

Chapter -4 Quadratic Equation

- ❖ Introduction
- ❖ Methods to find the solution of Quadratic Equations.
- ❖ Relation between the Roots and the co-efficient.
- ❖ Nature of the Roots.
- ❖ Formation of Quadratic Equation when the Roots are known.
- ❖ Equations Reducible to Quadratic Form.
- ❖ Application of Quadratic Equations in solving practical problems.

Introduction: A polynomial of the form $P(x) = ax^2 + bx + c$, where the highest index of power of the variable x is 2 and a, b, c are real numbers; $a \neq 0$ is called a quadratic polynomial.

Equation: An algebraic equation is an equality involving constants and variables. The values of the expression on L.H.S and R.H.S are equal.

Quadratic Equation: An equation $P(x) = 0$, where $P(x)$ is a quadratic polynomial is called a quadratic equation. The general form of quadratic equation is $ax^2 + bx + c = 0$, where a, b, c are real constants, $a \neq 0$ and x is a real variable.

Equation and Identity: The main difference between equation and an identity is that equation is true for the number of values of unknowns equal to the degrees of the variable involved.

If it is true for the number of values more than degree of an equation, then it will turn out to be an identity.

Roots of Quadratic equation:

A quadratic equation has only two roots. The value of x satisfying a quadratic equation known as the roots of the quadratic equation. Thus if α and β be the zero's of quadratic polynomial $P(x)$, then they are the roots of the quadratic equation $P(x) = 0$

Methods of finding the solution of Quadratic equations

1. Factorisation Method

2. Method of completing the square.
3. Quadratic Formula method
4. Converting all quadratic equations to the form $ax^2+c=0$ (Through Examples only)

1. FACTORISATION METHOD:

- ❖ Write the given quadratic equation in standard form $ax^2+bx+c=0$
- ❖ Splitting Middle term `b` i.e. find numbers α and β such that sum of $\alpha + \beta = b$ and product $\alpha \beta = a c$.
- ❖ Write the middle term as $\alpha x + \beta x$ and factorise the quadratic equation, let factors be $(lx+p)(mx+q) = 0$
- ❖ Now equate each factor to zero and find values of x .
- ❖ These values of x are required roots of the given quadratic equation.

A. Method of completing the square.

Solution: Let quadratic equation in standard form be

$$ax^2 + bx + c = 0 \quad \text{Transfer } c \text{ on R.H.S}$$

$$\text{or } ax^2 + bx = -c \quad \text{Dividing both sides by 'a'}$$

$$\text{or } x^2 + \frac{b}{a}x = -\frac{c}{a} \quad \left| \begin{array}{l} \text{Adding square of half of the} \\ \text{Co-efficient of } x \text{ i.e. } \left(\frac{b}{2a}\right)^2 \text{ on both sides.} \end{array} \right.$$

$$\text{or } x^2 + \frac{b}{a}x + \left(\frac{b}{2a}\right)^2 = -\frac{c}{a} + \left(\frac{b}{2a}\right)^2$$

$$\text{or } x^2 + 2 \cdot \left(\frac{b}{2a}\right)x + \left(\frac{b}{2a}\right)^2 = \frac{b^2}{4a^2} - \frac{c}{a}$$

$$\text{or } \left(x + \frac{b}{2a}\right)^2 = \frac{b^2 - 4ac}{4a^2} \quad \left| \begin{array}{l} \text{By writing L.H.S as a perfect square} \end{array} \right.$$

Taking square root on both sides.

$$\text{Or } x + \frac{b}{2a} = \pm \frac{\sqrt{b^2-4ac}}{2a}$$

$$\text{Or } x = -\frac{b}{2a} \pm \frac{\sqrt{b^2-4ac}}{2a} = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$

B. Method of completing the square.

Solution: let $ax^2+bx+c=0$ be a Quadratic equation
R.H.S

Transfer term 'c' on

$$\text{or } ax^2+bx = -c$$

multiplying b/s by 4a

$$\therefore 4a^2x^2+4abx = -4ac$$

Adding b^2 on both sides.

$$\text{Or } (2ax)^2+2(2ax).b+b^2 = -4ac+b^2$$

Make and write L.H.S as perfect square

$$(2ax+b)^2 = b^2 - 4ac$$

Taking square root on both sides.

$$\text{Or } \sqrt{(2ax+b)^2} = \pm \sqrt{b^2-4ac}$$

$$\text{Or } 2ax+b = \pm \sqrt{b^2-4ac}$$

$$\text{Or } 2ax = -b \pm \sqrt{b^2-4ac}$$

$$\text{Or } x = \frac{-b \pm \sqrt{b^2-4ac}}{2a} = \frac{-b \pm \sqrt{D}}{2a}$$

3. Quadratic Formula Method:

- ❖ Firstly , write the given quadratic equation in standard form $ax^2+bx+c=0$
- ❖ Write the values of a, b and c by comparing the given equation with standard form.
- ❖ Find discriminant $D=b^2-4ac$. If value of D is negative, there is no real solution

i.e. solution does not exist. If value of $D \geq 0$, the roots is real i.e. solution exists.

❖ Put the value of a, b and D in quadratic formula $x = \frac{-b \pm \sqrt{D}}{2a}$ and get the required roots/ solution.

4. Converting all quadratic equations to the form $ax^2+c=0$

A quadratic equation has four different forms viz .

1) $ax^2=0$ 2) $ax^2+bx = 0$ (3) $ax^2+c=0$ (4) $ax^2+bx+c= 0$

Where a, b , c are real numbers and $a \neq 0$

Case (I): $ax^2=0 \Rightarrow x^2 = \frac{0}{a}$ or $x.x = 0$

\Rightarrow Both roots are zero`s i.e. $x= 0 , 0$

Case (II) : $ax^2+bx= 0$ or $x(ax+b)= 0$

Either $x=0$ or $ax+b=0$

\Rightarrow Either $x=0$ or $x = - \frac{b}{a}$

Case (III) : $ax^2+c=0 \Rightarrow x^2 = - \frac{c}{a}$

Or $x = \pm \frac{\sqrt{-c}}{a}$. if c is negative, a is positive. Roots are real.

Or if `a` is negative, `c` is positive , Roots are real . Otherwise roots are imaginary.

Case (IV) : $ax^2+bx+c = 0$

Let us illustrate its solution through examples.

Example 1: $x^2-6x+8=0$

We will convert this into case (III)

Suppose roots lie around mean of roots.

$$\text{Mean of roots} = \frac{\text{sum of roots}}{\text{number of roots}} = - \left(- \frac{6}{2} \right) = \frac{6}{2} = 3$$

Let roots be $x = \text{mean} + h = 3 + h$, where h is zero, +ve or -ve real number.

Substitute value of x in given equation

$$(3+h)^2 - 6(3+h) + 8 = 0$$

$$\text{Or } 9 + h^2 + 6h - 18 - 6h + 8 = 0$$

$$\text{Or } h^2 - 1 = 0 \Rightarrow h^2 = 1 \Rightarrow h = \pm \sqrt{1} = \pm 1$$

Hence roots are $x = 3 + h = 3 \pm 1 = 3 + 1$ or $3 - 1$

i.e. $x = 4, 2$

Example 2: Let $2x^2 - 10x + 12 = 0$ be a given quadratic equation. Solve it

Solution: $2x^2 - 10x + 12 = 0$ dividing both sides by 2

$$\therefore x^2 - 5x + 6 = 0$$

Let roots be $x = \text{mean} + h = -\left(\frac{-5}{2}\right) + h = \frac{5}{2} + h$

Substitute in given equation

$$\left(\frac{5}{2} + h\right)^2 - 5\left(\frac{5}{2} + h\right) + 6 = 0 \text{ or } \frac{25}{4} + h^2 + 5h - \frac{25}{2} - 5h + 6 = 0$$

$$\text{Or } h^2 - \frac{25}{4} + 6 = 0 \text{ or } h^2 - \frac{1}{4} = 0 \Rightarrow h^2 = \frac{1}{4}$$

$$\text{Taking sq root ; } h = \pm \sqrt{\frac{1}{4}} = \pm \frac{1}{2}$$

$$\text{Roots are } = \frac{5}{2} + h = \frac{5}{2} \pm \frac{1}{2} = \frac{5-1}{2} \text{ or } \frac{5+1}{2} = 2, 3$$

Example 3: Solve $x^2 - 4x + 5 = 0$

Solution : let $x = \text{mean} + h = \frac{4}{2} + h = 2 + h$.

Substitute in given equation we get

$$(2+h)^2 - 4(2+h) + 5 = 0 \text{ or } 4 + h^2 + 4h - 8 - 4h + 5 = 0$$

Or $h^2+1=0 \Rightarrow h=\pm\sqrt{-1} \in \mathbb{R}$

\Rightarrow Given equation have no real roots

i.e. it has no solution.

Sum and Product of roots: Relation between roots and co-efficient.

❖ Solution of quadratic equation $ax^2+bx+c=0$

$$\text{Is } x = \frac{-b \pm \sqrt{b^2-4ac}}{2a} = \frac{-b \pm \sqrt{D}}{2a}$$

Where $D = b^2-4ac$ is called discriminant.

So two roots are $\frac{-b+\sqrt{D}}{2a}$ and $\frac{-b-\sqrt{D}}{2a}$

$$\text{Sum of two roots} = \frac{-b+\sqrt{D}}{2a} + \frac{-b-\sqrt{D}}{2a} = \frac{-2b}{2a}$$

$$= \frac{-b}{a} = -\left\{ \frac{\text{co-efficient of } x}{\text{co-efficient of } x^2} \right\}$$

$$\text{Product of roots} = \left[\frac{-b+\sqrt{b^2-4ac}}{2a} \right] \left[\frac{-b-\sqrt{b^2-4ac}}{2a} \right]$$

$$= (-b)^2 - \frac{(\sqrt{b^2-4ac})^2}{4a^2} = \frac{b^2-b^2+4ac}{4a^2} = \frac{4ac}{4a^2}$$

$$= \frac{c}{a} = \frac{\text{constant term}}{\text{co-efficient of } x^2} .$$

Nature of Roots: In $ax^2+bx+c=0$; $a \neq 0$ a, b, c are real numbers.

$D = b^2-4ac$ called the Discriminant. There are four cases:

Case (I) if $D=0$, then quadratic equation has two equal real roots i.e. $x = \frac{-b}{2a}$

and

$$\frac{-b}{2a}$$

Case (II) when $D > 0$ and is a perfect square, then the roots are rational (real) and distinct.

Case (III) when $D > 0$ and not a perfect square then the roots are irrational (real) and distinct.

Case (IV) when $D < 0$, then the roots are not real i.e. Real roots does not exist.

FORMATION OF A QUADRATIC EQUATION:

Let $ax^2 + bx + c = 0$ be a quadratic equation

Then $x^2 + \frac{b}{a}x + \frac{c}{a} = 0$ by dividing b/s by a

Then $x^2 - \left(\frac{-b}{a}\right)x + \frac{c}{a} = 0$

Or $x^2 - (\alpha + \beta)x + \alpha\beta = 0$

where α, β are roots of the equation

So any quadratic equation can be formed as

$$x^2 - (\text{sum of roots})x + \text{product of roots} = 0$$

Or simply remember $x^2 - Sx + P = 0$

Where 'S' is sum of roots 'P' the product of roots.

Very Short Answer Type Question (1 mark)

Q1. The roots of equation $x^2 - 3x - 10 = 0$ are (a) -2 and 5 (b) 2 and 5 (c) -2 and -5 (d) 2 and -5

Q2. Both the roots of equation $ax^2 + bx + c = 0$ are positive

If (a) $S > 0$ and $P > 0$ (b) $S < 0$ and $P < 0$

(c) $S < 0$ and $P > 0$ (d) $S > 0$ and $P < 0$

Q3. Both the roots of equation $ax^2 + bx + c = 0$ are negative if (a) $S > 0$ and $P > 0$ (b) $S < 0$

and $P < 0$

(c) $S < 0$ and $P > 0$ (d) $S > 0$ and $P < 0$

Q4. Sum of roots of equation $\sqrt{2}x^2 + 7x + 5\sqrt{2} = 0$ is

(a) $\frac{7}{\sqrt{2}}$ (b) $-\frac{7}{2\sqrt{2}}$ (c) $\frac{-7\sqrt{2}}{2}$ (d) $\frac{7\sqrt{2}}{2}$

Q5. Product of roots for equation $\sqrt{2}x^2 + 7x + 5 = 0$ is

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

Q6. If P and q are the roots of equation $x^2 - px + q = 0$

Then (a) $P = 1$; $q = -2$ (b) $P = -2$; $q = 0$ (c) $P = 0$; $q = 1$ (d) $P = 1$; $q = 0$

Q7. If the equation $x^2 + 4x + k = 0$ has real and equal roots then

(a) $K = 4$ (b) $K < 4$ (c) $K > 4$ (d) $-2 \leq k \leq 2$

Q8. If the equation $x^2 + 4x + k = 0$ has real and distinct roots then

(a) $K < 4$ (b) $K > 4$ (c) $K \leq 4$ (d) $K \geq 4$

Q9. If the equation $x^2 - ax + 1 = 0$ has two distinct roots then

(a) $|a| = 2$, (b) $|a| > 2$, (c) $|a| < 2$ (d) none of these.

Q10. A root of a quadratic equation which does not satisfy it is called (a) Real Root

(b) Un real root (c) Extraneous root (d) un defined root.

Q11. The equation $\frac{(x-a)(x-b)}{(c-a)(c-b)} + \frac{(x-b)(x-c)}{(a-b)(a-c)} + \frac{(x-c)(x-a)}{(b-c)(b-a)} = 1$

Where $a \neq b \neq c$ is true for values $x = a$, $x = b$ and $x = c$

Then this equation will be called

(a) Quadratic equation (b) Cubic equation (c) Identity (d) None of these.

Q12 (a) Match the statement under A with the statement under B

_____ A _____

_____ B _____

- (i) x^2+x+1 (a) Opens downwards in parabolic graph
And intersects x-axis at two points
- (ii) $x^2+2x+1=0$ (b) The graph in a parabola opens upwards
and intersects x-axis at two points.
- (iii) $x^2-5x+6=0$ (c) the graph opens upwards and do not touch
or intersect x-axis .
- (iv) $-x^2+2x+3=0$ (d) The graph opens downwards and do not
touch or intersect x-axis
- (v) $-x^2-x-1=0$ (e)The parabola graph of equation touches x-
axis at a single point.

Q12 (b) A polynomial equation of degree n has at the
most -----roots (fill in the blanks)

Q12 (c) The ----- of quadratic polynomial ax^2+bx+c and the ----- of a quadratic
equation $ax^2+bx+c=0$ are the same. (Fill in the blanks)

Q13. In a polynomial $P(x)$, in variable x ,such that $p(h)= 0$, then for $P(x) = 0$; h is a
root .

True / False

Q14. The graph of a quadratic equation is always a parabola

Q15. The graph of a Quadratic equation which intersect x-axis at one or two points
are called roots of quadratic equation. True/ false.

Q16. The parabola graph of a quadratic equation which intersects y-axis at one or
two points then these points are called solution or roots of equation .
True/false

Q17. If the two linear factors of a quadratic equation are taken as length and breadth
of a rectangle then the values of x at which length or breadth of rectangle is
zero (i.e area of rectangle is zero) are called roots of quadratic equation.
True/False

Q1. Find the roots of equation $2x^2-7x+3 =0$

Q2. Find the value of K for which the equation $x^2+kx+4=0$ and $x^2-8x+k=0$ will have
both real and equal roots.

- Q3. Find the value of k for which the quadratic equation $2x^2+kx+3=0$ has real and equal roots.
- Q4. If α, β are the roots of the quadratic equation $4x^2+3x+7=0$, then find the value $\frac{1}{\alpha} + \frac{1}{\beta}$
- Q5. Find the value of k for which $x=1$ is a root of the quadratic equation $kx^2+x-6=0$
- Q6. If $x=1$ and $x=2$ are roots of quadratic equation $px^2+3x+q=0$, then find the value of p and q .
- Q7. If $x^2-5x+1=0$; find the value of $x + \frac{1}{x}$?
- Q8. One root of the quadratic equation $x^2-5x+p=0$ is 2 .find the other root.
- Q9. Find the value of p so that the quadratic equation $x^2+5px+16=0$ have no real roots.
- Q10. The equation $x^2+4x+k=0$ has real and distinct roots, then find value of k
- Q11. Define degree of an equation in one variable.
- Q12. Find the sum and product of roots of quadratic equation $\sqrt{5}x^2+3x-5=0$
- Q13. Find the value of K if $x= -2$ is the root of the equation $2x^2+kx-6=0$.
- Q14. Fill in the blanks.
- (i) A quadratic equation $ax^2+bx+c=0$ has two ----- if $b^2- 4ac >0$
- (ii) Two equal roots ----- if $D= 0$
- (iii) Two equal roots if ----- = $\frac{b^2}{4a}$
15. Find the value of λ so that the equation $2x^2+\lambda x+3=0$ has equal roots.
- Q16. Find value of k for which the quadratic equation $kx^2-6x-2 = 0$ has two equal roots.
- Q17. Match column A with column B

_____ A _____

_____ B _____

(i) x^2+x+1
equation

(a) Not a quadratic

(ii) $(x+2)^2 = x^2+4x+4$

(b) equation has no real roots

(iii) $(x+2)^2 = x^2+3x+1$

(c) sum of roots=0

(iv) $x^2-6=0$

(d) This equation is an identity

LONG ANSWER TYPE (3 MARKS)

- Q1. If the equation $(a^2+b^2)x^2 - 2(ac+bd)x + c^2+d^2 = 0$ has equal roots, then show that $ad=bc$.
- Q2. Find two numbers whose sum is 27 and product is 182.
- Q3. The sum of a number and its reciprocal is $\frac{5}{2}$ find the number.
- Q4. The sum of the reciprocal of Rehman's ages (in years) 3 years ago and 5 years from now is $\frac{1}{3}$. Find his present age.
- Q5. A shopkeeper buys a number of books for Rs 80. If he had bought 4 more books for the same amount, each book would have cost Rs 1 less. How many books did he buy ?
- Q6. Out of a group of camels in a jungle, $\frac{7}{2}$ times the square root of number is playing in the jungle. The remaining two camels are drinking water from the stream. What is the total number of camels?
- Q7. If the list price of a toy is reduced by Rs 2, a person can buy 2 toys for Rs 360. find the original price of the toy.
- Q8. 300 apples are distributed equally among a certain number of students. Had there been 10 more students each would have received one apple less. Find number of students.
- Q9. If the roots of the equation $(a-b)^2x + (b-c)x + (c-a) = 0$ are equal . Prove that $b+c=2a$.
- Q10. If the roots of the equation $(c^2-ab)x^2 - 2(a^2-bc)x + (b^2-ac) = 0$ are real and equal . Show that either $a=0$ or $a^3+b^3+c^3=3abc$

- Q11. Find two consecutive odd positive integers, sum of whose squares is 290.
- Q12. A two digit number is such that the product of its digits is 12 when 36 is added to the number, the digits are reversed. Find the number.
- Q13. The sum of ages of a boy and his brother is 25 years and the product of their ages in years is 126. Find their ages.
- Q14. The side of a larger square is double the side of smaller square. The difference between areas is 432 sq cms. The sum of their perimeters is 144 cm. Find the sides of two squares.
- Q15. John and Jivanti together have 45 marbles. Both of them lost 5 marbles each and the product of the number of marbles they now have is 124. Find the number of marbles they had to start with.
16. The length and breadth of a rectangle are the factors of the polynomial $A(x) = 2x^2 - 7x + 6$. This area $A(x) = 0$ if length or breadth of a rectangle is zero. Find the value of x when length or breadth of a rectangle is zero.

VERY LONG ANSWER TYPE QUESTIONS

- Q1. Find the roots of the quadratic equation (if they exist)
By method of completing square. $2x^2 - 5x + 3 = 0$
- Q2. Solve the quadratic equation by completing square method $\frac{1}{2}x^2 - (\sqrt{2} + 1)x + \sqrt{2} = 0$
- Q3. Using quadratic formula to solve the quadratic equation $a^2b^2x^2 - (4b^4 - 3a^4)x - 12a^2b^2 = 0$
- Q4. Solve the quadratic equation by using quadratic formula. $3a^2x^2 + 8abx + 4b^2 = 0$; $a \neq 0$
- Q5. Prove that both the roots of the equation $(x-a)(x-b) + (x-c)(x-c)(x-a) = 0$ are real but they are equal only when $a=b=c$
- Q6. If the equation $(1+m^2)x^2 + 2mcx + (c^2 - a^2) = 0$ has equal roots. Prove that $c^2 = a^2(1+m^2)$
- Q7. If α, β are the roots of equation $x^2 - 5x + 6 = 0$. Form the equation whose roots are $3\alpha + 2\beta$ and $2\alpha + 3\beta$. Also explain the double answer.
- Q8. Find three consecutive positive integers such that the sum of the square of the first and the product of the other two is 154.

- Q9. A two digit number is four times the sum of digits and twice the product of its digits Find the number.
- Q10. A motor boat whose speed is 9km/h in still water , goes 15 km downstream and come back in a total time of 3 hours 45 minutes. Find the speed of the stream.
- Q11. A passenger train takes 2 hours less for a journey of 300 km, if its speed is increased by 5km/h from its usual speed. Find its usual speed.
- Q12. An aeroplane left 30 minutes later than its schedule time and in order to reach its destination 1500 km away in time .it had to increase its speed by 250 km/h from its usual speed. Determine its usual speed.
- Q13. The length of the hypotenuse of a right triangle exceeds the length of the base by 2cm and exceeds twice the length of the altitude by 1 cm .Find the length of each side of the triangle.
- Q14. If two pipes function simultaneously, a reservoir will be filled in 12 hours. one pipe fills the reservoir 10 hours faster than the other. How many hours will the second pipe take to fill the reservoir ?
- Q15. In a class test , the sum of Rahim`s marks in Mathematics and English is 40 .Had he got 3 marks more in mathematics and 4 marks less in English , the product of the marks would have been 360.find his marks in two subjects separately.
- Q16 A teacher attempting to arrange the students for mass drill in the form of a solid square found that 24 students were left. When he increased the size of the square by 1 student, he found that he was short of 25 students. Find the number of students.
- Q 17. One fourth of the herd of camels were grazing in the jungle. Twice the square root of the herd had gone to mountains and the remaining 15 camels were seen on the bank of a river. Find the total number of camels.
- Q 18. In a class test, the sum of marks by obtained by Ather in Mathematics and Science is 28. Had he got 3 more marks in Mathematics and 4 marks less in Science, the product of marks obtained in the two subjects would have been 180. Find the marks obtained by him in the two subjects separately.
- Q 19. Rs 250 were divided equally among a certain number of children. If there were 25 more children each would have received 50 paise less. Find the number of children.

Q 20. A man buys a number of pens for Rs 80. If he had bought 4 more pens for the same amount, each pen would have cost him Rs 1 less. How many pens did he buy?

Very short Answers

Q 1. (a) Q 2. (a) Q 3. (c) Q 4. (c) Q 5. (c) Q 6. (d)

Q 7. (a) Q 8. (a) Q 9. (b) Q 10. (c) Q 11. (c)

Q 12. (a) (i) → c (ii) → e (iii) → b (iv) → a (v) → d

Q 12. (b) : n Q 12. (c) zeros, Roots.

Q 13. True Q 14. True. Q 15. True Q 16. False

Q 17. True

Short Answer Type

Q 1. $\frac{1}{2}, 3$ Q 2. 16 Q 3. $\pm 2\sqrt{6}$ Q 4. $\frac{-3}{7}$ Q 5. $K = 5$

Q 6. $p = -1, q = -2$. Q 7. 5 Q 8. 3 Q 9. $\frac{-8}{5} < p < \frac{8}{5}$

Q 10. $-4 < k < 4$ Q 11. The highest power of the variable

Q 12. Sum = $\frac{-3\sqrt{5}}{5}$ product = $-\sqrt{5}$

Q 13. $K = 1$ Q 14. (i) Distinct real root (ii) Equal roots (iii) $c = \frac{b^2}{4a}$

Q 15. $\lambda = \pm 2\sqrt{6}$ Q 16. $K = \frac{-9}{2}$ Q 17. (i) ___c; (ii) ___(d)

(iii) ___(a) (iv) ___(c)

LONG ANSWER TYPE QUESTIONS

- Q2. 13, 14 Q3. $-\frac{1}{2}, 2$ Q4. 7 years Q5. 16 Q6. 16
- Q7. 18 Q8. 50 Q11. 11 and 13 Q12. 26 Q13. 18 years and 7 yrs.
- Q14. 24cm, 12cm Q15. 36 and 9 marbles Q16. $2; \frac{3}{2}$

VERY LONG ANSWER TYPE QUESTIONS

- Q1. $1; \frac{3}{2}$ Q2. $\sqrt{2} + \sqrt{3} + 1$ and $\sqrt{2} - \sqrt{3} + 1$
- Q3. $\frac{4b^2}{a^2}; \frac{3a^2}{b^2}$ Q4. $\frac{-2b}{3a}; \frac{-2b}{a}$
- Q7. $x^2 - 22x + 120 = 0$ or $x^2 - 23x + 130 = 0$
- Q8. 8,9,10 Q9. 36 Q10. 3 km /h
- Q11. 25km /h Q12. 750 km /h Q13. Sides of rt \triangle are 8 m, 15cm, 17cm.
- Q14. 30 hours Q15. Math 21, English 19 or Math = 12, English 28
- Q16. 600 students. Q17. 36 camels
- Q18. Math = 12, Science 16 or math =9, Science 19
- Q19. 100 children Q20. 16 pens

