

## Chapter 11: Conic Sections Exercise 11.4

NCERT · Class 11 · Maths

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### Questions

#### Question 1

$$x^2/16 - y^2/9 = 1$$

#### Solution

Given:

The equation is  $x^2/16 - y^2/9 = 1$  or  $x^2/4^2 - y^2/3^2 = 1$

On comparing this equation with the standard equation of hyperbola  $x^2/a^2 - y^2/b^2 = 1$ ,

We get  $a = 4$  and  $b = 3$ ,

It is known that  $a^2 + b^2 = c^2$

So,

$$c^2 = 4^2 + 3^2$$

$$= \sqrt{25}$$

$$c = 5$$

Then,

The coordinates of the foci are  $(\pm 5, 0)$ .

The coordinates of the vertices are  $(\pm 4, 0)$ .

Eccentricity,  $e = c/a = 5/4$

Length of latus rectum  $= 2b^2/a = (2 \times 3^2)/4 = (2 \times 9)/4 = 18/4 = 9/2$

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#### Question 2

$$y^2/9 - x^2/27 = 1$$

### Solution

Given:

The equation is  $y^2/9 - x^2/27 = 1$  or  $y^2/3^2 - x^2/27^2 = 1$

On comparing this equation with the standard equation of hyperbola  $y^2/a^2 - x^2/b^2 = 1$ ,

We get  $a = 3$  and  $b = \sqrt{27}$ ,

It is known that  $a^2 + b^2 = c^2$

So,

$$c^2 = 3^2 + (\sqrt{27})^2$$

$$= 9 + 27$$

$$c^2 = 36$$

$$c = \sqrt{36}$$

$$= 6$$

Then,

The coordinates of the foci are  $(0, 6)$  and  $(0, -6)$ .

The coordinates of the vertices are  $(0, 3)$  and  $(0, -3)$ .

Eccentricity,  $e = c/a = 6/3 = 2$

Length of latus rectum  $= 2b^2/a = (2 \times 27)/3 = (54)/3 = 18$

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### Question 3

$$9y^2 - 4x^2 = 36$$

### Solution

Given:

The equation is  $9y^2 - 4x^2 = 36$  or  $y^2/4 - x^2/9 = 1$  or  $y^2/2^2 - x^2/3^2 = 1$

On comparing this equation with the standard equation of hyperbola  $y^2/a^2 - x^2/b^2 = 1$ ,

We get  $a = 2$  and  $b = 3$ ,

It is known that  $a^2 + b^2 = c^2$

So,

$$c^2 = 4 + 9$$

$$c^2 = 13$$

$$c = \sqrt{13}$$

Then,

The coordinates of the foci are  $(0, \sqrt{13})$  and  $(0, -\sqrt{13})$ .

The coordinates of the vertices are  $(0, 2)$  and  $(0, -2)$ .

Eccentricity,  $e = c/a = \sqrt{13}/2$

Length of latus rectum  $= 2b^2/a = (2 \times 3^2)/2 = (2 \times 9)/2 = 18/2 = 9$

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#### Question 4

$$16x^2 - 9y^2 = 576$$

#### Solution

Given:

The equation is  $16x^2 - 9y^2 = 576$

Let us divide the whole equation by 576, we get

$$16x^2/576 - 9y^2/576 = 576/576$$

$$x^2/36 - y^2/64 = 1$$

On comparing this equation with the standard equation of hyperbola  $x^2/a^2 - y^2/b^2 = 1$ ,

We get  $a = 6$  and  $b = 8$ ,

It is known that  $a^2 + b^2 = c^2$

So,

$$c^2 = 36 + 64$$

$$c^2 = \sqrt{100}$$

$$c = 10$$

Then,

The coordinates of the foci are (10, 0) and (-10, 0).

The coordinates of the vertices are (6, 0) and (-6, 0).

Eccentricity,  $e = c/a = 10/6 = 5/3$

Length of latus rectum  $= 2b^2/a = (2 \times 8^2)/6 = (2 \times 64)/6 = 64/3$

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### Question 5

$$5y^2 - 9x^2 = 36$$

### Solution

Given:

The equation is  $5y^2 - 9x^2 = 36$

Let us divide the whole equation by 36. We get

$$5y^2/36 - 9x^2/36 = 36/36$$

$$y^2/(36/5) - x^2/4 = 1$$

On comparing this equation with the standard equation of hyperbola  $y^2/a^2 - x^2/b^2 = 1$ ,

We get  $a = 6/\sqrt{5}$  and  $b = 2$ ,

It is known that  $a^2 + b^2 = c^2$

So,

$$c^2 = 36/5 + 4$$

$$c^2 = 56/5$$

$$c = \sqrt{(56/5)}$$

$$= 2\sqrt{14}/\sqrt{5}$$

Then,

The coordinates of the foci are  $(0, 2\sqrt{14}/\sqrt{5})$  and  $(0, -2\sqrt{14}/\sqrt{5})$ .

The coordinates of the vertices are  $(0, 6/\sqrt{5})$  and  $(0, -6/\sqrt{5})$ .

$$\text{Eccentricity, } e = c/a = (2\sqrt{14}/\sqrt{5}) / (6/\sqrt{5}) = \sqrt{14}/3$$

$$\text{Length of latus rectum} = 2b^2/a = (2 \times 2^2)/6/\sqrt{5} = (2 \times 4)/6/\sqrt{5} = 4\sqrt{5}/3$$

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### Question 6

$$49y^2 - 16x^2 = 784.$$

### Solution

Given:

$$\text{The equation is } 49y^2 - 16x^2 = 784.$$

Let us divide the whole equation by 784. We get

$$49y^2/784 - 16x^2/784 = 784/784$$

$$y^2/16 - x^2/49 = 1$$

On comparing this equation with the standard equation of hyperbola  $y^2/a^2 - x^2/b^2 = 1$ ,

We get  $a = 4$  and  $b = 7$ ,

$$\text{It is known that } a^2 + b^2 = c^2$$

So,

$$c^2 = 16 + 49$$

$$c^2 = 65$$

$$c = \sqrt{65}$$

Then,

The coordinates of the foci are  $(0, \sqrt{65})$  and  $(0, -\sqrt{65})$ .

The coordinates of the vertices are (0, 4) and (0, -4).

Eccentricity,  $e = c/a = \sqrt{65}/4$

Length of latus rectum  $= 2b^2/a = (2 \times 7^2)/4 = (2 \times 49)/4 = 49/2$

**In each Exercises 7 to 15, find the equations of the hyperbola satisfying the given conditions**

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### Question 7

**Vertices  $(\pm 2, 0)$ , foci  $(\pm 3, 0)$**

#### Solution

Given:

Vertices  $(\pm 2, 0)$  and foci  $(\pm 3, 0)$

Here, the vertices are on the x-axis.

So, the equation of the hyperbola is of the form  $x^2/a^2 - y^2/b^2 = 1$

Since, the vertices are  $(\pm 2, 0)$ , so,  $a = 2$

Since, the foci are  $(\pm 3, 0)$ , so,  $c = 3$

It is known that  $a^2 + b^2 = c^2$

So,  $2^2 + b^2 = 3^2$

$b^2 = 9 - 4 = 5$

$\therefore$  The equation of the hyperbola is  $x^2/4 - y^2/5 = 1$

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### Question 8

**Vertices  $(0, \pm 5)$ , foci  $(0, \pm 8)$**

#### Solution

Given:

Vertices  $(0, \pm 5)$  and foci  $(0, \pm 8)$

Here, the vertices are on the y-axis.

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So, the equation of the hyperbola is of the form  $y^2/a^2 - x^2/b^2 = 1$

Since the vertices are  $(0, \pm 5)$ ,  $a = 5$

Since the foci are  $(0, \pm 8)$ ,  $c = 8$

It is known that  $a^2 + b^2 = c^2$

$$\text{So, } 5^2 + b^2 = 8^2$$

$$b^2 = 64 - 25 = 39$$

$\therefore$  The equation of the hyperbola is  $y^2/25 - x^2/39 = 1$

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### Question 9

**Vertices  $(0, \pm 3)$ , foci  $(0, \pm 5)$**

#### Solution

Given:

Vertices  $(0, \pm 3)$  and foci  $(0, \pm 5)$

Here, the vertices are on the y-axis.

So, the equation of the hyperbola is of the form  $y^2/a^2 - x^2/b^2 = 1$

Since the vertices are  $(0, \pm 3)$ , so,  $a = 3$

Since the foci are  $(0, \pm 5)$ , so,  $c = 5$

It is known that  $a^2 + b^2 = c^2$

$$\text{So, } 3^2 + b^2 = 5^2$$

$$b^2 = 25 - 9 = 16$$

$\therefore$  The equation of the hyperbola is  $y^2/9 - x^2/16 = 1$

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### Question 10

**Foci  $(\pm 5, 0)$ , the transverse axis is of length 8.**

### Solution

Given:

Foci  $(\pm 5, 0)$  and the transverse axis is of length 8.

Here, the foci are on the x-axis.

The equation of the hyperbola is of the form  $x^2/a^2 - y^2/b^2 = 1$

Since, the foci are  $(\pm 5, 0)$ , so,  $c = 5$

Since the length of the transverse axis is 8,

$$2a = 8$$

$$a = 8/2$$

$$= 4$$

It is known that  $a^2 + b^2 = c^2$

$$4^2 + b^2 = 5^2$$

$$b^2 = 25 - 16$$

$$= 9$$

$\therefore$  The equation of the hyperbola is  $x^2/16 - y^2/9 = 1$

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### Question 11

Foci  $(0, \pm 13)$ , the conjugate axis is of length 24.

### Solution

Given:

Foci  $(0, \pm 13)$  and the conjugate axis is of length 24.

Here, the foci are on the y-axis.

The equation of the hyperbola is of the form  $y^2/a^2 - x^2/b^2 = 1$

Since the foci are  $(0, \pm 13)$ , so,  $c = 13$

Since the length of the conjugate axis is 24,

$$2b = 24$$

$$b = 24/2$$

$$= 12$$

It is known that  $a^2 + b^2 = c^2$

$$a^2 + 12^2 = 13^2$$

$$a^2 = 169 - 144$$

$$= 25$$

∴ The equation of the hyperbola is  $y^2/25 - x^2/144 = 1$

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### Question 12

Foci  $(\pm 3\sqrt{5}, 0)$ , the latus rectum is of length 8.

### Solution

Given:

Foci  $(\pm 3\sqrt{5}, 0)$  and the latus rectum is of length 8.

Here, the foci are on the x-axis.

The equation of the hyperbola is of the form  $x^2/a^2 - y^2/b^2 = 1$

Since, the foci are  $(\pm 3\sqrt{5}, 0)$ , so,  $c = \pm 3\sqrt{5}$

Length of the latus rectum is 8

$$2b^2/a = 8$$

$$2b^2 = 8a$$

$$b^2 = 8a/2$$

$$= 4a$$

It is known that  $a^2 + b^2 = c^2$

$$a^2 + 4a = 45$$

$$a^2 + 4a - 45 = 0$$

$$a^2 + 9a - 5a - 45 = 0$$

$$(a + 9)(a - 5) = 0$$

$$a = -9 \text{ or } 5$$

Since  $a$  is non-negative,  $a = 5$

$$\text{So, } b^2 = 4a$$

$$= 4 \times 5$$

$$= 20$$

$\therefore$  The equation of the hyperbola is  $x^2/25 - y^2/20 = 1$

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### Question 13

Foci  $(\pm 4, 0)$ , the latus rectum is of length 12

### Solution

Given:

Foci  $(\pm 4, 0)$  and the latus rectum is of length 12

Here, the foci are on the  $x$ -axis.

The equation of the hyperbola is of form  $x^2/a^2 - y^2/b^2 = 1$

Since, the foci are  $(\pm 4, 0)$ , so,  $c = 4$

Length of the latus rectum is 12

$$2b^2/a = 12$$

$$2b^2 = 12a$$

$$b^2 = 12a/2$$

$$= 6a$$

It is known that  $a^2 + b^2 = c^2$

$$a^2 + 6a = 16$$

$$a^2 + 6a - 16 = 0$$

$$a^2 + 8a - 2a - 16 = 0$$

$$(a + 8)(a - 2) = 0$$

$$a = -8 \text{ or } 2$$

Since  $a$  is non-negative,  $a = 2$

$$\text{So, } b^2 = 6a$$

$$= 6 \times 2$$

$$= 12$$

$\therefore$  The equation of the hyperbola is  $x^2/4 - y^2/12 = 1$

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### Question 14

Vertices  $(\pm 7, 0)$ ,  $e = 4/3$

### Solution

Given:

Vertices  $(\pm 7, 0)$  and  $e = 4/3$

Here, the vertices are on the  $x$ -axis

The equation of the hyperbola is of form  $x^2/a^2 - y^2/b^2 = 1$

Since, the vertices are  $(\pm 7, 0)$ , so,  $a = 7$

It is given that  $e = 4/3$

$$c/a = 4/3$$

$$3c = 4a$$

Substitute the value of  $a$ , and we get

$$3c = 4(7)$$

$$c = 28/3$$

It is known that  $a^2 + b^2 = c^2$

$$7^2 + b^2 = (28/3)^2$$

$$b^2 = 784/9 - 49$$

$$= (784 - 441)/9$$

$$= 343/9$$

∴ The equation of the hyperbola is  $x^2/49 - 9y^2/343 = 1$

### Question 15

**Foci  $(0, \pm\sqrt{10})$ , passing through  $(2, 3)$**

### Solution

Given:

Foci  $(0, \pm\sqrt{10})$  and passing through  $(2, 3)$

Here, the foci are on the y-axis.

The equation of the hyperbola is of the form  $y^2/a^2 - x^2/b^2 = 1$

Since, the foci are  $(\pm\sqrt{10}, 0)$ , so,  $c = \sqrt{10}$

It is known that  $a^2 + b^2 = c^2$

$$b^2 = 10 - a^2 \dots\dots\dots (1)$$

It is given that the hyperbola passes through points  $(2, 3)$

$$\text{So, } 9/a^2 - 4/b^2 = 1 \dots (2)$$

From equations (1) and (2), we get,

$$9/a^2 - 4/(10-a^2) = 1$$

$$9(10 - a^2) - 4a^2 = a^2(10 - a^2)$$

$$90 - 9a^2 - 4a^2 = 10a^2 - a^4$$

$$a^4 - 23a^2 + 90 = 0$$

$$a^4 - 18a^2 - 5a^2 + 90 = 0$$

$$a^2(a^2 - 18) - 5(a^2 - 18) = 0$$

$$(a^2 - 18)(a^2 - 5) = 0$$

$$a^2 = 18 \text{ or } 5$$

In hyperbola,  $c > a$  i.e.,  $c^2 > a^2$

$$\text{So, } a^2 = 5$$

$$b^2 = 10 - a^2$$

$$= 10 - 5$$

$$= 5$$

$\therefore$  The equation of the hyperbola is  $y^2/5 - x^2/5 = 1$

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