# 2 Polynomials

## Fastrack« Revision

- **Polynomial:** An expression of the form $p(x) = a_0x^n + a_1x^{n-1} + a_2x^{n-2} + ... + a_{n-1}x + a_n$, where $a_0 \neq 0$, is called a polynomial in the variable $x$ of degree $n$.

  Here, $a_0, a_1, a_2, ..., a_n$ are real numbers and each power of $x$ (*i.e.*, $n$) is a non-negative integer.

  For example, $13x + 5$, $19x^2 + 5x + 8$, $-23y^3 + 12y^2 + 8y + 6$, etc.
- **Degree of the Polynomial:** The highest power of $x$ in a polynomial $p(x)$ is called the degree of the polynomial.
- **Types of Polynomials:** Main types of polynomials are given below:
  1. **Constant Polynomial:** A polynomial of degree zero (0) is called constant polynomial and it is of the form $p(x) = k$, where $k$ is a constant.

     For example, $p(x) = 5$
  2. **Zero Polynomial:** Constant polynomial 0 is called the zero polynomial.

     For example, $p(x) = 0x^3 - 0x + 0$
  3. **Linear Polynomial:** A polynomial of degree 1 is called linear polynomial and it is of the form $p(x) = ax + b$, where $a$ and $b$ are real numbers and $a \neq 0$.

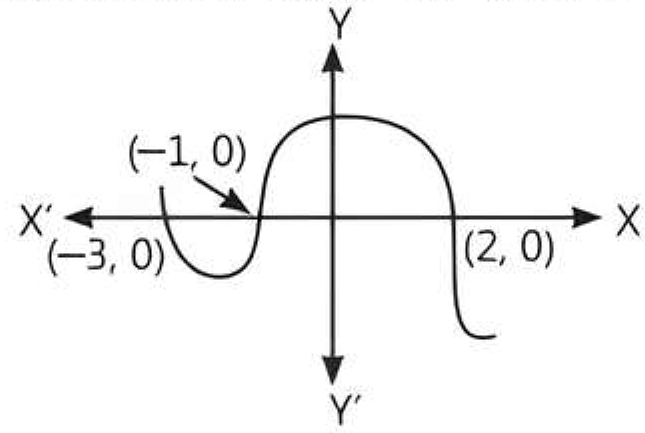
     For example, $p(x) = 5x + 3$
  4. **Quadratic Polynomial:** A polynomial of degree 2 is called quadratic polynomial and it is of the form $p(x) = ax^2 + bx + c$, where $a$, $b$ and $c$ are real numbers and $a \neq 0$.

     For example, $p(x) = 3x^2 + 4x - 6$
  5. **Cubic Polynomial:** A polynomial of degree 3 is called cubic polynomial and it is of the form $p(x) = ax^3 + bx^2 + cx + d$, where $a, b, c$ and $d$ are real numbers and $a \neq 0$.

     For example, $p(x) = 3x^3 + 5x^2 + 6x - 7$
  6. **Biquadratic Polynomial:** A polynomial of degree 4 is called biquadratic polynomial and it is of the form $p(x) = ax^4 + bx^3 + cx^2 + dx + e$, where $a, b, c, d$ and $e$ are real numbers and $a \neq 0$.

     For example, $p(x) = 5x^4 - 3x^3 + 4x^2 + 8x + 15$
- **Value of a Polynomial at a Given Point:** If $p(x)$ is a polynomial in $x$ and $\alpha$ is a real number, then the value obtained by putting $x = \alpha$ in $p(x)$ is called the value of $p(x)$ at $x = \alpha$.
- **Zero of a Polynomial:** A real number $\alpha$ is said to be a zero of a polynomial $p(x)$, if $p(\alpha) = 0$. Here, $(x - \alpha)$ is called the factor of the polynomial $p(x)$.
- **Geometrical Meaning of Zeroes of a Polynomial:** Whenever the curve intersect(s) the $X$-axis, the $x$-coordinate of that point(s) is/are the zeroes of the curve.

  *e.g.* Here zeroes of a curve are $-3$, $-1$ and 2.




### Knowledge BOOSTER

1. *A non-zero constant polynomial has no zero.*
2. *The degree of a zero polynomial is not defined.*
3. *A polynomial of degree 'n' can have atmost n zeroes. i.e., a quadratic polynomial can have atmost 2 zeroes and a cubic polynomial can have atmost 3 zeroes.*

- **Relationship between the Zeroes and the Coefficients of a Polynomial**
  1. A quadratic polynomial whose zeroes are $\alpha$ and $\beta$, is given by

     $p(x) = k[x^2 - (\alpha + \beta)x + \alpha\beta] = k[x^2 - (\text{Sum of zeroes})\, x + (\text{Product of zeroes})]$,

     where $k$ is the arbitrary constant.
  2. Let $\alpha$ and $\beta$ be the zeroes of a quadratic polynomial $p(x) = ax^2 + bx + c$, where $a \neq 0$, then

     $$\text{Sum of zeroes} = \alpha + \beta = (-1) \cdot \frac{b}{a} = (-1) \cdot \frac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$$

     $$\text{Product of zeroes} = \alpha\beta = (-1)^2 \cdot \frac{c}{a} = (-1)^2 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^2}$$
  3. A cubic polynomial whose zeroes are $\alpha$, $\beta$ and $\gamma$, is given by

     $p(x) = k[x^3 - (\alpha + \beta + \gamma)x^2 + (\alpha\beta + \beta\gamma + \gamma\alpha)x - \alpha\beta\gamma]$

     $\Rightarrow p(x) = k[x^3 - (\text{Sum of zeroes})\, x^2 + (\text{Sum of the product of zeroes taken two at a time})\, x - (\text{Product of zeroes})]$, where $k$ is the arbitrary constant.
  4. If $\alpha$, $\beta$ and $\gamma$ are the zeroes of a cubic polynomial $p(x) = ax^3 + bx^2 + cx + d$, where $a \neq 0$, then

     $$\text{Sum of zeroes} = \alpha + \beta + \gamma = (-1) \cdot \frac{b}{a} = (-1) \cdot \frac{\text{Coefficient of } x^2}{\text{Coefficient of } x^3}$$

     Sum of the product of zeroes taken two at a time

     $$= \alpha\beta + \beta\gamma + \gamma\alpha = (-1)^2 \cdot \frac{c}{a} = (-1)^2 \cdot \frac{\text{Coefficient of } x}{\text{Coefficient of } x^3}$$

     $$\text{Product of zeroes} = \alpha\beta\gamma = (-1)^3 \cdot \frac{d}{a} = (-1)^3 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^3}$$

# Practice Exercise

## Multiple Choice Questions

**Q 1. The maximum number of zeroes a cubic polynomial can have, is:** *[CBSE 2020]*

a. 1 b. 4
c. 2 d. 3

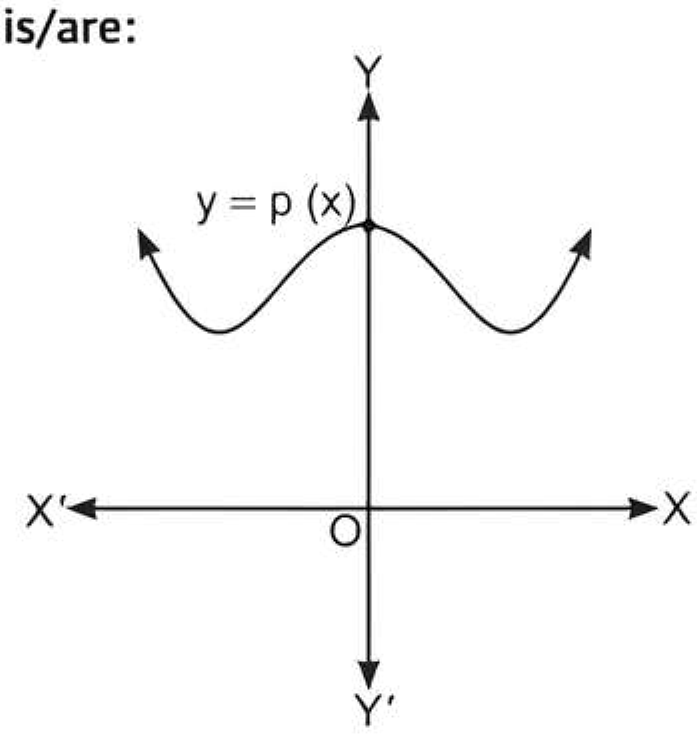
**Q 2. The zeroes of the quadratic polynomial $x^2 + 25x + 156$ are:**

a. both positive
b. both negative
c. one positive and one negative
d. Can't be determined

**Q 3. The graph of a polynomial $p(x)$ cuts the $X$-axis at 3 points and touches it at 2 other points. The number of zeroes of $p(x)$ is:** *[CBSE 2021 Term-I]*

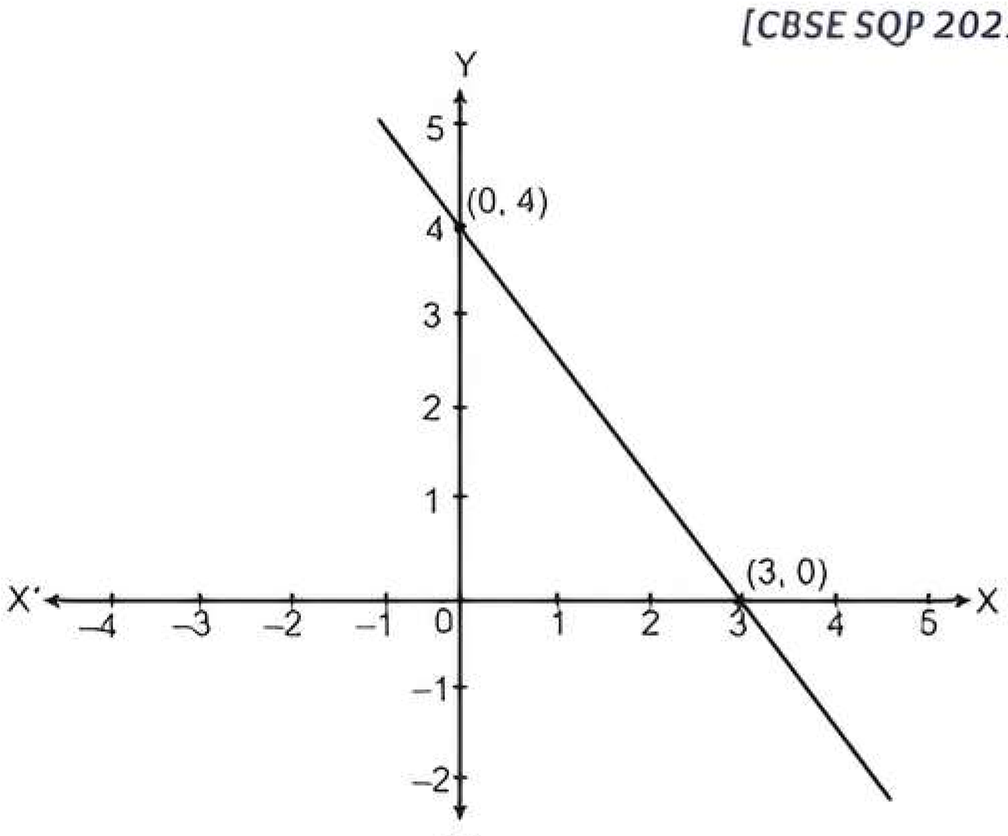
a. 1 b. 2
c. 3 d. 5

**Q 4. The graph of $y = p(x)$ is shown in the figure for some polynomial $p(x)$. The number of zeroes of $p(x)$ is/are:** *[CBSE 2023]*



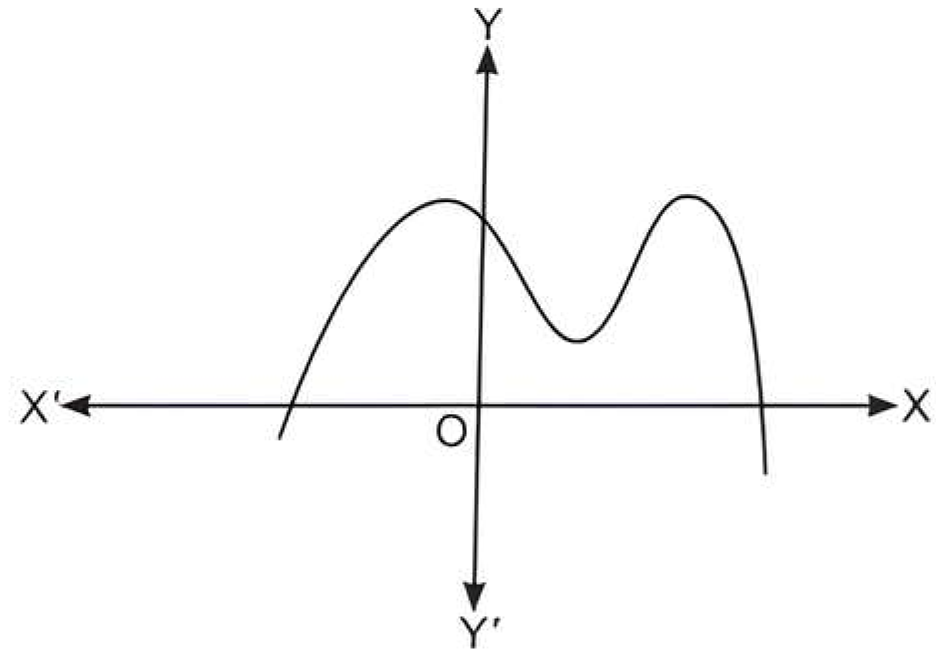

a. 0 b. 1
c. 2 d. 3

**Q 5. The given linear polynomial $y = f(x)$ has:** *[CBSE SQP 2023-24]*



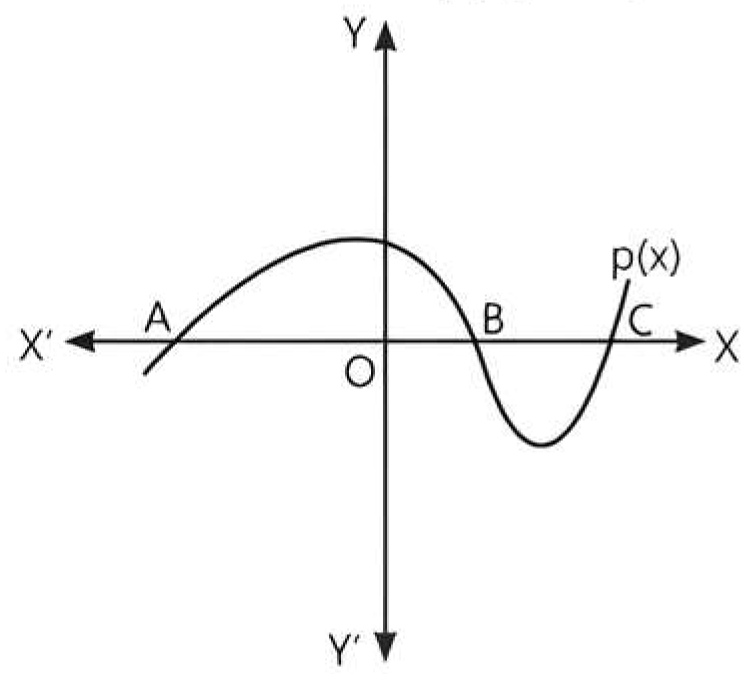

a. 2 zeroes
b. 1 zero and the zero is '3'
c. 1 zero and the zero is '4'
d. no zero

**Q 6. Graph of a polynomial $p(x)$ is given in the figure. The number of zeroes of $p(x)$ is:** *[CBSE 2023]*



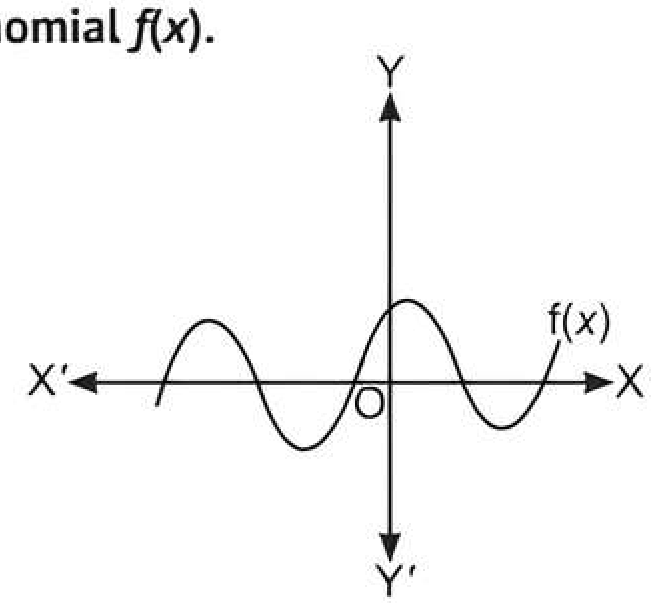

a. 2 b. 3 c. 4 d. 5

**Q 7. In figure, the graph of a polynomial $p(x)$ is shown. The number of zeroes of $p(x)$ is:** *[CBSE 2021 Term-I]*




a. 1 b. 2
c. 3 d. 4

**Q 8. The graph of $y = f(x)$ is shown in the figure for some polynomial $f(x)$.**




**The number of zeroes of *f(x)* is:** *[CBSE 2023]*

a. 5 b. 6
c. 4 d. 8

**Q 9. If one zero of the polynomial $f(x) = 3x^2 + 11x + p$ is reciprocal of the other, then the value of $p$ is:**

a. 0 b. 3 c. $\frac{1}{3}$ d. –3

**Q 10. If $\alpha, \beta$ are zeroes of the polynomial $x^2 - 1$, then value of $(\alpha + \beta)$ is:** *[CBSE 2023]*

a. 2 b. 1
c. – 1 d. 0

**Q 11.** A quadratic polynomial, the product and sum of whose zeroes are 5 and 8 respectively, is: [CBSE 2021 Term-I]

a. $k(x^2 - 8x + 5)$
b. $k(x^2 + 8x + 5)$
c. $k(x^2 - 5x + 8)$
d. $k(x^2 + 5x + 8)$

**Q 12.** If two zeroes of the polynomial $x^3 + x^2 - 9x - 9$ are 3 and −3, then its third zero is:

a. −1 b. 1 c. −9 d. 9

**Q 13.** If $\alpha$, $\beta$ are the zeroes of the polynomial $p(x) = 4x^2 - 3x - 7$, then $\left(\frac{1}{\alpha} + \frac{1}{\beta}\right)$ is equal to: [CBSE 2023]

a. $\frac{7}{3}$ b. $\frac{-7}{3}$ c. $\frac{3}{7}$ d. $\frac{-3}{7}$

**Q 14.** If $\alpha, \beta$ are the zeroes of $f(x) = 2x^2 + 8x - 8$, then:

a. $\alpha + \beta = \alpha\beta$
b. $\alpha + \beta > \alpha\beta$
c. $\alpha + \beta < \alpha\beta$
d. $\alpha + \beta + \alpha\beta = 0$

**Q 15.** If the sum of the zeroes of the polynomial $p(x) = (p^2 - 23)x^2 - 2x - 12$ is 1, then $p$ takes the value(s):

a. $\sqrt{23}$ b. −23 c. 2 d. ± 5

**Q 16.** If $\alpha, \beta, \gamma$ are the zeroes of the polynomial $f(x) = x^3 - ax^2 + bx - c$, then $\frac{1}{\alpha\beta} + \frac{1}{\beta\gamma} + \frac{1}{\gamma\alpha} =$

a. $\frac{c}{a}$ b. $\frac{a}{c}$ c. $-\frac{a}{c}$ d. $-\frac{c}{a}$

**Q 17.** If the zeroes of the quadratic polynomial $x^2 + (a + 1)x + b$ are 2 and −3, then: [NCERT EXEMPLAR; CBSE 2023]

a. $a = -7, b = -1$
b. $a = 5, b = -1$
c. $a = 2, b = -6$
d. $a = 0, b = -6$

**Q 18.** The sum and the product of zeroes of the polynomial $p(x) = x^2 + 5x + 6$ are respectively: [CBSE 2023]

a. 5, −6
b. −5, 6
c. 2, 3
d. −2, −3

**Q 19.** The sum and product of zeroes of the polynomial $P(x) = 3x^2 - 5x + 2$ are: [CBSE 2023]

a. $\frac{5}{3}, \frac{2}{3}$ b. $\frac{-5}{3}, \frac{2}{3}$ c. $1\frac{2}{3}$ d. $\frac{-5}{3}, \frac{-2}{3}$

**Q 20.** The zeroes of the polynomial $p(x) = x^2 + 3x + 2$ are given as: [CBSE 2023]

a. 1, 2 b. 2, −1 c. −2, 1 d. − 2, −1

**Q 21.** The zeroes of the polynomial $x^2 - 3x - m(m + 3)$ are: [CBSE 2023]

a. $m, m + 3$
b. $-m, m + 3$
c. $m, -(m + 3)$
d. $-m, -(m + 3)$

**Q 22.** If $x - 1$ is a factor of the polynomial $p(x) = x^3 + ax^2 + 2b$ and $a + b = 4$, then [CBSE 2021 Term-I]

a. $a = 5, b = -1$
b. $a = 9, b = -5$
c. $a = 7, b = -3$
d. $a = 3, b = 1$

**Q 23.** If a cubic polynomial with the sum of its zeroes, sum of the products two at a time and product of its zeroes as 0, −7 and −6 respectively, then the cubic polynomial is:

a. $x^3 + 7x - 6$
b. $x^3 + 7x + 6$
c. $x^3 - 7x - 6$
d. $x^3 - 7x + 6$

**Q 24.** If 2 and 1/2 are the zeroes of $px^2 + 5x + r$, then: [CBSE 2021 Term-I]

a. $p = r = 2$
b. $p = r = -2$
c. $p = 2, r = -2$
d. $p = -2, r = 2$

**Q 25.** 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: [CBSE 2023]

a. $a^2 - 2b$ b. $a^2 + 2b$ c. $b^2 - 2a$ d. $b^2 + 2a$

## Assertion & Reason Type Questions

**Directions (Q. Nos. 26-30):** *In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:*

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

**Q 26.** Assertion (A): $f(x) = 2x^3 - \frac{3}{x} + 7$ is a polynomial in the variable $x$ of degree 3.

Reason (R): The highest power of $x$ in a polynomial $f(x)$ is called the degree of the polynomial $f(x)$.

**Q 27.** 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. [CBSE 2023]

**Q 28.** Assertion (A): Polynomial $x^2 + 4x$ has two real zeroes.

Reason (R): Zeroes of the polynomial $x^2 + ax$ $(a \neq 0)$ are 0 and $a$. [CBSE 2023]

**Q 29.** Assertion (A): If the sum and product of zeroes of a quadratic polynomial is 3 and −2 respectively, then the quadratic polynomial is $x^2 - 3x - 2$.

Reason (R): If $S$ is the sum of zeroes and $P$ is the product of zeroes of a quadratic polynomial, then the quadratic polynomial is given by $x^2 - Sx + P$.

**Q 30.** Assertion (A): If two zeroes of the polynomial $f(x) = x^3 - 2x^2 - 3x + 6$ are $\sqrt{3}$ and $-\sqrt{3}$, then its third zero is 4.

Reason (R): If $\alpha$, $\beta$ and $\gamma$ are the zeroes of the polynomial $f(x) = ax^3 + bx^2 + cx + d$. Then,

$$\text{Sum of the zeroes} = -(1)\cdot\frac{\text{Coefficient of } x^2}{\text{Coefficient of } x^3}$$

## Fill in the Blanks Type Questions

**Q 31.** The polynomial of the form $ax^2 + bx + c, a = 0$ is of type ............... .

**Q 32.** If graph of a polynomial does not intersects the X-axis but intersects Y-axis in one point, then number of zeroes of the polynomial is equal to ............... .

**Q 33.** If $p(x) = ax^2 + bx + c$, then $-\frac{b}{a}$ is equal to ........... of zeroes.

**Q 34.** Suppose two zeroes of cubic polynomial $ax^3 + bx^2 + cx + d$ are zero. The third zero is ............... . *[NCERT EXERCISE]*

## True/False Type Questions

**Q 35.** A biquadratic polynomial have atmost four zeroes.

**Q 36.** If one of the factor of $x^2 + x - 20$ is $(x + 5)$, then the other factor is $(x + 4)$.

**Q 37.** If $(x + 2)$ is a factor of $x^3 - 2ax^2 + 16$, then the value of $a$ is 4.

**Q 38.** Graph of a quadratic polynomial is an ellipse.

**Q 39.** The quadratic polynomial whose sum of zeroes is 5 and product of zeroes is $-2$, is $x^2 - 5x - 2$.

## Solutions

**1.** (d) The maximum number of zeroes of a cubic polynomial can have 3.

**2.** (b) Let $\alpha$ and $\beta$ be the zeroes of $x^2 + 25x + 156$.
Then, $\alpha + \beta = -25$ and $\alpha\beta = 156$
This happens when $\alpha$ and $\beta$ are both negative.

**3.** (d)

**TiP**
*A curve either touches or intersects the X-axis, then it has zeroes of polynomial.*

The number of zeroes of $p(x)$
= Number of intersection points + Number of touches points
$= 3 + 2 = 5$

**4.** (a) The number of zeroes of the polynomial $p(x)$ is 0 as the graph does not intersect the X-axis at any point. So, the number of zeroes of $p(x)$ is 0.

**5.** (b) The number of zeroes of the polynomial $f(x)$ is one as the graph intersects the X-axis at one point only. So, $f(x)$ has 1 zero and the zero is 3.

**6.** (a) The number of zeroes of the polynomial $p(x)$ is 2 as the graph intersects the X-axis at two points.
So, the number of zeroes of $p(x)$ is 2.

**7.** (c) Given, curve intersect the X-axis at three points, then number of zeroes of $p(x)$ is 3.

**8.** (a) The number of zeroes of the polynomial $f(x)$ is 5 as the graph intersects the X-axis at five points.
So, the number of zeroes of $f(x)$ is 5.

**9.** (b) Let $\alpha$ and $\frac{1}{\alpha}$ be the zeroes of $f(x) = 3x^2 + 11x + p$.

$\therefore$ Product of zeroes $= \alpha \cdot \frac{1}{\alpha} = \frac{p}{3}$

$\Rightarrow \quad p = 3$

**10.** (d) Given, $\alpha$ and $\beta$ are the zeroes of a polynomial $f(x) = x^2 - 1 = x^2 + 0 \cdot x - 1$.

Then, $\alpha + \beta = (-1) \cdot \frac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$

$= -\frac{0}{1} = 0$

**11.** (c) Given, sum of zeroes = 8
and product of zeroes = 5

**TR!CK**
*Quadratic polynomial = k[$x^2$–(sum of zeroes)x + (product of zeroes)]*

$\therefore$ Required quadratic polynomial
$= k\,(x^2 - (\text{sum of zeroes})x + (\text{product of zeroes}))$
$= k\,(x^2 - 5x + 8)$

**12.** (a) Let the third zero of the polynomial $x^3 + x^2 - 9x - 9$ be $\alpha$.

Now, sum of zeroes $= (-1) \cdot \frac{\text{Coefficient of } x^2}{\text{Coefficient of } x^3}$

$= \frac{-1}{1} = -1$

$\Rightarrow \quad 3 + (-3) + \alpha = -1 \Rightarrow \alpha = -1$

**13.** (d) Given, $\alpha$ and $\beta$ are the zeroes of the polynomial $p(x) = 4x^2 - 3x - 7$.

$\therefore \quad \alpha + \beta = (-1) \cdot \frac{\text{Coefficient of } x}{\text{Coefficient of } x^2} = -\frac{(-3)}{4} = \frac{3}{4}$

and $\alpha\beta = (-1)^2 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^2} = 1 \cdot \frac{(-7)}{4} = -\frac{7}{4}$

So, $\frac{1}{\alpha} + \frac{1}{\beta} = \frac{\alpha + \beta}{\alpha\beta} = \frac{3}{4} \times \left(\frac{-4}{7}\right) = -\frac{3}{7}$

**14.** (a) Since, $\alpha$ and $\beta$ are the zeroes of $2x^2 + 8x - 8$.

$\therefore \quad \alpha + \beta = -\frac{8}{2} = -4$ and $\alpha\beta = -\frac{8}{2} = -4$

Hence, $\alpha + \beta = \alpha\beta$

**15.** (d) Let $\alpha$ and $\beta$ be the zeroes of the polynomial
$p(x) = (p^2 - 23)x^2 - 2x - 12$

Then, $\alpha + \beta = -\frac{(-2)}{p^2 - 23} = \frac{2}{p^2 - 23}$

Also, sum of zeroes $= \alpha + \beta = 1$ (given)

$\Rightarrow \quad p^2 - 23 = 2$

$\Rightarrow \quad p^2 = 25$

$\Rightarrow \quad p = \pm 5$

**16.** (b) Since, $\alpha$, $\beta$ and $\gamma$ are the zeroes of the polynomial

$$f(x) = x^3 - ax^2 + bx - c.$$

$$\alpha + \beta + \gamma = -\frac{(-a)}{1} = a, \ \alpha\beta\gamma = -\frac{(-c)}{1} = c$$

Now, $\frac{1}{\alpha\beta} + \frac{1}{\beta\gamma} + \frac{1}{\gamma\alpha} = \frac{\alpha+\beta+\gamma}{\alpha\beta\gamma} = \frac{a}{c}$

**17.** (d) Let $p(x) = x^2 + (a+1)x + b$

Given that, 2 and −3 are the zeroes of the quadratic polynomial $p(x)$.

$\therefore$ $p(2) = 0$ and $p(-3) = 0$

Now, $p(2) = 0$

$\Rightarrow$ $2^2 + (a+1)(2) + b = 0$

$\Rightarrow$ $2a + b = -6$ ...(1)

Also, $p(-3) = 0$

$\Rightarrow$ $(-3)^2 + (a+1)(-3) + b = 0$

$\Rightarrow$ $3a - b = 6$ ...(2)

On solving eqs. (1) and (2), we get

$$a = 0, b = -6$$

**18.** (b) Given, polynomial $p(x) = x^2 + 5x + 6$

Now, sum of the zeroes $= (-1)\cdot\frac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$

$$= -\frac{5}{1} = -5$$

and product of the zeroes $= (-1)^2\cdot\frac{\text{Constant term}}{\text{Coefficient of } x^2}$

$$= 1\cdot\frac{6}{1} = 6$$

**19.** (a) Given, polynomial $p(x) = 3x^2 - 5x + 2$

Now, sum of the zeroes $= (-1)\cdot\frac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$

$$= (-1)\cdot\frac{(-5)}{3} = \frac{5}{3}$$

and product of the zeroes $= (-1)^2\cdot\frac{\text{Constant term}}{\text{Coefficient of } x^2}$

$$= 1\cdot\frac{2}{3} = \frac{2}{3}$$

**20.** (d) Given, $p(x) = x^2 + 3x + 2$

$= x^2 + x + 2x + 2$

(by splitting the middle term)

$= x(x+1) + 2(x+1)$

$= (x+1)(x+2)$

For zeroes of $p(x)$, put

$(x+1)(x+2) = 0$

$\Rightarrow$ $x + 1 = 0$ or $x + 2 = 0$

$\Rightarrow$ $x = -1, -2$

**21.** (b) Let $f(x) = x^2 - 3x - m(m+3)$

$= x^2 - \{(m+3) - m\}x - m(m+3)$

$= x^2 - (m+3)x + mx - m(m+3)$

$= x\{x-(m+3)\} + m\{x-(m+3)\}$

$= \{x-(m+3)\}(x+m)$

For zeroes of $f(x)$, put

$\{x-(m+3)\}(x+m) = 0$

$\Rightarrow$ $x - (m+3) = 0$ or $x + m = 0$

$\Rightarrow$ $x = -m, (m+3)$

**22.** (b) Given, $p(x) = x^3 + ax^2 + 2b$

Since, $x - 1$ is a factor of $p(x)$.

Therefore, $p(1) = 0$

$\Rightarrow$ $(1)^3 + a(1)^2 + 2b = 0$

$\Rightarrow$ $a + 2b = -1$

Also given, $a + b = 4$

On solving, we get

$a = 9$ and $b = -5$

**23.** (d) Let $\alpha$, $\beta$ and $\gamma$ be the zeroes of the required polynomial.

Then, $\alpha + \beta + \gamma = 0$

$\alpha\beta + \beta\gamma + \alpha\gamma = -7$

$\alpha\beta\gamma = -6$

$\therefore$ Required cubic polynomial

$= k\{x^3 - (\alpha+\beta+\gamma)x^2 + (\alpha\beta+\beta\gamma+\gamma\alpha)x - \alpha\beta\gamma\}$

(where $k$ is non-zero constant)

$= k(x^3 + (0)x^2 + (-7)x - (-6)) = x^3 - 7x + 6$

(consider, $k = 1$)

**24.** (b) Let polynomial $f(x) = px^2 + 5x + r$

Given, 2 and $\frac{1}{2}$ are the zeroes of $f(x)$.

Now, sum of zeroes $= (-1)\cdot\frac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$

$\Rightarrow$ $2 + \frac{1}{2} = \frac{-5}{p}$

$\Rightarrow$ $\frac{5}{2} = -\frac{5}{p}$ $\Rightarrow p = -2$

and product of zeroes $= (-1)^2\cdot\frac{\text{Constant term}}{\text{Coefficient of } x^2}$

$\Rightarrow$ $2\times\frac{1}{2} = \frac{r}{p}$

$\Rightarrow$ $1 = \frac{r}{-2}$ $\Rightarrow r = -2$

$\therefore$ $p = r = -2$

**25.** (b) Given, $\alpha$ and $\beta$ are the zeroes of the quadratic polynomial $p(x) = x^2 - ax - b$.

$\therefore$ $\alpha + \beta = (-1)\cdot\frac{\text{Coefficient of } x}{\text{Coefficient of } x^2} = (-1)\cdot\frac{(-a)}{1} = a$

and $\alpha\beta = (-1)^2\cdot\frac{\text{Constant term}}{\text{Coefficient of } x^2} = 1\cdot\frac{(-b)}{1} = -b$

So, $\alpha^2 + \beta^2 = (\alpha+\beta)^2 - 2(\alpha\beta) = a^2 - 2(-b) = a^2 + 2b$

26. (d) **Assertion (A):** $f(x) = 2x^3 - \frac{3}{x} + 7 = 2x^3 - 3x^{-1} + 7$

is not a polynomial as one of the term is $-3x^{-1}$ in which the power of $x$ is negative.

So, Assertion (A) is false.

**Reason (R):** It is true to say that the highest power of $x$ in a polynomial $f(x)$ is the degree of the polynomial $f(x)$.

Hence, Assertion (A) is false but Reason (R) is true.

27. (d) **Assertion (A):** We have,

$$p(x) = x^2 + 3x + 3$$

For finding zeroes, put

$$p(x) = 0 \Rightarrow x^2 + 3x + 3 = 0$$

Compare with $ax^2 + bx + c = 0$, we get

$$a = 1, b = 3, c = 3$$

$\therefore$ Discriminant $(D) = b^2 - 4ac$

$$= (3)^2 - 4 \times 1 \times 3 = 9 - 12 = -3 < 0$$

$\Rightarrow p(x)$ has no real zero.

So, Assertion (A) is false.

**Reason (R):** It is true to say that a quadratic polynomial has atmost 2 zeroes.

Hence, Assertion (A) is false but Reason (R) is true.

28. (c) **Assertion (A):** Let polynomial $p(x) = x^2 + 4x$
$= x(x + 4)$

For the zeroes of $p(x)$, put

$$x(x + 4) = 0$$

$\Rightarrow \quad x = 0$ or $x + 4 = 0$

$\Rightarrow \quad x = 0, -4.$

So, $x^2 + 4x$ has two real zeroes.

Thus, Assertion (A) is true.

**Reason (R):** Let polynomial $f(x) = x^2 + ax, (a \neq 0)$
$= x(x + a)$

For the zeroes of f(x), put

$$x(x + a) = 0$$

$\Rightarrow \quad x = 0$ or $x + a = 0$

$\Rightarrow \quad x = 0, -a$

So, $x^2 + ax$ has two zeroes 0 and $-a$.

Thus, Reason (R) is false.

Hence, Assertion (A) is true but Reason (R) is false.

29. (a) **Assertion (A):** Let $\alpha$ and $\beta$ be the zeroes of quadratic polynomial.

Now, given $\alpha + \beta = 3 = S$ and $\alpha\beta = -2 = P$

$\Rightarrow \quad S = 3$ and $P = -2$

$\therefore$ The required quadratic polynomial

$$= x^2 - (S)x + P = x^2 - 3x - 2$$

Therefore, Assertion (A) is true.

**Reason (R):** It is also true.

Hence, both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

30. (d) **Assertion (A):** Let $\alpha = \sqrt{3}, \beta = -\sqrt{3}$ be the zeroes of the polynomial $f(x) = x^3 - 2x^2 - 3x + 6$ and $\gamma$ be its third zero.

Then, $\quad \alpha + \beta + \gamma = -\left(\frac{-2}{1}\right)$

$\Rightarrow \quad \sqrt{3} - \sqrt{3} + \gamma = 2 \Rightarrow \gamma = 2$

Therefore, Assertion (A) is false.

**Reason (R):** It is also true.

Hence, Assertion (A) is false but Reason (R) is true.

31. In polynomial $ax^2 + bx + c$, if $a = 0$, then given polynomial becomes $bx + c$, which is linear type.

32. Zero

33. In polynomial $p(x) = ax^2 + bx + c$

$\therefore$ Sum of zeroes $= -\frac{b}{a}$

34. Let three zeroes of given polynomial $p(x)$ be $\alpha$, $\beta$ and $\gamma$.

Then consider $\alpha = 0$ and $\beta = 0$

Now, sum of zeroes, $\alpha + \beta + \gamma = -\frac{b}{a}$

$\Rightarrow \quad 0 + 0 + \gamma = -\frac{b}{a}$

$\Rightarrow \quad \gamma = -\frac{b}{a}$

Hence, third zero is $-\frac{b}{a}$.

35. True

36. Let $p(x) = x^2 + x - 20$

$= x^2 + 5x - 4x - 20$

$= x(x + 5) - 4(x + 5)$

$= (x - 4)(x + 5)$

Hence, given statement is false.

37. Let $p(x) = x^3 - 2ax^2 + 16$

Since, $(x + 2)$ is a factor of $p(x)$. Therefore $p(-2) = 0$

$\therefore \quad (-2)^3 - 2a(-2)^2 + 16 = 0$

$\Rightarrow \quad -8 - 8a + 16 = 0$

$\Rightarrow \quad 8 - 8a = 0$

$\Rightarrow \quad a = 1$

Hence, given statement is false.

38. Graph of a quadratic polynomial is parabola.

Hence, given statement is false.

39. Given, sum of zeroes = 5

and product of zeroes = $-2$

$\therefore$ Quadratic polynomial

$= x^2 - (\text{Sum of zeroes})x + (\text{Product of zeroes})$

$= x^2 - 5x + (-2) = x^2 - 5x - 2$

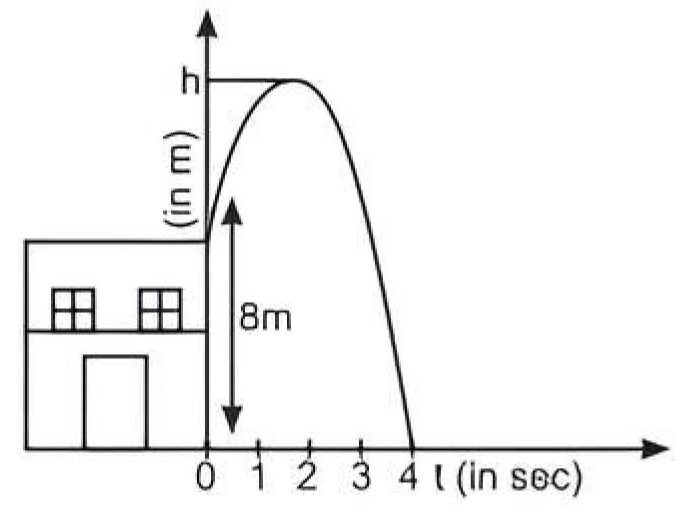
Hence, given statement is true.

## Case Study Based Questions

### Case Study 1

Sukriti throws a ball upwards, from a rooftop which is 8 m high from ground level. The ball reaches to some maximum height and then returns and hit the ground.

If height of the ball at time $t$ (in sec) is represented by $h$(m), then equation of its path is given as $h = -t^2 + 2t + 8$.




*Based on the given information, solve the following questions:*

**Q 1. The maximum height achieved by ball is:**

a. 7 m b. 8 m
c. 9 m d. 10 m

**Q 2. The polynomial represented by above graph is:**

a. linear polynomial b. quadratic polynomial
c. constant polynomial d. cubic polynomial

**Q 3. Time taken by ball to reach maximum height is:**

a. 2 sec b. 4 sec c. 1 sec d. 2 min

**Q 4. Number of zeroes of the polynomial whose graph is given, is:**

a. 1 b. 2
c. 0 d. 3

**Q 5. Zeroes of the polynomial are:**

a. 4 b. −2, 4
c. 2, 4 d. 0, 4

## Solutions

1. Given, $h = -t^2 + 2t + 8$

At $t = 0, h = -(0)^2 + 2(0) + 8 = 8$

$t = 1, h = -(1)^2 + 2(1) + 8 = 9$

$t = 2, h = -(2)^2 + 2(2) + 8 = 8$

$t = 3, h = -(3)^2 + 2(3) + 8 = 5$

$t = 4, h = -(4)^2 + 2(4) + 8 = 0$

Hence, the maximum height achieved by the ball is 9 m.

So, option (c) is correct.

2. The polynomial represented by given graph is a quadratic polynomial.
So, option (b) is correct.

3. The time taken by ball to reach maximum height is 1 sec.
So, option (c) is correct.

4. The number of zeroes of the polynomial whose graph is given, is 1.
So, option (a) is correct.

5. Since, at $t = 4, h = 0$
Hence, zeroes of the polynomial is 4.
So, option (a) is correct.

## Case Study 2

Asana is a body posture, originally and still a general term for a sitting meditation pose and later extended in hatha yoga and modern yoga as exercise, to any type of pose or position, adding reclining, standing, inverted, twisting and balancing poses. In the figure, one can observe that poses can be related to representation of quadratic polynomial.

*Based on the above information, solve the following questions:*

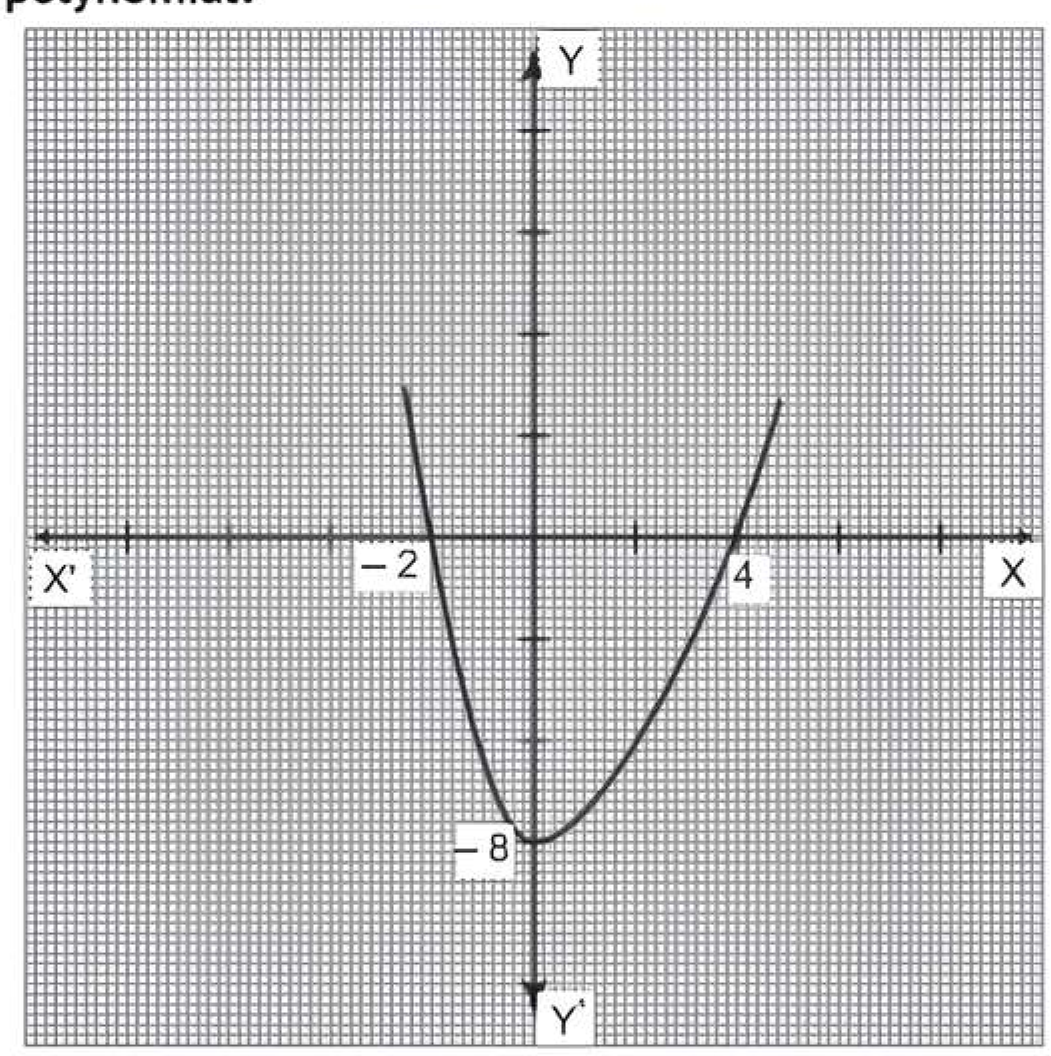
**Q 1. The shape of the poses shown is:**

a. spiral b. ellipse c. linear d. parabola

**Q 2. The graph of parabola opens downward, if:**

a. $a \geq 0$ b. $a = 0$ c. $a < 0$ d. $a > 0$

**Q 3. In the graph, how many zeroes are there for the polynomial?**




a. 0 b. 1 c. 2 d. 3

**Q 4. The quadratic polynomial of the two zeroes in the above shown graph are:**

a. $k(x^2 - 2x - 8)$ b. $k(x^2 + 2x - 8)$
c. $k(x^2 + 2x + 8)$ d. $k(x^2 - 2x + 8)$

**Q 5. The zeroes of the quadratic polynomial $4\sqrt{3}x^2 + 5x - 2\sqrt{3}$ are:**

a. $\frac{2}{\sqrt{3}}, \frac{\sqrt{3}}{4}$ b. $-\frac{2}{\sqrt{3}}, \frac{\sqrt{3}}{4}$

c. $\frac{2}{\sqrt{3}}, -\frac{\sqrt{3}}{4}$ d. $-\frac{2}{\sqrt{3}}, -\frac{\sqrt{3}}{4}$

## Solutions

1. The shape of the poses shown is parabola which is a plane curve, mirror symmetrical and approximately $\cup$ or $\cap$ shaped.

   So, option (d) is correct.

2. If $a < 0$ in $f(x) = ax^2 + bx + c$, the parabola opens downward.

   So, option (c) is correct.

3.

> **TR!CK**
> *The zeroes of the polynomial are the x-coordinates of those points where its graph touches or intersects the X-axis.*

   Here, the graph cuts X-axis at two distinct points $-2$ and 4. Therefore, two zeroes are there for the polynomial.

   So, option (c) is correct.

4. In the given graph, the graph cuts X-axis at points $-2$ and 4, which are the zeroes of the graph.

   Now, the required polynomial

   $= k\,(x^2 - \text{(Sum of zeroes)}\,x + \text{Product of zeroes})$

   $= k\,(x^2 - (-2 + 4)\,x + (-2 \times 4))$

   $= k\,(x^2 - 2x - 8)$, where $k$ is an arbitrary constant.

   So, option (a) is correct.

5. Given, polynomial $= 4\sqrt{3}x^2 + 5x - 2\sqrt{3}$

   $= 4\sqrt{3}x^2 + (8 - 3)x - 2\sqrt{3}$

   (by splitting the middle term)

   $= 4\sqrt{3}x^2 + 8x - 3x - 2\sqrt{3}$

   $= 4x(\sqrt{3}x + 2) - \sqrt{3}(\sqrt{3}x + 2)$

   $= (\sqrt{3}x + 2)(4x - \sqrt{3})$

   For the zeroes of the polynomial,

   $(\sqrt{3}x + 2)(4x - \sqrt{3}) = 0$

   $\Rightarrow \quad \sqrt{3}x + 2 = 0$ or $4x - \sqrt{3} = 0$

   $\Rightarrow x = \dfrac{-2}{\sqrt{3}}$ or $x = \dfrac{\sqrt{3}}{4} \Rightarrow x = \dfrac{-2}{\sqrt{3}}, \dfrac{\sqrt{3}}{4}$

   So, option (b) is correct.

## Case Study 3

**Roller Coaster Polynomials**

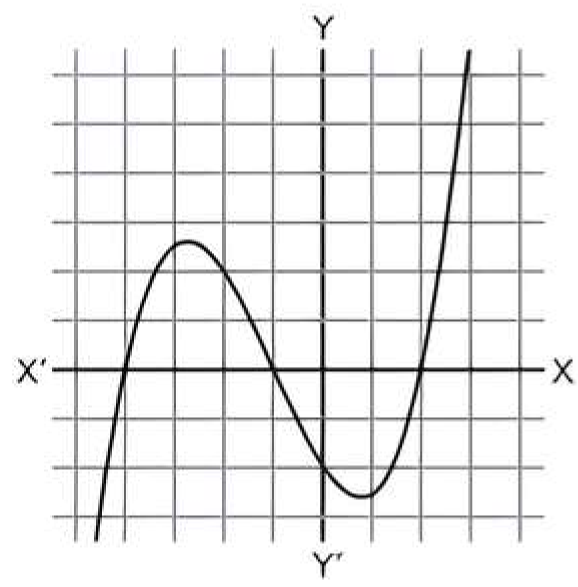
Polynomials are everywhere. They play a key role in the study of algebra, in analysis and on the whole many mathematical problems involving them.

Since, polynomials are used to describe curves of various types, engineers use polynomials to graph the curves of roller coasters.

*[CBSE SQP 2021 Term-I]*

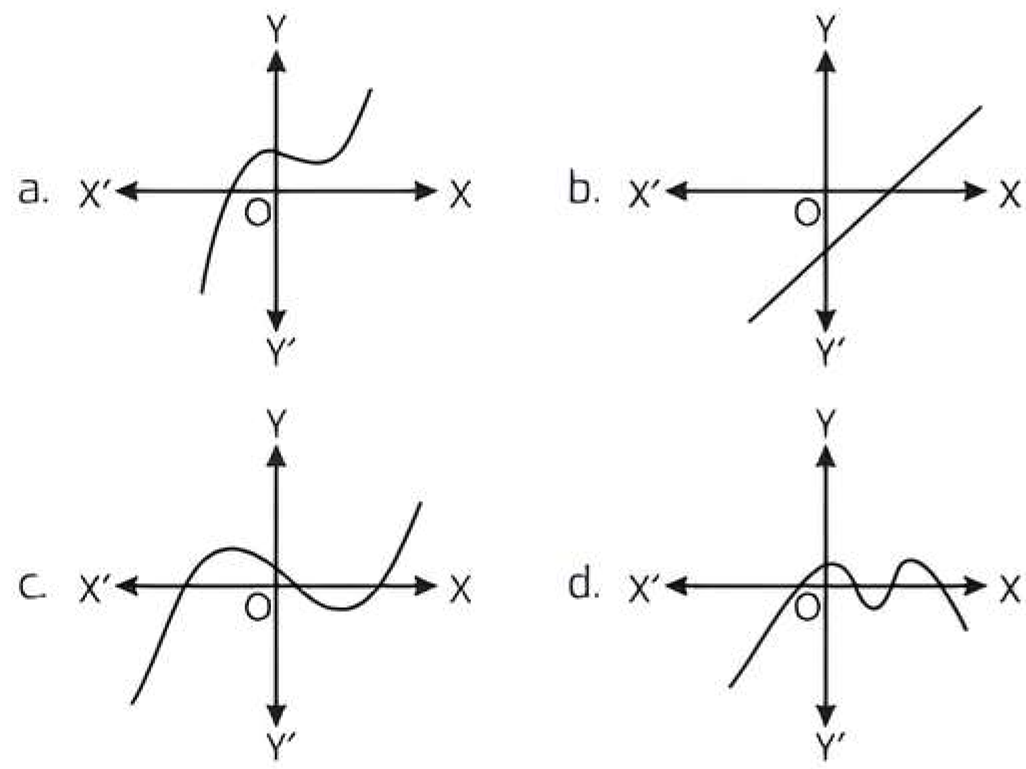
*Based on the given information, solve the following questions:*

**Q 1. If the Roller Coaster is represented by the following graph $y = p(x)$, then name the type of the polynomial it traces.**




a. Linear
b. Quadratic
c. Cubic
d. Bi-quadratic

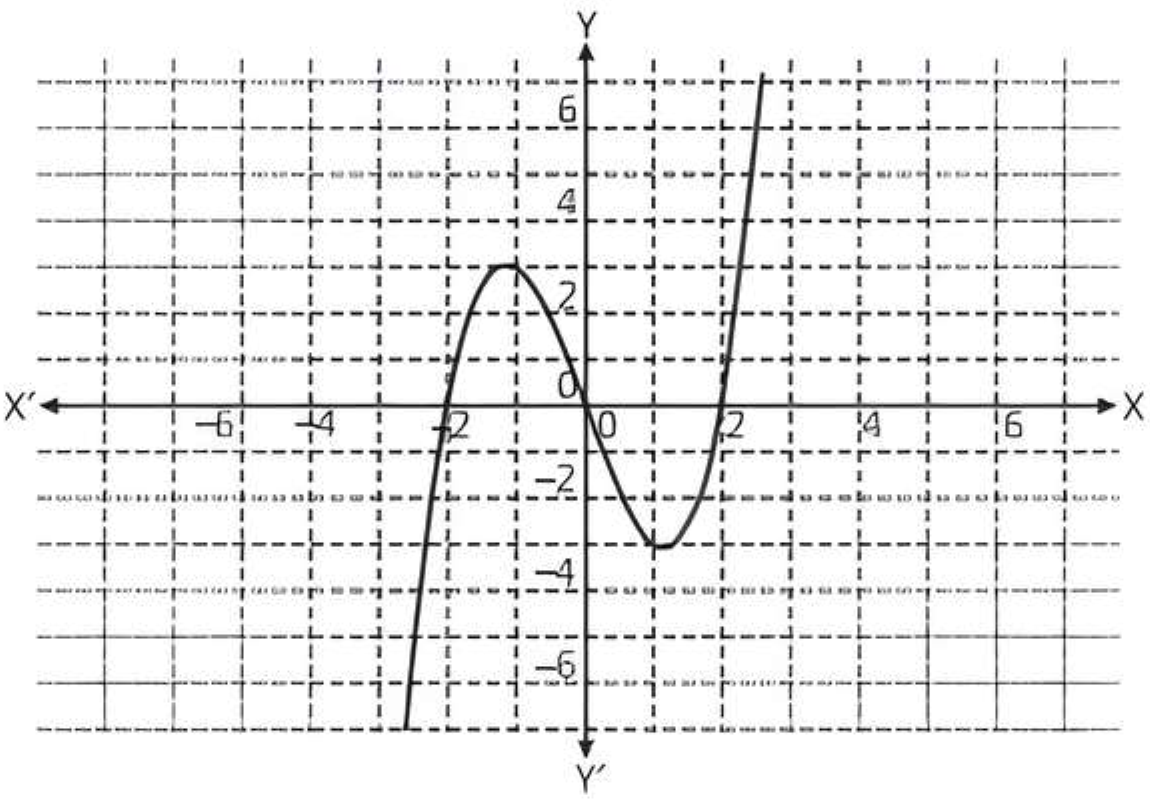
**Q 2. The Roller Coasters are represented by the following graphs $y = p(x)$. Which Roller Coaster has more than three distinct zeroes?**




**Q 3. If the Roller Coaster is represented by the cubic polynomial $t(x) = px^3 + qx^2 + rx + s$, then which of the following is always true?**

a. $s \neq 0$
b. $r \neq 0$
c. $q \neq 0$
d. $p \neq 0$

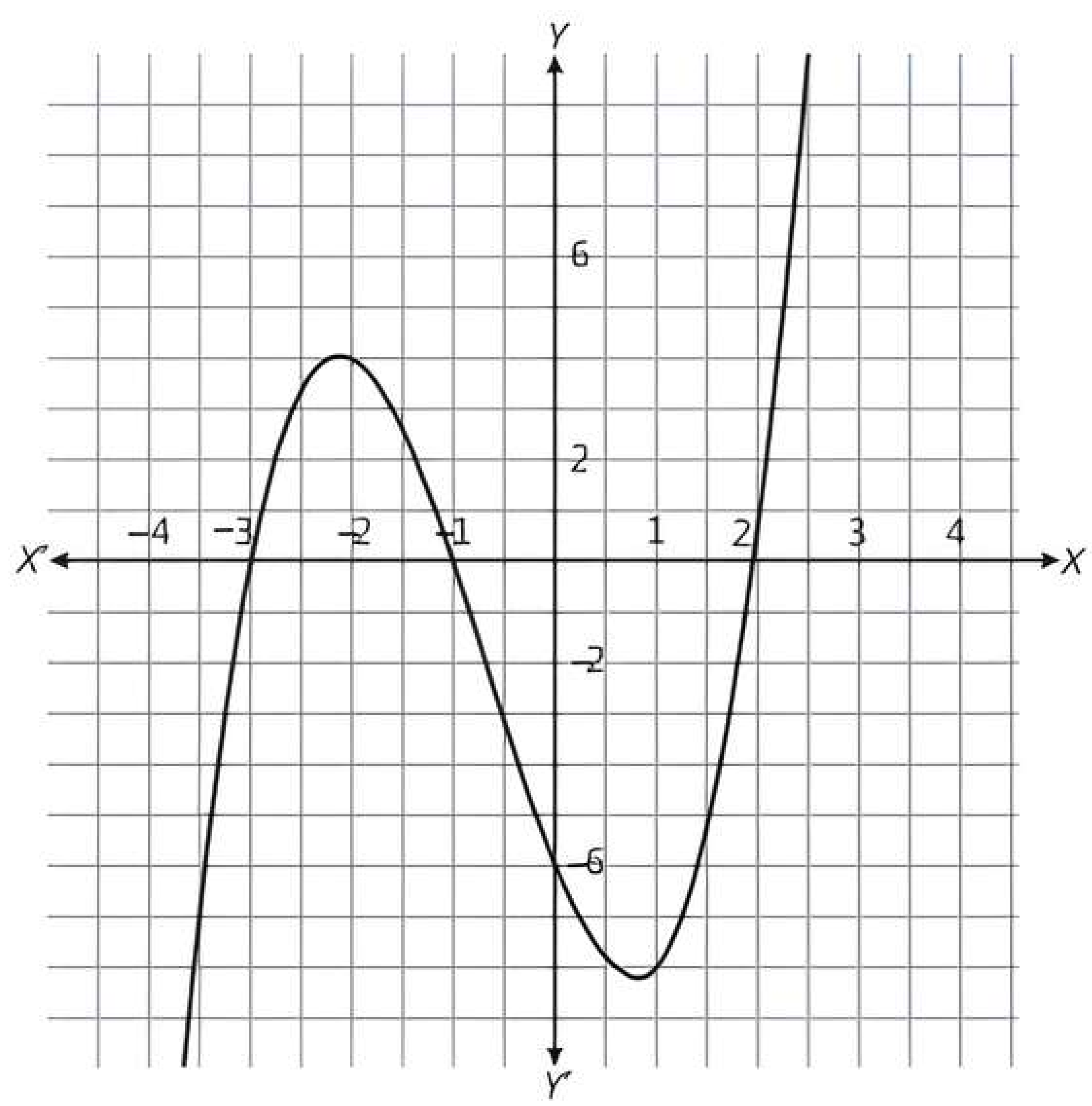
**Q 4. If the path traced by the Roller Coaster is represented by the following graph $y = p(x)$, find the number of zeroes.**



a. 0 b. 1

c. 2 d. 3

**Q 5. If the path traced by the Roller Coaster is represented by the following graph $y = p(x)$, find its zeroes.**



a. −3, −6, −1 b. 2, −6, −1

c. −3, −1, 2 d. 3, 1, −2

## Solutions

1. Since the graph of the given polynomial $y = p(x)$ cuts the $X$-axis at three points. So, the number of zeroes of the polynomial shown in the graph is three.
   This means the polynomial $y = p(x)$ is cubic.
   So, option (c) is correct.
2. Polynomial of graph (a) cuts the $X$-axis at one point.
   So, the number of zero is one.
   Polynomial of graph (b) cuts the $X$-axis at one point.
   So, the number of zeroes is one.
   Polynomial of graph (c) cut the $X$-axis at three points.
   So, the number of zeroes is three.
   Polynomial of graph (d) cut the $X$-axis at four points.
   So, the number of zeroes is four.
   Thus, Roller Coaster of option (d) has more than three distinct zeroes.
   So, option (d) is correct.
3. A cubic polynomial $t(x) = px^3 + qx^2 + rx + s$ is always true when $p, q, r$ and $s$ are real numbers and $p \neq 0$.
   So, option (d) is correct.
4. Since the graph of the given polynomial $y = p(x)$ cut the $X$-axis at three points. So, the number of zeroes of the polynomial shown in the graph is three.
   So, option (d) is correct.
5. (c)

**TiP**

*The zero of a polynomial, $y = p(x)$ is the X-coordinate of the point where the graph of $y = p(x)$ intersects the X-axis.*

The graph of the polynomial $y = p(x)$, cut the $X$-axis at three points −3, −1 and 2, which are also called the zeroes of $y = p(x)$.

So, option (c) is correct.

## Case Study 4

Ramesh was asked by one of his friends Anirudh to find the polynomial whose zeroes are $\frac{-2}{\sqrt{3}}$ and $\frac{\sqrt{3}}{4}$. He obtained the polynomial by following steps which are as shown below:

Let $\alpha = \frac{-2}{\sqrt{3}}$ and $\beta = \frac{\sqrt{3}}{4}$

Then, $\alpha + \beta = \frac{-2}{\sqrt{3}} + \frac{\sqrt{3}}{4} = \frac{-8+1}{4\sqrt{3}} = \frac{-7}{4\sqrt{3}}$

and $\alpha\beta = \frac{-2}{\sqrt{3}} \times \frac{\sqrt{3}}{4} = \frac{-1}{2}$

$$\therefore \text{Required polynomial } = x^2 - (\alpha+\beta)x + \alpha\beta$$

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

$$= x^2 + \frac{7x}{4\sqrt{3}} - \frac{1}{2}$$

$$= 4\sqrt{3}x^2 + 7x - 2\sqrt{3}$$

His another friend Kavita pointed out that the polynomial obtained is not correct.

*Based on the above information, solve the following questions:*

**Q 1. Is the claim of Kavita correct?**

**Q 2. If given polynomial is incorrect, then find the correct quadratic polynomial.**

**Q 3. Find the value of $\alpha^2 + \beta^2$.**

*OR*

**If correct polynomial $p(x)$ is a factor of $(x - 2)$, then find $f(2)$.**

## Solutions

1. Given, $\alpha = -\frac{2}{\sqrt{3}}$ and $\beta = \frac{\sqrt{3}}{4}$

$\therefore \quad \alpha + \beta = \frac{-2}{\sqrt{3}} + \frac{\sqrt{3}}{4} = \frac{-8+3}{4\sqrt{3}} = \frac{-5}{4\sqrt{3}}$

and $\alpha\beta = \frac{-2}{\sqrt{3}} \times \frac{\sqrt{3}}{4} = -\frac{1}{2}$

Yes, because value of $(\alpha + \beta)$ calculated by Anirudh is incorrect.

2. Required polynomial $= k(x^2 - (\alpha + \beta)x + \alpha\beta)$

$$= k\left(x^2 + \frac{5x}{4\sqrt{3}} - \frac{1}{2}\right)$$

$$= \frac{k}{4\sqrt{3}}(4\sqrt{3}x^2 + 5x - 2\sqrt{3})$$

$$= (4\sqrt{3}x^2 + 5x - 2\sqrt{3})$$

where $k = 4\sqrt{3}$

3. $\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta$

$$= \left(\frac{-5}{4\sqrt{3}}\right)^2 - 2\times\left(\frac{-1}{2}\right) = \frac{25}{48} + 1 = \frac{73}{48}$$

**Alternate method:**

$$\alpha^2 + \beta^2 = \left(\frac{-2}{\sqrt{3}}\right)^2 + \left(\frac{\sqrt{3}}{4}\right)^2 = \frac{4}{3} + \frac{3}{16} = \frac{64+9}{48} = \frac{73}{48}$$

*OR*

We have, $p(x) = 4\sqrt{3}x^2 + 5x - 2\sqrt{3}$

Since, $p(x)$ is a factor of $(x - 2)$, then

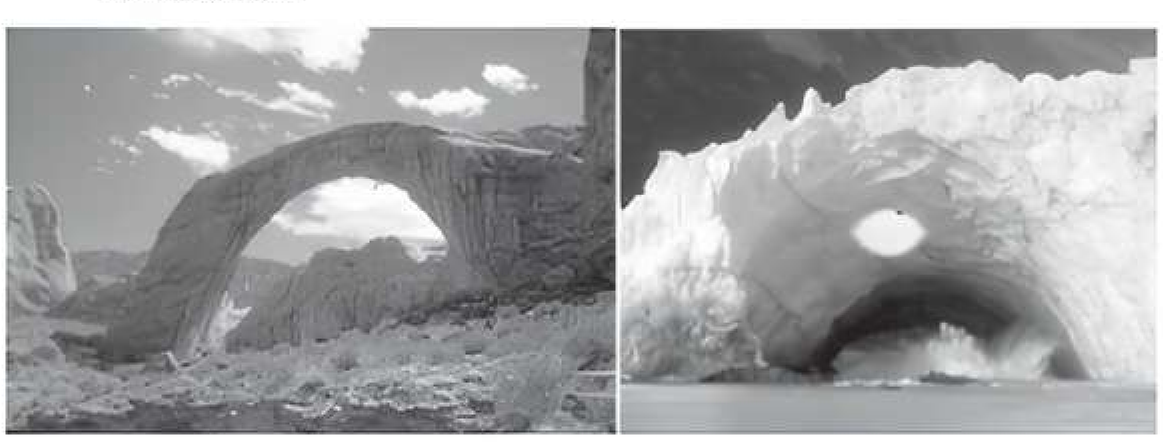
$$p(2) = 4\sqrt{3}(2)^2 + 5(2) - 2\sqrt{3}$$

$$= 16\sqrt{3} + 10 - 2\sqrt{3} = 14\sqrt{3} + 10$$

Hence, remainder is $14\sqrt{3} + 10$.

## Case Study 5

A group of school friends went on an expedition to see caves. One person remarked that the entrance of the caves resembles a parabola and can be represented by a quadratic polynomial $f(x) = ax^2 + bx + c$, $a \neq 0$, where $a$, $b$ and $c$ are real numbers.



*Based on the given information, solve the following questions:*

**Q 1. Draw a neat labelled figure to show above situation diagrammatically.**

**Q 2. If one of the zeroes of the quadratic polynomial $(p - 1)x^2 + px + 1$ is 4. Find the value of $p$.**

**Q 3. Find the quadratic polynomial whose zeroes are 5 and −12.**

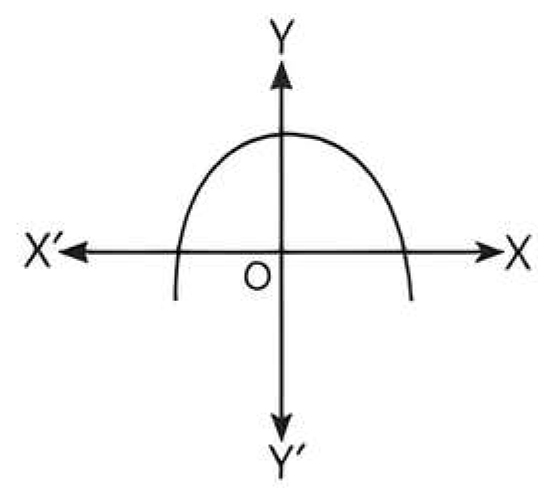
*OR*

**If one zero of the polynomial $f(x) = 5x^2 + 13x + m$ is reciprocal of the other, then find the value of $m$.**

## Solutions

1. We have, $f(x) = ax^2 + bx + c$, $a < 0$

It means a figure is a shape of parabola which open downwards.




2. Since, $x = 4$ is one of the zero of the polynomial $(p-1)x^2 + px + 1$.

$\therefore \quad (p-1)(4)^2 + p(4) + 1 = 0$

$\Rightarrow \quad 16p - 16 + 4p + 1 = 0$

$\Rightarrow \quad 20p = 15$

$\Rightarrow \quad p = \frac{3}{4}$

3. Required quadratic polynomial

$= k\,[x^2 - (\text{Sum of zeroes})x + (\text{Product of zeroes})]$

$= k\,[x^2 - (-12 + 5)x + (-12)(5)]$

$= k\,[x^2 + 7x - 60]$, where $k$ is any arbitrary constant.

*OR*

Let the zeroes of the quadratic polynomial be $\alpha$.

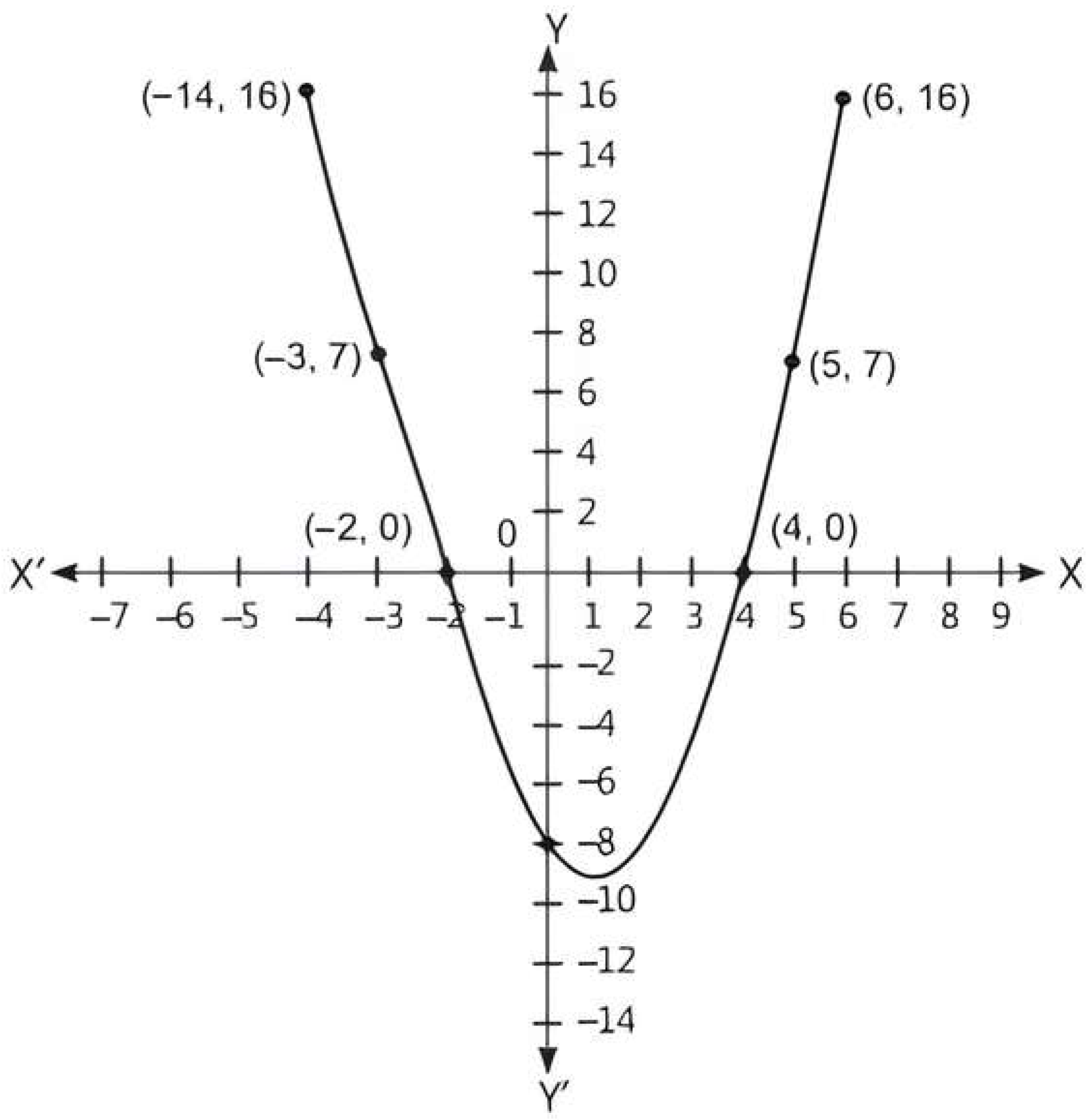
Since, one zero of the polynomial $f(x)$ is reciprocal of the other.

$\therefore$ Product of zeroes $= (-1)^2 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^2}$

$\Rightarrow \quad \alpha \cdot \frac{1}{\alpha} = 1 \cdot \frac{m}{5} \quad \Rightarrow m = 5$

## Case Study 6

A student was given a task to prepare a graph of quadratic polynomial $p(x) = -8 - 2x + x^2$. To draw this graph, he take seven values of $y$ corresponding to different values of $x$. After plotting the points on the graph paper with suitable values, he obtain the graph as shown below.




*Based on the above graph, solve the following questions:*

**Q 1. What is the shape of graph of a quadratic polynomial?**

**Q 2. Find the zeroes of given quadratic polynomial.**

**Q 3. The graph of the given quadratic polynomial cut at which points on the *X*-axis?**

***OR***

**The graph of the given quadratic polynomial cut at which point on *Y*-axis?**

## Solutions

1. The graph of a quadratic polynomial is a parabola which open upwards.

2. The zeroes of the quadratic polynomial $p(x) = -8 - 2x + x^2$ are *x*-coordinates of the points where the graph intersects the *X*-axis.

   From the given graph, −2 and 4 are the *x*-coordinates of the points where the graph of $p(x) = -8 - 2x + x^2$ intersects the *X*-axis.

   Hence, −2 and 4 are zeroes of $p(x) = -8 - 2x + x^2$.

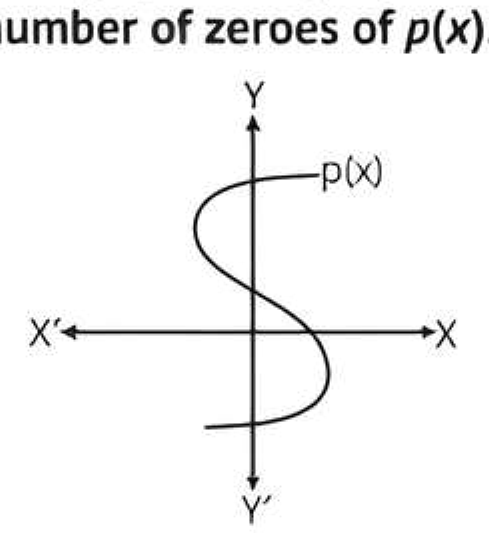
3. The graph of the given quadratic polynomial cut *X*-axis at points (−2, 0) and (4, 0).

   *OR*

   The graph of the given quadratic polynomial cut *Y*-axis at point (0, −8).

## Very Short Answer Type Questions

**Q 1. In figure, the graph of a polynomial $p(x)$ is shown. Find the number of zeroes of $p(x)$.** *[CBSE 2016]*




**Q 2. If the sum of the zeroes of the polynomial $p(x) = (k^2 - 14)\,x^2 - 2x - 12$ is 1, then find the value of *k*.** *[CBSE 2017]*

**Q 3. Find the polynomial whose zeroes are $\sqrt{\frac{3}{2}}, -\sqrt{\frac{3}{2}}$.**

**Q 4. If $\alpha$ and $\beta$ are the zeroes of a polynomial such that $\alpha + \beta = -6$ and $\alpha\beta = 5$, then find the polynomial.** *[CBSE 2016]*

**Q 5. If both the zeroes of the quadratic polynomial $ax^2 + bx + c$ are equal and opposite in sign, then find the value of *b*.** *[V. Imp.]*

**Q 6. If (−3) is one of the zeroes of the polynomial $(k - 1)\,x^2 + kx + 1$, find the value of *k*.** *[CBSE 2023]*

**Q 7. If $(x - a)$ is a factor of $p(x) = x^3 - ax^2 + 6 - a$, then find $p(a)$.**

**Q 8. If one zero of the polynomial $p(x) = 6x^2 + 37x - (k - 2)$ is reciprocal of the other, then find the value of *k*.** *[CBSE 2023]*

## Short Answer Type-I Questions

**Q 1. A teacher asked 10 of his students to write a polynomial in one variable on a paper and then to handover the paper. The following were the answers given by the students:** *[CBSE 2020]*

$2x + 3,\ 3x^2 + 7x + 2,\ 4x^3 + 3x^2 + 2,\ x^3 + \sqrt{3x} + 7,$

$7x + \sqrt{7},\ 5x^3 - 7x + 2,\ 2x^2 + 3 - \frac{5}{x},\ 5x - \frac{1}{2},$

$ax^3 + bx^2 + cx + d,\ x + \frac{1}{x}$

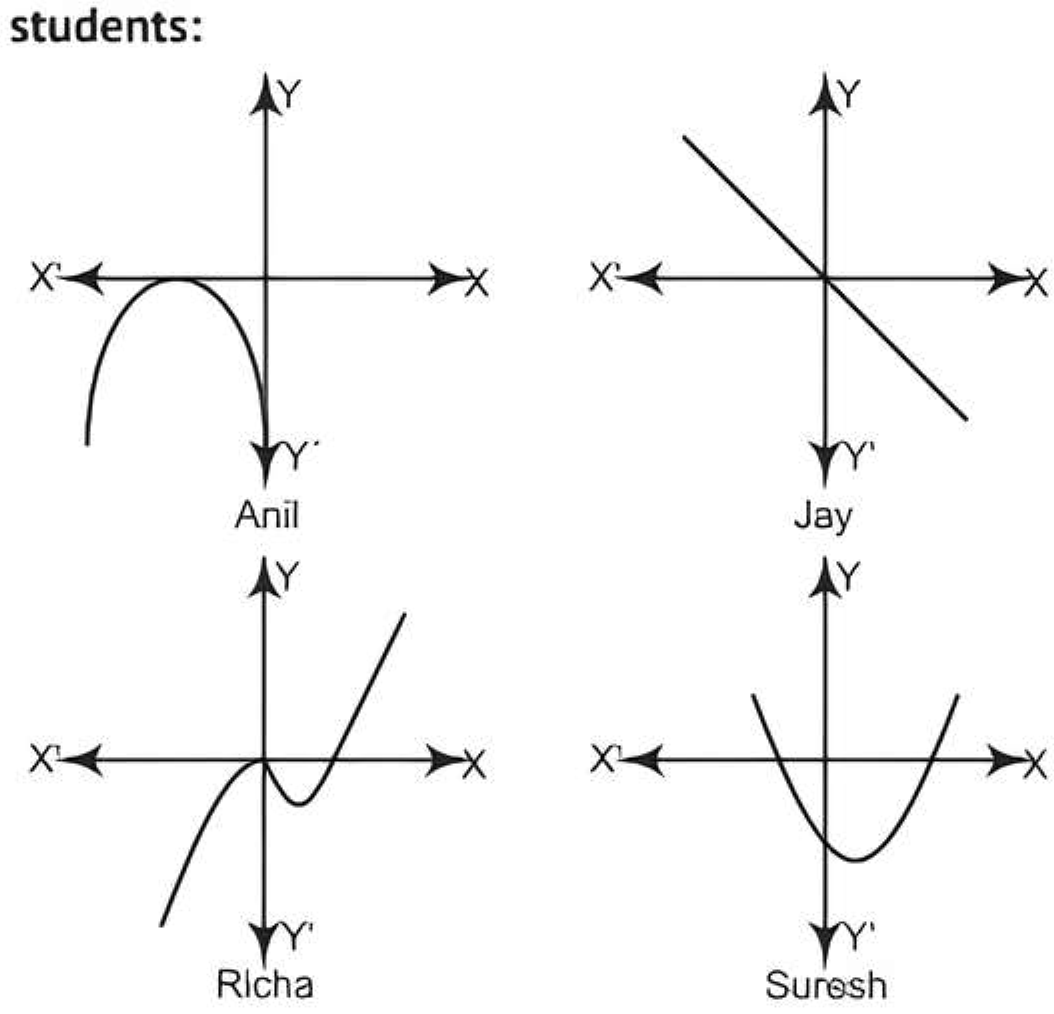
**Answer the following questions:**

**(i) How many of the above ten, are not polynomials?**

**(ii) How many of the above ten, are quadratic polynomials?**

**Q 2. *Read the following passage and answer the questions that follows:***

**In a classroom, four students Anil, Jay, Richa and Suresh were asked to draw the graph of $y = ax^2 + bx + c$. Following graphs are drawn by the students:**



(i) How many students have drawn the graph correctly?

(ii) Which type of polynomial is represented by Jay's graph?

**Q 3.** Find a quadratic polynomial whose zeroes are $\frac{3+\sqrt{5}}{5}$ and $\frac{3-\sqrt{5}}{5}$.

**Q 4.** Find the condition that zeroes of polynomial $p(x) = ax^2 + bx + c$ are reciprocal of each other. [CBSE 2017]

**Q 5.** If $\alpha$ and $\beta$ are the zeroes of $p(x) = 4x^2 + 3x + 7$, then find $\frac{1}{\alpha} + \frac{1}{\beta}$.

**Q 6.** If $\alpha$ and $\beta$ are the zeroes of the polynomial $x^2 - 5x + k$ such that $\alpha - \beta = 1$, find the value of $k$.

**Q 7.** If $\alpha$, $\beta$ are zeroes of quadratic polynomial $5x^2 + 5x + 1$, find the value of:

(i) $\alpha^2 + \beta^2$ (ii) $\alpha^{-1} + \beta^{-1}$ [CBSE SQP 2023-24]

**Q 8.** If $(x + a)$ is a factor of $2x^2 + 2ax + 5x + 10$, then find $a$. [CBSE 2016]

**Q 9.** If one zero of the polynomial $x^2 + 11x + k$ is $-3$, then find the value of $k$ and the other zero. [CBSE 2016]

## Short Answer Type-II Questions

**Q 1.** Find the zeroes of the quadratic polynomial $4s^2 - 4s + 1$ and verify the relationship between the zeroes and the coefficients. [CBSE SQP 2023-24]

**Q 2.** Find the zeroes of the polynomial $p(x) = 3x^2 + 5x - 28$ and verify the relationship between its coefficients and zeroes. [CBSE 2023]

**Q 3.** Find the quadratic polynomial, sum and product of whose zeroes are $-1$ and $-20$ respectively. Also, find the zeroes of the polynomial so obtained. [CBSE 2019]

**Q 4.** If one zero of polynomial $(a^2 + 9)\,x^2 + 13x + 6a$ is reciprocal of the other, find the value of $a$. [CBSE 2015]

**Q 5.** If $\alpha$ and $\beta$ are the zeroes of $x^2 - x - 2$, form a quadratic polynomial whose zeroes are $2\alpha + 1, 2\beta + 1$. [CBSE 2016]

**Q 6.** If $\alpha$, $\beta$ are zeroes of the quadratic polynomial $x^2 + 3x + 2$, find a quadratic polynomial whose zeroes are $\alpha + 1, \beta + 1$. [CBSE 2023]

## Long Answer Type Questions

**Q 1.** $\alpha$, $\beta$ are the zeroes of the quadratic polynomial $p(x) = x^2 - 8x + k$, such that $\alpha^2 + \beta^2 = 40$. Find the value of $k$. [CBSE 2023]

**Q 2.** Find the value of '$k$' such that the polynomial $p(x) = 3x^2 + 2kx + x - k - 5$ has the sum of zeroes equal to half of their product. [CBSE 2023]

**Q 3.** If $\alpha$ and $\beta$ are the zeroes of the quadratic polynomial $f(x) = kx^2 + 4x + 4$ such that $\alpha^2 + \beta^2 = 24$, find the value of $k$.

**Q 4.** If $\alpha$ and $\beta$ are the zeroes of the quadratic polynomial $f(x) = x^2 - 4x + 3$, find the value of $(\alpha^4\beta^2 + \alpha^2\beta^4)$. [CBSE 2019]

# Solutions

## Very Short Answer Type Questions

1.

**TR!CK**

*The zeroes of the polynomial are the x-coordinates of those points where its graph touches or intersects the X-axis.*

The number of zeroes of $p(x)$ is 1 as the graph intersects $X$-axis at one point.

**2.** Given, $p(x) = (k^2 - 14)\,x^2 - 2x - 12$

Also, sum of zeroes = 1 (given)

$\Rightarrow \quad -\frac{\text{Coefficient of } x}{\text{Coefficient of } x^2} = 1$

$\Rightarrow \quad \frac{-(-2)}{k^2 - 14} = 1$

$\Rightarrow \quad k^2 - 14 = 2$

$\Rightarrow \quad k^2 = 16$

$\Rightarrow \quad k = \pm 4$

**3.** The given zeroes are $\sqrt{\frac{3}{2}}, -\sqrt{\frac{3}{2}}$.

Required quadratic polynomial,

$p(x) = k[x^2 - (\text{Sum of zeroes})\,x + \text{Product of zeroes}]$

where $k$ is the arbitrary constant.

$$= k\left[x^2 - \left(\sqrt{\frac{3}{2}} - \sqrt{\frac{3}{2}}\right)x + \left(\sqrt{\frac{3}{2}}\right)\cdot\left(-\sqrt{\frac{3}{2}}\right)\right]$$

$$= k\left[x^2 - 0\cdot x - \frac{3}{2}\right] = k\left(x^2 - \frac{3}{2}\right)$$

$\therefore \quad p(x) = \frac{2}{2}(2x^2 - 3) = 2x^2 - 3$, where $k = 2$.

**4.** Given, $\alpha + \beta = -6$ and $\alpha\beta = 5$.

Required quadratic polynomial,

$p(x) = k[x^2 - (\text{sum of zeroes})\,x + \text{product of zeroes}]$

where $k$ is the arbitrary constant.

$= k[x^2 - (\alpha + \beta)\,x + \alpha\beta]$

$= k[x^2 - (-6)\,x + 5]$

$\therefore\ p(x) = x^2 + 6x + 5$, where $k = 1$.

5. Let $\alpha$ and $-\alpha$ be the zeroes of given polynomial.

$\because$ Sum of zeroes $= -\frac{b}{a} = -\frac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$

$\therefore \quad \alpha + (-\alpha) = \frac{-b}{a}$

$\Rightarrow \quad 0 = \frac{-b}{a} \Rightarrow b = 0$

6. Given, one zero of polynomial is $-3$.

**TiP**

*A real number a is said to be a zero of a polynomial $p(x) = ax^2 + bx + c$, if $a\alpha^2 + b\alpha + c = 0$.*

On substituting $-3$ in given polynomial, we get

$(k-1)(-3)^2 + k(-3) + 1 = 0$

$\Rightarrow \quad 9k - 9 - 3k + 1 = 0$

$\Rightarrow \quad 6k - 8 = 0 \quad \Rightarrow \quad 6k = 8$

$\Rightarrow \quad k = \frac{8}{6} \quad \Rightarrow \quad k = \frac{4}{3}$

7. Given, $p(x) = x^3 - ax^2 + 6 - a$

Since, $(x - a)$ is a factor of $p(x)$.

Therefore, $p(a) = a^3 - a \times a^2 + 6 - a$
$= a^3 - a^3 + 6 - a = 6 - a$

8. Given polynomial, $p(x) = 6x^2 + 37x - (k-2)$

Let $\alpha$ and $\beta$ be the zeroes of $p(x)$.

According to question, $\beta = \frac{1}{\alpha}$

$\therefore$ Product of zeroes $= (-1)^2 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^2}$

$\Rightarrow \quad \alpha \cdot \frac{1}{\alpha} = 1 \times \frac{-(k-2)}{6}$

$\Rightarrow \quad 6 = -k + 2 \Rightarrow k = 2 - 6 = -4$

## Short Answer Type-I Questions

1. (i) $x^3 + \sqrt{3x} + 7$, $2x^2 + 3 - \frac{5}{x}$ and $x + \frac{1}{x}$ are not polynomials, because these polynomials contains negative integral powers or fractional powers. So, there are 3 expressions which are not polynomials.

(ii)

**TiP**

*A polynomial whose degree is 2, is a quadratic polynomial. General form of quadratic polynomial is $ax^2 + bx + c, a \neq 0$.*

$3x^2 + 7x + 2$ is only a quadratic polynomial. So, there are only 1 quadratic polynomial.

2. (i)

**TR!CK**

*For any quadratic polynomial $ax^2 + bx + c$, the graph of the corresponding equation has one of the two shapes either open upwards like $\cup$ or open downwards like $\cap$.*

So, Anil and Suresh have drawn the correct graph. Hence, two students have drawn the graph correctly.

(ii) Linear polynomial is represented by Jay's graph.

3. $\because$ Sum of zeroes $= \frac{3+\sqrt{5}}{5} + \frac{3-\sqrt{5}}{5}$
$= \frac{3+\sqrt{5}+3-\sqrt{5}}{5} = \frac{6}{5}$

and product of zeroes $= \left(\frac{3+\sqrt{5}}{5}\right)\left(\frac{3-\sqrt{5}}{5}\right)$

$= \frac{(3)^2 - (\sqrt{5})^2}{25} = \frac{9-5}{25} = \frac{4}{25}$

$\therefore$ Required quadratic polynomial,

$p(x) = k[x^2 - (\text{sum of zeroes})\, x + \text{product of zeroes}]$

$= k\left[x^2 - \left(\frac{6}{5}\right)x + \left(\frac{4}{25}\right)\right] = \frac{k}{25}(25x^2 - 30x + 4)$

$\Rightarrow p(x) = (25x^2 - 30x + 4)$

where, $k = 25 \in R$ is an arbitrary constant.

4. Let one zero of the polynomial $p(x)$ be $\alpha$. Then other will be $\frac{1}{\alpha}$.

Now, product of zeroes $= (-1)^2 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^2}$

$\Rightarrow \quad \alpha \cdot \frac{1}{\alpha} = 1 \cdot \frac{c}{a} \Rightarrow 1 = \frac{c}{a}$

$\therefore \quad a = c$

Hence, required condition is

Coefficient of $x^2$ = Constant term

5. Given, $p(x) = 4x^2 + 3x + 7$

Sum of zeroes $= \alpha + \beta = (-1) \cdot \frac{\text{Coefficient of } x}{\text{Coefficient of } x^2} = -\frac{3}{4}$

Product of zeroes $= \alpha\beta = (-1)^2 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^2} = \frac{7}{4}$

Now, $\frac{1}{\alpha} + \frac{1}{\beta} = \frac{\beta + \alpha}{\alpha\beta} = \frac{-3/4}{7/4} = -\frac{3}{7}$

6. Given, $p(x) = x^2 - 5x + k$ and its zeroes are $\alpha$ and $\beta$.

Sum of zeroes $= \alpha + \beta = (-1) \cdot \frac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$

$\therefore \quad \alpha + \beta = \frac{-(-5)}{1} = 5$ ...(1)

Product of zeroes $= \alpha\beta = (-1)^2 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^2}$

$\therefore \quad \alpha\beta = \frac{k}{1} = k$ ...(2)

But $\quad \alpha - \beta = 1$ (given) ...(3)

Using identity,

$(\alpha - \beta)^2 = (\alpha + \beta)^2 - 4\alpha\beta$

$\Rightarrow \quad (1)^2 = (5)^2 - 4k$

[from eqs. (1), (2) and (3)]

$\Rightarrow \quad 1 = 25 - 4k$

$\Rightarrow \quad 4k = 24$

$\therefore \quad k = \frac{24}{4} = 6$

**7.** Given, α and β are the zeroes of the polynomial

$p(x) = 5x^2 + 5x + 1.$

$\therefore \quad \alpha + \beta = (-1) \cdot \frac{\text{Coefficient of } x}{\text{Coefficient of } x^2} = -\frac{5}{5} = -1$

and $\quad \alpha\beta = (-1)^2 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^2} = 1 \times \frac{1}{5} = \frac{1}{5}$

(i) $\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\,\alpha\beta = (-1)^2 - 2\left(\frac{1}{5}\right) = 1 - \frac{2}{5} = \frac{3}{5}$

(ii) $\alpha^{-1} + \beta^{-1} = \frac{1}{\alpha} + \frac{1}{\beta} = \frac{\alpha + \beta}{\alpha\beta} = \frac{-1}{(1/5)} = -5$

**8.** Given, $(x + a)$ is a factor of $2x^2 + 2ax + 5x + 10$.

Then, $x + a = 0$ must satisfy $2x^2 + 2ax + 5x + 10 = 0$.

Consider, $\quad x + a = 0$

*i.e.*, $\quad x = -a$

On substituting the value of '$x$' in given polynomial, we get

$2(-a)^2 + 2a(-a) + 5(-a) + 10 = 0$

$\Rightarrow \quad 2a^2 - 2a^2 - 5a + 10 = 0$

$\Rightarrow \quad -5a = -10$

$\Rightarrow \quad a = \frac{-10}{-5}$

$\Rightarrow \quad a = 2$

**9.** One zero of given polynomial is –3.

**TiP**

*A real number α is said to be a zero of a polynomial p(x), if p(α) = 0.*

On substituting –3 in given polynomial, we get

$(-3)^2 + 11(-3) + k = 0$

$\Rightarrow \quad 9 - 33 + k = 0$

$\Rightarrow \quad k - 24 = 0$

$\Rightarrow \quad k = 24$

$\therefore$ Polynomial, $p(x) = x^2 + 11x + 24$

$= x^2 + 8x + 3x + 24$

(by splitting the middle term)

$= x\,(x + 8) + 3\,(x + 8)$

$= (x + 8)\,(x + 3)$

For zeroes, $(x + 3)\,(x + 8) = 0$

$\Rightarrow \quad x + 3 = 0 \quad$ or $\quad x + 8 = 0$

$\Rightarrow \quad x = -3 \quad$ or $\quad x = -8$

Hence, the other zero is –8.

## Short Answer Type-II Questions

**1.** Let polynomial, $p(s) = 4s^2 - 4s + 1$

$= (2s)^2 - 2 \cdot (2s) \cdot 1 + (1)^2$

$= (2s - 1)^2 \quad [\because a^2 - 2ab + b^2 = (a - b)^2]$

$= (2s - 1)\,(2s - 1)$

For zeroes, $p(s) = 0$

$\therefore \quad (2s - 1)\,(2s - 1) = 0$

$\Rightarrow \quad s = \frac{1}{2}, \frac{1}{2}$

**Verification:**

Sum of zeroes $= \frac{1}{2} + \frac{1}{2} = 1 = \frac{4}{4} = (-1) \cdot \frac{(-4)}{4}$

$= (-1) \cdot \frac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$

Product of zeroes $= \frac{1}{2} \times \frac{1}{2} = \frac{1}{4} = (-1) \cdot \frac{(1)}{4}$

$= (-1)^2 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^2}$

Hence, the relationship between the zeroes and the coefficients is verified.

**2.** Given, $\quad p(x) = 3x^2 + 5x - 28$

$= 3x^2 + 12x - 7x - 28$

$= 3x\,(x + 4) - 7\,(x + 4) = (x + 4)\,(3x - 7)$

For zeroes, $p(x) = 0$

$\therefore \quad (x + 4)\,(3x - 7) = 0$

$\Rightarrow \quad x = -4,\ x = \frac{7}{3}$

**Verification:**

Sum of zeroes $= -4 + \frac{7}{3} = \frac{-12 + 7}{3} = \frac{-5}{3} = (-1) \cdot \left(\frac{5}{3}\right)$

$= (-1) \cdot \frac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$

Product of zeroes $= (-4) \times \left(\frac{7}{3}\right) = -\frac{28}{3} = (-1)^2 \cdot \frac{(-28)}{3}$

$= (-1)^2 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^2}$

Hence, the relationship between the zeroes and the coefficients is verified.

**3.** If α and β are the zeroes of the quadratic polynomial $f(x)$, then

$f(x) = x^2 - (\alpha + \beta)\,x + \alpha \cdot \beta \qquad \ldots(1)$

Given, sum of zeroes $= \alpha + \beta = -1$

and product of zeroes $= \alpha\beta = -20$

$\therefore$ From eq. (1),

$f(x) = x^2 - (-1)x - 20 = x^2 + x - 20$

$= x^2 + 5x - 4x - 20$

$= x(x + 5) - 4(x + 5)$

$= (x + 5)\,(x - 4)$

The value of $f(x)$ will be zero, when $x + 5 = 0$ or $x - 4 = 0$

*i.e.*, when $x = -5$ or $x = 4$

So, the zeroes of $f(x)$ are $-5$ and 4.

4. Given, $p(x) = (a^2+9)x^2 + 13x + 6a$.

Let one zero be $\alpha$, then other zero will be $\frac{1}{\alpha}$.

$\therefore$ Product of zeroes $= \alpha \times \frac{1}{\alpha} = (-1)^2 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^2}$

$\Rightarrow \quad 1 = \frac{6a}{a^2+9}$

or $\quad a^2 + 9 = 6a$

$\Rightarrow \quad a^2 - 6a + 9 = 0 \Rightarrow a^2 - 2 \times 3 \times a + (3)^2 = 0$

**TR!CK**

$x^2 - 2xy + y^2 = (x-y)^2$

$\Rightarrow \quad (a-3)^2 = 0$

$\Rightarrow \quad a = 3$

Hence, the value of $a$ is 3.

5. Let polynomial $f(x) = x^2 - x - 2$

As, $\alpha$ and $\beta$ are the zeroes of $f(x)$.

$\therefore$ Sum of zeroes $= \alpha + \beta$

$= (-1) \cdot \frac{\text{Coefficient of } x}{\text{Coefficient of } x^2} = -\frac{(-1)}{1} = 1$

and product of zeroes $= \alpha\beta$

$= (-1)^2 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^2} = \frac{(-2)}{1} = -2$

For the given zeroes $(2\alpha+1)$ and $(2\beta+1)$.

Sum of zeroes $= (2\alpha+1) + (2\beta+1) = 2(\alpha+\beta) + 2$

$= 2(1) + 2 = 2 + 2 = 4$

and product of zeroes $= (2\alpha+1)\cdot(2\beta+1)$

$= 4\alpha\beta + 2\beta + 2\alpha + 1$

$= 4\alpha\beta + 2(\alpha+\beta) + 1$

$= 4(-2) + 2(1) + 1$

$= -8 + 2 + 1 = -5$

Hence, the required polynomial,

$p(x) = k[x^2 - (\text{Sum of zeroes})\,x + (\text{Product of zeroes})]$

where, $k$ is an arbitrary constant.

$p(x) = k[x^2 - ((2\alpha+1) + (2\beta+1))x - (2\alpha+1)\cdot(2\beta+1)]$

$= k(x^2 - 4x - 5)$

6. Let polynomial, $p(x) = x^2 + 3x + 2$

As, $\alpha$ and $\beta$ are the zeroes of $p(x)$.

$\therefore$ Sum of the zeroes $= \alpha + \beta$

$= (-1) \cdot \frac{\text{Coefficient of } x}{\text{Coefficient of } x^2} = (-1) \cdot \frac{3}{1} = -3$

and product of zeroes $= \alpha\beta$

$= (-1)^2 \cdot \frac{\text{Constant term}}{\text{Coefficient of } x^2} = \frac{2}{1} = 2$

For the given zeroes $(\alpha+1)$ and $(\beta+1)$.

Sum of zeroes $= (\alpha+1) + (\beta+1) = (\alpha+\beta) + 2$

$= -3 + 2 = -1$

and product of zeroes $= (\alpha+1)\cdot(\beta+1)$

$= \alpha\beta + (\alpha+\beta) + 1$

$= 2 - 3 + 1 = 3 - 3 = 0$

Hence, the required polynomial,

$f(x) = k\,[x^2\,(\text{Sum of zeroes})\,x + (\text{Product of zeroes})]$

where, $k$ is an arbitrary constant.

$\Rightarrow f(x) = k\,[x^2 - (-1)x + 0] = k^2(x^2 + x)$

## Long Answer Type Questions

1. Given that $\alpha$ and $\beta$ are the zeroes of the quadratic polynomial $p(x) = x^2 - 8x + k$.

$\therefore \alpha + \beta = (-1) \cdot \frac{(-8)}{1} = 8$ and $\alpha\beta = (-1)^2 \cdot \frac{k}{1} = k$

Also, given $\alpha^2 + \beta^2 = 40$

**TR!CK**

$\alpha^2 + \beta^2 = (\alpha+\beta)^2 - 2\alpha\beta$

$\therefore \quad (\alpha+\beta)^2 - 2\alpha\beta = 40$

$(8)^2 - 2k = 40$

$\Rightarrow \quad 64 - 2k = 40$

$\Rightarrow \quad 2k = 64 - 40 = 24$

$\therefore \quad k = \frac{24}{2} = 12$

2. Let $\alpha$ and $\beta$ be the zeroes of the quadratic polynomial

$p(x) = 3x^2 + 2kx + x - k - 5$

$= 3x^2 + (2k+1)x - (k+5)$

$\alpha + \beta = (-1) \cdot \frac{2k+1}{3} = -\frac{2k+1}{3}$

and $\quad \alpha \cdot \beta = (-1)^2 \cdot \frac{-(k+5)}{3} = -\frac{k+5}{3}$

According to question,

Sum of the zeroes $= \frac{1}{2} \times$ product of the zeroes

$\therefore \quad (\alpha+\beta) = \frac{1}{2}(\alpha\beta)$

$\Rightarrow \quad -\frac{2k+1}{3} = \frac{1}{2} \times \frac{-(k+5)}{3}$

$\Rightarrow \quad 2(2k+1) = k+5$

$\Rightarrow \quad 4k + 2 = k + 5$

$\Rightarrow \quad 4k - k = 5 - 2$

$\Rightarrow \quad 3k = 3$

$\therefore \quad k = \frac{3}{3} = 1$

3. Given that $\alpha$ and $\beta$ are the zeroes of the quadratic polynomial $f(x) = kx^2 + 4x + 4$.

$\therefore \quad \alpha + \beta = -\frac{4}{k}$ and $\alpha\beta = \frac{4}{k}$

Also, given $\alpha^2 + \beta^2 = 24$

**TR!CK**

$\alpha^2 + \beta^2 = (\alpha+\beta)^2 - 2\alpha\beta$

$\therefore \quad (\alpha+\beta)^2 - 2\alpha\beta = 24$

$\Rightarrow \quad \left(-\frac{4}{k}\right)^2 - 2\times\frac{4}{k} = 24$

$\Rightarrow \quad \frac{16}{k^2} - \frac{8}{k} = 24$

$\Rightarrow \quad 16 - 8k = 24k^2$

$\Rightarrow \quad 3k^2 + k - 2 = 0$

$\Rightarrow \quad 3k^2 + 3k - 2k - 2 = 0$

$\Rightarrow \quad 3k(k+1) - 2(k+1) = 0$

$\Rightarrow \quad (k+1)(3k-2) = 0$

$\Rightarrow \quad k+1 = 0 \quad \text{or} \quad 3k - 2 = 0$

$\Rightarrow \quad k = -1 \quad \text{or} \quad k = 2/3$

Hence, $k = -1$ or $k = 2/3$

**4.** Given, $f(x) = x^2 - 4x + 3$

On comparing with $ax^2 + bx + c$, we get

$a = 1, b = -4, c = 3$

Sum of zeroes $= \alpha + \beta = (-1)\cdot\frac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$

$= \frac{-b}{a} = \frac{-(-4)}{1} = 4$

and product of zeroes $= \alpha\beta = (-1)^2\cdot\frac{\text{Constant term}}{\text{Coefficient of } x^2}$

$= \frac{c}{a} = \frac{3}{1} = 3$

Now, $\alpha^4\beta^2 + \alpha^2\beta^4 = \alpha^2\beta^2(\alpha^2 + \beta^2)$

$= \alpha^2\beta^2[(\alpha+\beta)^2 - 2\alpha\beta]$

**TR!CK**

$(\alpha+\beta)^2 = \alpha^2 + \beta^2 + 2\alpha\beta$

$= (\alpha\beta)^2[(\alpha+\beta)^2 - 2\alpha\beta]$

$= (3)^2[(4)^2 - 2(3)] = 9[16 - 6]$

$= 9(10) = 90$

# Chapter Test

## Multiple Choice Questions

**Q 1. The zeroes of quadratic polynomial $x^2 + 55x + 30$ are:**

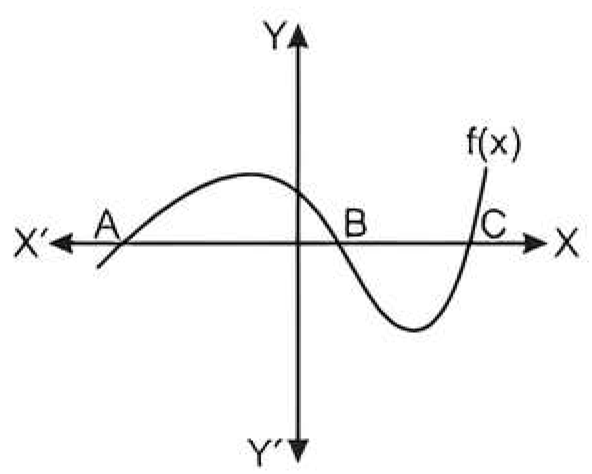
a. both positive

b. both negative

c. reciprocal of each other

d. one positive and one negative

**Q 2. In the given figure, the number of zeroes of the polynomial $f(x)$ are:**




a. 3 b. 2 c. 1 d. 0

## Assertion and Reason Type Questions

**Directions (Q. Nos. 3-4):** *In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option:*

a. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

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

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

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

**Q 3. Assertion (A): If one zero of polynomial $p(x) = (k^2 + 4)x^2 + 13x + 4k$ is reciprocal of other, then $k = 3$.**

**Reason (R): If $(x - \alpha)$ is a factor of $p(x)$, then $p(\alpha) = 0$.**

**Q 4. Assertion (A): $g(x) = 3x^2 - \frac{5}{x} + 8$ is a polynomial in the variable $x$ of degree 2.**

**Reason (R): The highest power of $x$ in a polynomial $g(x)$ is called the degree of the polynomial $f(x)$.**

## Fill in the Blanks

**Q 5. The number of quadratic polynomial whose zeroes are 3 and −5, is ................**

**Q 6. The parabola representing a quadratic polynomial $f(x) = ax^2 + bx + c$ opens upward when ................**

## True/False

**Q 7. A cubic polynomial can have atmost three zeroes.**

**Q 8. The zeroes of polynomial $p(x)$ are precisely the $x$-coordinate of the points, where the graph of $y = p(x)$ intersect the $X$-axis.**

## Case Study Based Question

**Q 9.** The below pictures show few natural examples of parabolic shape which can be represented by a quadratic polynomial. A parabolic arch is an arch in the shape of a parabola. In structures, there curves helps in fact loading and delivering that is why there curves are found in bridges and in architecture.

*Based on the given information, solve the following questions:*

(i) In the standard form of quadratic polynomial $ax^2 + bx + c$, $a$, $b$ and $c$ write the nature of

(ii) Write the maximum number of zeroes of quadratic polynomial.

(iii) If $\alpha$ and $\frac{1}{\alpha}$ are the zeroes of the quadratic polynomial $2x^2 - x + 8k$, then find the value of $k$.

*OR*

(iv) If the sum of the zeroes is $-p$ and product of the zeroes is $-\frac{1}{p}$, then find the quadratic polynomial.

## Very Short Answer Type Questions

Q 10. Find the value of $k$, if the product of the zeroes of $x^2 - 3kx + 2k^2 - 1$ is 7.

Q 11. If the sum of the zeroes of the polynomial $f(x) = 2x^3 - 3kx^2 + 4x + 5$ is 6, then find the value of $x$.

## Short Answer Type-I Questions

Q 12. If $(x + 3)$ is a factor of $2x^2 + 3bx + 7 = 0$, then find the value of $b$.

Q 13. If $\alpha$ and $\beta$ are the zeroes of the polynomial $f(x) = 2x^2 + 5x + k$ satisfying the relation $\alpha^2 + \beta^2 + \alpha\beta = \frac{21}{4}$, then find the value of $k$ for this to be possible.

## Short Answer Type-II Questions

Q 14. It is given that 1 is one of the zero of the polynomial $7x - x^3 - 6$. Find its other zero.

Q 15. If $\alpha$ and $\beta$ are the zero of the quadratic polynomial $f(x) = 2x^2 - 5x + 7$, find a polynomial whose zeroes are $2\alpha + 3\beta$ and $3\alpha + 2\beta$.

## Long Answer Type Question

Q 16. Find the zeroes of the polynomial $p(x) = x^2 + 2\sqrt{2}x - 6$ and also verify the relation between the zeroes and their coefficient.