by a hemi-spherical dome. The base radius of hemisphere is one-half the height of cylindrical part. Find total height of the room if it contains  $\left(\frac{1408}{21}\right) m^3$  of air. Take  $\left(\pi = \frac{22}{7}\right)$
22. In the given Fig. ??, An empty cone is of radius 3 cm and height 12 cm. Ice-cream is filled so that lower part of the cone which is  $\left(\frac{1}{6}\right)$ th of the volume of the cone is unfilled but hemisphere is formed on the top. Find volume of the ice-cream. Take  $(\pi = 3.14)$

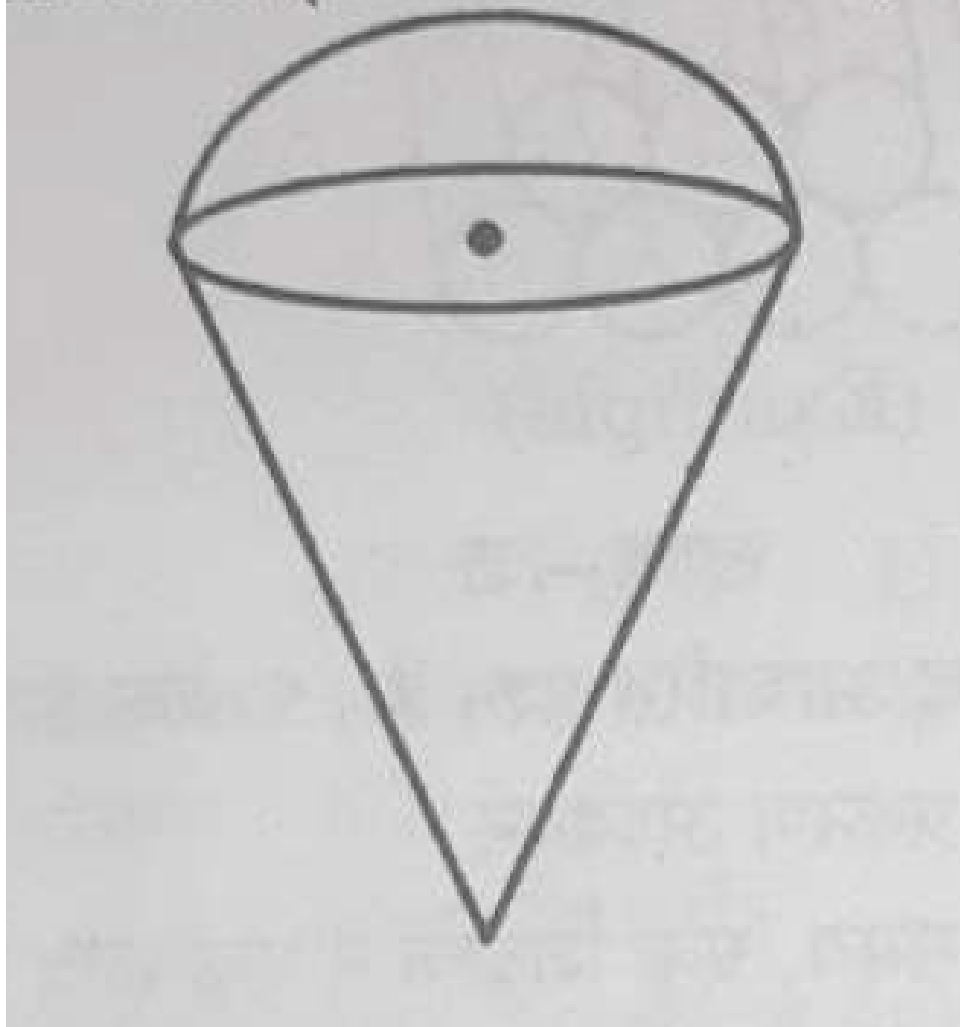
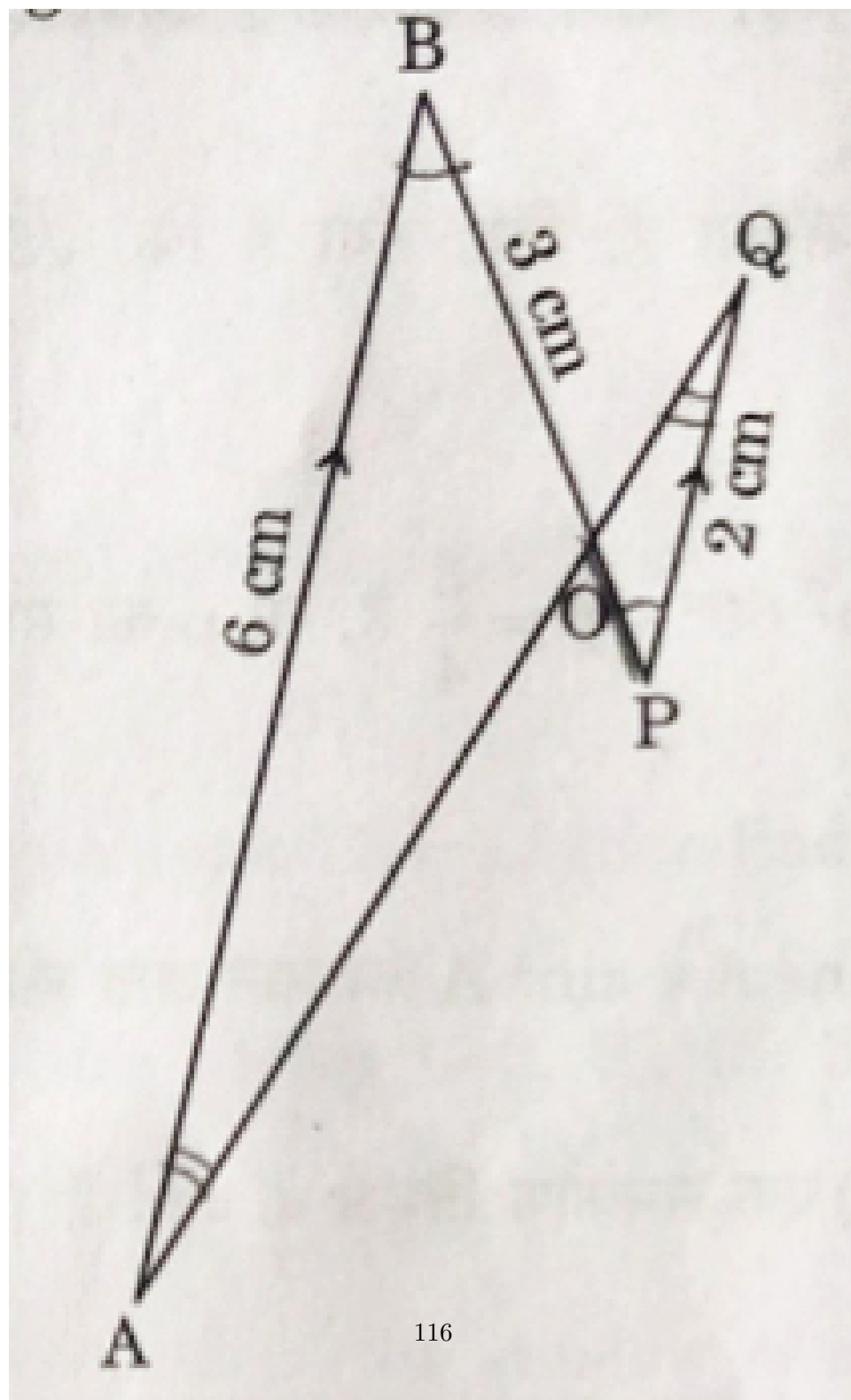


Figure 22.1:

23. If a line is drawn parallel to one side of a triangle to intersect the other two sides at distinct points, prove that the other two sides are divided in the same ratio.
24. The angle of elevation of the top of a tower 24 m high from the foot of

another tower in the same plane is  $60^\circ$ . The angle of elevation of the top of second tower from the foot of the first tower is  $30^\circ$ . Find the distance between two towers and the height of the other tower. Also, find the length of the wire attached to the tops of both the towers.

25. A spherical balloon of radius  $r$  subtends an angle of  $60^\circ$  at the eye of an observer. If the angle of elevation of its centre is  $45^\circ$  from the same point, then prove that height of the centre of the balloon is  $\sqrt{2}$  times its radius.
26. A chord of a circle of radius 14 cm subtends an angle of  $60^\circ$  at the centre. Find the area of the corresponding minor segment of the circle. Also find the area of the major segment of the circle.



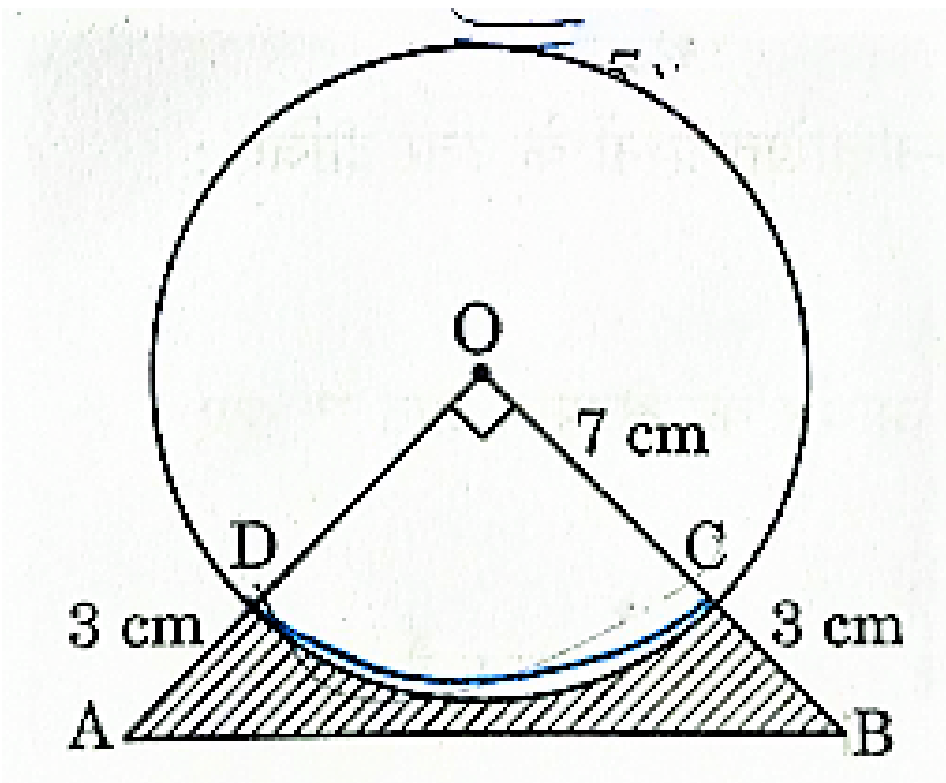


Figure 10.1: memento

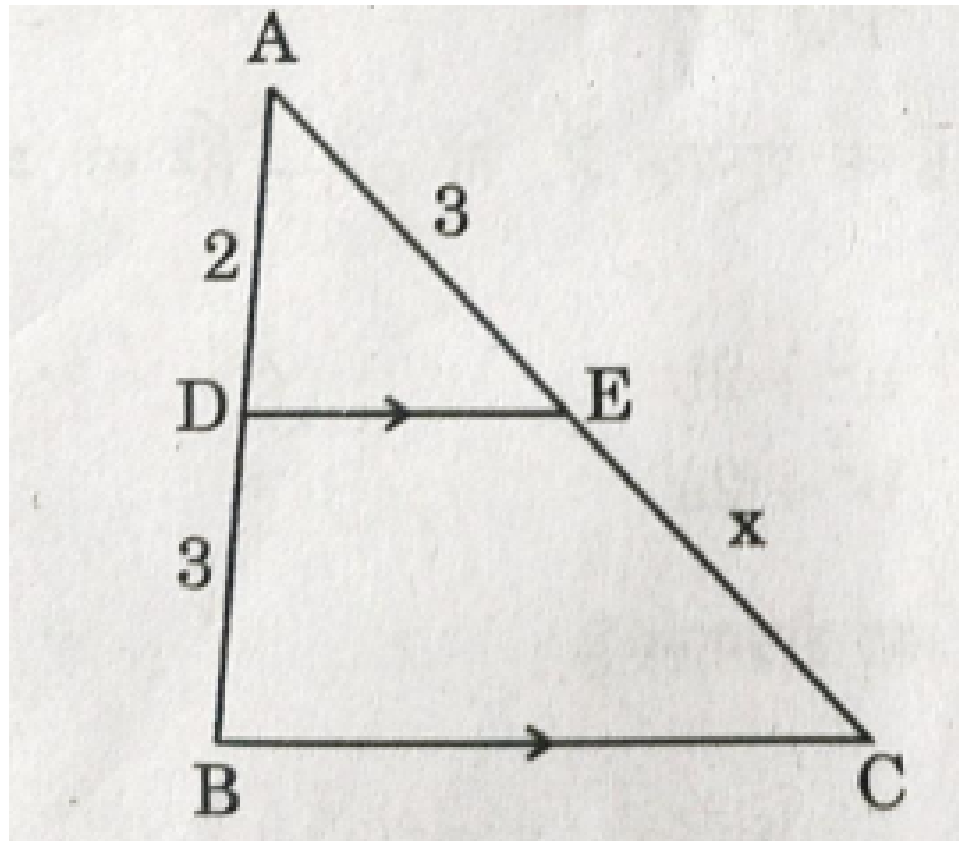


Figure 14.1:  $\triangle ABC$

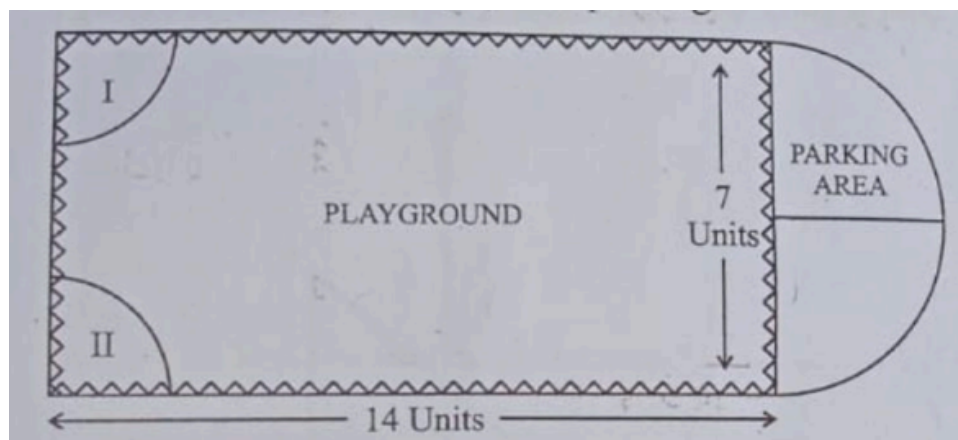


Figure 17.1: Playground

## Chapter 10

# Discrete

### 10.1. 2023

#### 10.1.1. 10

1. The ratio of HCF to LCM of the least composite number and the least prime number is :

(a)  $1 : 2$

(b)  $2 : 1$

(c)  $1 : 1$

(d)  $1 : 3$

2. The next term of the A.P.:  $\sqrt{7}$ ,  $\sqrt{28}$ ,  $\sqrt{63}$  is :

(a)  $\sqrt{70}$

(b)  $\sqrt{80}$

(c)  $\sqrt{97}$

(d)  $\sqrt{112}$



3. Two numbers are in the ratio 2 : 3 and their LCM is 180. what is the HCF of these numbers ?
4. How many terms are there in A.P whose first and fifth term are - 14 and 2, respectively and the last term is 62.
5. Which term of the A.P.:65, 61, 57, 53, ..... is the first negative term ?
6. Prove that  $\sqrt{5}$  is an irrational number.
7. If  $p$  and  $q$  are natural numbers and  $p$  is the multiple of  $q$ , then what is the HCF of  $p$  and  $q$  ?
  - (a)  $pq$
  - (b)  $p$
  - (c)  $q$
  - (d)  $p + q$
8. Prove that  $2 + \sqrt{3}$  is an irrational number, given that  $\sqrt{3}$  is an irrational number.
9. Find by prime factorisation the LCM of the numbers 18180 and 7575. Also, find the HCF of the two numbers
10. Three bells ring at intervals of 6, 12 and 18 minutes. If all the three bells rang at 6 a.m., when will they ring together again ?
11. How many terms of the arithmetic progression 45, 39, 33, ..... must be taken so that their sum is 180 ? Explain the double answer.

12. If  $p - 1$ ,  $p + 1$  and  $2p + 3$  are in A.P., then the value of  $p$  is

(a)  $-2$

(b)  $4$

(c)  $0$

(d)  $2$

13. Assertion (A): The perimeter of  $\triangle ABC$  is a rational number.

Reason (R): The sum of the squares of two rational numbers is always rational.

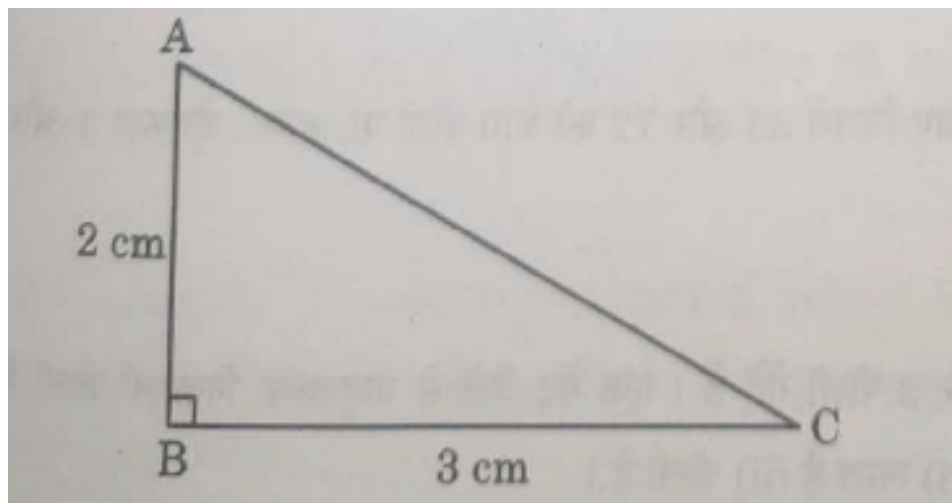


Figure 13.1:  $\triangle ABC$

14. Find the greatest number which divides 85 and 72 leaving remainders 1 and 2 respectively.

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

16. The ratio of the 11<sup>th</sup> term to 17<sup>th</sup> term of an A.P. is 3 : 4. Find the ratio of 5<sup>th</sup> to 21<sup>th</sup> of the same A.P. Also, find the ratio of the sum of first 5 terms to that of first 21 terms
17. 250 logs are stacked in the following manner:  
22 logs in the bottom row , 21 in the next row, 20 in the row next to it and so on(as shown by an example). In how many, are the 250 logs placed and how many logs are there in top row ?

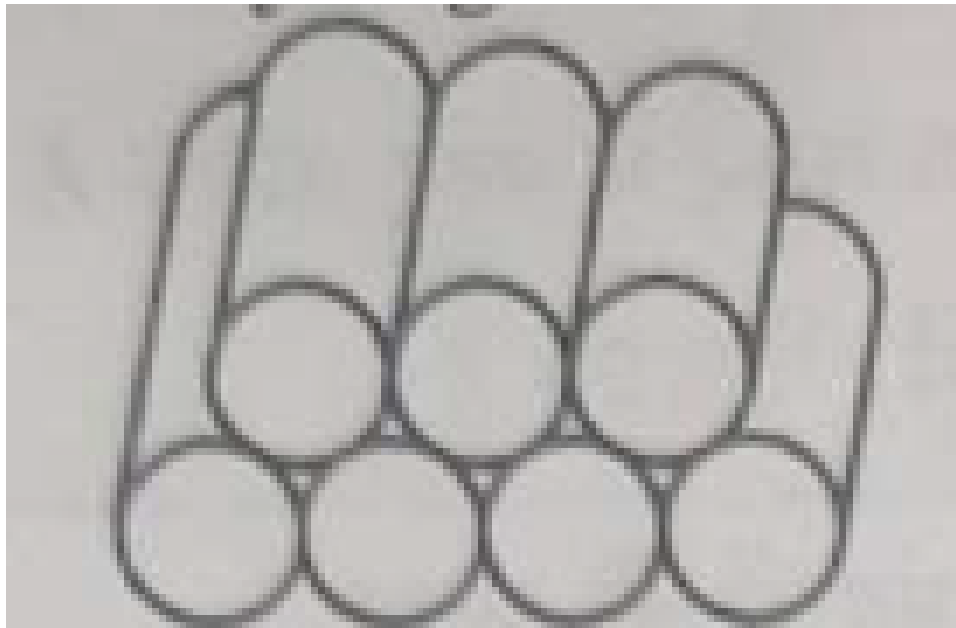


Figure 17.1: Pile of logs

## Chapter 11

# Differentiation

### 11.1. 2023

#### 11.1.1. 12

1. If  $\tan\left(\frac{x+y}{x-y}\right) = k$ , then  $\frac{dy}{dx}$  is equal to

(a)  $-\frac{y}{x}$

(b)  $\frac{y}{x}$

(c)  $\sec^2\left(\frac{y}{x}\right)$

(d)  $-\sec^2\left(\frac{y}{x}\right)$

2. **Assertion(A)** :Maximum value of  $(\cos^{-1})^2$  is  $\pi^2$ .

**Reason(R)**:Range of the principle value branch of  $\cos^{-1} x$  is  $\left[\frac{\pi}{2}, \frac{\pi}{2}\right]$ .

3. If  $y = \sqrt{ax + b}$ , prove that  $y \left(\frac{d^2y}{dx^2}\right) + \left(\frac{dy}{dx}\right)^2 = 0$

4. If the circumference of circle is increasing at the constant rate, prove that rate of change of area of circle is directly proportional to its radius.

5. Engine displacement is the measure of the cylinder volume swept by all the pistons of a piston engine. The piston moves inside the cylinder bore



Figure 5.1:

The cylinder bore in the form of circular cylinder open at the top is to be made from a metal sheet of area  $75\pi \text{ cm}^2$ .

Based on the above information , answer the following questions:

- (i) If the radius of cylinder is  $r$  cm and height is  $h$  cm, then write the volume  $V$  of cylinder in terms of radius  $r$ .
- (ii) Find  $\frac{dv}{dr}$
- (iii) (a) Find the radius of cylinder when its volume is maximum.  
(b) For maximum volume,  $h > r$ . State true or false and justify.

6. The use of electric vehicles will curb air pollution in the long run.

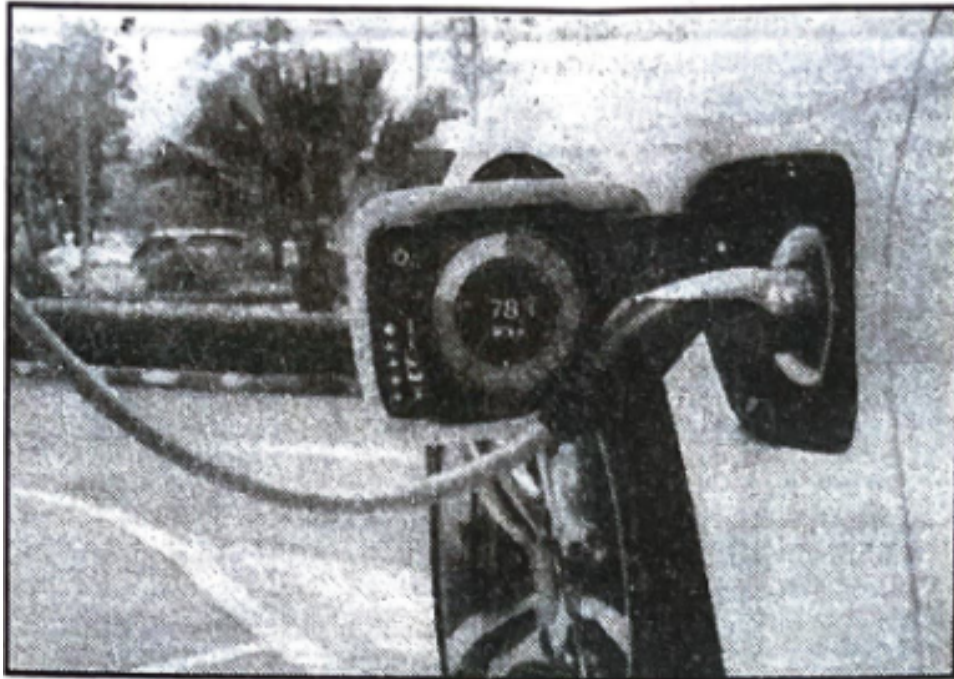


Figure 6.1:

The use of electric vehicles is increasing every year and estimated electric vehicles in use at any time  $t$  is given by the function  $V$  :

$$V(t) = \frac{1}{5}t^3 - \frac{5}{2}t^2 + 25t - 2 \quad (6.1)$$

Where  $t$  represents the time and  $t=1,2,3, \dots$  corresponds to year 2001,2002,2003. . . respectively. Based on the above information, answer the following questions :

- (i) Can the above function be used to estimate number of vehicles in the

year 2000 ? Justify.

(ii) Prove that the function  $V(t)$  is an increasing function.

## Chapter 12

# Integration

## 12.1. 2023

### 12.1.1. 12

1. If

$$\frac{d}{dx}(f(x)) = 2x + \frac{3}{x} \quad (1.1)$$

and  $f(1) = 1$ , then  $f(x)$  is

(a)  $x^2 + 3 \log |x| + 1$

(b)  $x^2 + 3 \log |x|$

(c)  $2 - \frac{3}{x^2}$

(d)  $x^2 + 3 \log |x| - 4$

2. The integral factor of the differential equation

$$(1 - y^2) \frac{dx}{dy} + yx = ay, (-1 < y < 1) \quad (2.1)$$



is

(a)  $\frac{1}{y^2-1}$

(b)  $\frac{1}{\sqrt{y^2-1}}$

(c)  $\frac{1}{1-y^2}$

(d)  $\frac{1}{\sqrt{1-y^2}}$

3. Anti derivative of  $\frac{\tan(x)-1}{\tan(x)+1}$  with respect to  $x$  is:

(a)  $\sec^2(\frac{\pi}{4} - x) + c$

(b)  $-\sec^2(\frac{\pi}{4} - x) + c$

(c)  $\log |\sec(\frac{\pi}{4} - x)| + c$

(d)  $-\log |\sec(\frac{\pi}{4} - x)| + c$

4. Evaluate  $\int_{\log \sqrt{2}}^{\log \sqrt{3}} \left( \frac{1}{(e^x + e^{-x})(e^x - e^{-x})} \right) dx$

5. (a) Find the general solution of the differential equation:

$$(xy - x^2) dy = y^2 dx \quad (5.1)$$

(b) Find the general solution of the differential equation:

$$(x^2 + 1) \frac{dy}{dx} + 2xy = \sqrt{x^2 + 4} \quad (5.2)$$

6. (a) Evaluate  $\int_{-1}^1 |x^4 - x| dx$

(b) Find  $\int e^x \left( \frac{\sin^{-1} x}{(1-x^2)^{\frac{3}{2}}} \right) dx$

7. Find  $\int e^x \left( \frac{1 - \sin x}{1 - \cos x} \right) dx$

## Chapter 13

# Functions

## 13.1. 2023

### 13.1.1. 12

1. The function  $f(x) = x|x|$  is
  - (a) continuous and differentiable at  $x = 0$ .
  - (b) continuous but not differentiable at  $x = 0$ .
  - (c) differentiable but not continuous at  $x = 0$ .
  - (d) neither differentiable nor continuous at  $x = 0$ .

2. If

$$f(x) = \begin{cases} ax + b & 0 < x \leq 1 \\ 2x^2 - x & 1 < x < 2 \end{cases} \quad (2.1)$$

is a differentiable function is  $(0,2)$ , then find the values of  $a$  and  $b$ .

3. A function  $f : [-4, 4] \rightarrow [0, 4]$  is given by  $f(x) = \sqrt{16 - x^2}$ . Show that  $f$  is an onto function but not a one-one function. Further, find all possible values of 'a' for which  $f(a) = \sqrt{7}$ .



## Chapter 14

# Matrices

### 14.1. 2023

#### 14.1.1. 10

1. The pair of linear equations  $2x = 5y + 6$  and  $15y = 6x - 18$  represents two lines which are :
  - (a) intersecting
  - (b) parallel
  - (c) coincident
  - (d) either intersecting or parallel
  
2. Two schools  $P$  and  $Q$  decided to award prizes to their students for two games of Hockey ₹ $x$  per students and cricket ₹ $y$  per student. School  $P$  decided to award a total of ₹9,500 for the two games to 5 and 4 students respectively; while school  $Q$  decided to award ₹7,370 for the two games to 4 and 3 students respectively.



Figure 2.1: trophies

Based on the given information, answer the following questions :

- (i) Represent the following information algebraically (in terms of  $x$  and  $y$ ).
- (ii) (a) what is the prize amount for hockey ?  
(b) Prize amount on which game is more and by how much ?
- (iii) what will be the total prize amount if there are 2 students each

from two games ?

3. If the pair of equations  $3x - y + 8 = 0$  and  $6x - ry + 16 = 0$  represents coincident lines, then the values of  $r$  is :

(a)  $-\frac{1}{2}$

(b)  $\frac{1}{2}$

(c) 2

(d)  $-2$

4. The pair of equations  $x = a$  and  $y = b$  graphically represents lines which are :

(a) parallel

(b) intersecting at  $(b, a)$

(c) coincident

(d) intersecting at  $(a, b)$

5. (a) If the system of linear equations  $2x + 3y = 7$  and  $2ax + (a + b)y = 28$  have infinite number of solutions, then find the values of  $a$  and  $b$ .

(b) If  $217x + 131y = 913$  and  $131x + 217y = 827$ , then solve the equations for the values of  $x$  and  $y$ .

6. Half of the difference between two numbers is 2. The sum of the greater number and twice the smaller number is 3. Find the numbers.

### 14.1.2. 12

1. If  $(a, b), (c, d)$  and  $(e, f)$  are the vertices of  $\triangle ABC$  and  $\Delta$  denotes the area of  $\triangle ABC$ , then

$$\begin{vmatrix} a & c & e \\ b & d & f \\ 1 & 1 & 1 \end{vmatrix}^2 \quad (1.1)$$

is equal to

- (a)  $2\Delta^2$   
(b)  $4\Delta^2$   
(c)  $2\Delta$   
(d)  $2\Delta$
2. If  $\begin{pmatrix} 2 & 0 \\ 5 & 4 \end{pmatrix} = P + Q$  is a symmetric and  $Q$  is a skew symmetric matrix, then  $Q$  is equal to

- (a)  $\begin{pmatrix} 2 & \frac{5}{2} \\ \frac{5}{2} & 4 \end{pmatrix}$   
(b)  $\begin{pmatrix} 0 & -\frac{5}{2} \\ \frac{5}{2} & 0 \end{pmatrix}$   
(c)  $\begin{pmatrix} 0 & \frac{5}{2} \\ -\frac{5}{2} & 0 \end{pmatrix}$   
(d)  $\begin{pmatrix} 2 & -\frac{5}{2} \\ \frac{5}{2} & 4 \end{pmatrix}$

3. If  $\begin{pmatrix} 1 & 2 & 1 \\ 2 & 3 & 1 \\ 3 & a & 1 \end{pmatrix}$  is non-singular matrix and  $a \in \mathbb{R}$ , then the set  $A$  is

(a)  $\mathbb{R}$

(b)  $\{0\}$

(c)  $\{4\}$

(d)  $\mathbb{R} - \{4\}$

4. If  $|A| = |kA|$ , where  $A$  is a square matrix of order 2, then sum of all possible values of  $k$  is

(a) 1

(b) -1

(c) 2

(d) 0

5. (a) If  $A = \begin{pmatrix} -3 & -2 & -4 \\ 2 & 1 & 2 \\ 2 & 1 & 3 \end{pmatrix}$  and  $B = \begin{pmatrix} 1 & 2 & 0 \\ -2 & -1 & -2 \\ 0 & -1 & 1 \end{pmatrix}$ , then find  $AB$  and use it to solve the following system of equations :

$$x - 2y = 3 \quad (5.1)$$

$$2x - y - z = 2 \quad (5.2)$$

$$-2y + z = 3 \quad (5.3)$$



(b) If  $f(\alpha) = \begin{pmatrix} \cos \alpha & -\sin \alpha & 0 \\ \sin \alpha & \cos \alpha & 0 \\ 0 & 0 & 1 \end{pmatrix}$ , then prove that

$$f(\alpha) \cdot f(-\beta) = f(\alpha - \beta). \quad (5.4)$$