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1. Find the value of k for which the system of linear equations $x+2y=3$, $5x+ky+7=0$ is inconsistent. [Board 2020 OD Standard]

Ans :

We have $x+2y-3=0$

and $5x+ky+7=0$

If system is inconsistent, then

$$\frac{a_1}{a_2}=\frac{b_1}{b_2}\neq\frac{c_1}{c_2}$$

From first two orders, we have

$$\frac{1}{5}=\frac{2}{k}\Rightarrow k=10$$

c235

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CHAPTER 1

REAL NUMBERS

ONE MARK QUESTIONS

1. What is the sum of exponents of prime factors in the prime-factorisation of 196 ?

Ans : [Board 2020 OD Standard]

Prime factors of 196,

$$196 = 4 \times 49$$
$$= 2^2 \times 7^2$$

a240

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

2. Find the HCF and the LCM of 12, 21, 15.

Ans : [Board 2020 Delhi Standard]

We have

$$12 = 2 \times 2 \times 3$$
$$21 = 3 \times 7$$
$$15 = 3 \times 5$$

a241

$$\text{HCF}(12, 21, 15) = 3$$
$$\text{LCM}(12, 21, 15) = 2 \times 2 \times 3 \times 5 \times 7 = 420$$

3. Explain why 13233343563715 is a composite number?

Ans : [Board Term-1 2016]

The number 13233343563715 ends in 5. Hence it is a multiple of 5. Therefore it is a composite number.

a101

4. Find the decimal representation of $\frac{11}{2^3 \times 5}$.

Ans : [Board 2020 SQP Standard]

We have $\frac{11}{2^3 \times 5} = \frac{11}{2^3 \times 5^1}$

Denominator of $\frac{11}{2^3 \times 5}$ is of the form $2^m \times 5^n$, where m , n are non- negative integers. Hence, $\frac{11}{2^3 \times 5}$ has terminating decimal expansion.

Now
$$\frac{11}{2^3 \times 5} = \frac{11}{2^3 \times 5} \times \frac{5^2}{5^2}$$
$$= \frac{11 \times 5^2}{2^3 \times 5^3} = \frac{11 \times 25}{10^3}$$
$$= 0.275$$

a242

So , it will terminate after 3 decimal places.

5. Find the LCM of smallest two digit composite number and smallest composite number.

Ans : [Board 2020 SQP Standard]

Smallest two digit composite number is 10 and smallest composite number is 4.

$$\text{LCM}(10, 4) = 20$$

a243

6. HCF of two numbers is 27 and their LCM is 162. If one of the numbers is 54, then what is the other number ?

Ans : [Board 2020 OD Basic]

Let y be the second number.

Since, product of two numbers is equal to product of LCM and HCM,

$$54 \times y = \text{LCM} \times \text{HCF}$$
$$54 \times y = 162 \times 27$$
$$y = \frac{162 \times 27}{54} = 81$$

a244

7. Find HCF of 144 and 198.

Ans : [Board 2020 Delhi Basic]

Using prime factorization method,

$$144 = 2 \times 2 \times 2 \times 2 \times 3 \times 3$$
$$= 2^4 \times 3^2$$

and
$$198 = 2 \times 3 \times 3 \times 11$$
$$= 2 \times 3^2 \times 11$$

a245

$$\text{HCF}(144, 198) = 2 \times 3^2$$
$$= 2 \times 9 = 18$$

8. Express 225 in prime factorization.

Ans : [Board 2020 Delhi Basic]

By prime factorization of 225, we have

$$225 = 3 \times 3 \times 5 \times 5$$
$$= 3^2 \times 5^2 \text{ or } 5^2 \times 3^2$$

a246

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9. The decimal expansion of $\frac{23}{2^5 \times 5^2}$ will terminate after how many places of decimal?

Ans : [Board 2020 OD Basic]

a247

$$\frac{23}{2^5 \times 5^2} = \frac{23 \times 5^3}{2^5 \times 5^2 \times 5^3}$$

$$= \frac{23 \times 125}{2^5 \times 5^5} = \frac{2875}{(10)^5}$$

$$= \frac{2875}{100000} = 0.02875$$

Hence, $\frac{23}{2^5 \times 5^2}$ will terminate after 5 five decimal places.

10. The decimal expansion of the rational number $\frac{14587}{1250}$ will terminate after how many places of decimal?

Ans : [Board 2020 Delhi Standard]

Rational number,

a248

$$\frac{14587}{1250} = \frac{14587}{2^1 \times 5^4} = \frac{14587}{2^1 \times 5^4} \times \frac{2^3}{2^3}$$

$$= \frac{14587 \times 8}{2^4 \times 5^4} = \frac{116696}{(10)^4}$$

$$= 11.6696$$

Hence, given rational number will terminate after four decimal places.

11. If two positive integers a and b are written as $a = x^3 y^2$ and $b = xy^3$, where x, y are prime numbers, then find HCF (a, b).

Ans : [Board Term -1 2014]

We have $a = x^3 y^2 = x \times x \times x \times y \times y$

$$b = xy^3 = x \times y \times y \times y$$

$$\text{HCF}(a,\ b) = \text{HCF}(x^3 y^2, xy^3)$$

$$= x \times y \times y = xy^2$$

a249

HCF is the product of the smallest power of each common prime factor involved in the numbers.

12. If two positive integers p and q can be expressed as $p = ab^2$ and $q = a^3 b$; where a, b being prime numbers, then what is the LCM of (p, q) ?

Ans : [Board Term -1 2014]

We have $p = ab^2 = a \times b \times b$

a250

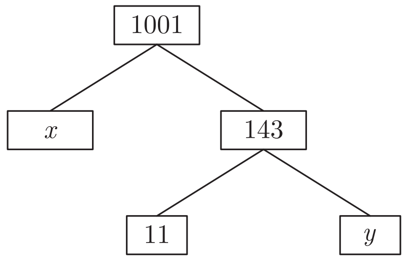
and $q = a^3 b = a \times a \times a \times b$

$$\text{LCM}(p,\ q) = \text{LCM}(ab^2, a^3 b)$$

$$= a \times b \times b \times a \times a = a^3 b^2$$

LCM is the product of the greatest power of each prime factor involved in the numbers.

13. What are the values of x and y in the given figure ?



Ans : [Board Term -1 2012]

We have $1001 = x \times 143 \Rightarrow x = 7$

$$143 = y \times 11 \Rightarrow y = 13$$

a251

Hence $x = 7,\ y = 13$

14. If $x = 0.\overline{7}$, then find $2x$.

Ans : [Board 2006]

a252

We have $x = 0.\overline{7}$

$$10x = 7.\overline{7}$$

Subtracting, $9x = 7$

$$x = \frac{7}{9}$$

$$2x = \frac{14}{9} = 1.555 \text{ ....}$$

$$= 1.\overline{5}$$

15. 1. The L.C.M. of x and 18 is 36.
2. The H.C.F. of x and 18 is 2.

What is the number x?

a253

Ans : [Board 2006]

LCM $\times$ HCF = First number $\times$ second number

Hence, required number $= \frac{36 \times 2}{18} = 4$

16. What is the HCF of smallest primer number and the smallest composite number?

Ans : [Board 2018]

Smallest prime number is 2 and smallest composite number is 4. HCF of 2 and 4 is 2.

a222

17. Write one rational and one irrational number lying between 0.25 and 0.32.

Ans : [Board 2020 SQP Standard]

Given numbers are 0.25 and 0.32.

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Clearly $0.30 = \frac{30}{100} = \frac{3}{10}$

Thus 0.30 is a rational number lying between 0.25 and 0.32. Also 0.280280028000..... has non-terminating non-repeating decimal expansion. It is an irrational number lying between 0.25 and 0.32.

a223

18. If HCF(336, 54) = 6, find LCM(336, 54).

Ans : [Board 2019 OD]

$$\text{HCF} \times \text{LCM} = \text{Product of number}$$

$$6 \times \text{LCM} = 336 \times 54$$

$$\text{LCM} = \frac{336 \times 54}{6}$$

$$= 56 \times 54 = 3024$$

a224

Thus LCM of 336 and 54 is 3024.

19. a and b are two positive integers such that the least prime factor of a is 3 and the least prime factor of b is 5. Then calculate the least prime factor of $(a+b)$.

Ans : [Board Term-1 2014]

Here a and b are two positive integers such that the least prime factor of a is 3 and the least prime factor of b is 5. The least prime factor of $(a+b)$ would be 2.

a102

20. What is the HCF of the smallest composite number and the smallest prime number?

Ans : [Board Term-1 OD 2018]

The smallest prime number is 2 and the smallest composite number is $4 = 2^2$.

Hence, required HCF is $(2^2, 2) = 2$.

a103

21. Calculate the HCF of $3^3 \times 5$ and $3^2 \times 5^2$.

Ans : [Board 2007]

We have $3^3 \times 5 = 3^2 \times 5 \times 3$

$$3^2 \times 5^2 = 3^2 \times 5 \times 5$$

$$\text{HCF}\ (3^3 \times 5,\ 3^2 \times 5^2) = 3^2 \times 5$$

$$= 9 \times 5 = 45$$

a104

22. If HCF $(a, b) = 12$ and $a \times b = 1,800$, then find LCM (a, b).

Ans :

We know that

$$\text{HCF}(a, b) \times \text{LCM}(a, b) = a \times b$$

a105

Substituting the values we have

$$12 \times \text{LCM}(a, b) = 1800$$

or, $$\text{LCM}(a,\ b) = \frac{1,800}{12} = 150$$

23. What is the condition for the decimal expansion of a rational number to terminate? Explain with the help of an example.

Ans : [Board Term-1 2016]

The decimal expansion of a rational number terminates, if the denominator of rational number can be expressed as $2^m 5^n$ where m and n are non negative integers and p and q both co-primes.

a148

e.g. $$\frac{3}{10} = \frac{3}{2^1 \times 5^1} = 0.3$$

24. Find the smallest positive rational number by which $\frac{1}{7}$ should be multiplied so that its decimal expansion terminates after 2 places of decimal.

Ans : [Board Term-1 2016]

Since $$\frac{1}{7} \times \frac{7}{100} = \frac{1}{100} = 0.01.$$

Thus smallest rational number is $\frac{7}{100}$.

a149

25. What type of decimal expansion does a rational number has? How can you distinguish it from decimal expansion of irrational numbers?

Ans : [Board Term-1 2016]

A rational number has its decimal expansion either terminating or non-terminating, repeating An irrational numbers has its decimal expansion non-repeating and non-terminating.

a150

26. Calculate $\frac{3}{8}$ in the decimal form.

Ans : [Board 2008]

We have $$\frac{3}{8} = \frac{3}{2^3} = \frac{2 \times 5^3}{2^3 \times 5^3}$$

$$= \frac{375}{10^3} = \frac{375}{1,000}$$

$$= 0.375$$

a151

27. The decimal representation of $\frac{6}{1250}$ will terminate after how many places of decimal?

Ans : [Board 2009]

We have $$\frac{6}{1250} = \frac{6}{2 \times 5^4} = \frac{6 \times 2^3}{2 \times 2^3 \times 5^4}$$

$$= \frac{6 \times 2^3}{2^4 \times 5^4} = \frac{6 \times 2^3}{(10)^4}$$

a152

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$$= \frac{48}{10000} = 0.0048$$

Thus $\frac{6}{1250}$ will terminate after 4 decimal places.

28. Find the least number that is divisible by all numbers between 1 and 10 (both inclusive).

Ans : [Board 2010]

The required number is the LCM of 1, 2, 3, 4, 5, 6, 7, 8, 9, 10,

$$\text{LCM} = 2 \times 2 \times 3 \times 2 \times 3 \times 5 \times 7$$

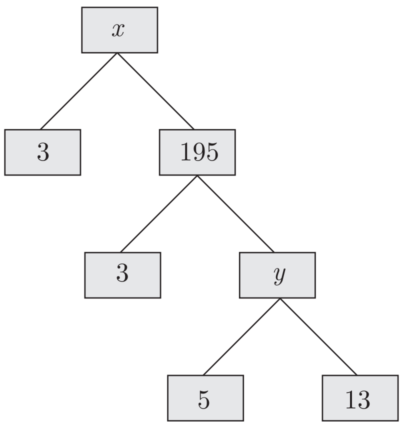
$$= 2520$$

29. Find HCF of the numbers given below:
$k, 2k, 3k, 4k$ and $5k$,, where k is a positive integer.

Ans : [Board Term-1 2015]

Here we can see easily that k is common factor between all and this is highest factor Thus HCF of k,$2k$,$3k$,$4k$ and $5k$, is k.

30. Complete the following factor tree and find the composite number x.



Ans : [Board Term-1 2015]

We have $y = 5 \times 13 = 65$

and $x = 3 \times 195 = 585$

31. Write whether rational number $\frac{7}{75}$ will have terminating decimal expansion or a non-terminating decimal.

Ans : [Board Term-1 2017, SQP]

We have $$\frac{7}{75} = \frac{7}{3 \times 5^2}$$

Since denominator of given rational number is not of form $2^m \times 5^n$, Hence, It is non-terminating decimal expansion.

32. Write the rational number $\frac{7}{75}$ will have a terminating decimal expansion. or a non-terminating repeating decimal.

Ans : [Board 2018 SQP]

We have $$\frac{7}{75} = \frac{7}{3 \times 5^2}$$

The denominator of rational number $\frac{7}{75}$ can not be written in form $2^m 5^n$ So it is non-terminating repeating decimal expansion.

TWO MARKS QUESTIONS

33. If HCF of 144 and 180 is expressed in the form $13m - 16$. Find the value of m.

Ans : [Board 2020 SQP Standard]

According to Euclid's algorithm any number a can be written in the form,

$$a = bq + r \text{ where } 0 \le r < b$$

Applying Euclid's division lemma on 144 and 180 we have

$$180 = 144 \times 1 + 36$$

$$144 = 36 \times 4 + 0$$

Here, remainder is 0 and divisor is 36. Thus HCF of 144 and 180 is 36.

Now $$36 = 13m - 16$$

$$36 + 16 = 13m$$

$$52 = 13m \Rightarrow m = 4$$

34. Find HCF and LCM of 404 and 96 and verify that HCF $\times$ LCM = Product of the two given numbers.

Ans : [Board 2018]

We have $$404 = 2 \times 2 \times 101$$

$$= 2^2 \times 101$$

$$96 = 2 \times 2 \times 2 \times 2 \times 2 \times 3$$

$$= 2^5 \times 3$$

$$\text{HCF}(404, 96) = 2^2 = 4$$

$$\text{LCM}(404, 96) = 101 \times 2^5 \times 3 = 9696$$

$$\text{HCF} \times \text{LCM} = 4 \times 9696 = 38784$$

Also, $$404 \times 96 = 38784$$

Hence, HCF $\times$ LCM = Product of 404 and 96

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35. Find HCF of the numbers given below:
$k, 2k, 3k, 4k$ and $5k$,, where k is a positive integer.

Ans : [Board Term-1 2015]

Here we can see easily that k is common factor between all and this is highest factor Thus HCF of $k, 2k, 3k, 4k$ and $5k$, is k.

a106

36. Find the HCF and LCM of 90 and 144 by the method of prime factorization.

Ans : [Board Term-1 2012]

We have $90 = 9 \times 10 = 9 \times 2 \times 5$

$= 2 \times 3^2 \times 5$

and $144 = 16 \times 9$

$= 2^4 \times 3^2$

a107

$\text{HCF} = 2 \times 3^2 = 18$

$\text{LCM} = 2^4 \times 3^2 \times 5 = 720$

37. Explain why $(7 \times 13 \times 11) + 11$ and $(7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1) + 3$ are composite numbers.

Ans : [Board Term-1 2012]

$(7 \times 13 \times 11) + 11 = 11 \times (7 \times 13 + 1)$

$= 11 \times (91 + 1)$

$= 11 \times 92$

a111

and

$(7 \times 6 \times 5 \times 4 \times 3 \times 2 \times 1) + 3$

$= 3(7 \times 6 \times 5 \times 4 \times 2 \times 1 + 1)$

$= 3 \times (1681) = 3 \times 41 \times 41$

Since given numbers have more than two prime factors, both number are composite.

38. Given that HCF $(306, 1314) = 18$. Find LCM $(306, 1314)$

Ans : [Board Term-1 2013]

We have $\text{HCF}(306, 1314) = 18$

$\text{LCM}(306, 1314) = ?$

a109

Let $a = 306$ and $b = 1314$, then we have

$$\text{LCM}(a, b) \times \text{HCF}(a, b) = a \times b$$

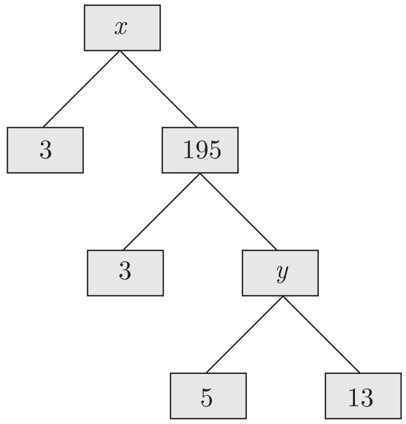
Substituting values we have

$$\text{LCM}(a, b) \times 18 = 306 \times 1314$$

$$\text{LCM}(a, b) = \frac{306 \times 1314}{18}$$

$$\text{LCM}(306, 1314) = 22{,}338$$

39. Complete the following factor tree and find the composite number x.



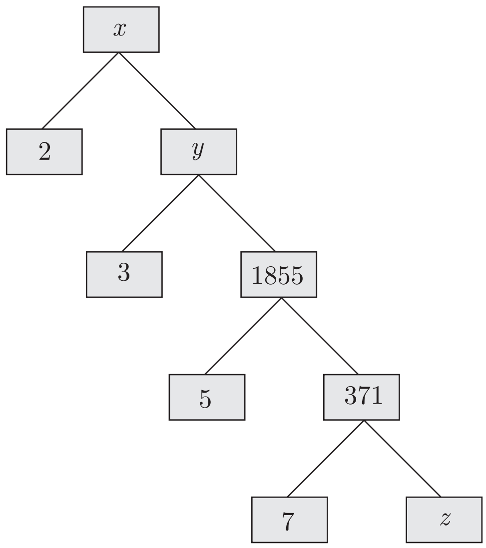
Ans : [Board Term-1 2015]

We have $y = 5 \times 13 = 65$

and $x = 3 \times 195 = 585$

a110

40. Complete the following factor tree and find the composite number x



Ans : [Board Term-1 2015]

We have $z = \frac{371}{7} = 53$

$y = 1855 \times 3 = 5565$

a112

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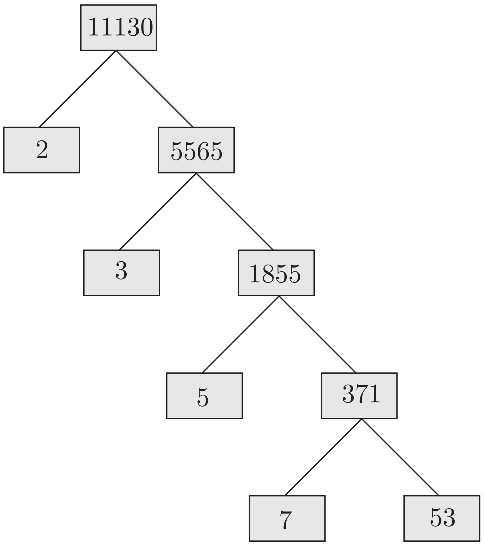
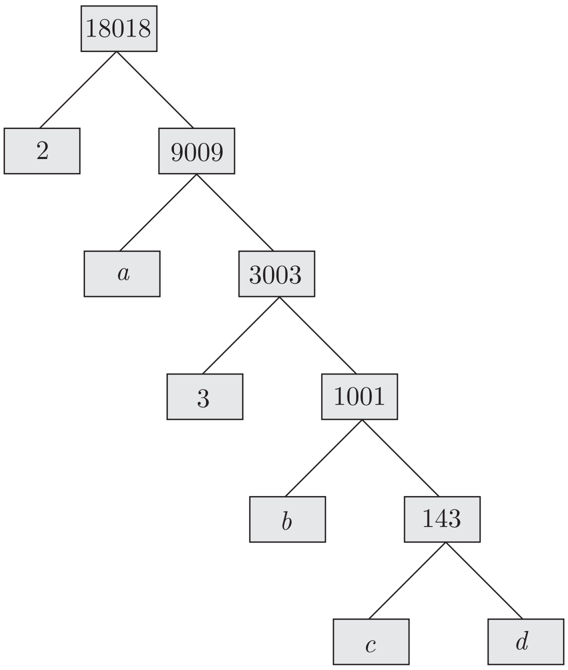
$$x = 2 \times y = 2 \times 5565 = 11130$$

Thus complete factor tree is as given below.



41. Find the missing numbers a, b, c and d in the given factor tree:



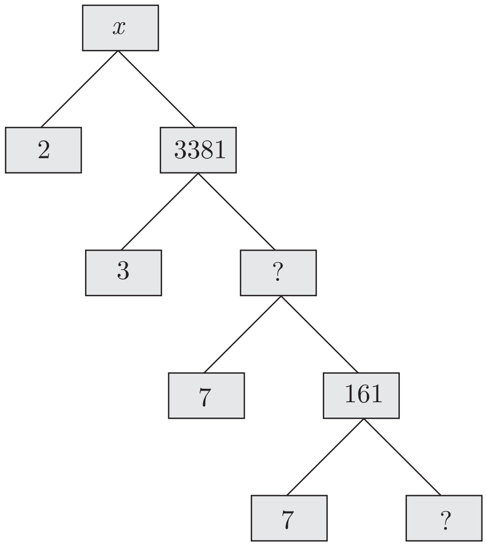
Ans : [Board Term-1 2012]

We have
$$a = \frac{9009}{3003} = 3$$
$$b = \frac{1001}{143} = 7$$

Since $143 = 11 \times 13$,

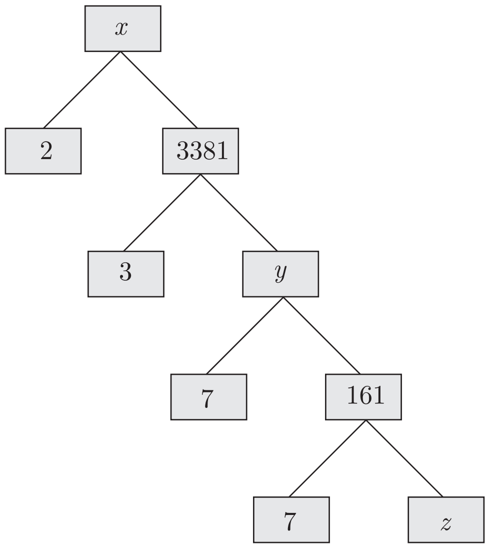
Thus $c = 11$ and $d = 13$ or $c = 13$ and $d = 11$

42. Complete the following factor tree and find the composite number x.



Ans : [Board Term-1 2015, 2014]

We complete the given factor tree writing variable y and z as following.



We have
$$z = \frac{161}{7} = 23$$
$$y = 7 \times 161 = 1127$$

Composite number, $x = 2 \times 3381 = 6762$

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43. Explain whether $3 \times 12 \times 101 + 4$ is a prime number or a composite number.

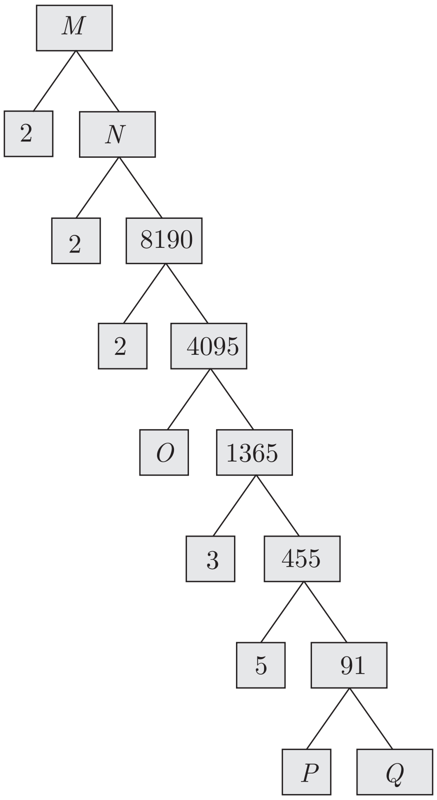
Ans : [Board Term-1 2017]

A prime number (or a prime) is a natural number greater than 1 that cannot be formed by multiplying two smaller natural numbers. A natural number greater than 1 that is not prime is called a composite number. For example, 5 is prime because the only ways of writing it as a product, 1×5 or 5×1, involve 5 itself. However, 6 is composite because it is the product of two numbers (2×3) that are both smaller than 6. Every composite number can be written as the product of two or more (not necessarily distinct) primes.

$$\begin{aligned} 3 \times 12 \times 101 + 4 &= 4(3 \times 3 \times 101 + 1) \\ &= 4(909 + 1) \\ &= 4(910) \\ &= 2 \times 2 \times (10 \times 7 \times 13) \\ &= 2 \times 2 \times 2 \times 5 \times 7 \times 13 \\ &= \text{a composite number} \end{aligned}$$

a115

44. Complete the factor-tree and find the composite number M.



Ans : [Board Term-1 2013]

We have $\quad 91 = P \times Q = 7 \times 13$

So $P = 7, Q = 13$ or $P = 13, Q = 7$

a116

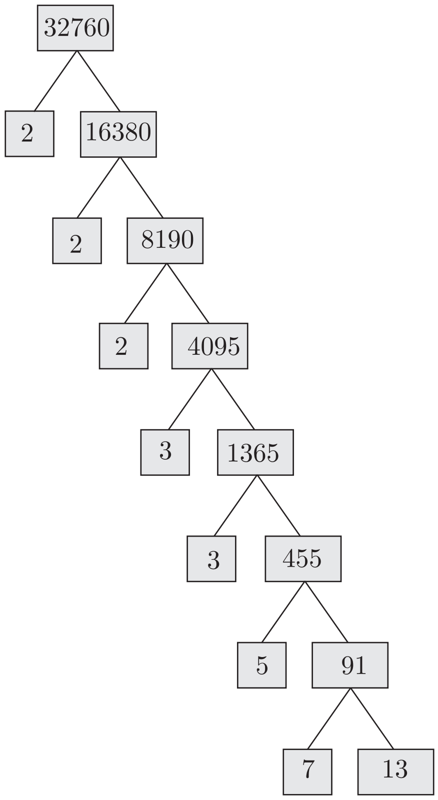
$$O = \frac{4095}{1365} = 3$$

$$N = 2 \times 8190 = 16380$$

Composite number,

$$M = 16380 \times 2 = 32760$$

Thus complete factor tree is shown below.



45. Find the smallest natural number by which 1200 should be multiplied so that the square root of the product is a rational number.

Ans : [Board Term-1 2016, 2015]

a117

We have
$$\begin{aligned} 1200 &= 12 \times 100 \\ &= 4 \times 3 \times 4 \times 25 \\ &= 4^2 \times 3 \times 5^2 \end{aligned}$$

Here if we multiply by 3, then its square root will be $4 \times 3 \times 5$ which is a rational number. Thus the required smallest natural number is 3.

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46. Can two numbers have 15 as their HCF and 175 as their LCM? Give reasons.

Ans : [Board Term-1 2012]

LCM of two numbers should be exactly divisible by their HCF. Since, 15 does not divide 175, two numbers cannot have their HCF as 15 and LCM as 175.

47. Check whether 4^n can end with the digit 0 for any natural number n.

Ans : [Board Term-1 2015, Set-FHN8MGD; NCERT]

If the number 4^n, for any n, were to end with the digit zero, then it would be divisible by 5 and 2.

That is, the prime factorization of 4^n would contain the prime 5 and 2. This is not possible because the only prime in the factorization of $4^n = 2^{2n}$ is 2. So, the uniqueness of the Fundamental Theorem of Arithmetic guarantees that there are no other primes in the factorization of 4^n. So, there is no natural number n for which 4^n ends with the digit zero. Hence 4^n cannot end with the digit zero.

48. Show that 7^n cannot end with the digit zero, for any natural number n.

Ans : [Board Term-1 2012]

If the number 7^n, for any n, were to end with the digit zero, then it would be divisible by 5 and 2.

That is, the prime factorization of 7^n would contain the prime 5 and 2. This is not possible because the only prime in the factorization of $7^n = (1 \times 7)^n$ is 7. So, the uniqueness of the Fundamental Theorem of Arithmetic guarantees that there are no other primes in the factorization of 7^n. So, there is no natural number n for which 7^n ends with the digit zero. Hence 7^n cannot end with the digit zero.

49. Check whether $(15)^n$ can end with digit 0 for any $n \in N$.

Ans : [Board Term-1 2012]

If the number $(15)^n$, for any n, were to end with the digit zero, then it would be divisible by 5 and 2.

That is, the prime factorization of $(15)^n$ would contain the prime 5 and 2. This is not possible because the only prime in the factorization of $(15)^n = (3 \times 5)^n$ are 3 and 5. The uniqueness of the Fundamental Theorem of Arithmetic guarantees that there are no other primes in the factorization of $(15)^n$. Since there is no prime factor 2, $(15)^n$ cannot end with the digit zero.

50. The length, breadth and height of a room are 8 m 50 cm, 6 m 25 cm and 4 m 75 cm respectively. Find the length of the longest rod that can measure the dimensions of the room exactly.

Ans : [Board Term-1 2016]

Here we have to determine the HCF of all length which can measure all dimension.

$$\begin{aligned}
\text{Length,} \quad l &= 8 \text{ m } 50 \text{ cm} = 850 \text{ cm} \\
&= 50 \times 17 = 2 \times 5^2 \times 17 \\
\text{Breadth,} \quad b &= 6 \text{ m } 25 \text{ cm} = 625 \text{ cm} \\
&= 25 \times 25 = 5^2 \times 5^2 \\
\text{Height,} \quad h &= 4 \text{ m } 75 \text{ cm} = 475 \text{ cm} \\
&= 25 \times 19 = 5^2 \times 19 \\
\text{HCF}(l, b, h) &= \text{HCF } (850, 625, 475) \\
&= \text{HCF } (2 \times 5^2 \times 17,\ 5^2,\ 5^2 \times 19) \\
&= 5^2 = 25 \text{ cm}
\end{aligned}$$

Thus 25 cm rod can measure the dimensions of the room exactly. This is longest rod that can measure exactly.

51. Show that $5\sqrt{6}$ is an irrational number.

Ans : [Board Term-1 2015]

Let $5\sqrt{6}$ be a rational number, which can be expressed as $\frac{a}{b}$, where $b \neq 0$; a and b are co-primes.

$$\begin{aligned}
\text{Now} \qquad 5\sqrt{6} &= \frac{a}{b} \\
\sqrt{6} &= \frac{a}{5b} \\
\text{or,} \qquad \sqrt{6} &= \text{rational}
\end{aligned}$$

But, $\sqrt{6}$ is an irrational number. Thus, our assumption is wrong. Hence, $5\sqrt{6}$ is an irrational number.

52. Write the denominator of the rational number $\frac{257}{500}$ in the form $2^m \times 5^n$, where m and n are non-negative integers. Hence write its decimal expansion without actual division.

Ans : [Board Term-1 2012]

$$\begin{aligned}
\text{We have} \qquad 500 &= 25 \times 20 \\
&= 5^2 \times 5 \times 4 \\
&= 5^3 \times 2^2
\end{aligned}$$

Here denominator is 500 which can be written as $2^2 \times 5^3$.

Now decimal expansion,

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$$\frac{257}{500} = \frac{257 \times 2}{2 \times 2^2 \times 5^3} = \frac{514}{10^3}$$
$$= 0.514$$

53. Write a rational number between $\sqrt{2}$ and $\sqrt{3}$.

Ans : [Board Term-1 2013]

We have $\sqrt{2} = \sqrt{\frac{200}{100}}$ and $\sqrt{3} = \sqrt{\frac{300}{100}}$

We need to find a rational number x such that

$$\frac{1}{10}\sqrt{200} < x < \frac{1}{10}\sqrt{300}$$

a156

Choosing any perfect square such as 225 or 256 in between 200 and 300, we have

$$x = \sqrt{\frac{225}{100}} = \frac{15}{10} = \frac{5}{3}$$

Similarly if we choose 256, then we have

$$x = \sqrt{\frac{256}{100}} = \frac{16}{10} = \frac{8}{5}$$

54. Write the rational number $\frac{7}{75}$ will have a terminating decimal expansion. or a non-terminating repeating decimal.

Ans : [Board 2018 SQP]

We have $\frac{7}{75} = \frac{7}{3 \times 5^2}$

a157

The denominator of rational number $\frac{7}{75}$ can not be written in form $2^m 5^n$ So it is non-terminating repeating decimal expansion.

55. Show that 571 is a prime number.

Ans :

a166

Let $x = 571$

$$\sqrt{x} = \sqrt{571}$$

Now 571 lies between the perfect squares of $(23)^2 = 529$ and $(24)^2 = 576$. Prime numbers less than 24 are 2, 3, 5, 7, 11, 13, 17, 19, 23. Here 571 is not divisible by any of the above numbers, thus 571 is a prime number.

56. If two positive integers p and q are written as $p = a^2 b^3$ and $q = a^3 b$, where a and b are prime numbers than verify LCM$(p,q) \times$HCF$(q,q) = pq$

Ans : [Sample Paper 2017]

We have $p = a^2 b^3 = a \times a \times b \times b \times b$

and $q = a^3 b = a \times a \times a \times b$

Now LCM $(p,q) = a \times a \times a \times b \times b \times b$

$= a^3 b^3$

a125

and HCF $(p,q) = a \times a \times b$

$= a^2 b$

$$\text{LCM }(p,q) \times \text{HCF }(p,q) = a^3 b^3 \times a^2 b$$
$$= a^5 b^4$$
$$= a^2 b^3 \times a^3 b$$
$$= pq$$

THREE MARKS QUESTIONS

57. An army contingent of 612 members is to march behind an army band of 48 members in a parade. The two groups are to march in the same number of columns. What is the maximum number of columns in which they can march?

Ans : [Board 2020 Delhi Basic]

Let the number of columns be x which is the largest number, which should divide both 612 and 48. It means x should be HCF of 612 and 48.

We can write 612 and 48 as follows

$$612 = 2 \times 2 \times 3 \times 3 \times 5 \times 17$$
$$48 = 2 \times 2 \times 2 \times 2 \times 3$$
$$\text{HCF}(612, 28) = 2 \times 2 \times 3 = 12$$

a230

Thus HCF of 104 and 96 is 12 i.e. 12 columns are required.

Here we have solved using Euclid's algorithm but you can solve this problem by simple mehtod of HCF.

58. Given that $\sqrt{5}$ is irrational, prove that $2\sqrt{5} - 3$ is an irrational number.

Ans : [Board 2020 SQP Standard]

Assume that $2\sqrt{5} - 3$ is a rational number. Therefore, we can write it in the form of $\frac{p}{q}$ where p and q are co-prime integers and $q \neq 0$.

Now $2\sqrt{5} - 3 = \frac{p}{q}$

where $q \neq 0$ and p and q are co-prime integers.

Rewriting the above expression as,

$$2\sqrt{5} = \frac{p}{q} + 3$$

$$\sqrt{5} = \frac{p + 3q}{2q}$$

a233

Here $\frac{p+3q}{2q}$ is rational because p and q are co-prime integers, thus $\sqrt{5}$ should be a rational number. But $\sqrt{5}$ is irrational. This contradicts the given fact that $\sqrt{5}$ is irrational. Hence $2\sqrt{5} - 3$ is an irrational number.

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59. Prove that $\frac{2+\sqrt{3}}{5}$ is an irrational number, given that $\sqrt{3}$ is an irrational number.

Ans : [Board 2019 Delhi]

Assume that $\frac{2+\sqrt{3}}{5}$ is a rational number. Therefore, we can write it in the form of $\frac{p}{q}$ where p and q are co-prime integers and $q \neq 0$.

$$\frac{2+\sqrt{3}}{5} = \frac{p}{q}$$

$$2+\sqrt{3} = \frac{5p}{q}$$

$$\sqrt{3} = \frac{5p}{q} - 2$$

$$\sqrt{3} = \frac{5p-2q}{q}$$

Since, p and q are co-prime integers, then $\frac{5p-2q}{q}$ is a rational number. But this contradicts the fact that $\sqrt{3}$ is an irrational number. So, our assumption is wrong. Therefore $\frac{2+\sqrt{3}}{5}$ is an irrational number.

60. Given that $\sqrt{3}$ is irrational, prove that $(5+2\sqrt{3})$ is an irrational number.

Ans : [Board 2020 Delhi Basic]

Assume that $(5+2\sqrt{3})$ is a rational number. Therefore, we can write it in the form of $\frac{p}{q}$ where p and q are co-prime integers and $q \neq 0$.

Now $$5+2\sqrt{3} = \frac{p}{q}$$

where $q \neq 0$ and p and q are integers.

Rewriting the above expression as,

$$2\sqrt{3} = \frac{p}{q} - 5$$

$$\sqrt{3} = \frac{p-5q}{2q}$$

Here $\frac{p-5q}{2q}$ is rational because p and q are co-prime integers, thus $\sqrt{3}$ should be a rational number. But $\sqrt{3}$ is irrational. This contradicts the given fact that $\sqrt{3}$ is irrational. Hence $(5+2\sqrt{3})$ is an irrational number.

61. Prove that $2+5\sqrt{3}$ is an irrational number, given that $\sqrt{3}$ is an irrational number.

Ans : [Board 2019 OD]

Assume that $2+5\sqrt{3}$ is a rational number. Therefore, we can write it in the form of $\frac{p}{q}$ where p and q are co-prime integers and $q \neq 0$.

$$2+5\sqrt{3} = \frac{p}{q}, \quad q \neq 0$$

$$5\sqrt{3} = \frac{p}{q} - 2$$

$$5\sqrt{3} = \frac{p-2q}{q}$$

$$\sqrt{3} = \frac{p-2q}{5q}$$

Here $\sqrt{3}$ is irrational and $\frac{p-2q}{5q}$ is rational because p and q are co-prime integers. But rational number cannot be equal to an irrational number. Hence $2+5\sqrt{3}$ is an irrational number.

62. Given that $\sqrt{2}$ is irrational, prove that $(5+3\sqrt{2})$ is an irrational number.

Ans : [Board 2018]

Assume that $(5+3\sqrt{2})$ is a rational number. Therefore, we can write it in the form of $\frac{p}{q}$ where p and q are co-prime integers and $q \neq 0$.

Now $$5+3\sqrt{2} = \frac{p}{q}$$

where $q \neq 0$ and p and q are integers.

Rewriting the above expression as,

$$3\sqrt{2} = \frac{p}{q} - 5$$

$$\sqrt{2} = \frac{p-5q}{3q}$$

Here $\frac{p-5q}{3q}$ is rational because p and q are co-prime integers, thus $\sqrt{2}$ should be a rational number. But $\sqrt{2}$ is irrational. This contradicts the given fact that $\sqrt{2}$ is irrational. Hence $(5+3\sqrt{2})$ is an irrational number.

63. Write the smallest number which is divisible by both 306 and 657.

Ans : [Board 2019 OD]

The smallest number that is divisible by two numbers is obtained by finding the LCM of these numbers Here, the given numbers are 306 and 657.

$$306 = 6 \times 51 = 3 \times 2 \times 3 \times 17$$

$$657 = 9 \times 73 = 3 \times 3 \times 73$$

$$\text{LCM}(306, 657) = 2 \times 3 \times 3 \times 17 \times 73$$

$$= 22338$$

Hence, the smallest number which is divisible by 306 and 657 is 22338.

64. Show that numbers 8^n can never end with digit 0 of any natural number n.

Ans : [Board Term-1 2015, NCERT]

If the number 8^n, for any n, were to end with the digit zero, then it would be divisible by 5 and 2. That is, the prime factorization

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of 8^n would contain the prime 5 and 2. This is not possible because the only prime in the factorization of $(8)^n = (2^3)^n = 2^{3n}$ is 2. The uniqueness of the Fundamental Theorem of Arithmetic guarantees that there are no other primes in the factorization of $(8)^n$. Since there is no prime factor 5, $(8)^n$ cannot end with the digit zero.

65. 144 cartons of Coke cans and 90 cartons of Pepsi cans are to be stacked in a canteen. If each stack is of the same height and if it equal contain cartons of the same drink, what would be the greatest number of cartons each stack would have?

Ans : [Board Term-1 2011]

The required answer will be HCF of 144 and 90.

$$144 = 2^4 \times 3^2$$

$$90 = 2 \times 3^2 \times 5$$

$$\text{HCF}(144, 90) = 2 \times 3^2 = 18$$

a130

Thus each stack would have 18 cartons.

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

Ans : [Board Term-1 2011, Set-44]

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

Finding prime factor of given number we have,

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

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

$$15 = 3 \times 5$$

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

$$= 150 \text{ minutes}$$

a131

The bells will toll next together after 180 minutes.

67. Find HCF and LCM of 16 and 36 by prime factorization and check your answer.

Ans :

Finding prime factor of given number we have,

$$16 = 2 \times 2 \times 2 \times 2 = 2^4$$

$$36 = 2 \times 2 \times 3 \times 3 = 2^2 \times 3^2$$

$$\text{HCF}(16, 36) = 2 \times 2 = 4$$

$$\text{LCM}(16, 36) = 2^4 \times 3^2$$

$$= 16 \times 9 = 144$$

a132

Check :

$$\text{HCF}(a, b) \times \text{LCM}(a, b) = a \times b$$

or, $$4 \times 144 = 16 \times 36$$

$$576 = 576$$

Thus $$\text{LHS} = \text{RHS}$$

68. Find the HCF and LCM of 510 and 92 and verify that HCF $\times$ LCM = Product of two given numbers.

Ans : [Board Term-1 2011]

Finding prime factor of given number we have,

$$92 = 2^2 \times 23$$

$$510 = 30 \times 17 = 2 \times 3 \times 5 \times 17$$

$$\text{HCF }(510, 92) = 2$$

$$\text{LCM }(510, 92 = 2^2 \times 23 \times 3 \times 5 \times 14$$

$$= 23460$$

$$\text{HCF }(510, 92) \times \text{LCM }(510, 92)$$

$$= 2 \times 23460 = 46920$$

a133

Product of two numbers $= 510 \times 92 = 46920$

Hence, HCF$\times$LCM = Product of two numbers

69. The HCF of 65 and 117 is expressible in the form $65m - 117$. Find the value of m. Also find the LCM of 65 and 117 using prime factorization method.

Ans : [Board Term-1 2011]

Finding prime factor of given number we have,

$$117 = 13 \times 2 \times 3$$

$$65 = 13 \times 5$$

a134

$$\text{HCF}(117, 65) = 13$$

$$\text{LCM}(117, 65) = 13 \times 5 \times 3 \times 3 = 585$$

$$\text{HCF} = 65m - 117$$

$$13 = 65m - 117$$

$$65m = 117 + 13 = 130$$

$$m = \frac{130}{65} = 2$$

70. Express $\left(\frac{15}{4} + \frac{5}{40}\right)$ as a decimal fraction without actual division.

Ans : [Board Term-1 2011]

We have $$\frac{15}{4} + \frac{5}{40} = \frac{15}{4} \times \frac{25}{25} + \frac{5}{40} \times \frac{25}{25}$$

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$$= \frac{375}{100} + \frac{125}{1000}$$

$$= 3.75 + 0.125 = 3.875$$

a158

71. Express the number $0.3\overline{178}$ in the form of rational number $\frac{a}{b}$.

Ans : [Board Term-1 2011]

Let $x = 0.3\overline{178}$

$$x = 0.3178178178$$

$$10{,}000x = 3178.178178...$$

$$10x = 3.178178....$$

a159

Subtracting, $9990x = 3175$

or, $x = \frac{3175}{9990} = \frac{635}{1998}$

72. Prove that $\sqrt{2}$ is an irrational number.

Ans : [Board Term-1 2011]

Let $\sqrt{2}$ be a rational number.

Then $\sqrt{2} = \frac{p}{q}$,

a160

where p and q are co-prime integers and $q \neq 0$ On squaring both the sides we have,

$$2 = \frac{p^2}{q^2}$$

or, $p^2 = 2p^2$

Since p^2 is divisible by 2, thus p is also divisible by 2.

Let $p = 2r$ for some positive integer r, then we have

$$p^2 = 4r^2$$

$$2q^2 = 4r^2$$

or, $q^2 = 2r^2$

Since q^2 is divisible by 2, thus q is also divisible by 2.

We have seen that p and q are divisible by 2, which contradicts the fact that p and q are co-primes. Hence, our assumption is false and $\sqrt{2}$ is irrational.

73. If p is prime number, then prove that $\sqrt{p}$ is an irrational.

Ans : [Board Term-1 2013]

Let p be a prime number and if possible, let $\sqrt{p}$ be rational

Thus $\sqrt{p} = \frac{m}{n}$,

a161

where m and n are co-primes and $n \neq 0$. Squaring on both sides, we get

$$p = \frac{m^2}{n^2}$$

or, $pn^2 = m^2$ ...(1)

Here p divides pn^2. Thus p divides m^2 and in result p also divides m.

Let $m = pq$ for some integer q and putting $m = pq$ in eq. (1), we have

$$pn^2 = p^2q^2$$

or, $n^2 = pq^2$

Here p divides pq^2.Thus p divides n^2 and in result p also divides n.

[p is prime and p divides $n^2 \Rightarrow p$ divides n]

Thus p is a common factor of m and n but this contradicts the fact that m and n are primes. The contradiction arises by assuming that $\sqrt{p}$ is rational. Hence, $\sqrt{p}$ is irrational.

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

Ans : [Board 2010]

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

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

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

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

a162

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

75. Prove that $\sqrt{5}$ is an irrational number and hence show that $2 - \sqrt{5}$ is also an irrational number.

Ans : [Board Term-1 2011]

Assume that $\sqrt{5}$ be a rational number then we have

$$\sqrt{5} = \frac{a}{b}, \qquad (a, b \text{ are co-primes and } b \neq 0)$$

$$a = b\sqrt{5}$$

Squaring both the sides, we have

$$a^2 = 5b^2$$

a163

Thus 5 is a factor of a^2 and in result 5 is also a factor of a.

Let $a = 5c$ where c is some integer, then we have

$$a^2 = 25c^2$$

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Substituting $a^2 = 5b^2$ we have

$$5b^2 = 25c^2$$

$$b^2 = 5c^2$$

Thus 5 is a factor of b^2 and in result 5 is also a factor of b.

Thus 5 is a common factor of a and b. But this contradicts the fact that a and b are co-primes. Thus, our assumption that $\sqrt{5}$ is rational number is wrong. Hence $\sqrt{5}$ is irrational.

Let us assume that $2-\sqrt{5}$ be rational equal to a, then we have

$$2-\sqrt{5} = a$$

$$2-a = \sqrt{5}$$

Since we have assume $2-a$ is rational, but $\sqrt{5}$ is not rational. Rational number cannot be equal to an irrational number. Thus $2-\sqrt{5}$ is irrational.

76. Show that exactly one of the number $n, n+2$ or $n+4$ is divisible by 3.

Ans : [Board SQP 2017]

If n is divisible by 3, clearly $n+2$ and $n+4$ is not divisible by 3.

a136

If n is not divisible by 3, then two case arise as given below.

Case 1: $n = 3k+1$

$$n+2 = 3k+1+2 = 3k+3 = 3(k+1)$$

and $$n+4 = 3k+1+4 = 3k+5 = 3(k+1)+2$$

We can clearly see that in this case $n+2$ is divisible by 3 and $n+4$ is not divisible by 3. Thus in this case only $n+2$ is divisible by 3.

Case 1: $n = 3k+2$

$$n+2 = 3k+2+2 = 3k+4 = 3(k+1)+1$$

and $$n+4 = 3k+2+4 = 3k+6 = 3(k+2)$$

We can clearly see that in this case $n+4$ is divisible by 3 and $n+2$ is not divisible by 3. Thus in this case only $n+4$ is divisible by 3.

Hence, exactly one of the numbers $n, n+2, n+4$ is divisible by 3.

FIVE MARKS QUESTIONS

77. Prove that $\sqrt{3}$ is an irrational number.

Ans : [Board 2020 OD Basic]

Assume that $\sqrt{3}$ is a rational number. Therefore, we can write it in the form of $\frac{a}{b}$ where a and b are co-prime integers and $q \neq 0$.

Assume that $\sqrt{3}$ be a rational number then we have

$$\sqrt{3} = \frac{a}{b},$$

where a and b are co-primes and $b \neq 0$.

a231

Now $$a = b\sqrt{3}$$

Squaring both the sides, we have

$$a^2 = 3b^2$$

Thus 3 is a factor of a^2 and in result 3 is also a factor of a.

Let $a = 3c$ where c is some integer, then we have

$$a^2 = 9c^2$$

Substituting $a^2 = 3b^2$ we have

$$3b^2 = 9c^2$$

$$b^2 = 3c^2$$

Thus 3 is a factor of b^2 and in result 3 is also a factor of b.

Thus 3 is a common factor of a and b. But this contradicts the fact that a and b are co-primes. Thus, our assumption that $\sqrt{3}$ is rational number is wrong. Hence $\sqrt{3}$ is irrational.

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

Ans : [Board 2020 OD Standard]

Assume that $\sqrt{5}$ be a rational number then we have

$$\sqrt{5} = \frac{a}{b},$$

where a and b are co-primes and $b \neq 0$.

a232

$$a = b\sqrt{5}$$

Squaring both the sides, we have

$$a^2 = 5b^2$$

Thus 5 is a factor of a^2 and in result 5 is also a factor of a.

Let $a = 5c$ where c is some integer, then we have

$$a^2 = 25c^2$$

Substituting $a^2 = 5b^2$ we have

$$5b^2 = 25c^2$$

$$b^2 = 5c^2$$

Thus 5 is a factor of b^2 and in result 5 is also a factor of b.

Thus 5 is a common factor of a and b. But this contradicts the fact that a and b are co-primes. Thus, our assumption that $\sqrt{5}$ is rational number is wrong. Hence $\sqrt{5}$ is irrational.

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79. Find HCF and LCM of 378, 180 and 420 by prime factorization method. Is HCF × LCM of these numbers equal to the product of the given three numbers?

Ans : [Board 2009]

Finding prime factor of given number we have,

$$378 = 2 \times 3^3 \times 7$$
$$180 = 2^2 \times 3^2 \times 5$$
$$420 = 2^2 \times 3 \times 7 \times 5$$
$$\text{HCF}(378, 180, 420) = 2 \times 3 = 6$$
$$\text{LCM}(378, 180, 420) = 2^2 \times 3^3 \times 5 \times 7$$
$$= 2^2 \times 3^3 \times 5 \times 7 = 3780$$
$$\text{HCF}\times\text{LCM} = 6\times 3780 = 22680$$

Product of given numbers

$$= 378 \times 180 \times 420$$
$$= 28576800$$

Hence, HCF × LCM $\neq$ Product of three numbers.

80. State Fundamental theorem of Arithmetic. Find LCM of numbers 2520 and 10530 by prime factorization by 3.

Ans : [Board Term-1 2016]

The fundamental theorem of arithmetic (FTA), also called the unique factorization theorem or the unique-prime-factorization theorem, states that every integer greater than 1 either is prime itself or is the product of a unique combination of prime numbers.

OR

Every composite number can be expressed as the product powers of primes and this factorization is unique.

Finding prime factor of given number we have,

$$2520 = 20 \times 126 = 20 \times 6 \times 21$$
$$= 2^3 \times 3^2 \times 5 \times 7$$
$$10530 = 30 \times 351 = 30 \times 9 \times 39$$
$$= 30 \times 9 \times 3 \times 13$$
$$= 2 \times 3^4 \times 5 \times 13$$
$$\text{LCM}(2520, 10530) = 2^3 \times 3^4 \times 5 \times 7 \times 13$$
$$= 294840$$

81. Can the number 6^n, n being a natural number, end with the digit 5 ? Give reasons.

Ans : [Board Term-1 2015]

If the number 6^n for any n, were to end with the digit five, then it would be divisible by 5. That is, the prime factorization of 6^n would contain the prime 5. This is not possible because the only prime in the factorization of $6^n = (2 \times 3)^n$ are 2 and 3. The uniqueness of the Fundamental Theorem of Arithmetic guarantees that there are no other primes in the factorization of 6^n. Since there is no prime factor 5, 6^n cannot end with the digit five.

82. State Fundamental theorem of Arithmetic. Is it possible that HCF and LCM of two numbers be 24 and 540 respectively. Justify your answer.

Ans : [Board Term-1 2015]

Fundamental theorem of Arithmetic : Every integer greater than one ither is prime itself or is the product of prime numbers and that this product is unique. Up to the order of the factors.

LCM of two numbers should be exactly divisible by their HCF. In other words LCM is always a multiple of HCF. Since, 24 does not divide 540 two numbers cannot have their HCF as 24 and LCM as 540.

$$\text{HCF} = 24$$
$$\text{LCM} = 540$$
$$\frac{LCM}{HCF} = \frac{540}{24} = 22.5 \text{ not an integer}$$

83. For any positive integer n, prove that $n^3 - n$ is divisible by 6.

Ans : [Board Term-1 2015, 2012]

We have $\quad n^3 - n = n(n^2 - 1)$

$$= (n-1)n(n+1)$$
$$= (n-1)n(n+1)$$

Thus $n^3 - n$ is product of three consecutive positive integers.

Since, any positive integers a is of the form $3q, 3q+1$ or $3q+2$ for some integer q.

Let $a, a+1, a+2$ be any three consecutive integers.

Case I : $a = 3q$

If $a = 3q$ then,

$$a(a+1)(a+2) = 3q(3q+1)(3q+2)$$

Product of two consecutive integers $(3q+1)$ and $(3q+2)$ is an even integer, say $2r$.

Thus $a(a+1)(a+2) = 3q(2r)$

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$$= 6qr, \text{ which is divisible by 6.}$$

Case II : $a = 3q + 1$

If $a = 3q + 1$ then

$$\begin{aligned} a(a+1)(a+2) &= (3q+1)(3q+2)(3q+3) \\ &= (2r)(3)(q+1) \\ &= 6r(q+1) \end{aligned}$$

which is divisible by 6.

Case III : $a = 3q + 2$

If $a = 3q + 2$ then

$$\begin{aligned} a(a+1)(a+2) &= (3q+2)(3q+3)(3q+4) \\ &= 3(3q+2)(q+1)(3q+4) \end{aligned}$$

Here $(3q+2)$ and $= 3(3q+2)(q+1)(3q+4)$

$$= \text{ multiple of 6 every } q$$

$$= 6r \text{ (say)}$$

which is divisible by 6. Hence, the product of three consecutive integers is divisible by 6 and $n^3 - n$ is also divisible by 3.

84. Prove that $n^2 - n$ is divisible by 2 for every positive integer n.

Ans : [Board Term-1 2012]

We have $n^2 - n = n(n-1)$

Thus $n^2 - n$ is product of two consecutive positive integers.

Any positive integer is of the form $2q$ or $2q+1$, for some integer q.

a144

Case 1 : $n = 2q$

If $n = 2q$ we have

$$\begin{aligned} n(n-1) &= 2q(2q-1) \\ &= 2m, \end{aligned}$$

where $m = q(2q-1)$ which is divisible by 2.

Case 1 : $n = 2q + 1$

If $n = 2q + 1$, we have

$$\begin{aligned} n(n-1) &= (2q+1)(2q+1-1) \\ &= 2q(2q+1) \\ &= 2m \end{aligned}$$

where $m = q(2q+1)$ which is divisible by 2.

Hence, $n^2 - n$ is divisible by 2 for every positive integer n.

85. Prove that $\sqrt{3}$ is an irrational number. Hence, show that $7 + 2\sqrt{3}$ is also an irrational number.

Ans : [Board Term-1 2012]

Assume that $\sqrt{3}$ be a rational number then we have

$$\sqrt{3} = \frac{a}{b}, \qquad (a, b \text{ are co-primes and } b \neq 0)$$

$$a = b\sqrt{3}$$

Squaring both the sides, we have

$$a^2 = 3b^2$$

Thus 3 is a factor of a^2 and in result 3 is also a factor of a.

Let $a = 3c$ where c is some integer, then we have

$$a^2 = 9c^2$$

a164

Substituting $a^2 = 9b^2$ we have

$$3b^2 = 9c^2$$

$$b^2 = 3c^2$$

Thus 3 is a factor of b^2 and in result 3 is also a factor of b.

Thus 3 is a common factor of a and b. But this contradicts the fact that a and b are co-primes. Thus, our assumption that $\sqrt{3}$ is rational number is wrong. Hence $\sqrt{3}$ is irrational.

Let us assume that $7 + 2\sqrt{3}$ be rational equal to a, then we have

$$7 + 2\sqrt{3} = \frac{p}{q} \qquad q \neq 0 \text{ and } p \text{ and } q \text{ are co-primes}$$

$$2\sqrt{3} = \frac{p}{q} - 7 = \frac{p - 7q}{q}$$

or $$\sqrt{3} = \frac{p - 7q}{2q}$$

Here $p - 7q$ and $2q$ both are integers, hence $\sqrt{3}$ should be a rational number. But this contradicts the fact that $\sqrt{3}$ is an irrational number. Hence our assumption is not correct and $7 + 2\sqrt{3}$ is irrational.

86. Show that there is no positive integer n, for which $\sqrt{n-1} + \sqrt{n-1}$ is rational.

Ans : [Board Term-1 2012]

a165

Let us assume that there is a positive integer n for which $\sqrt{n-1} + \sqrt{n-1}$ is rational and equal to $\frac{p}{q}$, where p and q are positive integers and $(q \neq 0)$.

$$\sqrt{n-1} + \sqrt{n-1} = \frac{p}{q} \qquad \text{...(1)}$$

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or, $$\frac{q}{p} = \frac{1}{\sqrt{n-1}+\sqrt{n+1}}$$

$$= \frac{\sqrt{n-1}-\sqrt{n+1}}{(\sqrt{n-1}+\sqrt{n+1})(\sqrt{n-1}-\sqrt{n+1})}$$

$$= \frac{\sqrt{n-1}-\sqrt{n+1}}{(n-1)-(n+1)}$$

or $$\frac{q}{p} = \frac{\sqrt{n-1}-\sqrt{n+1}}{-2}$$

$$\sqrt{n+1}-\sqrt{n-1} = \frac{2q}{p} \quad ...(2)$$

Adding (1) and (2), we get

$$2\sqrt{n+1} = \frac{p}{q}+\frac{2q}{p} = \frac{p^2+2q^2}{pq} \quad ...(3)$$

Subtracting (2) from (1) we have

$$2\sqrt{n-1} = \frac{p^2-2q^2}{pq} \quad ...(4)$$

From (3) and (4), we observe that $\sqrt{n+1}$ and $\sqrt{n-1}$ both are rational because p and q both are rational. But it possible only when $(n+1)$ and $(n-1)$ both are perfect squares. But they differ by 2 and two perfect squares never differ by 2. So both $(n+1)$ and $(n-1)$ cannot be perfect squares, hence there is no positive integer n for which $\sqrt{n-1}+\sqrt{n+1}$ is rational.

CASE STUDY QUESTIONS

87. Shalvi is a tuition teacher and teaches mathematics to some kids at her home. She is very innovative and always plan new games to make her students learn concepts.

Today, she has planned a prime number game. She announce the number 2 in her class and asked the first student to multiply it by a prime number and then pass it to second student. Second student also multiplied it by a prime number and passed it to third student. In this way by multiplying to a prime number the last student got 173250. He told this number to Shalvi in class. Now she asked some questions to the students as given below.

(i) How many students are in the class?
(a) 3 (b) 9
(c) 4 (d) 7

a401

(ii) What is the highest prime number used by student?
(a) 11 (b) 7
(c) 5 (d) 3

(iii) What is the least prime number used by students ?
(a) 2 (b) 7
(c) 5 (d) 3

(iv) Which prime number has been used maximum times ?
(a) 2 (b) 7
(c) 5 (d) 3

(v) Which prime number has been used minimum times ?
(a) 2 (b) 7
(c) 5 (d) 3

Ans :

(i) Prime factorization of 173250,

$$173250 = 2\times3\times3\times5\times5\times5\times7\times11$$

It includes 8 numbers. Number 2 has been used by Shalvi. Remaining 7 numbers have been by 7 students.

Thus (d) is correct option.

(ii) Highest prime factor included in factorization of 173250 is 11.

Thus (a) is correct option.

(iii) Least prime factor included in factorization of 173250 is 2. But 2 is used by Shalvi, thus next least prime number used by students is 3.

Thus (d) is correct option.

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(iv) Number 5 has been used 3 times which is maximum.

Thus (c) is correct option.

(v) Number 7 has been used only one time.

Thus (b) is correct option.

88. Amar, Akbar and Anthony are playing a game. Amar climbs 5 stairs and gets down 2 stairs in one turn. Akbar goes up by 7 stairs and comes down by 2 stairs every time. Anthony goes 10 stairs up and 3 stairs down each time.

Doing this they have to reach to the nearest point of 100th stairs and they will stop once they find it impossible to go forward. They can not cross 100th stair in anyway.

(i) Who reaches the nearest point?

(a) Amar

(b) Akbar

(c) Anthony

(d) All together reach to the nearest point.

(ii) How many times can they meet in between on same stair ?

(a) 3

(b) 4

(c) 5

(d) No, they cannot meet in between on same stair.

(iii) Who takes least number of steps to reach near hundred?

(a) Amar

(b) Akbar

(c) Anthony

(d) All of them take equal number of steps.

(iv) What is the first stair where any two out of three will meet together?

(a) Amar and Akbar will meet for the first time on 15th stair.

(b) Akbar and Anthony will meet for the first time on 35th stair.

(b) Amar and Anthony will meet for the first time on 21th stair.

(d) Amar and Akbar will meet for the first time on 21th stair.

(v) What is the second stair where any two out of three will meet together?

(a) Amar and Akbar will meet on 21th stair.

(b) Akbar and Anthony will meet on 35th stair.

(c) Amar and Anthony will meet on 21th stair.

(d) Amar and Anthony will meet on 35th stair.

Ans :

(i) Amar will reach up to 93th stairs then he will go for 5 stairs up and 2 stairs down hence covering 96 stairs. Since 100th stair is final, so he will not cover more stairs. Akbar will reach up to 95th stair, since 100th stair is final, so he will not cover more stairs. Anthony will reach up to 91th stairs, since 100th stair is final, so she will not cover more stairs. Thus amar reaches the nearest point.

Thus (a) is correct option.

(ii) We find the LCM of 3, 5, and 7.

LCM (3, 5, 7) =105th stair.

Since, total stairs are 100, they all cannot meet in between on same stair.

Thus (d) is correct option.

(iii) Amar will take $(\frac{100}{3} = 33.33)$ 32 steps to reach to 96th stair, Akbar will take $(\frac{100}{5} = 20)$ 19 steps to reach to 9th stairs and Anthony will take $(\frac{100}{7} = 14.22)$ 13 steps to reach 91th stairs.

Thus (c) is correct option.

(iv) Since LCM(3, 5)=15 ; LCM(5, 7)=35 ; LCM(3, 7)=21. Since, 15 is the smallest so Amar and Akbar will meet for the first time on 15th stair.

Thus (a) is correct option.

(v) As already calculated in (iii), LCM(3, 7) =21

Thus (c) is correct option.

89. The Republic Day parade, first held in 1950, has been a yearly ritual since. The parade marches from the Rashtrapati Bhawan along the Rajpath in New Delhi. Several regiments of the army, navy, and air force, along with their bands, march to India Gate. The parade is presided over by the President of India, who is the Commander-in-Chief of the Indian Armed Forces. As he unfurls the tricolour, the national anthem is played. The regiments of the Armed Forces then start their march past. Prestigious awards like Kirti Chakra, Ashok Chakra, Paramvir Chakra and Vir Chakra are given out by the President. Nine to twelve different regiments of the Indian Army, in addition

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to the Navy and Air Force march toward India Gate along with their bands. Contingents of paramilitary forces and other civil forces also participate in the parade.

On 71th republic day parade, captain RS Meel is planing for parade of following two group:

(a) First group of Army troops of 624 members behind an army band of 32 members.

(b) Second group of CRPF troops with 468 soldiers behind the 228 members of bikers.

These two groups are to march in the same number of columns. This sequence of soldiers is followed by different states Jhanki which are showing the culture of the respective states.

(i) What is the maximum number of columns in which the army troop can march?

(a) 8 (b) 16

(c) 4 (d) 32

a403

(ii) What is the maximum number of columns in which the CRPF troop can march?

(a) 4 (b) 8

(c) 12 (d) 16

(iii) What is the maximum number of columns in which total army troop and CRPF troop together can march past?

(a) 2 (b) 4

(c) 6 (d) 8

(iv) What should be subtracted with the numbers of CRPF soldiers and the number of bikers so that their maximum number of column is equal to the maximum number of column of army troop?

(a) 4 Soldiers and 4 Bikers

(b) 4 Soldiers and 2 Bikers

(c) 2 Soldiers and 4 Bikers

(d) 2 Soldiers and 2 Bikers

(v) What should be added with the numbers of CRPF soldiers and the number of bikers so that their maximum number of column is equal to the maximum number of column of army troop?

(a) 4 Soldiers and 4 Bikers

(b) 12 Soldiers and 12 Bikers

(c) 6 Soldiers and 6 Bikers

(d) 12 Soldiers and 6 Bikers

Ans :

(i) We will find the HCF (624, 32) = 16

Thus (b) is correct option.

(ii) We will find the HCF (228, 468) = 12.

Thus (c) is correct option.

According to the question, we have to find out

$$\text{HCF}(624, 32, 228, 468) = 4$$

(iii) Alternatively we can find,

$$\text{HCF } (16, 12) = 4$$

Thus (b) is correct option.

(iv) Maximum number of column of army troop is 16. But 228 and 468 are not divisible by 16. If we subtract 4 from 228 and 468, both(224 and 464) are divisible by 16.

Thus (a) is correct option.

(v) Maximum number of column of army troop is 16. But 228 and 468 are not divisible by 16. If we add 12 in 228 and 468, both(240 and 480) are divisible by 16.

90. Thus (b) is correct option. Lavanya wants to organize her birthday party. She is very happy on her birthday. She is very health conscious, thus she decided to serve fruits only in her birthday party.

She has 36 apples and 60 bananas at home and decided to serve them. She wants to distribute fruits among guests. She does not want to discriminate among guests, so she decided to distribute fruits equally among all.

(i) How many maximum guests Shalvi can invite?

(a) 12 (b) 120

(c) 6 (d) 180

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(ii) How many apples and bananas will each guest get?

(a) 3 apple 5 banana

(b) 5 apple 3 banana

(c) 2 apple 4 banana

(d) 4 apple 2 banana

a404

(iii) Lavanya decide to add 42 mangoes also. In this case how many maximum guests Lavanya can invite ?

(a) 12 (b) 120

(c) 6 (d) 180

(iv) How many total fruits will each guest get?

(a) 6 apple 5 banana and 6 mangoes

(b) 6 apple 10 banana and 7 mangoes

(c) 3 apple 5 banana and 7 mangoes

(d) 3 apple 10 banana and 6 mangoes

(v) If Lavanya decide to add 3 more mangoes and remove 6 apple in total fruits, in this case how many maximum guests Lavanya can invite ?

(a) 12 (b) 30

(c) 15 (d) 24

Ans :

(i) In this case we need to calculate HCF (36, 60) =12. Thus fruits will be equally distributed among 12 guests.

Thus (a) is correct option.

(ii) Out of 36 apples, each guest will get $\frac{36}{12} = 3$ apples and out of 60 bananas, each guest will get $\frac{60}{5} = 12$ bananas.

Thus (a) is correct option.

(iii) In this case we need to calculate HCF (36, 42, 60) =6.

Thus fruits will be equally distributed among 6 guests.

Thus (c) is correct option.

(iv) Out of 36 apples, each guest will get $\frac{36}{6} = 6$ apples and out of 42 mangoes, each guest will get $\frac{42}{6} = 7$ mangoes, out of 60 bananas, each guest will get $\frac{60}{6} = 10$ bananas. Thus each guest will get $6 + 7 + 12 = 25$ fruits.

Thus (b) is correct option.

(v) Now Lavanya has 30 apples, 60 bananas, and 45 mangoes. HCF (30, 45, 60) = 15. Thus Lavanya can invite 15 guest.

Thus (c) is correct option.

91. Ashish supplies bread and jams to a hospital and a school. Bread and jam are supplied in equal number of pieces. Bread comes in a packet of 8 pieces and Jam comes in a pack of 6 pieces.

On a particular day, Ashish has supplied x packets of bread and y packets of jam to the school. On the same day, Ashish has supplied $3x$ packets of bread along with sufficient packets of jam to hospital. It is known that the number of students in the school are between 500 and 550.

(i) How many students are there in school?

(a) 508 (b) 504

(c) 512 (d) 548

a405

(ii) How many packets of bread are supplied in the school?

(a) 63 packets (b) 86 packets

(c) 65 packets (d) 84 packets

(iii) How many packets of jams are supplied in the school?

(a) 63 packets (b) 86 packets

(c) 65 packets (d) 84 packets

(iv) How many packets of bread are supplied in the hospital?

(a) 189 packets (b) 252 packets

(c) 165 packets (d) 288 packets

(v) How many packets of jams are supplied in the hospital?

(a) 248 packets (b) 252 packets

(c) 165 packets (d) 288 packets

Ans :

(i) First we will find LCM (8, 6) =24. Now we will find a multiple of 24 in between 500 and 550 i.e., 504 or 528. Thus there 504 students in school.

Thus (b) is correct option.

(ii) For equal distribution of bread among each student, we need 504 pieces of bread. Hence, we need $\frac{504}{8} = 63$ i.e. 63 packets of bread.

Thus (a) is correct option.

(iii) For equal distribution of jam pieces among each student, we need 504 pieces of jam. Hence, we need $\frac{504}{6} = 84$ i.e. 84 packets of jam.

Thus (d) is correct option.

(iv) For hospital, we need $3x$ packets of bread i.e. $3 \times 63 = 189$ packets of bread.

Thus (a) is correct option.

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(v) Since, number of bread pieces are $189 \times 8 = 1512$, so we need same number of jam pieces. Hence $\frac{1512}{6} = 252$ packets of jam are distributed in the hospital.
Thus (b) is correct option.

92. Mahesh works as a manager in a hotel. He has to arrange chairs in hall for a function. The hall has a certain number of chairs. Guests want to sit in different groups like in pairs, triplets, quadruplets, fives and sixes etc. Mahesh want to arrange chairs in such a way that there are no chair left after arrangement.

When Mahesh arranges chairs in such pattern like in 2's, 3's, 4's 5's and 6's then 1, 2, 3, 4 and 5 chairs are left respectively. But when he arranges in 11's, no chair will be left.

(i) In the hall, how many chairs are available?
(a) 407 (b) 143
(c) 539 (d) 209

(ii) If one chair is removed, which arrangement is possible now?
(a) Pair of 2 chairs
(a) Pair of 3 chairs
(a) Pair of 4 chairs
(a) Pair of 5 chairs

a406

(iii) If one chair is added to the total number of chairs, how many chairs will be left when arranged in 11's.
(a) 1 (b) 2
(c) 3 (d) 4

(iv) How many chairs will be left in original arrangement if same number of chairs are arranged in 7's?
(a) 0 (b) 1
(c) 2 (d) 3

(v) How many chairs will be left in original arrangement if same number of chairs will be arranged in 9's?
(a) 8 (b) 1
(c) 6 (d) 3

Ans :

(i) By dividing all the options by 2, 3, 4, 5, 6 and 11, we will get that 539 is the only option which leaves remainder 1, 2, 3, 4, 5, 0 respectively.
Thus (c) is correct option.
(ii) After removing 1 chair, we are left with 538 chairs. On arranging chairs in pair of 3's, 4's, 5's, 6's, 11's ; 1, 2, 3 ,4, 10 chairs are left. So, only pair of 2 chairs is possible now.
Thus (a) is correct option.
(iii) 539 chairs are already arranged in pair of 11's. On adding 1 extra chair, that 1 chair will be left only.
Thus (a) is correct option.
(iv) 539 is divisible by 7 and remainder is zero, so arranging chairs in pair of 7's, no chair will be left.
Thus (a) is correct option.
(v) If 539 is divided by 9, remainder is 8, so arranging chairs in pair of 9's, 8 chair will be left.
Thus (a) is correct option.

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CHAPTER 2

POLYNOMIALS

ONE MARK QUESTIONS

1. If one zero of a quadratic polynomial (kx^2+3x+k) is 2, then the what is the value of k ?

Ans : [Board 2020 Delhi Basic]

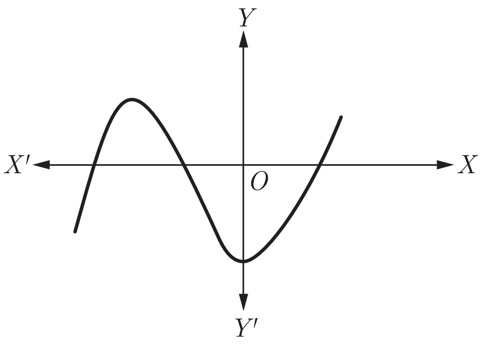
We have $\quad p(x) = kx^2+3x+k$

Since, 2 is a zero of the quadratic polynomial

$$p(2) = 0$$
$$k(2)^2+3(2)+k = 0$$
$$4k+6+k = 0$$
$$5k = -6 \Rightarrow k = -\frac{6}{5}$$

b223

2. The graph of a polynomial is shown in Figure. What is the number of its zeroes?



b224

Ans : [Board 2020 Delhi Basic]

Since, the graph cuts the x-axis at 3 points, the number of zeroes of polynomial $p(x)$ is 3.

3. If one zero of the quadratic polynomial x^2+3x+k is 2, then the what is the value of k?

Ans : [Board 2020 Delhi Standard]

We have $\quad p(x) = x^2+3x+k$

If 2 is a zero of $p(x)$, then we have

$$p(2) = 0$$
$$(2)^2+3(2)+k = 0$$
$$4+6+k = 0$$
$$10+k = 0 \Rightarrow k = -10$$

b225

4. Find the quadratic polynomial, the sum of whose zeroes is -5 and their product is 6.

Ans : [Board 2020 Delhi Standard]

Let α and β be the zeroes of the quadratic polynomial, then we have

$$\alpha+\beta = -5$$

and $\quad \alpha\beta = 6$

Now $\quad p(x) = x^2-(\alpha+\beta)x+\alpha\beta$

$$= x^2-(-5)x+6$$
$$= x^2+5x+6$$

b226

5. If one zero of the polynomial $(3x^2+8x+k)$ is the reciprocal of the other, then what is the value of k?

Ans : [Board 2020 OD Basic]

Let the zeroes be α and $\frac{1}{\alpha}$.

Product of zeroes,

$$\alpha\cdot\frac{1}{\alpha} = \frac{\text{constant}}{\text{coefficient of } x^2}$$
$$1 = \frac{k}{3} \Rightarrow k = 3$$

b227

6. What is the value of x, for which the polynomials x^2-1 and x^2-2x+1 vanish simultaneously?

Ans : [Board Term-1 OD 2011]

Both expression $(x-1)(x+1)$ and $(x-1)(x-1)$ have 1 as zero. This both vanish if $x=1$.

Thus (d) is correct option.

b228

7. If α and β are zeroes and the quadratic polynomial $f(x)=x^2-x-4$, then what is the value of $\frac{1}{\alpha}+\frac{1}{\beta}-\alpha\beta$?

Ans : [Board Term-1 Delhi 2017]

We have $\quad f(x) = x^2-x-4$

$$\alpha+\beta = -\frac{-1}{1} = 1 \text{ and } \alpha\beta = \frac{-4}{1}-4$$

b229

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Now $$\frac{1}{\alpha}+\frac{1}{\beta}-\alpha\beta = \frac{\alpha+\beta}{\alpha\beta}-\alpha\beta$$

$$= -\frac{1}{4}+4 = \frac{15}{4}$$

8. What is the lowest value of x^2+4x+2 ?

Ans : [Board Term-1 OD 2013]

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

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

Here $(x+2)^2$ is always positive and its lowest value is zero. Thus lowest value of $(x+2)^2-2$ is -2 when $x+2=0$.

b230

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

Ans : [Board Term-1 2016]

Sum of the zeroes, $$6 = \frac{3k}{2}$$

$$k = \frac{12}{3} = 4$$

b231

10. If the square of difference of the zeroes of the quadratic polynomial $x^2+px+45$ is equal to 144, then what is the value of p ?

Ans : [Board Term-1 Foreign 2014]

We have $$f(x) = x^2+px+45$$

Then, $$\alpha+\beta = \frac{-p}{1} = -p$$

and $$\alpha\beta = \frac{45}{1} = 45$$

b232

According to given condition, we have

$$(\alpha-\beta)^2 = 144$$

$$(\alpha+\beta)^2-4\alpha\beta = 144$$

$$(-p)^2-4(45) = 144$$

$$p^2 = 144+180 = 324 \Rightarrow p = \pm 18$$

11. If one of the zeroes of the quadratic polynomial $(k-1)x^2+kx+1$ is -3, then what is the value of k ?

Ans : [Board Term-1 Delhi 2013]

If a is zero of quadratic polynomial $f(x)$, then

$$f(a) = 0$$

So, $$f(-3) = (k-1)(-3)^2+(-3)k+1$$

$$0 = (k-1)(9)-3k+1$$

$$0 = 9k-9-3k+1$$

$$0 = 6k-8$$

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

b233

12. Find a quadratic polynomial, whose zeroes are -3 and 4 ?

Ans :

b234

We have $\alpha = -3$ and $\beta = 4$.

Sum of zeros $$\alpha+\beta = -3+4 = 1$$

Product of zeros, $$\alpha\cdot\beta = -3\times 4 = -12$$

So, the quadratic polynomial is

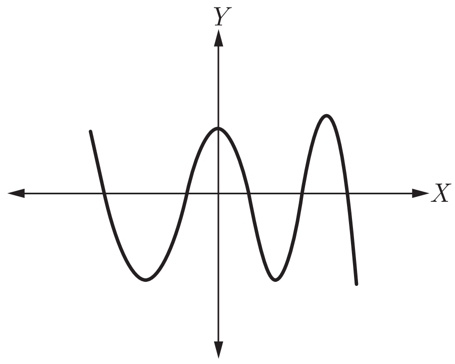
$$x^2-(\alpha+\beta)x+\alpha\beta = x^2-1\times x+(-12)$$

$$= x^2-x-12$$

$$= \frac{x^2}{2}-\frac{x}{2}-6$$

13. The graph of $y=p(x)$, where $p(x)$ is a polynomial in variable x, is as follows.

b209



The number of zeroes of $p(x)$ is ....

Ans : [Board 2020 SQP Standard]

The graph of the given polynomial $p(x)$ crosses the x-axis at 5 points. So, number of zeroes of $p(x)$ is 5.

14. If one root of the equation $(k-1)x^2-10x+3=0$ is the reciprocal of the other then the value of k is ....

Ans : [Board 2020 SQP Standard]

We have $(k-1)x^2-10x+3=0$

Let one root be α, then another root will be $\frac{1}{\alpha}$

Now $$\alpha\cdot\frac{1}{\alpha} = \frac{c}{a} = \frac{3}{(k-1)}$$

$$1 = \frac{3}{(k-1)}$$

$$k-1 = 3 \Rightarrow k = 4$$

b210

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15. If α and β are the roots of $ax^2 - bx + c = 0\,(a \neq 0)$, then calculate $\alpha + \beta$.

Ans : [Board Term-1 2014]

We know that

$$\text{Sum of the roots} = -\frac{\text{coefficient of } x}{\text{coefficient of } x^2}$$

b101

Thus $\alpha + \beta = -\left(\frac{-b}{a}\right) = \frac{b}{a}$

16. Calculate the zeroes of the polynomial $p(x) = 4x^2 - 12x + 9$.

Ans : [Board Term-1 2010]

$$\begin{aligned} p(x) &= 4x^2 - 12x + 9 \\ &= 4x^2 - 6x - 6x + 9 \\ &= 2x(2x - 3) - 3(2x - 3) \\ &= (2x - 3)(2x - 3) \end{aligned}$$

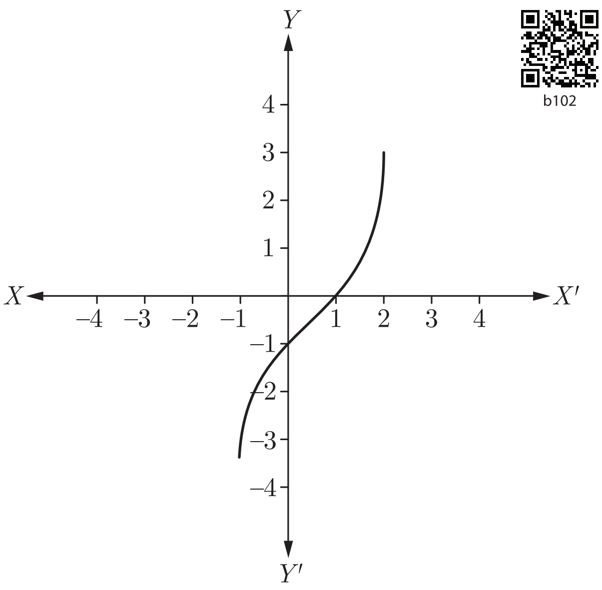
b103

Substituting $p(x) = 0$, and solving we get $x = \frac{3}{2}, \frac{3}{2}$

$x = \frac{3}{2}, \frac{3}{2}$

Hence, zeroes of the polynomial are $\frac{3}{2}, \frac{3}{2}$.

17. In given figure, the graph of a polynomial $p(x)$ is shown. Calculate the number of zeroes of $p(x)$.



b102

Ans : [Board Term-1 2013]

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

18. If sum of the zeroes of the quadratic polynomial $3x^2 - kx + 6$ is 3, then find the value of k.

Ans : [Board 2009]

We have $p(x) = 3x^2 - kx - 6$

b104

$$\text{Sum of the zeroes} = 3 = -\frac{\text{coefficient of } x}{\text{coefficient of } x^2}$$

Thus $3 = -\frac{(-k)}{3} \Rightarrow k = 9$

19. If -1 is a zero of the polynomial $f(x) = x^2 - 7x - 8$, then calculate the other zero.

Ans :

We have $f(x) = x^2 - 7x - 8$

b105

Let other zero be k, then we have

Sum of zeroes, $-1 + k = -\left(\frac{-7}{1}\right) = 7$

or $k = 8$

20. If zeroes of the polynomial $x^2 + 4x + 2a$ are a and $\frac{2}{a}$, then find the value of a.

Ans : [Board Term-1 2016]

Product of (zeroes) roots,

$$\frac{c}{a} = \frac{2a}{1} = \alpha \times \frac{2}{\alpha} = 2$$

b106

or, $2a = 2$

Thus $a = 1$

21. Find all the zeroes of $f(x) = x^2 - 2x$.

Ans : [Board Term-1 2013]

We have $f(x) = x^2 - 2x$

$= x(x - 2)$

b107

Substituting $f(x) = 0$, and solving we get $x = 0, 2$

Hence, zeroes are 0 and 2.

22. Find the condition that zeroes of polynomial $p(x) = ax^2 + bx + c$ are reciprocal of each other.

Ans : [Board Term-1 2012]

We have $p(x) = ax^2 + bx + c$

b115

Let α and $\frac{1}{\alpha}$ be the zeroes of $p(x)$, then

Product of zeroes,

$$\frac{c}{a} = \alpha \times \frac{1}{\alpha} = 1 \text{ or } \frac{c}{a} = 1$$

So, required condition is, $c = a$

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23. Find the values of a and b, if they are the zeroes of polynomial $x^2 + ax + b$.

Ans : [Board Term-1 2013]

We have $\quad p(x) = x^2 + ax + b$

Since a and b, are the zeroes of polynomial, we get,

Product of zeroes, $\quad ab = b \Rightarrow a = 1$

Sum of zeroes, $\quad a + b = -a \Rightarrow b = -2a = -2$

24. What are the zeroes of the polynomial $x^2 - 3x - m(m+3)$?

Ans : [Board 2020 OD Standard]

We have $\quad p(x) = x^2 - 3x - m(m+3)$

Substituting $x = -m$ in $p(x)$ we have

$$p(-m) = (-m)^2 - 3(-m) - m(m+3)$$
$$= m^2 + 3m - m^2 - 3m = 0$$

Thus $x = -m$ is a zero of given polynomial.

Now substituting $x = m+3$ in given polynomial we have

$$p(x) = (m+3)^2 - 3(m+3) - m(m+3)$$
$$= (m+3)[m+3-3-m]$$
$$= (m+3)[0] = 0$$

Thus $x = m+3$ is also a zero of given polynomial.

Hence, $-m$ and $m+3$ are the zeroes of given polynomial.

25. If the zeroes of the quadratic polynomial $x^2 + (a+1)x + b$ are 2 and -3, then find the value of a and b.

Ans :

If a is zero of the polynomial, then $f(a) = 0$.

Here, 2 and -3 are zeroes of the polynomial $x^2 + (a+1)x + b$

So, $\quad f(2) = (2)^2 + (a+1)(-3) + b = 0$

$$4 + 2a + 2 + b = 0$$
$$6 + 2a + b = 0$$
$$2a + b = -6 \quad \text{...(1)}$$

Again, $\quad f(-3) = (-3)^2 + (a+1)2 + b = 0$

$$9 - 3(a+1) + b = 0$$
$$9 - 3a - 3 + b = 0$$
$$6 - 3a + b = 0$$
$$-3a + b = -6$$
$$3a - b = 6 \quad \text{...(2)}$$

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

$$5a = 0 \Rightarrow a = 0$$

Substituting value of a in equation (1), we get

$$b = -6$$

Hence, $a = 0$ and $b = -6$.

TWO MARKS QUESTIONS

26. If zeroes of the polynomial $x^2 + 4x + 2a$ are a and $\frac{2}{a}$, then find the value of a.

Ans : [Board Term-1 2016]

Product of (zeroes) roots,

$$\frac{c}{a} = \frac{2a}{1} = \alpha \times \frac{2}{\alpha} = 2$$

or, $\quad 2a = 2$

Thus $\quad a = 1$

27. Find all the zeroes of $f(x) = x^2 - 2x$.

Ans : [Board Term-1 2013]

We have $\quad f(x) = x^2 - 2x$

$$= x(x-2)$$

Substituting $f(x) = 0$, and solving we get $x = 0, 2$

Hence, zeroes are 0 and 2.

28. Find the zeroes of the quadratic polynomial $\sqrt{3}x^2 - 8x + 4\sqrt{3}$.

Ans : [Board Term-1 2013]

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

$$= \sqrt{3}x^2 - 6x - 2x + 4\sqrt{3}$$
$$= \sqrt{3}x(x - 2\sqrt{3}) - 2(x - 2\sqrt{3})$$
$$= (\sqrt{3}x - 2)(x - 2\sqrt{3})$$

Substituting $p(x) = 0$, we have

$$(\sqrt{3}x - 2)(x - 2\sqrt{3}) \;\; p(x) = 0$$

Solving we get $x = \frac{2}{\sqrt{3}}, 2\sqrt{3}$

Hence, zeroes are $\frac{2}{\sqrt{3}}$ and $2\sqrt{3}$.

29. Find a quadratic polynomial, the sum and product of

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whose zeroes are 6 and 9 respectively. Hence find the zeroes.

Ans : [Board Term-1 2016]

Sum of zeroes, $\alpha+\beta = 6$

Product of zeroes $\alpha\beta = 9$

b109

Now $p(x) = x^2-(\alpha+\beta)x+\alpha\beta$

Thus $= x^2-6x+9$

Thus quadratic polynomial is x^2-6x+9.

Now $p(x) = x^2-6x+9 = (x-3)(x-3)$

Substituting $p(x)=0$, we get $x=3,3$

Hence zeroes are 3, 3

30. Find the quadratic polynomial whose sum and product of the zeroes are $\frac{21}{8}$ and $\frac{5}{16}$ respectively.

Ans : [Board Term-1 2012]

Sum of zeroes, $\alpha+\beta = \frac{21}{8}$

Product of zeroes $\alpha\beta = \frac{5}{16}$

b110

Now $p(x)\ x^2-(\alpha+\beta)x+\alpha\beta$

$= x^2-\frac{21}{8}x+\frac{5}{16}$

or $p(x) = \frac{1}{16}(16x^2-42x+5)$

31. Form a quadratic polynomial $p(x)$ with 3 and $-\frac{2}{5}$ as sum and product of its zeroes, respectively.

Ans : [Board Term-1 2012]

Sum of zeroes, $\alpha+\beta = 3$

Product of zeroes $\alpha\beta = -\frac{2}{5}$

b111

Now $p(x)\ x^2-(\alpha+\beta)x+\alpha\beta$

$= x^2-3x-\frac{2}{5}$

$= \frac{1}{5}(5x^2-15x-2)$

The required quadratic polynomial is $\frac{1}{5}(5x^2-15x-2)$

32. If m and n are the zeroes of the polynomial $3x^2+11x-4$, find the value of $\frac{m}{n}+\frac{n}{m}$.

Ans : [Board Term-1 2012]

We have $\frac{m}{n}+\frac{n}{m} = \frac{m^2+n^2}{mn} = \frac{(m+n)^2-2mn}{mn}$ (1)

Sum of zeroes $m+n = -\frac{11}{3}$

b113

Product of zeroes $mn = \frac{-4}{3}$

Substituting in (1) we have

$$\frac{m}{n}+\frac{n}{m} = \frac{(m+n)^2-2mn}{mn}$$

$$= \frac{(-\frac{11}{3})^2-\frac{-4}{3}\times 2}{\frac{-4}{3}}$$

$$= \frac{121+4\times 3\times 2}{-4\times 3}$$

or $\frac{m}{n}+\frac{n}{m} = \frac{-145}{12}$

33. If p and q are the zeroes of polynomial $f(x)=2x^2-7x+3$, find the value of p^2+q^2.

Ans : [Board Term-1 2012]

We have $f(x) = 2x^2-7x+3$

Sum of zeroes $p+q = -\frac{b}{a} = -\left(\frac{-7}{2}\right) = \frac{7}{2}$

Product of zeroes $pq = \frac{c}{a} = \frac{3}{2}$

b114

Since, $(p+q)^2 = p^2+q^2+2pq$

so, $p^2+q^2 = (p+q)^2-2pq$

$$= \left(\frac{7}{2}\right)^2-3 = \frac{49}{4}-\frac{3}{1} = \frac{37}{4}$$

Hence $p^2+q^2 = \frac{37}{4}$.

34. Find the condition that zeroes of polynomial $p(x)=ax^2+bx+c$ are reciprocal of each other.

Ans : [Board Term-1 2012]

We have $p(x) = ax^2+bx+c$

Let α and $\frac{1}{\alpha}$ be the zeroes of $p(x)$, then

b115

Product of zeroes,

$$\frac{c}{a} = \alpha\times\frac{1}{\alpha} = 1 \text{ or } \frac{c}{a} = 1$$

So, required condition is, $c = a$

35. Find the value of k if -1 is a zero of the polynomial $p(x)=kx^2-4x+k$.

Ans : [Board Term-1 2012]

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We have $p(x) = kx^2 - 4x + k$

Since, -1 is a zero of the polynomial, then

$$p(-1) = 0$$
$$k(-1)^2 - 4(-1) + k = 0$$
$$k + 4 + k = 0$$
$$2k + 4 = 0$$
$$2k = -4$$

Hence, $k = -2$

b116

36. If α and β are the zeroes of a polynomial $x^2 - 4\sqrt{3}x + 3$, then find the value of $\alpha + \beta - \alpha\beta$.

Ans : [Board Term-1 2015]

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

If α and β are the zeroes of $x^2 - 4\sqrt{3}x + 3$, then

Sum of zeroes, $\alpha + \beta = -\dfrac{b}{a} = -\dfrac{(-4\sqrt{3})}{1}$

or, $\alpha + \beta = 4\sqrt{3}$

b117

Product of zeroes $\alpha\beta = \dfrac{c}{a} = \dfrac{3}{1}$

or, $\alpha\beta = 3$

Now $\alpha + \beta - \alpha\beta = 4\sqrt{3} - 3$.

37. Find the values of a and b, if they are the zeroes of polynomial $x^2 + ax + b$.

Ans : [Board Term-1 2013]

We have $p(x) = x^2 + ax + b$

Since a and b, are the zeroes of polynomial, we get,

Product of zeroes, $ab = b \Rightarrow a = 1$

Sum of zeroes, $a + b = -a \Rightarrow b = -2a = -2$

38. If α and β are the zeroes of the polynomial $f(x) = x^2 - 6x + k$, find the value of k, such that $\alpha^2 + \beta^2 = 40$.

Ans : [Board Term-1 2015]

We have $f(x) = x^2 - 6x + k$

Sum of zeroes, $\alpha + \beta = -\dfrac{b}{a} = \dfrac{-(-6)}{1} = 6$

Product of zeroes, $\alpha\beta = \dfrac{c}{a} = \dfrac{k}{1} = k$

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

$$(6)^2 - 2k = 40$$
$$36 - 2k = 40$$
$$-2k = 4$$

b119

Thus $k = -2$

39. If one of the zeroes of the quadratic polynomial $f(x) = 14x^2 - 42k^2x - 9$ is negative of the other, find the value of 'k'.

Ans : [Board Term-1 2012]

We have $f(x) = 14x^2 - 42k^2x - 9$

Let one zero be α, then other zero will be $-\alpha$.

Sum of zeroes $\alpha + (-\alpha) = 0$.

Thus sum of zero will be 0.

b120

Sum of zeroes $0 = -\dfrac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$

$$0 = -\frac{42k^2}{14} = -3k^2$$

Thus $k = 0$.

40. If one zero of the polynomial $2x^2 + 3x + \lambda$ is $\frac{1}{2}$, find the value of λ and the other zero.

Ans : [Board Term-1 2012]

Let, the zero of $2x^2 + 3x + \lambda$ be $\dfrac{1}{2}$ and β.

Product of zeroes $\dfrac{c}{a}$, $\dfrac{1}{2}\beta = \dfrac{\lambda}{2}$

b121

or, $\beta = \lambda$

and sum of zeroes $-\dfrac{b}{a}$, $\dfrac{1}{2} + \beta = -\dfrac{3}{2}$

or $\beta = -\dfrac{3}{2} - \dfrac{1}{2} = -2$

Hence $\lambda = \beta = -2$

Thus other zero is -2.

41. If α and β are zeroes of the polynomial $f(x) = x^2 - x - k$, such that $\alpha - \beta = 9$, find k.

Ans : [Board Term-1 2013]

We have $f(x) = x^2 - x - k$

Since α and β are the zeroes of the polynomial, then

Sum of zeroes, $\alpha + \beta = -\dfrac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$

$$= -\left(\frac{-1}{1}\right) = 1$$

b122

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

Given $\alpha - \beta = 9 \quad ...(2)$

Solving (1) and (2) we get $\alpha = 5$ and $\beta = -4$

$$\alpha\beta = \frac{\text{Constan term}}{\text{Coefficient of } x^2}$$

or $\alpha\beta = -k$

Substituting $\alpha = 5$ and $\beta = -4$ we have

$$(5)(-4) = -k$$

Thus $k = 20$

42. If the zeroes of the polynomial $x^2 + px + q$ are double in value to the zeroes of $2x^2 - 5x - 3$, find the value of p and q.

Ans : [Board Term-1 2012]

We have $f(x) = 2x^2 - 5x - 3$

Let the zeroes of polynomial be α and β, then

Sum of zeroes $\alpha + \beta = \frac{5}{2}$

Product of zeroes $\alpha\beta = -\frac{3}{2}$

According to the question, zeroes of $x^2 + px + q$ are 2α and 2β.

Sum of zeros, $2\alpha + 2\beta = \frac{-p}{1}$

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

Substituting $\alpha + \beta = \frac{5}{2}$ we have

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

or $p = -5$

Product of zeroes, $2\alpha 2\beta = \frac{q}{1}$

$$4\alpha\beta = q$$

Substituting $\alpha\beta = -\frac{3}{2}$ we have

$$4 \times \frac{-3}{2} = q$$

$$-6 = q$$

Thus $p = -5$ and $q = -6$.

43. If α and β are zeroes of $x^2 - (k-6)x + 2(2k-1)$, find the value of k if $\alpha + \beta = \frac{1}{2}\alpha\beta$.

Ans : [Board Term-1 2013]

We have $p(x) = x^2 - (k-6)x + 2(2k-1)$

Since α, β are the zeroes of polynomial $p(x)$, we get

$$\alpha + \beta = -[-(k-6)] = k - 6$$

$$\alpha\beta = 2(2k-1)$$

Now $\alpha + \beta = \frac{1}{2}\alpha\beta$

Thus $k + 6 = \frac{2(2k-1)}{2}$

or, $k - 6 = 2k - 1$

$$k = -5$$

Hence the value of k is -5.

THREE MARKS QUESTIONS

44. Find a quadratic polynomial whose zeroes are reciprocals of the zeroes of the polynomial $f(x) = ax^2 + bx + c$, $a \neq 0$, $c \neq 0$.

Ans : [Board 2020 Delhi Standard]

Let α and β be zeros of the given polynomial $ax^2 + bx + c$.

$$\alpha + \beta = -\frac{b}{a} \text{ and } \alpha\beta = \frac{c}{a}$$

Let $\frac{1}{\alpha}$ and $\frac{1}{\beta}$ be the zeros of new polynomial then we have

Sum of zeros, $s = \frac{1}{\alpha} + \frac{1}{\beta} = \frac{\beta + \alpha}{\alpha\beta}$

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

Product of zeros, $p = \frac{1}{\alpha} \cdot \frac{1}{\beta} = \frac{1}{\alpha\beta} = \frac{a}{c}$

Required polynomial,

$$g(x) = x^2 - sx + p$$

$$g(x) = x^2 + \frac{b}{c}x + \frac{a}{c}$$

$$cg(x) = cx^2 + bx + a$$

$$g'(x) = cx^2 + bx + a$$

45. Verify whether 2, 3 and $\frac{1}{2}$ are the zeroes of the polynomial $p(x) = 2x^3 - 11x^2 + 17x - 6$.

Ans : [Board Term-1 2013]

If 2, 3 and $\frac{1}{2}$ are the zeroes of the polynomial $p(x)$, then these must satisfy $p(x) = 0$

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(1) 2,
$$p(x) = 2x^2 - 11x^2 + 17x - 6$$
$$p(2) = 2(2)^3 - 11(2)^2 + 17(2) - 6$$
$$= 16 - 44 + 34 - 6$$
$$= 50 - 50$$

b125

or $$p(2) = 0$$

(2) 3,
$$p(3) = 2(3)^3 - 11(3)^2 + 17(3) - 6$$
$$= 54 - 99 + 51 - 6$$
$$= 105 - 105$$

or $$p(3) = 0$$

(3) $\frac{1}{2}$
$$p\left(\frac{1}{2}\right) = 2\left(\frac{1}{2}\right)^3 - 11\left(\frac{1}{2}\right)^2 + 17\left(\frac{1}{2}\right) - 6$$
$$= \frac{1}{4} - \frac{11}{4} + \frac{17}{2} - 6$$

or $$p\left(\frac{1}{2}\right) = 0$$

Hence, 2, 3, and $\frac{1}{2}$ are the zeroes of $p(x)$.

46. If the sum and product of the zeroes of the polynomial $ax^2 - 5x + c$ are equal to 10 each, find the value of 'a' and 'c'.

Ans : [Board Term-1 2011]

We have $$f(x) = ax^2 - 5x + c$$

Let the zeroes of $f(x)$ be α and β, then,

Sum of zeroes $$\alpha + \beta = -\frac{-5}{a} = \frac{5}{a}$$

b126

Product of zeroes $$\alpha\beta = \frac{c}{a}$$

According to question, the sum and product of the zeroes of the polynomial $f(x)$ are equal to 10 each.

Thus $$\frac{5}{a} = 10 \quad ...(1)$$

and $$\frac{c}{a} = 10 \quad ...(2)$$

Dividing (2) by eq. (1) we have
$$\frac{c}{5} = 1 \Rightarrow c = 5$$

Substituting $c = 5$ in (2) we get $a = \frac{1}{2}$

Hence $a = \frac{1}{2}$ and $c = 5$.

47. If one the zero of a polynomial $3x^2 - 8x + 2k + 1$ is seven times the other, find the value of k.

Ans : [Board Term-1 2011]

We have $$f(x) = 3x^2 - 8x + 2k + 1$$

Let α and β be the zeroes of the polynomial, then
$$\beta = 7\alpha$$

Sum of zeroes, $$\alpha + \beta = -\left(-\frac{8}{3}\right)$$

b127

$$\alpha + 7\alpha = 8\alpha = \frac{8}{3}$$

So $$\alpha = \frac{1}{3}$$

Product of zeroes, $$\alpha \times 7\alpha = \frac{2k+1}{3}$$
$$7\alpha^2 = \frac{2k+1}{3}$$
$$7\left(\frac{1}{3}\right)^2 = \frac{2k+1}{3}$$
$$7 \times \frac{1}{9} = \frac{2k+1}{1}$$
$$\frac{7}{3} - 1 = 2k$$
$$\frac{4}{3} = 2k \Rightarrow k = \frac{2}{3}$$

48. Quadratic polynomial $2x^2 - 3x + 1$ has zeroes as α and β. Now form a quadratic polynomial whose zeroes are 3α and 3β.

Ans : [Board Term-1 2015]

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

If α and β are the zeroes of $2x^2 - 3x + 1$, then

Sum of zeroes $$\alpha + \beta = \frac{-b}{a} = \frac{3}{2}$$

b128

Product of zeroes $$\alpha\beta = \frac{c}{a} = \frac{1}{2}$$

New quadratic polynomial whose zeroes are 3α and 3β is,
$$p(x) = x^2 - (3\alpha + 3\beta)x + 3\alpha \times 3\beta$$
$$= x^2 - 3(\alpha + \beta)x + 9\alpha\beta$$
$$= x^2 - 3\left(\frac{3}{2}\right)x + 9\left(\frac{1}{2}\right)$$
$$= x^2 - \frac{9}{2}x + \frac{9}{2}$$
$$= \frac{1}{2}(2x^2 - 9x + 9)$$

Hence, required quadratic polynomial is $\frac{1}{2}(2x^2 - 9x + 9)$

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49. If α and β are the zeroes of the polynomial $6y^2 - 7y + 2$, find a quadratic polynomial whose zeroes are $\frac{1}{\alpha}$ and $\frac{1}{\beta}$.

Ans : [Board Term-1 2011]

We have $p(y) = 6y^2 - 7y + 2$

Sum of zeroes $\alpha + \beta = -\left(-\frac{7}{6}\right) = \frac{7}{6}$

Product of zeroes $\alpha\beta = \frac{2}{6} = \frac{1}{3}$

Sum of zeroes of new polynomial $g(y)$

$$\frac{1}{\alpha} + \frac{1}{\beta} = \frac{\alpha + \beta}{\alpha\beta} = \frac{7/6}{2/6} = \frac{7}{2}$$

and product of zeroes of new polynomial $g(y)$,

$$\frac{1}{\alpha} \times \frac{1}{\beta} = \frac{1}{\alpha\beta} = \frac{1}{1/3} = 3$$

The required polynomial is

$$g(x) = y^2 - \frac{7}{2}y + 3 = \frac{1}{2}[2y^2 - 7y + 6]$$

50. Show that $\frac{1}{2}$ and $\frac{-3}{2}$ are the zeroes of the polynomial $4x^2 + 4x - 3$ and verify relationship between zeroes and coefficients of the polynomial.

Ans : [Board Term-1 2011]

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

If $\frac{1}{2}$ and $\frac{-3}{2}$ are the zeroes of the polynomial $p(x)$, then these must satisfy $p(x) = 0$

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

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

and $$p\left(-\frac{3}{2}\right) = 4\left(\frac{9}{2}\right) + 4\left(-\frac{3}{2}\right) - 3$$

$$= 9 - 6 - 3 = 0$$

Thus $\frac{1}{2}, -\frac{3}{2}$ are zeroes of polynomial $4x^2 + 4x - 3$.

$$\text{Sum of zeroes} = \frac{1}{2} - \frac{3}{2} = -1 = \frac{-4}{4}$$

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

$$\text{Product of zeroes} = \left(\frac{1}{2}\right)\left(-\frac{3}{2}\right) = \frac{-3}{4}$$

$$= \frac{\text{Constan term}}{\text{Coefficient of } x^2}$$ Verified

51. 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 :

$2x + 3$, $3x^2 + 7x + 2$, $4x^3 + 3x^2 + 2$, $x^3 + \sqrt{3x} + 7$, $7x + \sqrt{7}$, $5x^3 - 7x + 2$, $2x^2 + 3 - \frac{5}{x}$, $5x - \frac{1}{2}$, $ax^3 + bx^2 + cx + d$, $x + \frac{1}{x}$.

Answer the following question :

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

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

Ans : [Board 2020 OD Standard]

(i) $x^3 + \sqrt{3x} + 7, 2x^2 + 3 - \frac{5}{x}$ and $x + \frac{1}{x}$ are not polynomials.

(ii) $3x^2 + 7x + 2$ is only one quadratic polynomial.

52. Find the zeroes of the quadratic polynomial $x^2 - 2\sqrt{2}\,x$ and verify the relationship between the zeroes and the coefficients.

Ans : [Board Term-1 2015]

We have $p(x) x^2 - 2\sqrt{2}\,x = 0$

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

Thus zeroes are 0 and $2\sqrt{2}$.

Sum of zeroes $2\sqrt{2} = -\frac{\text{Coefficient of } x}{\text{Coefficient of } x^2}$

and product of zeroes $0 = \frac{\text{Constan term}}{\text{Coefficient of } x^2}$

Hence verified.

53. Find the zeroes of the quadratic polynomial $5x^2 + 8x - 4$ and verify the relationship between the zeroes and the coefficients of the polynomial.

Ans : [Board Term-1 2013]

We have $p(x) = 5x^2 + 8x - 4 = 0$

$$= 5x^2 + 10x - 2x - 4 = 0$$

$$= 5x(x + 2) - 2(x + 2) = 0$$

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

Substituting $p(x) = 0$ we get zeroes as -2 and $\frac{2}{5}$.

Verification :

$$\text{Sum of zeroes} = -2 + \frac{2}{5} = \frac{-8}{5}$$

$$\text{Product of zeroes} = (-2) \times \left(\frac{2}{5}\right) = \frac{-4}{5}$$

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Now from polynomial we have

Sum of zeroes $-\frac{b}{a} = -\frac{\text{Coefficient of } x}{\text{Coefficient of } x^2} = \frac{-8}{5}$

Product of zeroes $\frac{c}{a} = \frac{\text{Constan term}}{\text{Coefficient of } x^2} = -\frac{4}{5}$

Hence Verified.

54. If α and β are the zeroes of a quadratic polynomial such that $\alpha + \beta = 24$ and $\alpha - \beta = 8$. Find the quadratic polynomial having α and β as its zeroes.

Ans : [Board 2009]

We have $\alpha + \beta = 24$ ...(1)

$\alpha - \beta = 8$ ...(2)

Adding equations (1) and (2) we have

$$2\alpha = 32 \Rightarrow \alpha = 16$$

Subtracting (1) from (2) we have

$$2\beta = 16 \Rightarrow \beta = 8$$

Hence, the quadratic polynomial

$$\begin{aligned} p(x) &= x^2 - (\alpha + \beta)x + \alpha\beta \\ &= x^2 - (16+8)x + (16)(8) \\ &= x^2 - 24x + 128 \end{aligned}$$

55. If α, β and γ are zeroes of the polynomial $6x^3 + 3x^2 - 5x + 1$, then find the value of $\alpha^{-1} + \beta^{-1} + \gamma^{-1}$.

Ans : [Board 2010]

We have $p(x) = 6x^3 + 3x^2 - 5x + 1$

Since α, β and γ are zeroes polynomial $p(x)$, we have

$$\alpha + \beta + \gamma = -\frac{b}{c} = -\frac{3}{6} = -\frac{1}{2}$$

$$\alpha\beta + \beta\gamma + \gamma\alpha = \frac{c}{a} = -\frac{5}{6}$$

and $$\alpha\beta\gamma = -\frac{d}{a} = -\frac{1}{6}$$

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

$$= \frac{-\frac{5}{6}}{-\frac{1}{6}} = \frac{-5}{6} \times \frac{6}{-1} = 5$$

Hence $\alpha^{-1} + \beta^{-1} + \gamma^{-1} = 5$.

56. When $p(x) = x^2 + 7x + 9$ is divisible by $g(x)$, we get $(x+2)$ and -1 as the quotient and remainder respectively, find $g(x)$.

Ans : [Board Term-1 2011]

We have $p(x) = x^2 + 7x + 9$

$q(x) = x + 2$

$r(x) = -1$

Now $p(x) = g(x)q(x) + r(x)$

$$x^2 + 7x + 9 = g(x)(x+2) - 1$$

or, $$g(x) = \frac{x^2 + 7x + 10}{x+2}$$

$$= \frac{(x+2)(x+5)}{(x+2)} = x + 5$$

Thus $g(x) = x + 5$

57. Find the value for k for which $x^4 + 10x^3 + 25x^2 + 15x + k$ is exactly divisible by $x + 7$.

Ans : [Board Term 2010]

We have $f(x) = x^4 + 10x^3 + 25x^2 + 15x + k$

If $x + 7$ is a factor then -7 is a zero of $f(x)$ and $x = -7$ satisfy $f(x) = 0$.

Thus substituting $x = -7$ in $f(x)$ and equating to zero we have,

$$(-7)^4 + 10(-7)^3 + 25(-7)^2 + 15(-7) + k = 0$$

$$\begin{aligned} 2401 - 3430 + 1225 - 105 + k &= 0 \\ 3626 - 3535 + k &= 0 \\ 91 + k &= 0 \\ k &= -91 \end{aligned}$$

58. On dividing the polynomial $4x^4 - 5x^3 - 39x^2 -$ by the polynomial $g(x)$, the quotient is $x^2 - 3x - 5$ and the remainder is $-5x + 8$. Find the polynomial $g(x)$.

Ans : [Board 2009]

Dividend = (Divisor $\times$ Quotient) + Remainder

$$4x^4 - 5x^3 - 39x^3 - 46x - 2$$
$$= g(x)(x^2 - 3x - 5) + (-5x + 8)$$

$$4x^2 - 5x^3 - 39x^2 - 46x - 2 + 5x - 8$$
$$= g(x)(x^2 - 3x - 5)$$

$$4x^4 - 5x^3 - 39x^2 - 41x - 10 = g(x)(x^2 - 3x - 5)$$

$$g(x) = \frac{4x^4 - 5x^3 - 39x^2 - 41x - 10}{(x^2 - 3x - 5)}$$

Hence, $g(x) = 4x^2 + 7x + 2$

59. If the squared difference of the zeroes of the quadratic polynomial $f(x) = x^2 + px + 45$ is equal to 144, find

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the value of p.

Ans : [Board 2008]

We have $f(x) = x^2 + px + 45$

Let α and β be the zeroes of the given quadratic polynomial.

Sum of zeroes, $\alpha + \beta = -p$

Product of zeroes $\alpha\beta = 45$

b171

Given, $(\alpha - \beta)^2 = 144$

$$(\alpha + \beta)^2 - 4\alpha\beta = 144$$

Substituting value of $\alpha + \beta$ and $\alpha\beta$ we get

$$(-p)^2 - 4 \times 45 = 144$$

$$p^2 - 180 = 144$$

$$p^2 = 144 + 180 = 324$$

Thus $p = \pm\sqrt{324} = \pm 18$

Hence, the value of p is ± 18.

FIVE MARKS QUESTIONS

60. Polynomial $x^4 + 7x^3 + 7x^2 + px + q$ is exactly divisible by $x^2 + 7x + 12$, then find the value of p and q.

Ans : [Board Term-1 2015]

We have $f(x) = x^4 + 7x^3 + 7x^2 + px + q$

Now $x^2 + 7x + 12 = 0$

b135

$$x^2 + 4x + 3x + 12 = 0$$

$$x(x + 4) + 3(x + 4) = 0$$

$$(x + 4)(x + 3) = 0$$

$$x = -4, -3$$

Since $f(x) = x^4 + 7x^3 + 7x^2 + px + q$ is exactly divisible by $x^2 + 7x + 12$, then $x = -4$ and $x = -3$ must be its zeroes and these must satisfy $f(x) = 0$

So putting $x = -4$ and $x = -3$ in $f(x)$ and equating to zero we get

$$f(-4): \; (-4)^4 + 7(-4)^3 + 7(-4)^2 + p(-4) + q = 0$$

$$256 - 448 + 112 - 4p + q = 0$$

$$-4p + q - 80 = 0$$

$$4p - q = -80 \quad \text{...(1)}$$

$$f(-3): \; (-3)^4 + 7(-3)^3 + 7(-3)^2 + p(-3) + q = 0$$

$$81 - 189 + 63 - 3p + q = 0$$

$$-3p + q - 45 = 0$$

$$3p - q = -45 \quad \text{...(2)}$$

Subtracting equation (2) from (1) we have

$$p = -35$$

Substituting the value of p in equation (1) we have

$$4(-35) - q = -80$$

$$-140 - q = -80$$

$$-q = 140 - 80$$

or $-q = 60$

$$q = -60$$

Hence, $p = -35$ and $q = -60$.

61. If α and β are the zeroes of the polynomial $p(x) = 2x^2 + 5x + k$ satisfying the relation, $\alpha^2 + \beta^2 + \alpha\beta = \frac{21}{4}$, then find the value of k.

Ans : [Board Term-1 2012]

We have $p(x) = 2x^2 + 5x + k$

Sum of zeroes, $\alpha + \beta = -\frac{b}{a} = -\left(\frac{5}{2}\right)$

Product of zeroes $\alpha\beta = \frac{c}{a} = \frac{k}{2}$

b136

According to the question,

$$\alpha^2 + \beta^2 + \alpha\beta = \frac{21}{4}$$

$$\alpha^2 + \beta^2 + 2\alpha\beta - \alpha\beta = \frac{21}{4}$$

$$(\alpha + b)^2 - \alpha\beta = \frac{21}{4}$$

Substituting values we have

$$\left(\frac{-5}{2}\right)^2 - \frac{k}{2} = \frac{21}{4}$$

$$\frac{k}{2} = \frac{25}{4} - \frac{21}{4}$$

$$\frac{k}{2} = \frac{4}{4} = 1$$

Hence, $k = 2$

62. If α and β are the zeroes of polynomial $p(x) = 3x^2 + 2x + 1$, find the polynomial whose zeroes are $\frac{1-\alpha}{1+\alpha}$ and $\frac{1-\beta}{1+\beta}$.

Ans : [Board Term-1 2010, 2012]

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We have $p(x) = 3x^2 + 2x + 1$

Since α and β are the zeroes of polynomial $3x^2 + 2x + 1$, we have

$$\alpha + \beta = -\frac{2}{3}$$

b137

and $$\alpha\beta = \frac{1}{3}$$

Let α_1 and β_1 be zeros of new polynomial $q(x)$.

Then for $q(x)$, sum of the zeroes,

$$\alpha_1 + \beta_1 = \frac{1-\alpha}{1+\alpha} + \frac{1-\beta}{1+\beta}$$

$$= \frac{(1-\alpha+\beta-\alpha\beta)+(1+\alpha-\beta-\alpha\beta)}{(1+\alpha)(1+\beta)}$$

$$= \frac{2-2\alpha\beta}{1+\alpha+\beta+\alpha\beta} = \frac{2-\frac{2}{3}}{1-\frac{2}{3}+\frac{1}{3}}$$

$$= \frac{\frac{4}{3}}{\frac{2}{3}} = 2$$

For $q(x)$, product of the zeroes,

$$\alpha_1\beta_1 = \left[\frac{1-\alpha}{1+\alpha}\right]\left[\frac{1-\beta}{1+\beta}\right] = \frac{(1-\alpha)(1-\beta)}{(1+\alpha)(1+\beta)}$$

$$= \frac{1-\alpha-\beta+\alpha\beta}{1+\alpha+\beta+\alpha\beta} = \frac{1-(\alpha+\beta)+\alpha\beta}{1+(\alpha+\beta)+\alpha\beta}$$

$$= \frac{1+\frac{2}{3}+\frac{1}{3}}{1-\frac{2}{3}+\frac{1}{3}} = \frac{\frac{6}{3}}{\frac{2}{3}} = 3$$

Hence, Required polynomial

$$q(x) = x^2 - (\alpha_1+\beta_1)2x + \alpha_1\beta_1$$

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

63. If α and β are the zeroes of the polynomial $x^2 + 4x + 3$, find the polynomial whose zeroes are $1 + \frac{\beta}{\alpha}$ and $1 + \frac{\alpha}{\beta}$.

Ans : [Board Term-1 2013]

We have $p(x) = x^2 + 4x + 3$

Since α and β are the zeroes of the quadratic polynomial $x^2 + 4x + 3$,

So, $$\alpha + \beta = -4$$

b138

and $$\alpha\beta = 3$$

Let α_1 and β_1 be zeros of new polynomial $q(x)$.

Then for $q(x)$, sum of the zeroes,

$$\alpha_1 + \beta_1 = 1 + \frac{\beta}{\alpha} + 1 + \frac{\alpha}{\beta}$$

$$= \frac{\alpha\beta + \beta^2 + \alpha\beta + \alpha^2}{\alpha\beta}$$

$$= \frac{\alpha^2+\beta^2+2\alpha\beta}{\alpha\beta}$$

$$= \frac{(\alpha+\beta)^2}{\alpha\beta} = \frac{(-4)}{3} = \frac{16}{3}$$

For $q(x)$, product of the zeroes,

$$\alpha_1\beta_1 = \left(1+\frac{\beta}{\alpha}\right)\left(1+\frac{\alpha}{\beta}\right)$$

$$= \left(\frac{\alpha+\beta}{\alpha}\right)\left(\frac{\beta+\alpha}{\beta}\right)$$

$$= \frac{(\alpha+\beta)^2}{\alpha\beta} = \frac{(-4)^2}{3} = \frac{16}{3}$$

Hence, required polynomial

$$q(x) = x^2 - (\alpha_1+\beta_1)x + \alpha_1\beta_1$$

$$= x^2 - \left(\frac{16}{3}\right)x + \frac{16}{3}$$

$$= \left(x^2 - \frac{16}{3}x + \frac{16}{3}\right)$$

$$= \frac{1}{3}(3x^2 - 16x + 16)$$

64. If α and β are zeroes of the polynomial $p(x) = 6x^2 - 5x + k$ such that $\alpha - \beta = \frac{1}{6}$, Find the value of k.

Ans : [Board 2007]

We have $p(x) = 6x^2 - 5x + k$

b139

Since α and β are zeroes of

$$p(x) = 6x^2 - 5x + k,$$

Sum of zeroes, $$\alpha + \beta = -\left(\frac{-5}{6}\right) = \frac{5}{6} \quad ...(1)$$

Product of zeroes $$\alpha\beta = \frac{k}{6} \quad ...(2)$$

Given $$\alpha - \beta = \frac{1}{6} \quad ...(3)$$

Solving (1) and (3) we get $\alpha = \frac{1}{2}$ and $\beta = \frac{1}{3}$ and substituting the values of (2) we have

$$\alpha\beta = \frac{k}{6} = \frac{1}{2} \times \frac{1}{3}$$

Hence, $k = 1$.

65. If β and $\frac{1}{\beta}$ are zeroes of the polynomial $(a^2 + a)x^2 + 61x + 6a$. Find the value of β and α.

Ans :

We have $p(x) = (a^2 + a)x^2 + 61x + 6$

Since β and $\frac{1}{\beta}$ are the zeroes of polynomial, $p(x)$

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Sum of zeroes, $\beta + \frac{1}{\beta} = -\frac{61}{a^2 + a}$

or, $\frac{\beta^2 + 1}{\beta} = \frac{-61}{a^2 + a}$ ...(1)

Product of zeroes $\beta\frac{1}{\beta} = \frac{6a}{a^2 + a}$

b140

or, $1 = \frac{6}{a + 1}$

$$a + 1 = 6$$

$$a = 5$$

Substituting this value of a in (1) we get

$$\frac{\beta^2 + 1}{\beta} = \frac{-61}{5^2 + 5} = -\frac{61}{30}$$

$$30\beta^2 + 30 = -61\beta$$

$$30\beta^2 + 61\beta + 30 = 0$$

Now $\beta \frac{-61 \pm \sqrt{(-61)^2 - 4 \times 30 \times 30}}{2 \times 30}$

$$= \frac{-61 \pm \sqrt{3721 - 3600}}{60}$$

$$\frac{-61 \mp 11}{60}$$

Thus $\beta = \frac{-5}{6}$ or $\frac{-6}{5}$

Hence, $\alpha = 5, \beta = \frac{-5}{6}, \frac{-6}{5}$

66. If α and β are the zeroes the polynomial $2x^2 - 4x + 5$, find the values of

(i) $\alpha^2 + \beta^2$ (ii) $\frac{1}{\alpha} + \frac{1}{\beta}$

(iii) $(\alpha - \beta)^2$ (iv) $\frac{1}{\alpha^2} + \frac{1}{\beta^2}$

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

Ans : [Board 2007]

We have $p(x) = 2x^2 - 4x + 5$

If α and β are then zeroes of $p(x) = 2x^2 - 4x + 5$, then

$$\alpha + \beta = -\frac{b}{a} = \frac{-(-4)}{2} = 2$$

b169

and $\alpha\beta = \frac{c}{a} = \frac{5}{2}$

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

$$= 2^2 - 2 \times \frac{5}{2} = 4 - 5 = -1$$

(ii) $\frac{1}{\alpha} + \frac{1}{\beta} = \frac{\alpha + \beta}{\alpha\beta} = \frac{2}{\frac{5}{2}} = \frac{4}{5}$

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

$$= 2^2 - \frac{4 \times 5}{2}$$

$$4 - 10 = -6$$

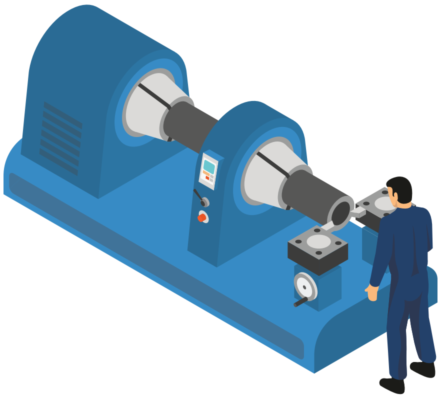
(iv) $\frac{1}{\alpha^2} + \frac{1}{\beta^2} = \frac{\alpha^2 + \beta^2}{(\alpha\beta)^2} = \frac{-1}{(\frac{5}{2})^2} = \frac{-4}{25}$

(v) $(\alpha^3 + \beta^3) = (\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$

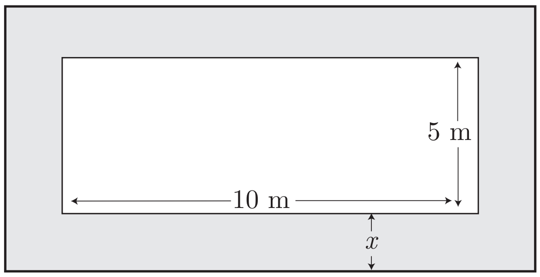
$$= 2^3 - 3 \times \frac{5}{2} \times 2 = 8 - 15 = -7$$

CASE STUDY QUESTIONS

67. RK Fabricators has got a order for making a frame for machine of their client. For which, they are using a AutoCAD software to create a constructible model that includes the relevant information such as dimensions of the frame and materials needed.



The frame will have a solid base and will be cut out of a piece of steel. The final area of the frame should be 54 sq m. The digram of frame is shown below.



In order to input the right values in the AutoCAD software, the engineer needs to calculate some basic values.

(i) What are the dimensions of the outer frame ?

(a) $(10 + x)$ and $(5 + x)$

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(b) $(10-x)$ and $(5-x)$

(c) $(10+2x)$ and $(5+2x)$

(d) $(10-2x)$ and $(5-2x)$

b401

(ii) A metal sheet of minimum area is used to make the frame. What should be the minimum area of metal sheet before cutting ?

(a) $4x^2+30x+50$ (b) $x^2+27x+55$

(c) $5x^2+30$ (d) $4x^2+50$

(iii) What is the area of required final metal frame ?

(a) $4x^2+30x+50\ \text{m}^2$ (b) $x^2+27x+55\ \text{m}^2$

(c) $4x^2+50x\ \text{m}^2$ (d) $4x^2+30x\ \text{m}^2$

(iv) If the area of the frame is 54 sq m, what is the value of x?

(a) 0.75 m (b) 3.0 m

(c) 1.5 m (d) 1.8 m

(v) What is the perimeter of the frame?

(a) 36 m (b) 42 m

(c) 45 m (d) 39 m

Ans :

(i) Length $=(10+x+x)=(10+2x)$

Breadth $=(5+x+x)=(5+2x)$ cm

Thus (c) is correct option.

(ii) Length of steel plate, $l=(10+2x)$

Breadth of steel plate, $b=(5+2x)$

Area of steel plate, $A=lb$

$$=(10+2x)(5+2x)$$

$$=50+10x+20x+4x^2$$

$$=50+30x+4x^2$$

$$A=4x^2+30x+50$$

Thus (a) is correct option.

(iii) Area of frame to be cut $=10\times5=50\ \text{m}^2$

Area of frame left $=4x^2+30x+50-50$

$$=4x^2+30x\ \text{m}^2$$

Thus (d) is correct option.

(iv) Here,area of frame $=54\ \text{m}^2$

$$4x^2+30x=54$$

$$2x^2+15x-27=0$$

$$2x^2+18x-3x-27=0$$

$$(x+9)(2x-3)=0$$

$$x=1.5 \text{ or } -9$$

Thus (c) is correct option.

(v) Perimeter of frame =Perimeter of Outside Rectangle

$$=2(10+2x+5+2x)$$

$$=2(15+4x)$$

$$=2(15+4\times1.5)=42\ \text{m}$$

Thus (b) is correct option.

68. The Prime Minister's Citizen Assistance and Relief in Emergency Situations Fund was created on 28 March 2020, following the COVID-19 pandemic in India. The fund will be used for combating, and containment and relief efforts against the coronavirus outbreak and similar pandemic like situations in the future.

The allotment officer is trying to come up with a method to calculate fair division of funds across various affected families so that the fund amount and amount received per family can be easily adjusted based on daily revised numbers. The total fund allotted for a village is $x^3+6x^2+20x+9$. The officer has divided the fund equally among families of the village and each family receives an amount of x^2+2x+2. After distribution, some amount is left.

(i) How many families are there in the village?

(a) $x+4$

(b) $x-3$

(c) $x-4$

(d) $x+3$

b402

(ii) If an amount of ₹1911 is left after distribution, what is value of x?

(a) 190 (b) 290

(c) 191 (d) 291

(iii) How much amount does each family receive?

(a) 24490 (b) 34860

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(c) 22540 (d) 36865

(iv) What is the amount of fund allocated?
(a) Rs 72 72 759 (b) Rs 75 72 681
(c) Rs 69 72 846 (d) Rs 82 74 888

(v) How many families are there in the village?
(a) 191 (b) 98
(c) 187 (d) 195

Ans :

(i) To get number of families we divide $x^3+6x^2+20x+9$ by x^2+2x+2.

$$\begin{array}{r|l} & x+4 \\ x^2+2x+2 & x^3+6x^2+20x+9 \\ & \underline{x^3+2x^2+2x} \\ & \quad 4x^2+18x+9 \\ & \quad \underline{4x^2+8x+8} \\ & \qquad 10x+1 \end{array}$$

Number of families are $x+4$.
Thus (a) is correct option.

(ii)
$$\text{Amount left} = 10x+1$$
$$10x+1 = 1911$$
$$x = \frac{1910}{10} = 191$$

Thus (c) is correct option.

(iii) Since, $x=191$, amount received by each family is

$$x^2+2x+2 = (191)^2+2(191)+2$$
$$= 36865$$

Thus (d) is correct option.

(iv) Since $x=191$, allotted fund,

$$x^3+6x^2+20x+9 = (x^2+2x+2)(x+4)+10x+1$$
$$= 36865(191+4)+1911$$
$$= 69{,}72{,}846$$

Thus (c) is correct option.

(v)
$$\text{No. of families} = x+4$$
$$= 191+4 = 195$$

Thus (d) is correct option.

69. An barrels manufacturer can produce up to 300 barrels per day. The profit made from the sale of these barrels can be modelled by the function $P(x) = -10x^2+3500x-66000$ where $P(x)$ is the profit in rupees and x is the number of barrels made and sold.

Based on this model answer the following questions:

(i) When no barrels are produce what is a profit loss?
(a) Rs 22000
(b) Rs 66000
(c) Rs 11000
(d) Rs 33000

b403

(ii) What is the break even point ? (Zero profit point is called break even)
(a) 10 barrels (b) 30 barrels
(c) 20 barrels (d) 100 barrels

(iii) What is the profit/loss if 175 barrels are produced
(a) Profit 266200 (b) Loss 266200
(c) Profit 240250 (d) Loss 240250

(iv) What is the profit/loss if 400 barrels are produced
(a) Profit Rs 466200 (b) Loss Rs 266000
(c) Profit Rs 342000 (d) Loss Rs 342000

(v) What is the maximum profit which can manufacturer earn?
(a) Rs 240250 (b) Rs 480500
(c) Rs 680250 (d) Rs 240250

Ans :

(i) When no barrels are produced, $x=0$

$$P(x) = 0+0-66000$$
$$P(x) = -66000 \text{ Rs}$$

Thus (b) is correct option.

(ii) At break-even point $P(x)=0$, thus

$$0 = -10x^2+3500x-66000$$
$$x^2+350x+6600 = 0$$
$$x^2-330x-20x+6600 = 0$$
$$x(x-330)-20(x+330) = 0$$

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$$(x-330)(x-20) = 0$$

$$x = 20, 330$$

Thus (c) is correct option.

(iii) $P(175) = -10(175)^2 + 3500(175) - 66000$

$$= 240250$$

Thus (c) is correct option.

(iv) $P(400) = -10(400)^2 + 3500(400) - 66000$

$$= -266000 \text{ Rs}$$

Thus (b) is correct option.

(v) Rearranging the given equation we have

$$P(x) = -10x^2 + 3500x - 66000$$

$$= -10(x^2 - 350x + 6600)$$

$$= -10[(x-175)^2 - 30625 + 6600]$$

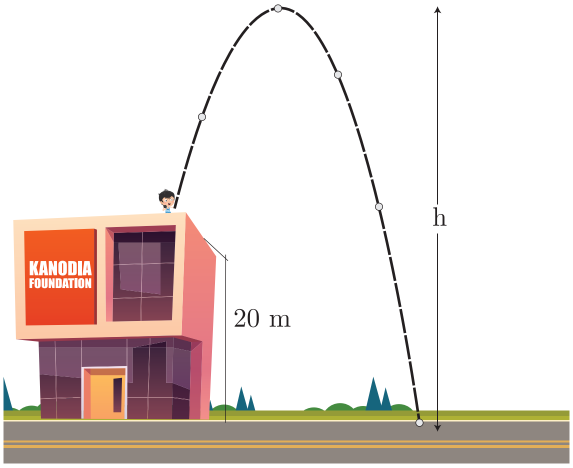
$$= -10[(x-175)^2 - 24025]$$

$$= -10(x-175)^2 + 240250$$

From above equation it is clear that maximum value of $P(x)$ is Rs 240250.

Thus (a) is correct option.

70. Lavanya throws a ball upwards, from a rooftop, which is 20 m above from ground. It will reach a maximum height and then fall back to the ground. The height of the ball from the ground at time t is h, which is given by $h = -4t^2 + 16t + 20$.



(i) What is the height reached by the ball after 1 second?

(a) 64 m
(b) 128 m
(c) 32 m
(d) 20 m

b404

(ii) What is the maximum height reached by the ball?

(a) 54 m (b) 44 m
(c) 36 m (d) 18 m

(iii) How long will the ball take to hit the ground?

(a) 4 seconds (b) 3 seconds
(c) 5 seconds (d) 6 seconds

(iv) What are the two possible times to reach the ball at the same height of 32 m?

(a) 1 and 3 seconds (b) 1 and 4 seconds
(c) 1 and 2 seconds (d) 1 and 5 seconds

(v) Where is the ball after 5 seconds ?

(a) at the ground (b) rebounds
(c) at highest point (d) fall back

Ans :

(i) Height is given by,

$$h = -4t^2 + 16t + 20$$

At $t = 1$ second,

$$h = -4(1)^2 + 16(1) + 20 = 32 \text{ m}$$

Thus (c) is correct option.

(ii) Rearranging the given equation, by completing the square,

$$h = -4(t^2 - 4t - 5)$$

$$= -4(t^2 - 4t + 4 - 4 - 5)$$

$$= -4[(t-2)^2 - 9]$$

$$= -4(t-2)^2 + 36$$

Height is maximum, at $t = 2$, thus

$$h_{max} = 0 + 36 = 36 \text{ m}$$

Thus (c) is correct option.

(iii) When ball hits the ground, $h = 0$, thus

$$-4t^2 + 16t + 20 = 0$$

$$t^2 - 4t - 5 = 0$$

$$(t-5)(t+1) = 0$$

Thus $t = 5$ or $t = -1$. Since, time cannot be negative, the $t = 5$ seconds is correct answer.

Thus (c) is correct option.

(iv) Since, $h = -4t^2 + 16t^2 + 20$

$$32 = -4t^2 + 16t^2 + 20$$

$$8 = -t^2 + 4t^2 + 5$$

$$t^2 - 4t + 3 = 0$$

$$t^2 + 3t - t + 3 = 0$$

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$$(t-1)(t-3) = 0 \Rightarrow t = 3, 1$$

Thus (a) is correct option.

(v) From (iii) at $t = 5$ we have $h = 0$. Thus it will hit ground, then after that ball will rebound.

Thus (b) is correct option.

71. For a jewellery metal box to satisfy certain requirements, its length must be three meter greater than the width, and its height must be two meter less than the width.

(i) If width is taken as x, which of the following polynomial represent volume of box ?
   (a) $x^2 - 5x - 6$
   (b) $x^3 + x^2 - 6x$
   (c) $x^3 - 6x^2 - 6x$
   (d) $x^2 + x - 6$

b405

(ii) Which of the following polynomial represent the area of metal sheet used to make box ?
   (a) $x^2 - 5x - 6$ (b) $6x^2 + 4x - 12$
   (c) $x^3 - 6x^2 - 6x$ (d) $6x^2 + 3x - 4$

(iii) If it must have a volume of 18 in^3, what must be its length ?
   (a) 6 in (b) 3 in
   (c) 4 in (d) 2 in

(iv) At a volume of 18 in^3, what must be its height ?
   (a) 1 in (b) 3 in
   (c) 2 in (d) 4 in

(v) If box is made of a metal sheet which cost is 10 rs per in^2, what is the cost of metal ?
   (a) Rs 540 (b) Rs 1080
   (c) Rs 270 (d) Rs 340

Ans :

(i) $$V(x) = x(x+3)(x-2)$$
$$= x(x^2 + x - 6) = x^3 + x^2 - 6x$$

Thus (d) is correct option.

(ii) $$S(x) = 2(LW + WH + HL)$$
$$= 2[x(x+3) + (x+3)(x-2) + x(x-2)]$$
$$= 2[x^2 + 3x + x^2 + x - 6 + x^2 - 2x]$$
$$= 2(3x^2 + 2x - 6)$$
$$= 6x^2 + 4x - 12$$

Thus (b) is correct option.

(iii) We have $$V(x) = x^3 + x^2 - 6$$
$$18 = x^3 + x^2 - 6x$$
$$x^3 + x^2 - 6x - 18 = 0$$
$$x^3 - 3x^2 + 4x^2 - 12x + 6x - 18 = 0$$
$$x^2(x-3) + 4x(x-3) + 6(x-3) = 0$$
$$(x-3)(x^2 + 4x + 6) = 0$$

Thus width is 3 in.

$$\text{Length} = x + 3 = 6 \text{ in}$$

Thus (a) is correct option.

(iv) $$\text{Height} = x - 2 = 3 - 2 = 1 \text{ in}$$

Thus (a) is correct option.

(v) $$S(x) = 6x^2 + 4x - 12$$
$$= 6 \times 3 \times 3 + 4 \times 3 - 12 = 54 \text{ in}^2$$
$$C = 10 \times 54 = 540 \text{ ₹}$$

Thus (a) is correct option.

72. Pyramid, in architecture, a monumental structure constructed of or faced with stone or brick and having a rectangular base and four sloping triangular sides meeting at an apex. Pyramids have been built at various times in Egypt, Sudan, Ethiopia, western Asia, Greece, Cyprus, Italy, India, Thailand, Mexico, South America, and on some islands of the Pacific Ocean. Those of Egypt and of Central and South America are the best known.

The volume and surface area of a pyramid with a square base of area a^2 and height h is given by

$$V = \frac{ha^2}{3} \text{ and } S = a^2 + 2a\sqrt{\left(\frac{a}{2}\right)^2 + h^2}$$

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A pyramid has a square base and a volume of $3y^3 + 18y^2 + 27y$ cubic units.

(i) If its height is y, then what polynomial represents the length of a side of the square base ?

(a) $9(y+3)$

(b) $9(y+3)^2$

(c) $3(y+3)$

(d) $3(y+3)^2$

(ii) If area of base is 576 metre, what is the side of base?

(a) 24 metre (b) 16 metre

(c) 13 metre (d) 12 metre

(iii) What is the height of pyramid at above area of base ?

(a) 4 metre (b) 6 metre

(c) 5 metre (d) 12 metre

(iv) What is the ratio of length of side to the height ?

(a) $\frac{1}{5}$ (b) $\frac{2}{5}$

(c) $\frac{5}{24}$ (d) $\frac{24}{5}$

(v) What is surface area of pyramid ?

(a) 800 m^2 (b) 2400 m^2

(c) 1200 m^2 (d) 1600 m^2

Ans :

(i) $$V(y) = 3y^3 + 18y^2 + 27y$$
$$= 3y(y^2 + 6y + 9) = 3y(y+3)^2$$

If y represent height, then comparing its volume with standard volume, we have

$$h\frac{a^2}{3} = 3y(y+3)^2$$

$$y\frac{a^2}{3} = 3y(y+3)^2$$

$$a^2 = 9(y+3)^2$$

$$a = 3(y+3)$$

Thus (c) is correct option.

(ii) $a^2 = 576 \Rightarrow a = 24$ unit

Thus (a) is correct option.

(iii) At $a = 24$ meter,

$$24 = 3(y+3)$$

$$8 = y+3$$

$$y = 5 \text{ metre}$$

Thus (c) is correct option.

(iv) We have $a = 24$ and $y = 5$.

$$\frac{a}{y} = \frac{24}{5}$$

Thus (c) is correct option.

(v) We have $$S = a^2 + 2a\sqrt{(\tfrac{a}{2})^2 + h^2}$$

We have $a = 24$ and $y = 5$.

Thus $$S = 24^2 + 2 \times 24\sqrt{(\tfrac{24}{2})^2 + 5^2}$$
$$= 2 \times 24(12 + \sqrt{12^2 + 5^2})$$
$$= 48(12 + 13)$$
$$= 1200 \text{ m}^2$$

Thus (c) is correct option.

73. Underground water tank is very popular in India. It is usually used for large water tank storage and can be built cheaply using cement-like materials. Underground water tank are typically chosen by people who want to save space. The water in the underground water tank is not affected by extreme weather conditions. The underground water tank maintain cool temperatures in both winter and summer.

A builder wants to build a tank to store water in an apartment. The volume of the rectangular tank will be modelled by $V(x) = x^3 + x^2 - 4x - 4$.

(i) He planned in such a way that its base dimensions are $(x+1)$ and $(x+2)$. How much he has to dig ?

(a) $(x+1)$

(b) $(x-2)$

(c) $(x-3)$

(d) $(x+2)$

(ii) If $x = 4$ meter, what is the volume of the water tank?

(a) 30 m^3 (b) 20 m^3

(c) 15 m^3 (d) 60 m^3

(iii) If $x = 4$ and the builder wants to paint the entire inner portion on the water tank, what is the total

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area to be painted ?

(a) 52 m^2 (b) 96 m^2

(c) 208 m^2 (d) 104 m^2

(iv) If the cost of paint is Rs. 25/ per square metre, what is the cost of painting ?

(a) 3900 Rs (b) 2600 Rs

(c) 1300 Rs (d) 5200 Rs

(v) What is the storage capacity of this water tank ?

(a) 3000 litre (b) 6000 litre

(c) 60000 litre (d) 30000 litre

Ans :

(i) We have,

$$\begin{aligned} V(x) &= x^3 + x^2 - 4x - 4 \\ &= x^2(x+1) - 4(x+1) \\ &= (x+1)(x^2-4) \\ &= (x+1)(x-2)(x+2) \end{aligned}$$

If $(x+1)$ and $(x+2)$ are two dimension, 3rd dimension will be $(x-2)$. Thus he has to dig $(x-2)$.
Thus (b) is correct option.

(ii) $$\begin{aligned} V(x) &= (x+1)(x-2)(x+2) \\ V(4) &= (4+1)(4-2)(4+2) \\ &= 5 \times 2 \times 6 = 60\,\text{m}^3 \end{aligned}$$

Thus (d) is correct option.

(iii) Three dimension of tank are

$$\begin{aligned} x+1 &= 4+1 = 5 \\ x+2 &= 4+2 = 6 \\ x-2 &= 4-2 = 2 \end{aligned}$$

$$\begin{aligned} S &= 2(5 \times 2 + 2 \times 6 + 6 \times 5) \\ &= 2(10+12+30) \\ &= 2(52) = 104\,\text{m}^2 \end{aligned}$$

Thus (d) is correct option.

(iv) $$C = 104 \times 25 = 2600\,₹$$

Thus (b) is correct option.

(v) 1 m^3 can store 1000 litre, thus 60 m^3 can store 60000 litre.
Thus (c) is correct option.

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CHAPTER 3

PAIR OF LINEAR EQUATION IN TWO VARIABLES

ONE MARK QUESTIONS

1. Find the value of k for which the system of linear equations $x+2y=3$, $5x+ky+7=0$ is inconsistent.

Ans : [Board 2020 OD Standard]

We have $\quad x+2y-3=0$

and $\quad 5x+ky+7=0$

If system is inconsistent, then

$$\frac{a_1}{a_2}=\frac{b_1}{b_2}\neq\frac{c_1}{c_2}$$

From first two orders, we have

$$\frac{1}{5}=\frac{2}{k}\Rightarrow k=10$$

2. Find the value of k for which the system of equations $x+y-4=0$ and $2x+ky=3$, has no solution.

Ans : [Board 2020 Delhi Standard]

We have $\quad x+y-4=0$

and $\quad 2x+ky-3=0$

Here, $\quad \frac{a_1}{a_1}=\frac{1}{2},\ \frac{b_1}{b_2}=\frac{1}{k}$ and $\frac{c_1}{c_2}=\frac{-4}{-3}=\frac{4}{3}$

Since system has no solution, we have

$$\frac{a_1}{a_2}=\frac{b_1}{b_2}\neq\frac{c_1}{c_2}$$

$$\frac{1}{2}=\frac{1}{k}\neq\frac{4}{3}$$

$$k=2 \text{ and } k\neq\frac{3}{4}$$

3. For which value(s) of p, will the lines represented by the following pair of linear equations be parallel ?

$$3x-y-5=0$$

$$6x-2y-p=0$$

Ans : [Board Term-1 OD 2017]

We have, $\quad 3x-y-5=0$

and $\quad 6x-2y-p=0$

Here, $\quad a_1=3,\ b_1=-1,\ c_1=-5$

and $\quad a_2=6,\ b_2=-2,\ c_2=-p$

Since given lines are parallel,

$$\frac{a_1}{a_2}=\frac{b_1}{b_2}\neq\frac{c_1}{c_2}$$

$$\frac{-1}{-2}\neq\frac{-5}{-p}$$

$$p\neq 5\times 2\Rightarrow p\neq 10$$

4. The 2 digit number which becomes $\frac{5}{6}$th of itself when its digits are reversed. If the difference in the digits of the number being 1, what is the two digits number?

Ans : [Board Term-1 Delhi 2011]

If the two digits are x and y, then the number is $10x+y$.

Now $\quad \frac{5}{6}(10x+y)=10y+x$

Solving, we get $44x+55y$

$$\frac{x}{y}=\frac{5}{4}$$

Also $x-y=1$. Solving them, we get $x=5$ and $y=4$. Therefore, number is 54.

5. In a number of two digits, unit's digit is twice the tens digit. If 36 be added to the number, the digits are reversed. What is the number ?

Ans : [Board Term-1 Delhi 2016]

Let x be units digit and y be tens digit, then number will be $10y+x$

Then, $\quad x=2y \quad$ ...(1)

If 36 be added to the number, the digits are reversed, i.e number will be $10x+y$.

$$10y+x+36=10x+y$$

$$9x-9y=36$$

$$x-y=4 \quad \text{...(2)}$$

Solving (1) and (2) we have $x=8$ and $y=4$.

Thus number is 48.

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6. If $3x+4y:x+2y=9:4$, then find the value of $3x+5y:3x-y$.

Ans : [Board Term-1 Foreign 2012]

We have $\quad \frac{3x+4y}{x+2y} = \frac{9}{4}$

Hence, $\quad 12x+16y = 9x+18y$

or $\quad 3x = 2y$

$$x = \frac{2}{3}y$$

Substituting $x=\frac{2}{3}y$ in the required expression we have

$$\frac{3x\frac{2}{3}y+5y}{3x\frac{2}{3}y-y} = \frac{7y}{y} = \frac{7}{1} = 7:1$$

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

Ans : [Board Term-1 Foreign 2016]

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

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

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

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

8. x and y are 2 different digits. If the sum of the two digit numbers formed by using both the digits is a perfect square, then what is the value of $x+y$?

Ans : [Board Term-1 OD 2013]

The numbers that can be formed are xy and yx. Hence, $(10x+y)+(10y+x)=11(x+y)$. If this is a perfect square than $x+y=11$.

9. If a pair of linear equations is consistent, then the lines will be intersecting or coincident. Justify.

Ans : [Board 2008]

Condition for a consistent pair of linear equations

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

[intersecting lines having unique solution]

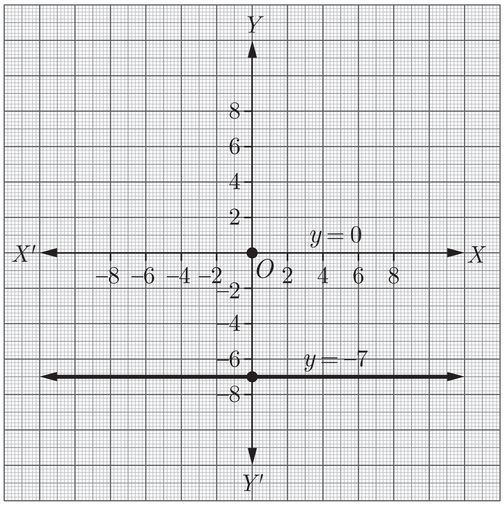
and $\quad \frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2} \quad$ [coincident or dependent]

10. The pair of equations $y=0$ and $y=-7$ has no solution. Justify.

Ans : [Board Term-1 Foreign 2014]

The given pair of equations are

$$y = 0 \quad y = -7$$



The pair of both equations are parallel to x-axis and we know that parallel lines never intersects. So, there is no solution of these lines.

11. If the equations $kx-2y=3$ and $3x+y=5$ represent two intersecting lines at unique point, then the value of k is ....

Ans : [Board Term-1 2011]

For unique solution

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

Here, $a_1 = k$, $b_1 = -2$, $a_2 = 3$ and $b_2 = 1$

Now $\quad \frac{k}{3} \neq -\frac{2}{1}$

or, $\quad k \neq -6$

12. Find whether the pair of linear equations $y=0$ and $y=-5$ has no solution, unique solution or infinitely many solutions.

Ans : [Board Term-1 OD 2011]

The given variable y has different values. Therefore the pair of equations $y=0$ and $y=-5$ has no solution.

13. If $am=bl$, then find whether the pair of linear equations $ax+by=c$ and $lx+my=n$ has no solution, unique solution or infinitely many solutions.

Ans : [Board Term-1

Since, $am = bl$, we have

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$$\frac{a}{1} = \frac{b}{m} \neq \frac{c}{n}$$

Thus, $ax + by = c$ and $lx + my = n$ has no solution.

14. If $ad \neq bc$, then find whether the pair of linear equations $ax + by = p$ and $cx + dy = q$ has no solution, unique solution or infinitely many solutions.

Ans : [Board Term-1 Delhi 2015]

Since $\qquad ad \neq bc$ or $\frac{a}{c} \neq \frac{b}{d}$

Hence, the pair of given linear equations has unique solution.

15. Two lines are given to be parallel. The equation of one of the lines is $4x + 3y = 14$, then find the equation of the second line.

Ans : [Board 2007]

Ans :

The equation of one line is $4x + 3y = 14$. We know that if two lines $a_1x + b_1y + c_1 = 0$ and $a_2x + b_2y + c_2 = 0$ are parallel, then

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$$

or $$\frac{4}{a_2} = \frac{3}{b_2} \neq \frac{c_1}{c_2} \Rightarrow \frac{a_2}{b_2} = \frac{4}{3} = \frac{12}{9}$$

Hence, one of the possible, second parallel line is $12x + 9y = 5$.

16. Find whether the lines represented by $2x + y = 3$ and $4x + 2y = 6$ are parallel, coincident or intersecting.

Ans : [Board Term-1 Delhi 2016]

Here $a_1 = 2, b_1 = 1, c_1 = -3$ and $a_1 = 4, b_2 = 2, c_2 = -6$

If $$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

then the lines are parallel.

Clearly $$\frac{2}{4} = \frac{1}{2} = \frac{3}{6}$$

Hence lines are coincident.

17. Given the linear equation $3x + 4y = 9$. Write another linear equation in these two variables such that the geometrical representation of the pair so formed is:

(1) intersecting lines

(2) coincident lines.

Ans : [Board Term-1 2016]

(1) For intersecting lines $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$

So, one of the possible equation $3x - 5y = 10$

(2) For coincident lines $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$

So, one of the possible equation $6x + 8y = 18$

18. Find the value(s) of k so that the pair of equations $x + 2y = 5$ and $3x + ky + 15 = 0$ has a unique solution.

Ans : [Board 2019 OD]

We have $\qquad x + 2y - 5 = 0 \qquad$ ...(1)

and $\qquad 3x + ky + 15 = 0 \qquad$ ...(2)

Comparing equation (1) with $a_1x + b_1y + c_1 = 0$, and equation (2) with $a_2x + b_2y + c_2 = 0$, we get

$$a_1 = 1,\ a_2 = 3,\ b_1 = 2,\ b_2 = k,\ c_1 = -5 \text{ and } c_2 = 15$$

Since, given equations have unique solution, So,

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

i.e. $$\frac{1}{3} \neq \frac{2}{k}$$

$$k \neq 6$$

Hence, for all values of k except 6, the given pair of equations have unique solution.

19. If $2x + y = 23$ and $4x - y = 19$, find the value of $(5y - 2x)$ and $\left(\frac{y}{x} - 2\right)$.

Ans : [Board 2020 OD Standard]

We have $\qquad 2x + y = 23 \qquad$ ...(1)

$\qquad 4x - y = 19 \qquad$ ...(2)

Adding equation (1) and (2), we have

$$6x = 42 \Rightarrow x = 7$$

Substituting the value of x in equation (1), we get

$$14 + y = 23$$

$$y = 23 - 14 = 9$$

Hence, $$5y - 2x = 5 \times 9 - 2 \times 7$$

$$= 45 - 14 = 31$$

and $$\frac{y}{x} - 2 = \frac{9}{7} - 2 = \frac{9 - 14}{7} = \frac{-5}{7}$$

20. Find whether the lines represented by $2x + y = 3$ and $4x + 2y = 6$ are parallel, coincident or intersecting.

Ans : [Board Term-1 2016]

Ans :

Here $a_1 = 2, b_1 = 1, c_1 = -3$ and $a_1 = 4, b_2 = 2, c_2 = -6$

If $$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

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then the lines are parallel.

Clearly $\frac{2}{4} = \frac{1}{2} = \frac{3}{6}$

Hence lines are coincident.

c105

21. Find whether the following pair of linear equation is consistent or inconsistent:

$3x + 2y = 8, \ \ 6x - 4y = 9$

Ans : [Board Term-1 2016]

We have $\frac{3}{6} \neq \frac{2}{-4}$

i.e., $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$

c106

Hence, the pair of linear equation is consistent.

22. Is the system of linear equations $2x + 3y - 9 = 0$ and $4x + 6y - 18 = 0$ consistent? Justify your answer.

Ans : [Board Term-1 2012]

For the equation $2x + 3y - 9 = 0$ we have

$$a_2 = 2, b_1 = 3 \text{ and } c_1 = -9$$

and for the equation, $4x + 6y - 18 = 0$ we have

$$a_2 = 4, b_2 = 6 \text{ and } c_2 = -18$$

Here $\frac{a_1}{a_2} = \frac{2}{4} = \frac{1}{2}$

c107

$\frac{b_1}{b_2} = \frac{3}{6} = \frac{1}{2}$

and $\frac{c_1}{c_2} = \frac{-9}{-18} = \frac{1}{2}$

Thus $\frac{c_1}{c_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$

Hence, system is consistent and dependent.

23. Given the linear equation $3x + 4y = 9$. Write another linear equation in these two variables such that the geometrical representation of the pair so formed is:

(1) intersecting lines

(2) coincident lines.

Ans : [Board Term-1 2016]

(1) For intersecting lines $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$

So, one of the possible equation $3x - 5y = 10$

c108

(2) For coincident lines $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$

So, one of the possible equation $6x + 8y = 18$

24. For what value of p does the pair of linear equations given below has unique solution ?

$4x + py + 8 = 0$ and $2x + 2y + 2 = 0$.

Ans : [Board Term-1 2012]

We have $4x + py + 8 = 0$

$2x + 2y + 2 = 0$

c109

The condition of unique solution, $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$

Hence, $\frac{4}{2} \neq \frac{p}{2}$ or $\frac{2}{1} \neq \frac{p}{2}$

Thus $p \neq 4$. The value of p is other than 4 it may be $1, 2, 3, -4$.....etc.

25. For what value of k, the pair of linear equations $kx - 4y = 3$, $6x - 12y = 9$ has an infinite number of solutions ?

Ans : [Board Term-1 2012]

We have $kx - 4y - 3 = 0$

and $6x - 12y - 9 = 0$

c110

where, $a_1 = k, b_1 = 4, c_1 = -3$

$a_2 = 6, b_2 = -12, c_2 - 9$

Condition for infinite solutions:

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

$$\frac{k}{6} = \frac{-4}{-12} = \frac{3}{9}$$

Hence, $k = 2$

26. For what value of k, $2x + 3y = 4$ and $(k+2)x + 6y = 3k + 2$ will have infinitely many solutions ?

Ans : [Board Term-1 2012]

We have $2x + 3y - 4 = 0$

and $(k+2)x + 6y - (3k+2) = 0$

c111

Here $a_1 = 2, b_1 = 3, c_1 = -4$

and $a_2 = k + 2, b_2 = 6, c_3 = -(3k+2)$

For infinitely many solutions

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

or, $\frac{2}{k+2} = \frac{3}{6} = \frac{4}{3k+2}$

From $\frac{2}{k+2} = \frac{3}{6}$ we have

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$3(k+2) = 2 \times 6 \Rightarrow (k+2) = 4 \Rightarrow k = 2$

From $\frac{3}{6} = \frac{4}{3k+2}$ we have

$3(3k+2) = 4 \times 6 \Rightarrow (3k+2) = 8 \Rightarrow k = 2$

Thus $k = 2$

27. For what value of k, the system of equations $kx + 3y = 1$, $12x + ky = 2$ has no solution.

Ans : [Board Term-1 2011]

The given equations can be written as
$kx + 3y - 1 = 0$ and $12x + ky - 2 = 0$

Here, $a_1 = k, b_1 = 3, c_1 = -1$

and $a_2 = 12, b_2 = k, c_2 = -2$

The equation for no solution if

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$$

c112

or, $$\frac{k}{12} = \frac{3}{k} \neq \frac{-1}{-2}$$

From $\frac{k}{12} = \frac{3}{k}$ we have $k^2 = 36 \Rightarrow k \pm 6$

From $\frac{3}{k} \neq \frac{-1}{-2}$ we have $k \neq 6$

Thus $k = -6$

28. Solve the following pair of linear equations by cross multiplication method:

$$x + 2y = 2$$
$$x - 3y = 7$$

Ans : [Board Term-1 2016]

We have $x + 2y - 2 = 0$

$x - 3y - 7 = 0$

c133

Using the formula

$$\frac{x}{b_1c_2 - b_2c_1} = \frac{y}{c_1a_2 - c_2a_1} = \frac{1}{a_1b_2 - a_2b_1}$$

we have $$\frac{x}{-14-6} = \frac{y}{-2+7} = \frac{1}{-3-2}$$

$$\frac{x}{-20} = \frac{y}{5} = \frac{-1}{5}$$

$$\frac{x}{-20} = \frac{-1}{5} \Rightarrow x = 4$$

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

29. Solve the following pair of linear equations by substitution method:

$$3x + 2y - 7 = 0$$
$$4x + y - 6 = 0$$

Ans : [Board Term-1 2015]

We have $3x + 2y - 7 = 0$ ...(1)

$4x + y - 6 = 0$ ...(2)

From equation (2), $y = 6 - 4x$ ...(3)

Putting this value of y in equation (1) we have

$$3x + 2(6 - 4x) - 7 = 0$$
$$3x + 12 - 8x - 7 = 0$$
$$5 - 5x = 0$$
$$5x = 5$$

c134

Thus $x = 1$

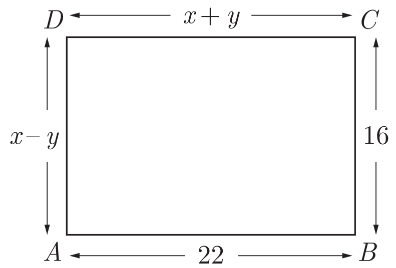
Substituting this value of x in (2), we obtain,

$$y = 6 - 4 \times 1 = 2$$

Hence, values of x and y are 1 and 2 respectively.

30. In the figure given below, $ABCD$ is a rectangle. Find the values of x and y.

Ans : [Board Term-1 2012]



From given figure we have

$x + y = 22$ ...(1)

and $x - y = 16$ ...(2)

Adding (1) and (2), we have

c135

$$2x = 38$$
$$x = 19$$

Substituting the value of x in equation (1), we get

$$19 + y = 22$$

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$y = 22 - 19 = 3$

Hence, $x = 19$ and $y = 3$.

31. Solve : $99x + 101y = 499$, $101x + 99y = 501$

Ans : [Board Term-1 2012]

We have $99x + 101y = 499$ ...(1)

$101x + 99y = 501$ ...(2)

Adding equation (1) and (2), we have

c136

$200x + 200y = 1000$

$x + y = 5$ ...(3)

Subtracting equation (2) from equation (1), we get

$-2x + 2y = -2$

$x - y = 1$ ...(4)

Adding equations (3) and (4), we have

$2x = 6 \Rightarrow x = 3$

Substituting the value of x in equation (3), we get

$3 + y = 5 \Rightarrow y = 2$

32. Solve the following system of linear equations by substitution method:

c137

$2x - y = 2$

$x + 3y = 15$

Ans : [Board Term-1 2012]

We have $2x - y = 2$ ...(1)

$x + 3y = 15$ ...(2)

From equation (1), we get $y = 2x - 2$ ...(3)

Substituting the value of y in equation (2),

$x + 6x - 6 = 15$

or, $7x = 21 \Rightarrow x = 3$

Substituting this value of x in (3), we get

$y = 2 \times 3 - 2 = 4$

Thus $x = 3$ and $y = 4$

33. Find the value(s) of k for which the pair of Linear equations $kx + y = d^2$ and $x + ky = 1$ have infinitely many solutions.

Ans : [Board Term-1 2017]

We have $kx + y = k^2$

and $x + ky = 1$

$$\frac{a_1}{a_2} = \frac{k}{1}, \frac{b_1}{b_2} = \frac{1}{k}, \frac{c_1}{c_2} = \frac{k^2}{1}$$

For infinitely many solution

c138

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

$$\frac{k}{1} = \frac{1}{k} = \frac{k^2}{1} = k^2 = 1$$

$$k = \pm 1$$

THREE MARKS QUESTIONS

34. Solve the following system of equations.

$\frac{21}{x} + \frac{47}{y} = 110$, $\frac{47}{x} + \frac{21}{y} = 162$, $x, y \neq 0$

Ans : [Board 2020 SQP Standard]

c219

We have $\frac{21}{x} + \frac{47}{y} = 110$

$\frac{47}{x} + \frac{21}{y} = 162$

Let $\frac{1}{x} = u$ and $\frac{1}{y} = v$. then given equation become

$21u + 47v = 110$ ...(1)

and $47u + 21v = 162$ ...(2)

Adding equation (1) and (2) we get

$68u + 68v = 272$

$u + v = 4$ ...(3)

Subtracting equation (1) from (2) we get

$26u - 26v = 52$

$u - v = 2$ ...(4)

Adding equation (3) and (4), we get

$2u = 6 \Rightarrow u = 3$

Substituting $u = 3$ in equation (3), we get $v = 1$.

Thus $x = \frac{1}{u} = \frac{1}{3}$ and $y = \frac{1}{v} = \frac{1}{1} = 1$

35. Solve graphically :

$2x - 3y + 13 = 0$; $3x - 2y + 12 = 0$

Ans : [Board 2020 OD Basic]

Solved graphically :

c218

We have $2x - 3y + 13 = 0$

and $3x - 2y + 12 = 0$

Now $2x - 3y = -13$

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$$y = \frac{2x+13}{3}$$

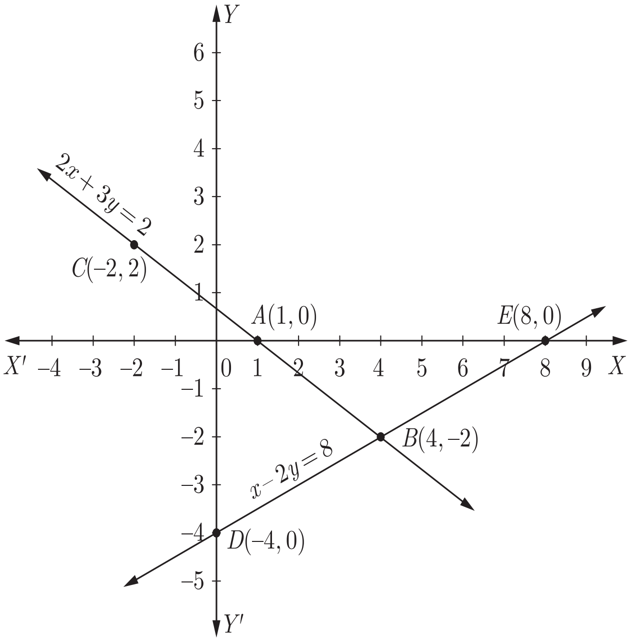
x	0	-6.5	1
y	4.3	0	5

and $\quad 3x - 2y = -12$

$$y = \frac{3x+12}{2}$$

x	0	-4	-2
y	6	0	3

These lines intersect each other at point $(-2, 3)$ Hence, $x = -2$ and $y = 3$.



36. Solve graphically : $2x + 3y = 2$, $x - 2y = 8$

Ans : [Board 2020 Delhi Basic]

We have $\quad 2x + 3y = 2 \quad$ ...(1)

and $\quad x - 2y = 8 \quad$ ...(2)

Taking equation (1), $\quad y = \frac{2-2x}{3}$

x	1	4	-2
y	0	-2	2

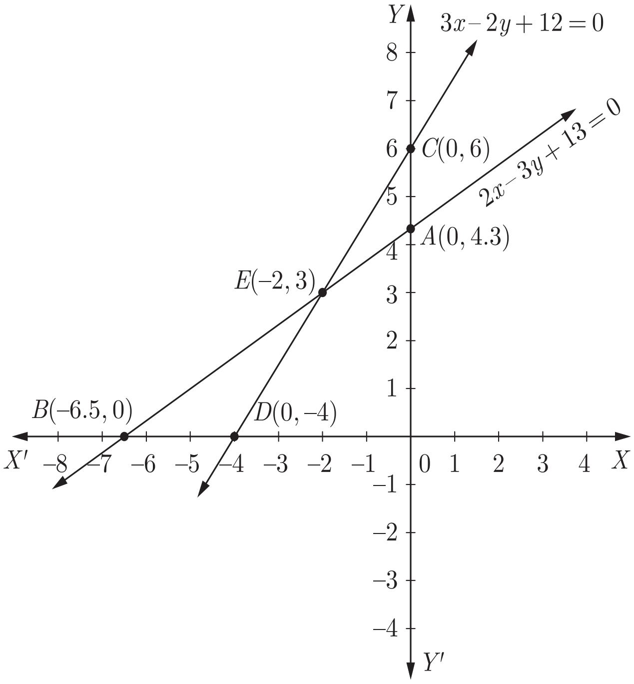
and $\quad x - 2y = 8$

c220

Taking equation (2), $\quad y = \frac{x-8}{2}$

x	0	8	4
y	-4	0	-2

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



Two obtained lines intersect at point $P(4, -2)$.
Hence, Solution of the given equation is $x = 4$, $y = -2$

37. A fraction becomes $\frac{1}{3}$ when 2 is subtracted from the numerator and it becomes $\frac{1}{2}$ when 1 is subtracted from the denominator- Find the fraction.

Ans : [Board 2019 Delhi]

Let the fraction be $\frac{x}{y}$. According to the first condition,

$$\frac{x-2}{y} = \frac{1}{3}$$

c221

$$3x - 6 = y$$

$$y = 3x - 6 \quad ...(1)$$

According to the second condition,

$$\frac{x}{y-1} = \frac{1}{2}$$

$$2x = y - 1$$

$$y = 2x + 1 \quad ...(2)$$

From equation (1) and (2), we have

$$3x - 6 = 2x + 1 \Rightarrow x = 7$$

Substitute value of x in equation (1), we get

$$y = 3(7) - 6$$

$$= 21 - 6 = 15$$

Hence, fraction is $\frac{7}{15}$.

38. In the figure, $ABCDE$ is a pentagon with $BE \parallel CD$

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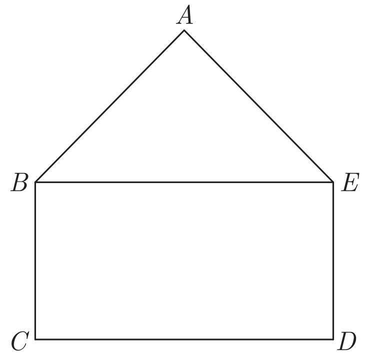
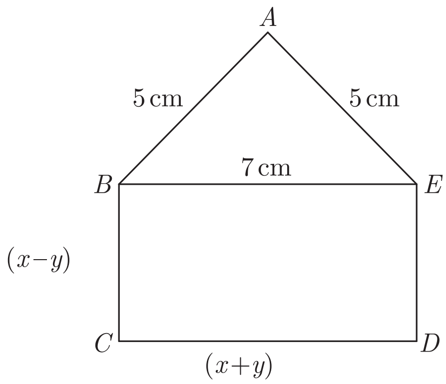
and $BC \parallel DE$. BC is perpendicular to CD. $AB = 5$ cm, $AE = 5$ cm, $BE = 7$ cm, $BC = x - y$ and $CD = x + y$. If the perimeter of $ABCDE$ is 27 cm. Find the value of x and y, given $x, y \neq 0$.

c222



Ans : [Board 2020 SQP Standard]

We have redrawn the given figure as shown below.



We have $CD = BE$

$$x + y = 7 \quad ...(1)$$

Also, perimeter of $ABCDE$ is 27 cm, thus

$$AB + BC + CD + DE + AE = 27$$

$$5 + (x - y) + (x + y) + (x - y) + 5 = 27$$

$$3x - y = 17 \quad ...(2)$$

Adding equation (1) and (2) we have

$$4x = 24 \Rightarrow x = 6$$

Substituting $x = 6$ in equation (1) we obtain

$$y = 7 - x = 7 - 6 = 1$$

Thus $x = 6$ and $y = 1$.

39. Half the perimeter of a rectangular garden, whose length is 4 m more then its width, is 36 m. Find the dimensions of garden.

Ans : [Board Term-1 2013]

Let the length of the garden be x m and its width be y m.

Perimeter of rectangular garden

c113

$$p = 2(x + y)$$

Since half perimeter is given as 36 m,

$$(x + y) = 36 \quad ...(1)$$

Also, $x = y + 4$

or $x - y = 4 \quad ...(2)$

For $x + y = 36$

$$y = 36 - x$$

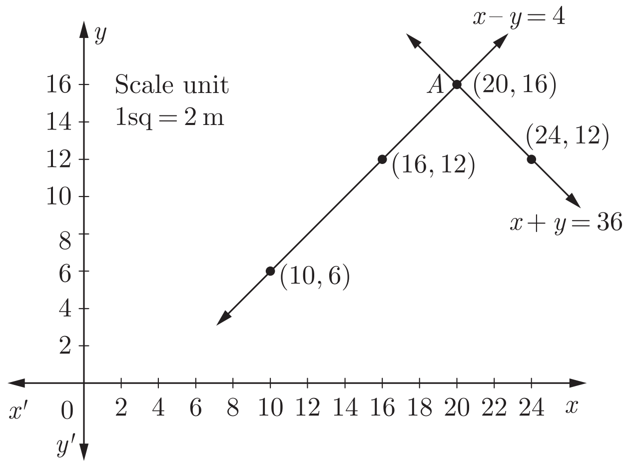
x	20	24
y	16	12

For $x - y = 4$

or, $y = x - 4$

x	10	16	20
y	6	12	16

Plotting the above points and drawing lines joining them, we get the following graph. we get two lines intersecting each other at (20, 16)



Hence, length is 20 m and width is 16 m.

40. Given the linear equation $2x + 3y - 8 = 0$, write another linear equation in two variables such that the geometrical representation of the pair so formed is :

(a) intersecting lines

(b) parallel lines

(c) coincident lines.

Ans : [Board Term-1 2014]

Given, linear equation is $2x + 3y - 8 = 0 \quad ...(1)$

(a) For intersecting lines, $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$

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To get its parallel line one of the possible equation may be taken as

$$5x + 2y - 9 = 0 \qquad (2)$$

(b) For parallel lines, $\frac{a_1}{a_2} = \frac{b_1}{b_2} \neq \frac{c_1}{c_2}$

One of the possible line parallel to equation (1) may be taken as

c114

$$6x + 9y + 7 = 0$$

(c) For coincident lines, $\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$

To get its coincident line, one of the possible equation may be taken as

$$4x + 6y - 16 = 0$$

41. Determine the values of m and n so that the following system of linear equation have infinite number of solutions :

$$(2m-1)x + 3y - 5 = 0$$

$$3x + (n-1)y - 2 = 0$$

Ans : [Board Term-1 2013]

We have $(2m-1)x + 3y - 5 = 0 \qquad ...(1)$

Here $a_1 = 2m-1, b_1 = 3, c_1 = -5$

$$3x + (n-1)y - 2 = 0 \qquad ...(2)$$

Here $a_2 = 3, b_2 = (n-1), c_2 = -2$

For a pair of linear equations to have infinite number of solutions,

c116

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

$$\frac{2m-1}{3} = \frac{3}{n-1} = \frac{5}{2}$$

or $\qquad 2(2m-1) = 15$ and $5(n-1) = 6$

Hence, $\qquad m = \frac{17}{4}, n = \frac{11}{5}$

42. Solve the pair of equations graphically :
$4x - y = 4$ and $3x + 2y = 14$

Ans : [Board Term-1 2014]

We have $\qquad 4x - y = 4$

or, $\qquad y = 4x - 4$

c115

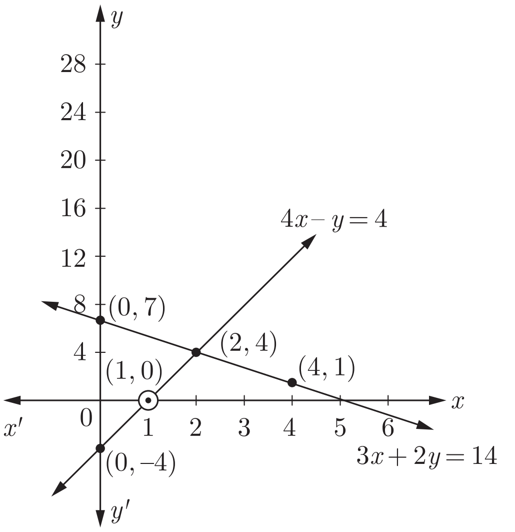
x	0	1	2
y	-4	0	4

and $\qquad 3x + 2y = 14$

or, $\qquad y = \frac{14-3x}{2}$

x	0	2	4
y	7	4	1

Plotting the above points and drawing lines joining them, we get the following graph. We get two obtained lines intersect each other at (2, 4).



Hence, $x = 2$ and $y = 4$.

43. Find the values of α and β for which the following pair of linear equations has infinite number of solutions : $2x + 3y = 7$; $2\alpha x + (\alpha + \beta)y = 28$.

Ans : [Board Term-1 2011]

We have $2x + 3y = 7$ and $2\alpha x + (\alpha+\beta)y = 28$.

For a pair of linear equations to be consistent and having infinite number of solutions,

c117

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

$$\frac{2}{2\alpha} = \frac{3}{\alpha+\beta} = \frac{7}{28}$$

$$\frac{2}{2\alpha} = \frac{7}{28}$$

$$2\alpha \times 7 = 28 \times 2 \Rightarrow \alpha = 4$$

$$\frac{3}{\alpha+\beta} = \frac{7}{28}$$

$$7(\alpha+\beta) = 28 \times 3$$

$$\alpha + \beta = 12$$

$$\beta = 12 - \alpha = 12 - 4 = 8$$

Hence $\alpha = 4$, and $\beta = 8$

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44. Represent the following pair of linear equations graphically and hence comment on the condition of consistency of this pair.

$$x-5y=6 \text{ and } 2x-10y=12.$$

Ans : [Board Term-1 2011]

We have $x-5y=6$ or $x=5y+6$

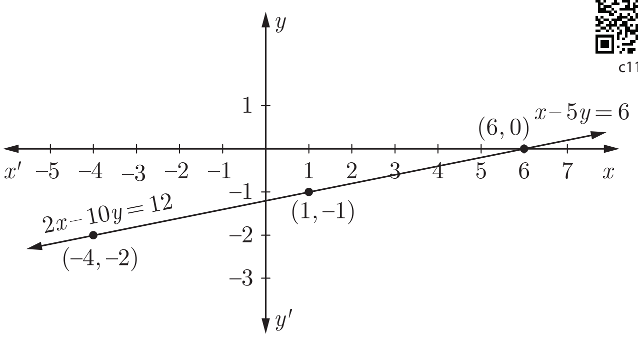
x	6	1	-4
y	0	-1	-2

and $2x-10y=12$ or $x=5y+6$

x	6	1	-4
y	0	-1	-2

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

c118



Since the lines are coincident, so the system of linear equations is consistent with infinite many solutions.

45. For what value of p will the following system of equations have no solution ?

$$(2p-1)x+(p-1)y=2p+1;\; y+3x-1=0$$

Ans : [Board Term-1 2011]

We have $(2p-1)x+(p-1)y-(2p+1)=0$

Here $a_1=2p-1, b_1=p-1$ and $c_1=-(2p+1)$

Also $3x+y-1=0$

Here $a_2=3, b_2=1$ and $c_2=-1$

c119

The condition for no solution is

$$\frac{a_1}{a_2}=\frac{b_1}{b_2}\neq\frac{c_1}{c_2}$$

$$\frac{2p-1}{3}=\frac{p-1}{1}\neq\frac{2p+1}{1}$$

From $\frac{2p-1}{3}=\frac{p-1}{1}$ we have

$$3p-3=2p-1$$

$$3p-2p=3-1$$

$$p=2$$

From $\frac{p-1}{1}\neq\frac{2p+1}{1}$ we have

$$p-1\neq 2p+1 \text{ or } 2p-p\neq -1-1$$

$$p\neq -2$$

From $\frac{2p-1}{3}\neq\frac{2p+1}{1}$ we have

$$2p-1\neq 6p+3$$

$$4p\neq -4$$

$$p\neq -1$$

Hence, system has no solution when $p=2$

46. Find the value of k for which the following pair of equations has no solution :

$x+2y=3,(k-1)x+(k+1)y=(k+2)$.

Ans : [Board Term-1 2011]

For $x+2y=3$ or $x+2y-3=0$,

c120

$$a_1=1, b_1=2, c_1=-3$$

For $(k-1)x+(k+1)y=(k+2)$

or $(k-1)x+(k+1)y-(k-2)=0$

$$a_2=(k-1), b_2=(k+1), c_2=-(k+2)$$

For no solution, $\frac{a_1}{a_2}=\frac{b_1}{b_2}\neq\frac{c_1}{c_2}$

$$\frac{1}{k-1}=\frac{2}{k+1}\neq\frac{3}{k+2}$$

From $\frac{1}{k-1}=\frac{2}{k+1}$ we have

$$k+1=2k-2$$

$$3=k$$

Thus $k=3$.

47. Sum of the ages of a father and the son is 40 years. If father's age is three times that of his son, then find their respective ages.

Ans : [Board Term-1 2015]

Let age of father and son be x and y respectively.

$$x+y=40 \quad ...(1)$$

$$x=3y$$

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

c139

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$$x = 30 \text{ and } y = 10$$

Ages are 30 years and 10 years.

48. Solve using cross multiplication method:

$$5x + 4y - 4 = 0$$
$$x - 12y - 20 = 0$$

Ans : [Board Term-1 2015]

We have $5x + 4y - 4 = 0$ ...(1)

$x - 12y - 20 = 0$ ...(2)

By cross-multiplication method,

$$\frac{x}{b_2c_1 - b_1c_2} = \frac{y}{c_1a_2 - c_2a_1} = \frac{1}{b_1b_2 - a_2b_1}$$

$$\frac{x}{-80-48} = \frac{y}{-4+100} = \frac{1}{-60-4}$$

$$\frac{x}{-128} = \frac{y}{96} = \frac{1}{64}$$

c140

$$\frac{x}{-128} = \frac{1}{-64} \Rightarrow x = 2$$

and $\frac{y}{96} = \frac{1}{-64} \Rightarrow y = \frac{-3}{2}$

Hence, $x = 2$ and $y = \frac{-3}{2}$

49. The Present age of the father is twice the sum of the ages of his 2 children. After 20 years, his age will be equal to the sum of the ages of his children. Find the age of the father.

Ans : [Board Term-1 2012]

Let the sum of the ages of the 2 children be x and the age of the father be y years.

Now $y = 2x$

$2x - y = 0$ ...(1)

and $20 + y = x + 40$

$x - y = -20$ ...(2)

Subtracting (2) from (1), we get

$$x = 20$$

c166

From(1), $y = 2x = 2 \times 20 = 40$

Hence, the age of the father is 40 years.

50. A part of monthly hostel charge is fixed and the remaining depends on the number of days one has taken food in the mess. When Swati takes food for 20 days, she has to pay Rs. 3,000 as hostel charges whereas Mansi who takes food for 25 days Rs. 3,500 as hostel charges. Find the fixed charges and the cost of food per day.

Ans : [Board Term-1 2016, 2015]

Let fixed charge be x and per day food cost be y

$x + 20y = 3000$ ...(1)

$x + 25y = 3500$ ...(2)

Subtracting (1) from (2) we have

$$5y = 500 \Rightarrow y = 100$$

c141

Substituting this value of y in (1), we get

$$x + 20(100) = 3000$$
$$x = 1000$$

Thus $x = 1000$ and $y = 100$

Fixed charge and cost of food per day are Rs. 1,000 and Rs. 100.

51. Solve for x and y :

$$\frac{x}{2} + \frac{2y}{3} = -1$$
$$x - \frac{y}{3} = 3$$

Ans : [Board Term-1 2015]

We have $\frac{x}{2} + \frac{2y}{3} = -1$

$3x + 4y = -6$ ...(1)

and $\frac{x}{1} - \frac{y}{3} = 3$

$3x - y = 9$ ...(2)

Subtracting equation (2) from equation (1), we have

$$5y = -15 \Rightarrow y = -1$$

c142

Substituting $y = -3$ in eq (1), we get

$$3x + 4(-3) = -6$$
$$3x - 12 = -6$$
$$3x = 12 - 6 \Rightarrow x = 2$$

Hence $x = 2$ and $y = -3$.

52. Solve the following pair of linear equations by the substitution and cross - multiplication method :

$$8x + 5y = 9$$
$$3x + 2y = 4$$

Ans : [Board Term-1 2015]

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We have $8x+5y = 9$

or, $8x+5y-9 = 0$ ...(1)

and $3x+2y = 4$

or, $3x+2y-4 = 0$ ...(2)

Comparing equation (1) and (2) with $ax+by+c=0$,

$$a_1 = 8, b_1 = 5, c_1 = -9$$

and $a_2 = 3, b_2 = 2, c_2 = -4$

By cross-multiplication method,

$$\frac{x}{b_2c_1-b_1c_2} = \frac{y}{c_1a_2-c_2a_1} = \frac{1}{a_1b_2-b_2b_1}$$

$$\frac{x}{\{(5)(-4)-(2)(-9)\}} = \frac{y}{\{(-9)(3)-(-4)(8)\}}$$

$$= \frac{1}{\{8\times 2-3\times 5\}}$$

or, $\frac{x}{-2} = \frac{1}{1}$ and $\frac{y}{5} = \frac{1}{1}$

$$x = -2 \text{ and } y = 5$$

c143

We use substitution method.

From equation (2), we have

$$3x = 4-2y$$

or, $x = \frac{4-2y}{3}$ ...(3)

Substituting this value of y in equation (3) in (1), we get

$$8\left(\frac{4-2y}{3}\right)+5y = 9$$

$$32-16y+15y = 27$$

$$-y = 27-32$$

Thus $y = 5$

Substituting this value of y in equation (3)

$$x = \frac{4-2(5)}{3} = \frac{4-10}{3} = -2$$

Hence, $x = -2$ and $y = 5$.

53. 2 man and 7 boys can do a piece of work in 4 days. It is done by 4 men and 4 boys in 3 days. How long would it take for one man or one boy to do it ?

Ans : [Board Term-1 2013]

Let the man can finish the work in x days and the boy can finish work in y days.

Work done by one man in one day $= \frac{1}{x}$

And work done by one boy in one day $= \frac{1}{y}$

$$\frac{2}{x}+\frac{7}{y} = \frac{1}{4} \quad ...(1)$$

and $\frac{4}{x}+\frac{4}{y} = \frac{1}{3}$ ...(2)

Let $\frac{1}{x}$ be a and $\frac{1}{y}$ be b, then we have

$$2a+7b = \frac{1}{4} \quad ...(3)$$

and $4a+4b = \frac{1}{3}$ ...(4)

Multiplying equation (3) by 2 and subtract equation (4) from it

$$10b = \frac{1}{6}$$

c144

$$b = \frac{1}{60} = \frac{1}{y}$$

Thus $y = 60$ days.

Substituting $b = \frac{1}{60}$ in equation (3), we have

$$2a+\frac{7}{60} = \frac{1}{4}$$

$$2a = \frac{1}{4}-\frac{7}{60}$$

$$a = \frac{1}{15}$$

Now $\frac{1}{15} = \frac{1}{x}$

Thus $x = 15$ days.

54. In an election contested between A and B, A obtained votes equal to twice the no. of persons on the electoral roll who did not cast their votes and this later number was equal to twice his majority over B. If there were 1,8000 persons on the electoral roll. How many votes for B.

Ans : [Board Term-1 2012]

Let x and y be the no. of votes for A and B respectively.

The no. of persons who did not vote is $18000-x-y$.

We have $x = 2(18000-x-y)$

$$3x+2y = 36000 \quad ...(1)$$

and $(18000-x-y) = 2(x-y)$

or $3x-y = 18000$ ...(2)

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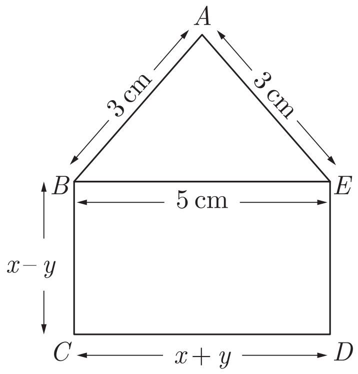
Subtracting equation (2) from equation (1),

$$3y = 18000$$

$$y = 6000$$

Hence vote for B is 6000.

55. In the figure below $ABCDE$ is a pentagon with $BE || CD$ and $BC || DE$. BC is perpendicular to DC. If the perimeter of $ABCDE$ is 21 cm, find the values of x and y.



Ans : [Board 2010]

Since $BC || DE$ and $BE || CD$ with $BC \perp DC$, $BCDE$ is a rectangle.

$$BE = CD,$$

$$x + y = 5 \quad ...(1)$$

and $$DE = BE = x - y$$

Since perimeter of $ABCDE$ is 21,

$$AB + BC + CD + DE + EA = 21$$

$$3 + x - y + x + y + x - y + 3 = 21$$

$$6 + 3x - y = 21$$

$$3x - y = 15$$

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

$$4x = 20 \quad ...(2)$$

$$x = 5$$

Substituting the value of x in (1), we get

$$y = 0$$

Thus $x = 5$ and $y = 0$.

56. Solve for x and y :

$$\frac{x+1}{2} + \frac{y-1}{3} = 9 \ ; \ \frac{x-1}{3} + \frac{y+1}{2} = 8.$$

Ans : [Board Term-1 Delhi 2011]

We have $$\frac{x+1}{2} + \frac{y-1}{3} = 9$$

$$3(x+1) + 2(y-1) = 54$$

$$3x + 3 + 2y - 2 = 54$$

$$3x + 2y = 53 \quad (1)$$

and $$\frac{x-1}{3} + \frac{y+1}{2} = 8$$

$$2(x-1) + 3(y+1) = 48$$

$$2x - 2 + 3y + 3 = 48$$

$$2x + 3y = 47 \quad (2)$$

Multiplying equation (1) by 3 we have

$$9x + 6y = 159 \quad (3)$$

Multiplying equation (2) by 2 we have

$$4x + 6y = 94 \quad (4)$$

Subtracting equation (4) from (3) we have

$$5x = 65$$

or $$x = 13$$

Substitute the value of x in equation (2),

$$2(13) + 3y = 47$$

$$3y = 47 - 26 = 21$$

$$y = \frac{21}{3} = 7$$

Hence, $x = 13$ and $y = 7$

57. Solve for x and y :

$$\frac{6}{x-1} - \frac{3}{y-2} = 1$$

$$\frac{5}{x-1} - \frac{1}{y-2} = 2, \text{ where } x \neq 1, y \neq 2.$$

Ans : [Board Term-1 OD 2011]

We have $$\frac{6}{x-1} - \frac{3}{y-2} = 1 \quad (1)$$

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

Let $\frac{1}{x-1} = p$ and $\frac{1}{y-2} = q$. then given equations become

$$6p - 3q = 1 \quad ...(3)$$

and $$5p - q = 2 \quad ...(4)$$

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Multiplying equation (4) by 3 and adding in equation (3), we have

$$21p = 7$$

$$p = \frac{7}{21} = \frac{1}{3}$$

Substituting this value of p in equation (3), we have

$$6\left(\frac{1}{3}\right) - 3q = 1$$

$$2 - 3q = 1 \Rightarrow q = \frac{1}{3}$$

Now, $\frac{1}{x-1} = p = \frac{1}{3}$

or, $x - 1 = 3 \Rightarrow x = 4$

and $\frac{1}{y-2} = q = \frac{1}{3}$

or, $y - 2 = 3 \Rightarrow y = 5$

Hence $x = 4$ and, $y = 5$.

58. Seven times a two digit number is equal to four times the number obtained by reversing the order of its digits. If the difference of the digits is 3, determine the number.

Ans : [Board Term-1 2017]

Let the ten's and unit digit by y and x respectively,
So the number is $10y + x$
The number when digits are reversed becomes $10x + y$

Thus $7(10y + x) = 4(10x + y)$

$$70y + 7x = 40x + 4y$$

$$70y - 4y = 40x - 7x$$

$$2y = x \quad ...(1)$$

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

From (1) and (2) we get

$$y = 3 \text{ and } x = 6$$

Hence the number is 36.

59. Solve the following pair of equations for x and y :

$$\frac{a^2}{x} - \frac{b^2}{y} = 0, \frac{a^2 b}{x} + \frac{b^2 a}{y} = a + b, \qquad x \neq 0; y \neq 0.$$

Ans : [Board Term-1 2011]

We have $\frac{a^2}{x} - \frac{b^2}{y} = 0$

$$\frac{a^2 b}{x} + \frac{b^2 a}{y} = a + b = a + b$$

Substituting $p = \frac{1}{x}$ and $q = \frac{1}{y}$ in the given equations,

$$a^2 p - b^2 q = 0 \quad ...(1)$$

$$a^2 bp + b^2 aq = a + b \quad ...(2)$$

Multiplying equation (1), by a

$$a^3 p - b^2 aq = 0 \quad ...(3)$$

Adding equation (2) and equation (3),

$$(a^3 + a^2 b)p = a + b$$

or, $p = \frac{(a+b)}{a^2(a+b)} = \frac{1}{a^2}$

Substituting the value of p in equation (1),

$$a^2\left(\frac{1}{a^2}\right) - b^2 q = 0 \Rightarrow q = \frac{1}{b^2}$$

Now, $p = \frac{1}{x} = \frac{1}{a^2} \Rightarrow x = a^2$

and $q = \frac{1}{y} = \frac{1}{b^2} \Rightarrow y = b^2$

Hence, $x = a^2$ and $y = b^2$

60. Solve for x and y :

$$ax + by = \frac{a+b}{2}$$

$$3x + 5y = 4$$

Ans : [Board Term-1 2011]

We have $ax + by = \frac{a+b}{2}$

or $2ax + 2by = a + b \quad ...(1)$

and $3x + 5y = 4 \quad ...(2)$

Multiplying equation (1) by 5 we have

$$10ax + 10by = 5a + 5b \quad ...(3)$$

Multiplying equation (2) by $2b$, we have

$$6bx + 10by = 8b \quad ...(4)$$

Subtracting (4) from (3) we have

$$(10a - 6b)x = 5a - 3b$$

or $x = \frac{5a - 3b}{10a - 6b} = \frac{1}{2}$

Substitute $x = \frac{1}{2}$ in equation (2), we get

$$3 \times \frac{1}{2} + 5y = 4$$

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

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

Hence $x = \frac{1}{2}$ and $y = \frac{1}{2}$.

61. Solve the following pair of equations for x and y :

$4x + \frac{6}{y} = 15, 6x - \frac{8}{y} = 14$

and also find the value of p such that $y = px - 2$.

Ans : [Board Term-1 2011]

We have $$4x + \frac{6}{y} = 15 \quad (1)$$

$$6x - \frac{8}{y} = 14, \quad (2)$$

Let $\frac{1}{y} = z$, the given equations become

$$4x + 6z = 15 \quad ...(3)$$

$$6x - 8z = 14 \quad ...(4)$$

Multiply equation (3) by 4 we have

$$16x + 24z = 60 \quad (5)$$

Multiply equation (4) by 3 we have

$$18x - 24z = 24 \quad (6)$$

Adding equation (5) and (6) we have

$$34x = 102$$

$$x = \frac{102}{34} = 3$$

c150

Substitute the value of x in equation (3),

$$4(3) + 6z = 15$$

$$6z = 15 - 12 = 3$$

$$z = \frac{3}{6} = \frac{1}{2}$$

Now $$z = \frac{1}{y} = \frac{1}{2} \Rightarrow y = 2$$

Hence $x = 3$ and $y = 2$.

Again $$y = px - 2$$

$$2 = p(3) - 2$$

$$3p = 4$$

Thus $$p = \frac{4}{3}$$

62. A chemist has one solution which is 50 % acid and a second which is 25 % acid. How much of each should be mixed to make 10 litre of 40 % acid solution.

Ans : [Board Term-1 2015]

Let 50 % acids in the solution be x and 25 % of other solution be y.

Total volume in the mixture

$$x + y = 10 \quad ...(1)\ 1$$

and $$\frac{50}{100}x + \frac{25}{100}y = \frac{40}{100} \times 10$$

$$2x + y = 16 \quad ...(2)\ 1$$

Subtracting equation (1) from (2) we have

$$x = 6$$

Substituting this value of x in equation (1) we get

c177

$$6 + y = 10$$

$$y = 4$$

Hence, $x = 6$ and $y = 4$.

63. Find whether the following pair of linear equations has a unique solutions. If yes, find the solution :

$$7x - 4y = 49, 5x - 6y = 57.$$

Ans : [Board Term-1 2017]

We have $$7x - 4y = 49 \quad (1)$$

$$5x - 6y = 57 \quad (2)$$

Comparing with the equation $a_1x + b_1y = c_1$,

$$a_1 = 7, b_1 = -4, c_1 = 49$$

$$a_2 = 5, b_2 = -6, c_2 = 57$$

c151

Since, $$\frac{a_1}{a_2} = \frac{7}{5} \text{ and } \frac{b_1}{b_2} = \frac{4}{6}$$

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

So, system has a unique solution.

Multiply equation (1) by 5 we get

$$35x - 20y = 245 \quad (3)$$

Multiply equation (2) by 7 we get

$$35x - 42y = 399 \quad (4)$$

Subtracting (4) by (3) we have

$$22y = -154$$

$$y = -7$$

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Putting the value of y in equation (2),

$$5x-6(-7) = 57$$

$$5x = 57-42 = 15$$

$$x = 3$$

Hence $x = 3$ and $y = -7$

64. 4 chairs and 3 tables cost Rs 2100 and 5 chairs and 2 tables cost Rs 1750. Find the cost of one chair and one table separately.

Ans : [Board Term-1 2015]

Let cost of 1 chair be Rs x and cost of 1 table be Rs y According to the question,

$$4x+3y = 2100 \quad ...(1)$$

$$5x+2y = 1750 \quad ...(2)$$

Multiplying equation (1) by 2 and equation (2) by 3,

$$8x+6y = 4200 \quad ...(3)$$

$$15x+6y = 5250 \quad ...(iv)$$

Subtracting equation (3) from (4) we have

$$7x = 1050$$

$$x = 150$$

c152

Substituting the value of x in (1), $y = 500$

Thus cost of chair and table is Rs 150, Rs 500 respectively.

FIVE MARKS QUESTIONS

65. A man can row a boat downstream 20 km in 2 hours and upstream 4 km in 2 hours. Find his speed of rowing in still water. Also find the speed of the stream.

Ans : [Board 2020 Delhi Standard]

Let x be the speed of the boat in still water and y be the speed of the stream.

Relative Speed of boat in upstream will be $(x-y)$ and relative speed of boat in downstream will be $(x+y)$.

According to question, we have

c224

$$\frac{20}{x+y} = 2$$

$$x+y = 10 \quad ...(1)$$

and $$\frac{4}{x-y} = 2$$

$$x-y = 2 \quad ...(2)$$

Adding equation (1) and (2), we have

$$2x = 12 \Rightarrow x = 6 \text{ km/hr}$$

Substituting the value of x is equation (1) we have,

$$6+y = 10 \Rightarrow y = 10-6 = 4 \text{ km/hr}$$

Thus speed of a boat in still water is 6 km/hr and speed of the stream 4 km/hr.

66. For what value of k, which the following pair of linear equations have infinitely many solutions:
$2x+3y = 7$ and $(k+1)x+(2k-1)y = 4k+1$

Ans : [Board 2019 Delhi]

We have $$2x+3y = 7$$

and $$(k+1)x+(2k-1)y = 4k+1$$

c226

Here $$\frac{a_1}{a_2} = \frac{2}{k+1}, \frac{b_1}{b_2} = \frac{3}{(2k-1)}$$

and $$\frac{c_1}{c_2} = \frac{-7}{-(4k+1)} = \frac{7}{(4k+1)}$$

For infinite many solutions

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

For $\frac{a_1}{a_2} = \frac{c_1}{c_2}$ we have

$$\frac{2}{k+1} = \frac{7}{4k+1}$$

$$2(4k+1) = 7(k+1)$$

$$8k+2 = 7k+7$$

$$k = 5$$

Hence, the value of k is 5, for which the given equation have infinitely many solutions.

67. Determine graphically the coordinates of the vertices of triangle, the equations of whose sides are given by $2y-x = 8$, $5y-x = 14$ and $y-2x = 1$.

Ans : [Board 2020 Delhi Standard]

We have $$2y-x = 8$$

c223

L_1 : $$x = 2y-8$$

y	0	4	5
$x = 2y-8$	-8	0	2

$$5y-x = 14$$

L_2 : $$x = 5y-14$$

y	3	4	2
$x = 5y-14$	1	6	-4

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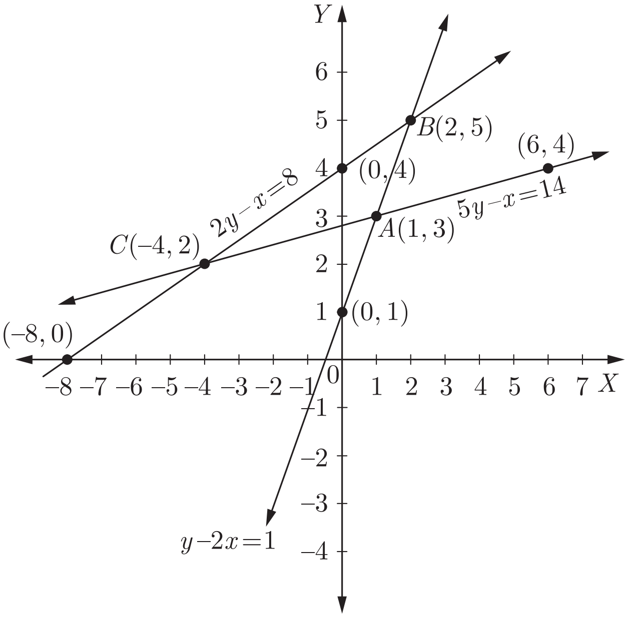
and $y-2x=1$

L_3 : $y=1+2x$

x	0	1	2
$y=1+2x$	1	3	5

Plotting the above points and drawing lines joining them, we get the graphical representation:



Hence, the coordinates of the vertices of a triangle ABC are $A(1,3)$, $B(2,5)$ and $C(-4,2)$.

68. It can take 12 hours to fill a swimming pool using two pipes. If the pipe of larger diameter is used for four hours and the pipe of smaller diameter for 9 hours, only half of the pool can be filled. How long would it take for each pipe to fill the pool separately?

Ans : [Board 2020 OD Standard]

Let x be time taken to fill the pool by the larger diameter pipe and y be the time taken to fill the pool by the smaller diameter pipe.

According to question,

$$\frac{1}{x}+\frac{1}{y}=\frac{1}{12} \quad ...(1)$$

and $$\frac{4}{x}+\frac{9}{y}=\frac{1}{2} \quad ...(2)$$

Multiplying equation (1) by 9 and subtracting from equation (2), we get

$$\frac{5}{x}=\frac{9}{12}-\frac{1}{2}=\frac{1}{4}$$

c225

$$x=20$$

Substituting the value of x in equation (1), we have

$$\frac{1}{20}+\frac{1}{y}=\frac{1}{12}$$

$$\frac{1}{y}=\frac{1}{12}-\frac{1}{20}=\frac{5-3}{60}$$

$$\frac{1}{y}=\frac{2}{60}=\frac{1}{30} \Rightarrow y=30$$

Hence, time taken to fill the pool by the larger and smaller diameter pipe are 20 hrs and 30 hrs respectively.

69. Find c if the system of equations $cx+3y+(3-c)=0; 12x+cy-c=0$ has infinitely many solutions?

Ans : [Board 2019 Delhi]

c227

We have $$cx+3y+(3-c)=0$$

$$12x+cy-c=0$$

Here, $$\frac{a_1}{a_2}=\frac{c}{12}, \frac{b_1}{b_2}=\frac{3}{c}, \frac{c_1}{c_2}=\frac{3-c}{-c}$$

For infinite many solutions,

$$\frac{a_1}{a_2}=\frac{b_1}{b_2}=\frac{c_1}{c_2}$$

For $\frac{a_1}{a_2}=\frac{c_1}{c_2}$ we have,

$$\frac{c}{12}=\frac{3-c}{-c}$$

$$-c^2=36-12c$$

$$-c^2+12c-36=0$$

$$c^2-12c+36=0$$

$$c^2-6c-6c+36=0$$

$$c(c-6)-6(c-6)=0$$

$$(c-6)(c-6)=0 \Rightarrow c=6$$

and for $\frac{b_1}{b_2}=\frac{c_1}{c_2}$,

$$\frac{3}{c}=\frac{3-c}{-c}$$

$$-3c=3c-c^2$$

$$c^2-6c=0$$

$$c(c-6)=0 \Rightarrow c=6 \text{ or } c\neq 0$$

Hence, the value of c is 6, for which the given equations have infinitely many solutions.

70. A father's age is three times the sum of the ages of his two children. After 5 years his age will be two times the sum of their ages. Find the present age of

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the father.

Ans : [Board 2019 Delhi]

Let x be the age of father and y be the sum of the ages of his children.

After 5 years,

$$\text{Father's age} = (x+5) \text{ years}$$

c228

$$\text{Sum of ages of his children} = (y+10) \text{ years}$$

According to the given condition,

$$x = 3y \qquad ...(1)$$

and $$x+5 = 2(y+10)$$

or, $$x-2y = 15 \qquad ...(2)$$

Solving equation (1) and (2), we have

$$3y-2y = 15 \Rightarrow y = 15$$

Substituting value of y in equation (1), we get

$$x = 3 \times 15 = 45$$

Hence, father's present age is 45,

71. Two water taps together can fill a tank in $1\frac{7}{8}$ hours. The tap with longer diameter takes 2 hours less than the tap with smaller one to fill the tank separately. Find the time in which each tap can fill the tank separately.

Ans : [Board 2019 Delhi]

Let t be the time taken by the smaller diameter top. Time for larger tap diameter will be $t-2$.

$$\text{Total time taken} = 1\frac{7}{8} = \frac{15}{8}h.$$

Portion filled in one hour by smaller diameter tap will $\frac{1}{t}$ and by lager diameter tap will be $\frac{1}{t-2}$

According to the problem,

c229

$$\frac{1}{t}+\frac{1}{t-2} = \frac{8}{15}$$

$$\frac{t-2+t}{t(t-2)} = \frac{8}{15}$$

$$15(2t-2) = 8t(t-2)$$

$$30t-30 = 8t^2-16t$$

$$8t^2-46t+30 = 0$$

$$4t^2-23t+15 = 0$$

$$4t^2-20t-3t+30 = 0$$

$$(4t-3)(t-5) = 0 \Rightarrow t = \frac{3}{4} \text{ or } t=5$$

If $t = \frac{3}{4}$ then $$t-2 = \frac{3}{4}-2 = \frac{-5}{4}$$

Since, time cannot be negative, we neglect $t = \frac{3}{4}$

Therefore, $$t = 5$$

and $$t-2 = 5-2 = 3$$

Hence, time taken by larger tap is 3 hours and time taken by smaller is 5 hours

72. A boat goes 30 km upstream and 44 km downstream in 10 hours. In 13 hours, it can go 40 km upstream and 55 km downstream. Determine the speed of the stream and that of the boat in still water.

Ans : [Board 2019 Delhi]

Let x be the speed of boat in still water and y be the speed of stream.

Relative speed of boat in downstream will be $x+y$ and relative speed of boat in upstream will be $x-y$.

Time taken to go 30 km upstream,

$$t_1 = \frac{30}{x-y}$$

Time taken to go 44 km downstream,

c230

$$t_2 = \frac{40}{x+y}$$

According to the first condition we have

$$\frac{30}{x-y}+\frac{44}{x+y} = 10 \qquad ...(1)$$

Similarly according to the second condition we have

$$\frac{40}{x-y}+\frac{55}{x+y} = 13 \qquad ...(2)$$

Let $\frac{1}{x-y} = u$ and $\frac{1}{x+y} = \upsilon$, then we have

$$30u+44\upsilon = 10 \qquad ...(3)$$

$$40u+55\upsilon = 13 \qquad ...(4)$$

Multiplying equation (3) by 4 and equation (4) by 3 and then subtracting we have

$$11v = 1 \Rightarrow \upsilon = \frac{1}{11}$$

Multiplying equation (3) by 5 and equation (4) by 4 and then subtracting we have

$$-10u = -2 \qquad ...(4)$$

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

Now $$u = \frac{1}{x-y} = \frac{1}{5}$$

$$x-y = 5 \qquad (5)$$

and $$\upsilon = \frac{1}{x+y} = \frac{1}{11}$$

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$$x + y = 11 \quad (6)$$

Adding equation (5) and (6), we get

$$2x = 16 \Rightarrow x = 8$$

Substitute value of x in equation (5), we get

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

Hence speed of boat in still water is 8 km/hour and and speed of stream is 3 km/hour.

73. Sumit is 3 times as old as his son. Five years later he shall be two and a half times as old as his son. How old is Sumit at present?

Ans : [Board 2019 OD]

Let x be Sumit's present age and y be his son's present age.

According to given condition,

$$x = 3y$$

After five years, ...(1)

$$\text{Sumit's age} = x + 5$$

and $$\text{His son's age} = y + 5$$

Now, again according to given condition,

c231

$$x + 5 = 2\frac{1}{2}(y + 5)$$

$$x + 5 = \frac{5}{2}(y + 5)$$

$$2(x + 5) = 5(y + 5)$$

$$2x + 10 = 5y + 25$$

$$2x = 5y + 15$$

$$2(3y) = 5y + 15 \quad \text{[from eq (1)]}$$

$$6y = 5y + 15$$

$$y = 15$$

Again, from eq (1)

$$x = 3y = 3 \times 15 = 45$$

Hence, Sumit's present age is 45 years.

74. For what value of k, will the following pair of equations have infinitely many solutions:
$2x + 3y = 7$ and $(k + 2)x - 3(1 - k)y = 5k + 1$

Ans : [Board 2019 OD]

We have $$2x + 3y = 7 \quad ...(1)$$

and $$(k + 2)x - 3(1 - k)y = 5k + 1 \quad ...(2)$$

Comparing equation (1) with $a_1x + b_1y = c_1$ and equation (2) by $a_2x + b_2y = c_2$ we have

$$a_1 = 2,\ b_1 = 3,\ c_1 = 7$$

and $$a_2 = (k + 2),\ b_2 = -3(1 - k),\ c_1 = 5k + 1$$

Here, $$\frac{a_1}{a_2} = \frac{2}{k + 2},$$

$$\frac{b_1}{b_2} = \frac{3}{-3(1 - k)},\ \frac{c_1}{c_2} = \frac{7}{5k + 1}$$

For a pair of linear equations to have infinitely many solutions,

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

c232

So, $$\frac{2}{k + 2} = \frac{3}{-3(1 - k)} = \frac{7}{5k + 1}$$

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

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

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

Hence, for $k = 4$, the pair of linear equations has infinitely many solutions.

75. The total cost of a certain length of a piece of cloth is ₹200. If the piece was 5 m longer and each metre of cloth costs ₹2 less, the cost of the piece would have remained unchanged. How long is the piece and what is its original rate per metre?

Ans : [Board 2019 OD]

Let x be the length of the cloth and y be the cost of cloth per meter.

Now $$x \times y = 200$$

$$y = \frac{200}{x} \quad ...(1)$$

According to given conditions,

1. If the piece were 5 m longer
2. Each meter of cloth costed ₹ 2 less

c233

i.e., $$(x + 5)(y - 2) = 200$$

$$xy - 2x + 5y - 10 = 200$$

$$xy - 2x + 5y = 210$$

$$x\left(\frac{200}{x}\right) - 2x + 5\left(\frac{200}{x}\right) = 210$$

$$200 - 2x + \frac{1000}{x} = 210$$

$$\frac{1000}{x} - 2x = 10$$

$$1000 - 2x^2 = 10x$$

$$x^2 + 25x - 20x - 500 = 0$$

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$$x(x+25)-20(x+25) = 0$$

$$(x+25)(x-20) = 0$$

$$x = -25, 20$$

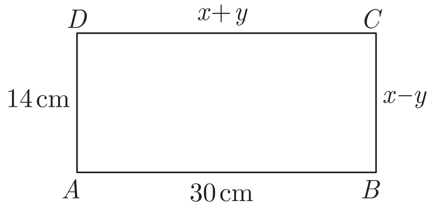
Neglecting $x = -25$ we get $x = 20$.

Now from equation (1), we have

$$y = \frac{200}{x} = \frac{200}{20} = 10$$

Hence, length of the piece of cloths is 20 m and rate per meter is ₹ 10.

76. In Figure, $ABCD$ is a rectangle. Find the values of x and y.



Ans : [Board 2018]

Since $ABCD$ is a rectangle, we have

$$AB = CD \text{ and } BC = AD$$

Now $\quad x+y = 30 \quad$ ...(1)

$$x-y = 14 \quad ...(2)$$

Adding equation (1) and (3) we obtain,

$$2x = 44 \Rightarrow x = \frac{44}{2} = 22$$

c234

Substituting value of x in equation (1) we have

$$22+y = 30$$

$$y = 30-22 = 8$$

$$x = 22\text{ cm and } y = 8\text{ cm}$$

77. Determine graphically whether the following pair of linear equations :

$$3x-y = 7$$

$$2x+5y+1 = 0 \text{ has :}$$

a. unique solution
b. infinitely many solutions or
c. no solution.

Ans : [Board Term-1 2015]

We have $\quad 3x-y = 7$

or $\quad 3x-y-7 = 0 \quad$ (1)

Here $a_1 = 3, b_1 = 1, c_1 = -7$

$$2x+5y+1 = 0 \quad (2)$$

Here $a_2 = 2, b_2 = 5, c_2 = 1$

Now $\quad \frac{a_1}{a_2} = \frac{3}{2}, \frac{b_1}{b_2} = \frac{-1}{5}$

c122

Since $\frac{3}{2} \neq \frac{-1}{5}$, thus $\frac{a_1}{a_2} \neq \frac{b_1}{b_2}$

Hence, given pair of linear equations has a unique solution.

Now line (1) $\quad y = 3x-7$

x	0	2	3
y	-7	-1	2

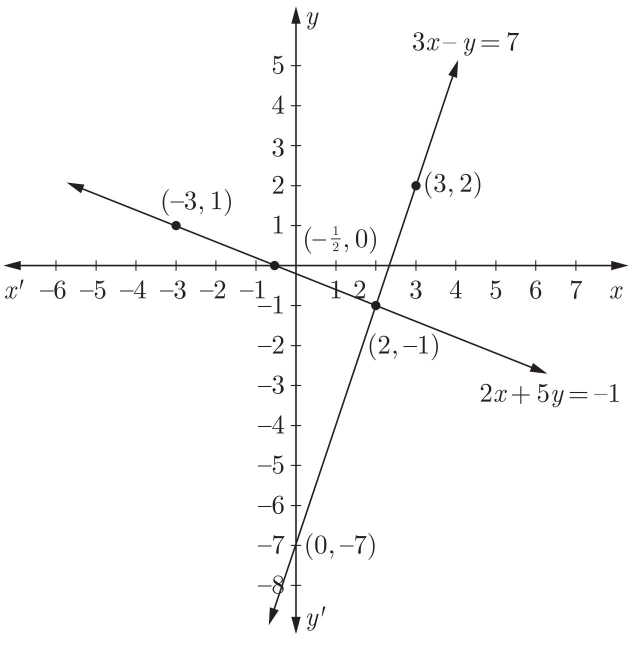
and line (2)

$$2x+5y+1 = 0$$

or, $\quad y = \frac{-1-2x}{5}$

x	2	-3
y	-1	1

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



Clearly, the two lines intersect at point $(2, -1)$. Hence $x = 2$ and $y = -1$

78. Draw the graphs of the pair of linear equations : $x+2y = 5$ and $2x-3y = -4$

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Also find the points where the lines meet the $x-$axis.

Ans : [Board Term-1 2015]

c123

We have $x+2y = 5$

or, $y = \frac{5-x}{2}$

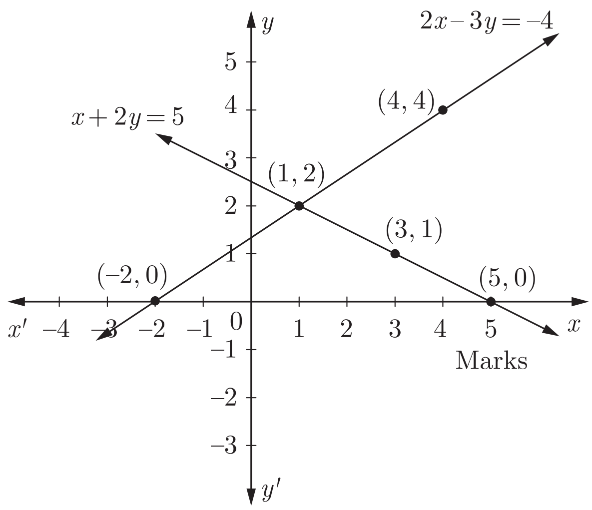
x	1	3	5
y	2	1	0

and $2x-3y = -4$

or, $y = \frac{2x+4}{3}$

x	1	4	-2
y	2	4	0

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



Clearly two lines meet x-axis at $(5,0)$ and $(-2,0)$ respectively.

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

Ans : [Board Term-1 2015]

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

7 years ago father's(Aftab) age $= (x-7)$years

7 years ago daughter's age $= (y-7)$ years

According to the question,

c125

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

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

After 3 years father's(Aftab) age $= (x+3)$ years

After 3 years daughter's age $= (y+3)$ years

According to the condition,

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

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

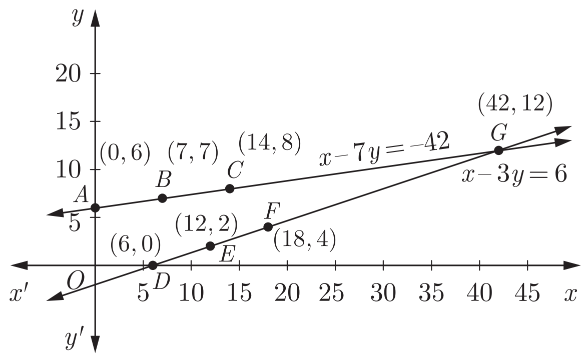
From equation(1) $x-7y = -42$

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

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

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

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



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

Hence, father's age $= 42$ years

and daughter's age $= 12$ years

80. For Uttarakhand flood victims two sections A and B of class contributed Rs. 1,500. If the contribution of X-A was Rs. 100 less than that of X-B, find graphically the amounts contributed by both the sections.

c121

Ans : [Board Term-1 2016]

Let amount contributed by two sections X-A and X-B be Rs. x and Rs.y.

$x+y = 1{,}500$ ...(1)

$y-x = 100$ ...(2)

From (1) $y = 1500-x$

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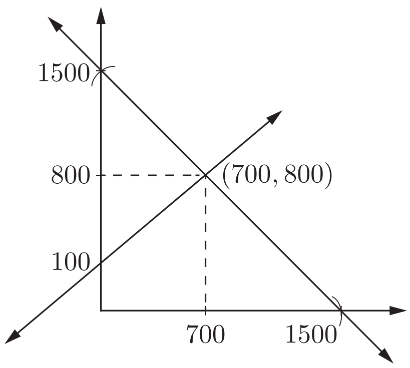
x	0	700	1,500
y	1,500	800	0

From (2) $y = 100 + x$

x	0	700
y	100	800

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



Clearly, the two lines intersect at point (700, 800)

Hence X-A contributes 700 Rs and X-B contributes 800 Rs.

81. Solve graphically the pair of linear equations :

$3x - 4y + 3 = 0$ and $3x + 4y - 21 = 0$

Find the co-ordinates of the vertices of the triangular region formed by these lines and x-axis. Also, calculate the area of this triangle.

Ans : [Board Term-1 2015]

c124

We have $3x - 4y + 3 = 0$

or, $y = \frac{3x+3}{4}$

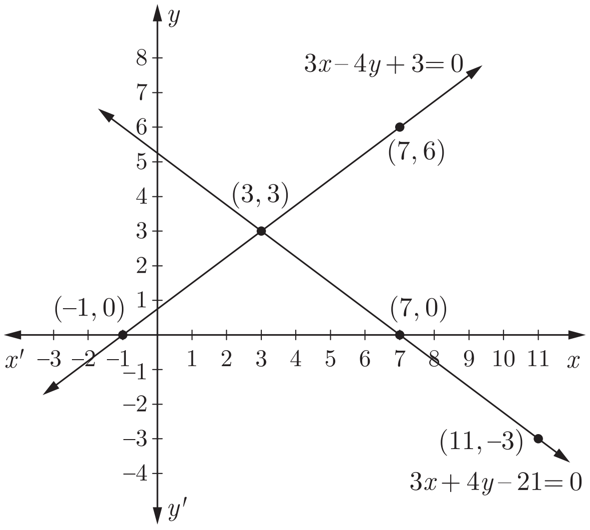
x	3	7	-1
y	3	6	0

and $3x + 4y - 21 = 0$

or, $y = \frac{21-3x}{4}$

x	3	7	11
y	3	0	-2

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



Clearly, the two lines intersect at point $(3, 3)$.

(a) These lines intersect each other at point $(3, 3)$. Hence $x = 3$ and $y = 3$

(b) The vertices of triangular region are $(3, 3)$, $(-1, 0)$ and $(7, 0)$.

(c) Area of $\Delta = \frac{1}{2} \times 8 \times 3 = 12$

Hence, Area of obtained Δ is 12 sq unit.

82. The cost of 2 kg of apples and 1kg of grapes on a day was found to be Rs. 160. After a month, the cost of 4kg of apples and 2kg of grapes is Rs. 300. Represent the situations algebraically and geometrically.

Ans : [Board Term-1 2013]

Let the cost of 1 kg of apples be Rs. x and cost of 1 kg of grapes be Rs. y.

The given conditions can be represented given by the following equations :

$$2x + y = 160 \quad ...(1)$$

$$4x + 2y = 300 \quad ...(2)$$

From equation (1) $y = 160 - 2x$

c126

x	50	45
y	60	70

From equation (2) $y = 150 - 2x$

x	50	40
y	50	70

Plotting these points on graph, we get two parallel line as shown below.

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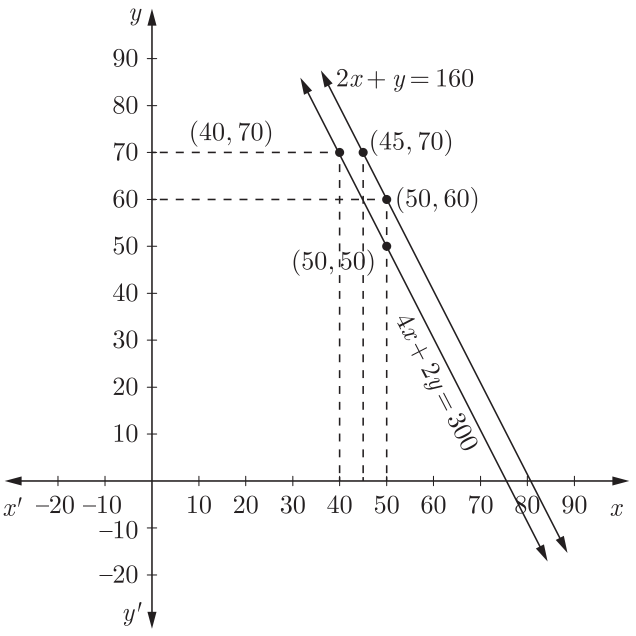


83. Solve the following pair of equations :

$$\frac{2}{\sqrt{x}}+\frac{3}{\sqrt{y}}=2 \text{ and } \frac{4}{\sqrt{x}}-\frac{9}{\sqrt{y}}=-1$$

Ans : [Board Term-1 2015]

We have $\frac{2}{\sqrt{x}}+\frac{3}{\sqrt{y}}=2$

$\frac{4}{\sqrt{x}}-\frac{9}{\sqrt{y}}=-1$

Substitute $\frac{1}{\sqrt{x}}=X$ and $\frac{1}{\sqrt{y}}=Y$

$2X+3Y=2$ ...(1)

$4X-9Y=-1$ ...(2)

Multiplying equation (1) by 3, and adding in (2) we get

$$10X=5 \Rightarrow X=\frac{5}{10}=\frac{1}{2}$$

c153

Thus $\frac{1}{\sqrt{x}}=\frac{1}{2} \Rightarrow x=4$

Putting the value of X in equation (1), we get

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

$$3Y=2-1$$

$$Y=\frac{1}{3}$$

Now $Y=\frac{1}{3} \Rightarrow \frac{1}{\sqrt{y}}=\frac{1}{3} \Rightarrow y=9$

Hence $x=4$, $y=9$.

84. Draw the graphs of the equations $x-y+1=0$ and $3x+2y-12=0$. Determine the co-ordinates of the vertices of the triangle formed by these lines and the X-axis and shade the triangular region.

Ans : [Board Term-1 2013]

We have $x-y+1=0$ ...(1)

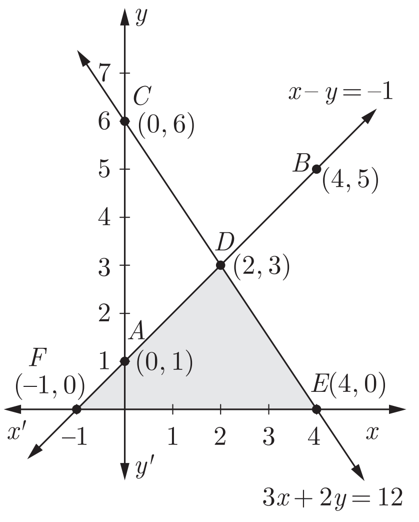
x	0	4	2
$y=x+1$	1	5	3

and $3x+2y-12=0$ ...(2)

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

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

c127



Clearly, the two lines intersect at point $D(2,3)$.

Hence, $x=2$ and $y=3$ is the solution of the given pair of equations. The line CD intersects the x-axis at the point $E(4,0)$ and the line AB intersects the x-axis at the points $F(-1,0)$. Hence, the co-ordinates of the vertices of the triangle are $D(2,3)$, $E(4,0)$ and $F(-1,0)$.

85. Solve the following pair of linear equations graphically:

$2x+3y=12$ and $x-y=1$

Find the area of the region bounded by the two lines representing the above equations and y-axis.

Ans : [Board Term-1 2012]

We have $2x+3y=12 \Rightarrow y=\frac{12-2x}{3}$

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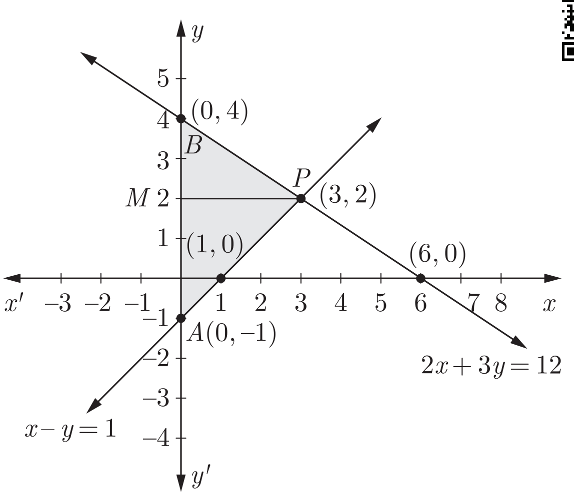
x	0	6	3
y	4	0	2

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

x	0	1	3
y	1	0	2

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



Clearly, the two lines intersect at point $p(3,2)$.

Hence, $x = 3$ and $y = 2$

Area of shaded triangle region,

$$\text{Area of } \Delta PAB = \frac{1}{2} \times \text{base} \times \text{height}$$

$$= \frac{1}{2} \times AB \times PM$$

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

$$= 7.5 \text{ square unit.}$$

86. Solve the following pair of linear equations graphically:
$x + 3y = 12,\ 2x - 3y = 12$
Also shade the region bounded by the line $2x - 3y = 2$ and both the co-ordinate axes.

Ans : [Board Term-1 2013, 2012]

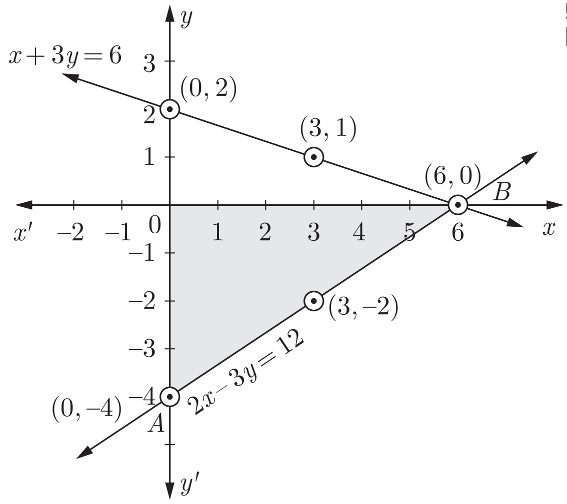
We have $x + 3y = 6 \Rightarrow y = \dfrac{6 - x}{3}$ ...(1)

x	3	6	0
y	1	0	2

and $2x - 3y = 12 \Rightarrow y = \dfrac{2x - 12}{3}$

x	0	6	3
y	-4	0	-2

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



The two lines intersect each other at point $B(6,0)$.

Hence, $x = 6$ and $y = 0$

Again ΔOAB is the region bounded by the line $2x - 3y = 12$ and both the co-ordinate axes.

87. Solve for x and y :

$$2x - y + 3 = 0$$

$$3x - 5y + 1 = 0$$

Ans : [Board Term-1 2015]

We have $2x - y + 3 = 0$ ...(1)

$3x - 5y + 1 = 0$ ...(2)

Multiplying equation (1) by 5,and subtracting (2) from it we have

$$7x = -14$$

$$x = \frac{-14}{7} = -2$$

Substituting the value of x in equation (1) we get

$$2x - y + 3 = 0$$

$$2(-2) - y + 3 = 0$$

$$-4 - y + 3 = 0$$

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$$-y-1=0$$

$$y=-1$$

Hence, $x=-2$ and $y=-1$.

88. Solve the following pair of linear equations graphically:
$x-y=1,\ 2x+y=8$
Also find the co-ordinates of the points where the lines represented by the above equation intersect $y-axis$.
Ans : [Board Term-1 Delhi 2012]

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

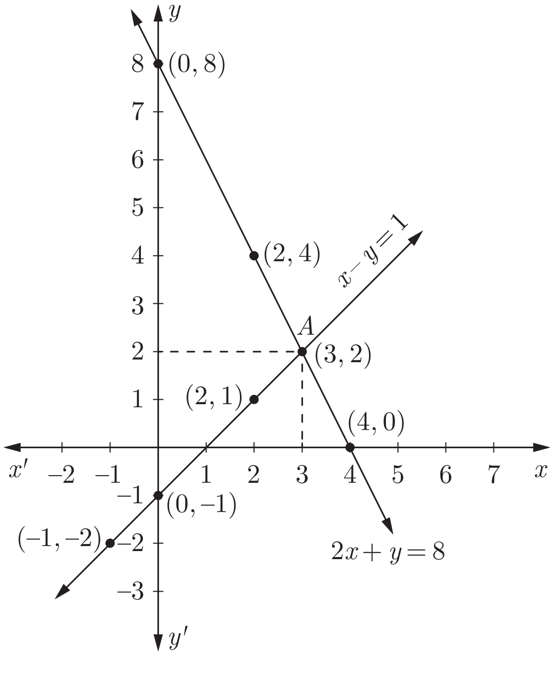
x	2	3	-1
y	1	2	-2

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

x	2	4	0
y	4	0	8

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

c130



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

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

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

89. Draw the graph of the following equations:

$$2x-y=1,\ x+2y=13$$

Find the solution of the equations from the graph and shade the triangular region formed by the lines and the y-axis.
Ans : [Board Term-1 OD 2012]

We have $2x-y=1 \Rightarrow y=2x-1$

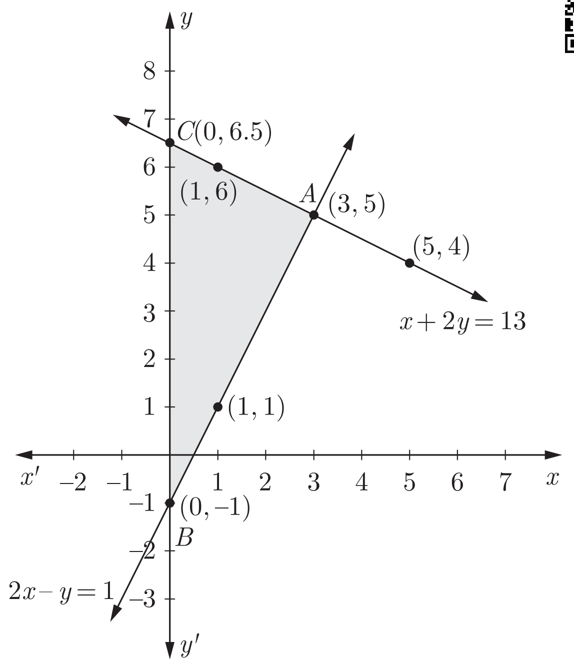
x	0	1	3
y	-1	1	5

and $x+2y=13 \Rightarrow y=\dfrac{13-x}{2}$

x	1	3	5
y	6	5	4

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

c131



Clearly two obtained lines intersect at point $A(3,5)$.

Hence, $x=3$ and $y=5$

ABC is the triangular shaded region formed by the obtained lines with the y-axis.

90. Solve the following pair of equations graphically:

$$2x+3y=12,\ x-y-1=0.$$

Shade the region between the two lines represented by the above equations and the X-axis.
Ans : [Board Term-1 2013]

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We have $2x+3y = 12 \Rightarrow y = \frac{12-2x}{3}$

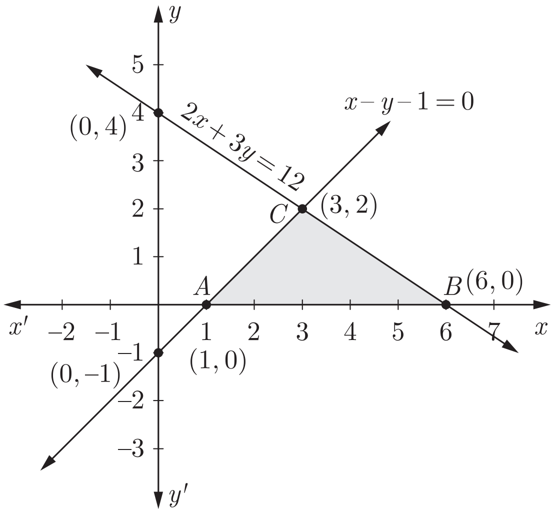
x	0	6	3
y	4	0	2

also $x-y = 1 \Rightarrow y = x-1$

x	0	1	3
y	-1	0	2

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

c132



The two lines intersect each other at point $(3,2)$,
Hence, $x = 3$ and $y = 2$.
ΔABC is the region between the two lines represented by the given equations and the X-axis.

91. Solve $x+y=5$ and $2x-3y=4$ by elimination method and the substitution method.

Ans : [Board Term-1 2015]

By Elimination Method :

We have, $x+y = 5$ ...(1)

and $2x-3y = 4$ ...(2)

Multiplying equation (1) by 3 and adding in (2) we have

$$3(x+y)+(2x-3y) = 3\times 5+4$$

or, $3x+3y+2x-3y = 15+4$

c155

$$5x = 19 \Rightarrow x = \frac{19}{5}$$

Substituting $x = \frac{19}{5}$ in equation (1),

$$\frac{19}{5}+y = 5$$

$$y = 5-\frac{19}{5} = \frac{25-19}{5} = \frac{6}{5}$$

Hence, $x = \frac{19}{5}$ and $y = \frac{6}{5}$

By Substituting Method :

We have, $x+y = 5$ ...(1)

and $2x-3y = 4$ ...(2)

From equation (1), $y = 5-x$ ...(3)

Substituting the value of y from equation (3) in equation (2),

$$2x-3(5-x) = 4$$

$$2x-15+3x = 4$$

$$5x = 19$$

$$x = \frac{19}{5}$$

Substituting this value of x in equation (3), we get

$$y = 5-\frac{19}{5} = \frac{6}{5}$$

Hence $x = \frac{19}{5}$ and $y = \frac{6}{5}$

92. Solve for x and y :

$$3x+4y = 10$$

$$2x-2y = 2$$

Ans : [Board Term-1 2015]

By Elimination Method :

We have, $3x+4y = 10$ ...(1)

and $2x-2y = 2$ ...(2)

Multiplying equation (2) by 2 and adding in (1),

$$(3x+4y)+2(2x-2y) = 10+2\times 2$$

or, $3x+4y+4x-4y = 10+4$

or, $7x = 14 \Rightarrow x = 2$

c156

Hence, $x = 2$ and $y = 1$.

By Substitution Method :

We have $3x+4y = 10$ ...(1)

and $2x-2y = 2$ ...(2)

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

or, $y = x-1$ ...(3)

Substituting this value of y in equation (1),

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$$3x+4(x-1) = 10$$

$$7x = 14 \Rightarrow x = 2$$

From equation (3), $y = 2-1=1$

Hence, $x = 2$ and $y=1$

93. Solve $3x-5y-4=0$ and $9x=2y+7$ by elimination method and the substitution method.

Ans : [Board Term-1 OD 2012]

By Elimination Method :

We have, $3x-5y = 4$ ...(1)

and $9x = 2y+7$ ...(2)

Multiplying equation (1) by 3 and rewriting equation (2) we have

$$9x-15y = 12 \qquad ...(3)$$

$$9x-2y = 7 \qquad ...(4)$$

Subtracting equation (4) from equation (3),

$$-13y = 5$$

$$y = -\frac{5}{13}$$

c157

Substituting value of y in equation (1),

$$3x-5\left(\frac{-5}{13}\right) = 4$$

$$3x = 4-\frac{25}{13}$$

$$x = \frac{27}{13\times 3} = \frac{9}{13}$$

Hence $x = \frac{9}{13}$ and $y=-\frac{5}{13}$

By Substituting Method :

We have $3x-5y = 4$ ...(1)

and $9x = 2y+7$ ...(2)

$$y = \frac{9x-7}{2} \qquad ...(3)$$

Substituting this value of y (3) in equation (1),

$$3x-5\times\left(\frac{9x-7}{2}\right) = 4$$

$$6x-45x+35 = 8$$

$$-39x = -27$$

$$x = \frac{9}{13}$$

Substituting $x=\frac{9}{13}$ in equation (3),

$$y = \frac{9\times\frac{9}{13}-7}{2} = \frac{81-91}{2\times 13}$$

$$= -\frac{10}{26} = -\frac{5}{13}$$

Hence, $x = \frac{9}{13}$ and $y=\frac{-5}{13}$

94. A train covered a certain distance at a uniform speed. If the train would have been 10 km/hr scheduled time. And, if the train were slower by 10 km/hr, it would have taken 3 hr more than the scheduled time. Find the distance covered by the train.

Ans : [Board Term-1 Delhi 2012]

Let the actual speed of the train be s and actual time taken t.

$$\text{Distance} = \text{Speed} \times \text{Time}$$

$$= st \text{ km}$$

c158

According to the given condition, we have

$$st = (s+10)(t-2)$$

$$st = st-2s+10t-20$$

$$2s-10t+20 = 0$$

$$s-5t = -10 \qquad (1)$$

and $st = (s-10)(t+3)$

$$st = st+3s-10t-30$$

$$3s-10t = 30 \qquad ...(2)$$

Multiplying equation (1) by 3 and subtracting equation (2) from equation (1),

$$3\times(s-5t)-(3s-10t) = -3\times 10-30$$

$$-5t = -60 \Rightarrow t = 12$$

Substituting value of t equation (1),

$$s-5\times 12 = -10$$

$$s = -10+60 = 50$$

Hence, the distance covered by the train

$$= 50\times 12 = 600 \text{ km.}$$

95. The ratio of incomes of two persons is 11:7 and the ratio of their expenditures is 9:5. If each of them manages to save Rs 400 per month, find their monthly incomes.

Ans : [Board Term-1 2012]

Let the incomes of two persons be $11x$ and $7x$.

Also the expenditures of two persons be $9y$ and $5y$.

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$$11x - 9y = 400 \quad ...(1)$$

and $$7x - 5y = 400 \quad ...(2)$$

Multiplying equation (1) by 5 and equation (2) by 9 we have

$$55x - 45y = 2000 \quad ...(3)$$

and $$63x - 45y = 3600 \quad ...(4)$$

Subtracting, above equation we have

$$-8x = -1600$$

or, $$x = \frac{-1,600}{-8} = 200$$

c159

Hence Their monthly incomes are $11 \times 200 =$ Rs 2200 and $7 \times 200 =$ Rs 1400.

96. A and B are two points 150 km apart on a highway. Two cars start A and B at the same time. If they move in the same direction they meet in 15 hours. But if they move in the opposite direction, they meet in 1 hours. Find their speeds.

Ans : [Board Term-1 2012]

Let the speed of the car I from A be x and speed of the car II from B be y.

Same Direction :

Distance covered by car I

$$= 150 + (\text{distance covered by car II})$$

$$15x = 150 + 15y$$

$$15x - 15y = 150$$

c160

$$x - y = 10 \quad ...(1)$$

Opposite Direction :

Distance covered by car I + distance covered by car II

$$= 150 \text{ km}$$

$$x + y = 150 \quad ...(2)$$

Adding equation (1) and (2), we have $x = 80$.

Substituting $x = 80$ in equation (1), we have $y = 70$.

Speed of the car I from $A = 80$ km/hr and speed of the car II from $B = 70$ km/hr.

97. If 2 is subtracted from the numerator and 1 is added to the denominator, a fraction becomes $\frac{1}{2}$, but when 4 is added to the numerator and 3 is subtracted from the denominator, it becomes $\frac{3}{2}$. Find the fraction.

Ans : [Board Term-1 2012]

Let the fraction be $\frac{x}{y}$ then we have

c161

$$\frac{x-2}{y+1} = \frac{1}{2}$$

$$2x - 4 = y + 1$$

$$2x - y = 5 \quad ...(1)1$$

Also, $$\frac{x+4}{y-3} = \frac{3}{2}$$

$$2x + 8 = 3y - 9]$$

$$2x - 3y = -17 \quad ...(2)\ 1$$

Subtracting equation (2) from equation (1),

$$2y = 22 \Rightarrow y = 11$$

Substituting this value of y in equation (1) we have,

$$2x - 11 = 5$$

$$x = 8$$

Hence, $$\text{Fraction} = \frac{8}{11}$$

98. If a bag containing red and white balls, half the number of white balls is equal to one-third the number of red balls. Thrice the total number of balls exceeds seven times the number of white balls by 6. How many balls of each colour does the bag contain ?

Ans : [Board Term-1 2012]

Let the number of red balls be x and white balls be y. According to the question,

$$\frac{y}{2} = \frac{1}{3}x \text{ or } 2x - 3y = 0 \quad ...(1)$$

and $$3(x + y) - 7y = 6$$

or $$3x - 4y = 6 \quad ...(2)$$

Multiplying equation (1) by 3 and equation (2) by we have

$$6x - 9y = 0 \quad ...(3)$$

$$6x - 8y = 12 \quad ...(4)$$

Subtracting equation (3) from (4) we have

$$y = 12$$

c162

Substituting $y = 12$ in equation (1),

$$2x - 36 = 0$$

$$x = 18$$

Hence, number of red balls = 18

and number of white balls = 12

99. A two digit number is obtained by either multiplying the sum of digits by 8 and then subtracting 5 or by multiplying the difference of digits by 16 and adding

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3. Find the number.

Ans : [Board Term-1 2012]

Let the digits of number be x and y, then number will $10x+y$.

According to the question, we have

$$8(x+y)-5 = 10x+y$$

$$2x-7y+5 = 0 \quad ...(1)$$

also $$16(x-y)+3 = 10x+y$$

$$6x-17y+3 = 0 \quad ...(2)$$

Comparing the equation with $ax+by+c=0$ we get

$$a_1 = 2, b_1 = -1, c_1 = 5$$

$$a_2 = 6, b_2 = -17, c_2 = 3$$

Now $$\frac{x}{b_2c_1-b_1c_2} = \frac{y}{c_1a_2-c_2a_1} = \frac{1}{c_1b_2-a_2b_1}$$

$$\frac{x}{(-7)(3)-(-17)(5)} = \frac{y}{(5)(6)-(2)(3)}$$

$$= \frac{1}{(2)(-17)-(6)(-7)}$$

c163

$$\frac{x}{-21+85} = \frac{y}{30-6} = \frac{1}{-34+42}$$

$$\frac{x}{64} = \frac{y}{24} = \frac{1}{8}$$

$$\frac{x}{8} = \frac{y}{3} = 1$$

Hence, $$x = 8, y = 3$$

So required number$=10\times 8+3=83$.

100. The area of a rectangle gets reduced by 9 square units, if its length is reduced by 5 units and the breadth is increased by 3 units. The area is increased by 67 square units if length is increased by 3 units and breadth is increased by 2 units. Find the perimeter of the rectangle.

Ans : [Board Term-1 Delhi 2012]

Let length of given rectangle be x and breadth be y, then area of rectangle will be xy.

According to the first condition we have

$$(x-5)(y+3) = xy-9$$

or, $$3x-5y = 6 \quad ...(1)$$

According to the second condition, we have

$$(x+3)(y+2) = xy-67$$

or, $$2x+5y = 61 \quad ...(2)$$

Multiplying equation (1) by 3 and equation (2) by 5 and then adding,

$$9x-15y = 18$$

$$10x+15y = 305$$

c164

$$x = \frac{323}{19} = 17$$

Substituting this value of x in equation (1),

$$3(17)-5y = 6$$

$$5y = 51-6$$

$$y = 9$$

Hence, perimeter $=2(x+y)=2(17+9)=52$ units.

101. Solve for x and y : $2(3x-y)=5xy, 2(x+3y)=5xy$.

Ans : [Board Term-1 OD 2012]

We have $$2(3x-y) = 5xy \quad ...(1)$$

$$2(x+3y) = 5xy \quad ...(2)$$

Divide equation (1) and (2) by xy,

$$\frac{6}{y}-\frac{2}{x} = 5 \quad ...(3)$$

and $$\frac{2}{y}+\frac{6}{x} = 5 \quad ...(4)$$

Let $\frac{1}{y}=a$ and $\frac{1}{x}=b$, then equations (3) and (4) become

$$6a-2b = 5 \quad ...(5)$$

$$2a+6b = 5 \quad ...(6)$$

Multiplying equation (5) by 3 and then adding with equation (6),

$$20a = 20$$

$$a = 1$$

c165

Substituting this value of a in equation (5),

$$b = \frac{1}{2}$$

Now $$\frac{1}{y} = a = 1 \Rightarrow y = 1$$

and $$\frac{1}{x} = b = \frac{1}{2} \Rightarrow x = 2$$

Hence, $x=2, y=1$

102. The students of a class are made to stand in rows. If 3 students are extra in a row, there would be 1 row less. If 3 students are less in a row, there would be 2

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rows more. Find the number of students in the class.

Ans : [Board Term-1 2012]

Let the number of students in a row be x and the number of rows be y. Thus total will be xy.

Now $$(x+3)(y-1) = xy$$

$$xy+3y-x-3 = xy$$

$$-x+3y-3 = 0 \quad ...(1)$$

and $$(x-3)(y+2) = xy$$

$$xy-3y+2x-6 = xy$$

$$2x-3y-6 = 0 \quad ...(2)$$

Multiply equation (1) 2 we have

$$-2x+6y-6 = 0 \quad ...(3)$$

Adding equation (2) and (3) we have

$$3y-12 = 0$$

$$y = 4$$

c167

Substitute $y = 4$ in equation (1)

$$-x+12-3 = 0$$

$$x = 9$$

Total students $xy = 9 \times 4 = 36$

Total students in the class is 36.

103. The ages of two friends ani and Biju differ by 3 years. Ani's father Dharam is twice as old as ani and Biju is twice as old as his sister Cathy. The ages of Cathy and Dharam differ by 30 year. Find the ages of Ani and Biju.

Ans : [Board Term-1 2012]

Let the ages of Ani and Biju be x and y, respectively.
According to the given condition,

$$x-y = \pm 3 \quad ...(1)$$

Also, age of Ani's father Dharam $= 2x$ years

And age of Biju's sister $= \frac{y}{2}$ years

c168

According to the given condition,

$$2x-\frac{y}{2} = 30$$

$$4x-y = 60 \quad ...(2)$$

Case I : When $x-y = 3 \quad ...(3)$

Subtracting equation (3) from equation (2),

$$3x = 57$$

$$x = 19 \text{ years}$$

Putting $x=19$ in equation (3),

$$19-y = 3$$

$$y = 16 \text{ years}$$

Case II : When $x-y = -3 \quad ...(4)$

Subtracting equation (iv) from equation (2),

$$3x = 60+3$$

$$3x = 63$$

$$x = 21 \text{ years}$$

Subtracting equation (4), we get

$$21-y = -3$$

$$y = 24 \text{ years}$$

Hence, Ani's age = 19 years or 21 years Biju age = 16 years or 24 years.

104. One says, "Give me a hundred, friend! I shall then become twice as rich as you." The other replies, "If you give me ten, I shall be six times as rich as you." Tell me what is the amount of their (respective) capital.

Ans : [Board Term-1 2012]

Let the amount of their respective capitals be x and y.
According to the given condition,

$$x+100 = 2(y-100)$$

$$x-2y = -300 \quad ...(1)$$

and $$6(x-10) = y+10$$

$$6x-y = 70 \quad ...(2)$$

Multiplying equation (2) by 2 we have

$$12x-2y = 140 \quad ...(3)$$

Subtracting (1) from equation (3) we have

$$11x = 440$$

$$x = 40$$

c169

Substituting $x=40$ in equation (1),

$$40-2y = -300$$

or, $$2y = 340$$

$$y = 170$$

Hence, the amount of their respective capitals are 40

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and 170.

105. A fraction become $\frac{9}{11}$ if 2 is added to both numerator and denominator. If 3 is added to both numerator and denominator it becomes $\frac{5}{6}$. Find the fraction.

Ans : [Board Term-1 2012]

Let the fraction be $\frac{x}{y}$, then according to the question,

$$\frac{x+2}{y+2} = \frac{9}{11}$$

c170

$$11x + 22 = 9y + 18$$

or, $$11x - 9y + 4 = 0 \quad ...(1)$$

and $$\frac{x+3}{y+3} = \frac{5}{6}$$

or, $$6x - 5y + 3 = 0 \quad ...(2)$$

Comparing with $ax + by + c = 0$

we get $$a_1 = 11, b_1 = 9, c_1 = 4,$$

$$a_2 = 6, b_2 = -5, \text{ and } c_2 = 3$$

Now, $$\frac{x}{b_2c_1 - b_1c_2} = \frac{y}{c_1a_2 - c_2a_1} = \frac{1}{a_1b_2 - b_2b_1}$$

$$\frac{x}{(-9)(3)-(-5)(4)} = \frac{y}{(4)(6)-(11)(3)}$$

$$= \frac{1}{(11)(-5)-(9)(-9)}$$

or, $$\frac{x}{-27+20} = \frac{y}{24-33} = \frac{1}{-55+54}$$

$$\frac{x}{-7} = \frac{y}{-9} = \frac{1}{-1}$$

Hence, $x = 7, y = 9$

Thus fraction is $\frac{7}{9}$.

106. A motor boat can travel 30 km upstream and 28 km downstream in 7 hours. It can travel 21 km upstream and return in 5 hours. Find the speed of the boat in still water and the speed of the stream.

Ans : [Board Term-1 2012]

Let the speed of the boat in still water be x km/hr and speed of the stream be y km/hr.

Speed of boat up stream $= (x - y)$ km/hr.

Speed of boat down stream $= (x + y)$ km/hr.

$$\frac{30}{x-y} + \frac{28}{x+y} = 7$$

and $$\frac{21}{x-y} + \frac{21}{x+y} = 5$$

c171

Let $\frac{1}{x-y}$ be a and $\frac{1}{x+y}$ be b, then we have

$$30a + 28b = 7 \quad ...(1)$$

$$21a + 21b = 5 \quad ...(2)$$

Multiplying equation (1) by 3 and equation (2) by 4 we have

$$90a + 84b = 21 \quad ...(3)$$

$$84a + 84b = 20 \quad ...(4)$$

Subtracting (4) from (3) we have,

$$6a = 1$$

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

Putting this value of a in equation (1),

$$30 \times \frac{1}{6} + 28b = 7$$

$$28b = 7 - 30 \times \frac{1}{6} = 2$$

$$b = \frac{1}{14}$$

Thus $$x + y = 14 \quad ...(5)$$

Now, $$a = \frac{1}{x-y} = \frac{1}{6}$$

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

and $$x + y = 14$$

Solving equation (5) and (6), we get

$$x = 10, y = 4$$

Hence, speed of the boat in still water = 10km/hr

and speed of the stream = 4 km/hr.

107. A boat covers 32 km upstream and 36 km downstream in 7 hours. Also, it covers 40 km upstream and 48 km downstream in 9 hours. Find the speed of the boat in still water and that of the stream.

Ans : [Board Term-1 2012]

Let the speed of the boat be x km/hr and the speed of the stream be y km/hr.

According to the question,

$$\frac{32}{x-y} + \frac{36}{x+y} = 7$$

c172

and $$\frac{40}{x-y} + \frac{48}{x+y} = 9$$

Let $\frac{1}{x-y} = A, \frac{1}{x+y} = B$, then we have

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$$32A + 36B = 7 \qquad ...(1)$$

and $$40A + 48B = 9 \qquad ...(2)$$

Multiplying equation (1) by 5 and (2) by 4, we have

$$160A + 180B = 35 \qquad ...(3)$$

and $$160A + 192B = 36 \qquad ...(4$$

Subtracting (4) from (3) we have

$$-12B = -1$$

$$B = \frac{1}{12}$$

Substituting the value of B in (2) we get

$$40A + 48\left(\frac{1}{12}\right) = 9$$

$$40A + 4 = 9$$

$$40A = 5$$

$$A = \frac{1}{8}$$

Thus $A = \frac{1}{8}$ and $B = \frac{1}{12}$

Hence $$A = \frac{1}{8} = \frac{1}{x-y}$$

$$x - y = 8 \qquad ...(5)$$

and $$B = \frac{1}{12} = \frac{1}{x+y}$$

$$x + y = 12 \qquad ...(6)$$

Adding equations (5) and (6) we have,

$$2x = 20$$

$$x = 10$$

Substituting this value of x in equation (1),

$$y = x - 8 = 10 - 8 = 2$$

Hence, the speed of the boat in still water = 10 km/hr and speed of the stream = 2 km/hr.

108. For what values of a and b does the following pair of linear equations have infinite number of solution ?

$2x + 3y = 7, a(x+y) - b(x-y) = 3a + b - 2$

Ans : [Board Term-1 2015]

We have $$2x + 3y - 7 = 0$$

Here $a_1 = 2, b_1 = 3, c_1 = -7$

and $$a(x+y) - b(x-y) = 3a + b - 2$$

$$ax + ay - bx + by = 3a + b - 2$$

$$(a-b)x + (a+b)y - (3a+b-2) = 0$$

Here $a_2 = a - b, b_2 = a + b, c_2 = -(3a + b - 2)$

For infinite many solutions

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

$$\frac{2}{a-b} = \frac{3}{a+b} = \frac{-7}{(3a+b-2)}$$

From $\frac{2}{a-b} = \frac{7}{3a+b-2}$ we have

c173

$$2(3a+b-2) = 7(a-b)$$

$$6a + 2b - 4 = 7a - 7b$$

$$a - 9b = -4 \qquad ...(1)$$

From $\frac{3}{a+b} = \frac{7}{3a+b-2}$ we have

$$3(3a+b-2) = 7(a+b)$$

$$9a + 3b - 6 = 7a + 7b$$

$$2a - 4b = 6$$

$$a - 2b = 3 \qquad ...(2)$$

Subtracting equation (1) from (2),

$$-7b = -7$$

$$b = 1$$

Substituting the value of b in equation (1),

$$a = 5$$

Hence, $a = 5, b = 1$.

109. At a certain time in a deer, the number of heads and the number of legs of deer and human visitors were counted and it was found that there were 39 heads and 132 legs.

Find the number of deer and human visitors in the park.

Ans : [Board Term-1 2015]

Let the no. of deer be x and no. of human be y.
According to the question,

$$x + y = 39 \qquad ...(1)$$

and $$4x + 2y = 132 \qquad ...(2)$$

Multiply equation (1) from by 2,

$$2x + 2y = 78 \qquad ...(3)$$

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Subtract equation (3) from (2),

$$2x = 54$$

$$x = 27$$

Substituting this value of x in equation (1)

$$27 + y = 39$$

$$y = 12$$

So, No. of deer $= 27$ and No. of human $= 12$

110. Find the value of p and q for which the system of equations represent coincident lines $2x + 3y = 7$, $(p + q + 1)x + (p + 2q + 2)y = 4(p + q) + 1$

Ans : [Board Term-1 Delhi 2012]

We have $2x + 3y = 7$

$$(p + q + 1)x + (p + 2q + 2)y = 4(p + q) + 1$$

Comparing given equation to $ab + by + c = 0$ we have

$a_1 = 2, b_1 = 3, c_1 = -7$

$a_2 = p + q + 1, b_2 = p + 2q + 2, c_2 = -4(p + q) - 1$

For coincident lines,

$$\frac{a_1}{a_2} = \frac{b_1}{b_2} = \frac{c_1}{c_2}$$

$$\frac{2}{p + q + 1} = \frac{3}{p + 2q + 2} = \frac{7}{4(p + q) + 1}$$

From $\frac{3}{p + 2q + 2} = \frac{7}{4(p + q) + 1}$ we have

$$7p + 14q + 14 = 12p + 12q + 3$$

$$5p - 2q - 11 = 0 \qquad ...(1)$$

From $\frac{2}{p + q + 1} = \frac{7}{4(p + q) + 1}$ we have

$$8(p + q) + 2 = 7p + 7q + 7$$

$$8p + 8q + 2 = 7p + 7q + 7$$

$$p + q - 5 = 0 \qquad ...(2)$$

Multiplying equation (2) by 5 we have

$$5p + 5q - 25 = 0 \qquad ...(3)$$

Subtracting equation (1) from (3) we get

$$7q = 14$$

$$q = 2$$

Hence, $p = 3$ and $q = 2$.

111. The length of the sides of a triangle are $2x + \frac{y}{2}$, $\frac{5x}{3} + y + \frac{1}{2}$ and $\frac{2}{3}x + 2y + \frac{5}{2}$. If the triangle is equilateral , find its perimeter.

Ans : [Board Term-1 2012]

For an equilateral Δ,

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

Now $$\frac{4x + y}{2} = \frac{10x + 6y + 3}{6}$$

$$12x + 3y = 10x + 6y + 3$$

$$2x - 3y = 3 \qquad ...(1)$$

Again, $$2x + \frac{y}{2} = \frac{2}{3}x + 2y + \frac{5}{2}$$

$$\frac{4x + y}{2} = \frac{4x + 12y + 15}{6}$$

$$12x + 3y = 4x + 12y + 15$$

$$8x - 9y = 15 \qquad ...(2)$$

Multiplying equation (1) by 3 we have

$$6x - 9y = 9 \qquad ...(1)$$

Subtracting it from (2) we get

$$2x = 6 \Rightarrow x = 3$$

Substituting this value of x into (1), we get

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

or, $$3y = 3 \Rightarrow y = 1$$

Now substituting these value of x and y

$$2x + \frac{y}{2} = 2 \times 3 + \frac{1}{2} = 6.5$$

The perimeter of equilateral triangle $=$ side $\times 3$

$$= 6.5 \times 3 = 19.5 \text{ cm}$$

Hence, the perimeter of $\Delta = 19.5$ m

112. When 6 boys were admitted and 6 girls left, the percentage of boys increased from 60% to 75%. Find the original no. of boys and girls in the class.

Ans : [Board Term-1 2015]

Let the no. of boys be x and no. of girls be y.

No. of students $= x + y$

Now $$\frac{x}{x + y} = \frac{60}{100} \qquad ...(1)$$

and $$\frac{x + 6}{(x + 6) + (y - 6)} = \frac{75}{100} \qquad ...(2)$$

From (1), we have

$$100x = 60x + 60y$$

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$$40x - 60y = 0$$

$$2x - 3y = 0$$

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

From (2) we have

$$100x + 600 = 75x + 75y$$

$$25x - 75y = -600$$

$$x - 3y = -24 \quad ...(4)$$

Substituting the value of $3y$ from (3) in to (4) we have,

$$x - 2x = -24 \Rightarrow x = 24$$

$$3y = 24 \times 2$$

$$y = 16$$

Hence, no. of boys is 24 and no. of girls is 16.

113. A cyclist, after riding a certain distance, stopped for half an hour to repair his bicycle, after which he completes the whole journey of 30 km at half speed in 5 hours. If the breakdown had occurred 10 km farther off, he would have done the whole journey in 4 hours. Find where the breakdown occurred and his original speed.

Ans : [Board Term-1 2013]

Let x be the distance of the place where breakdown occurred and y be the original speed,

c181

$$\frac{x}{y} + \frac{30 - x}{\frac{y}{2}} = 5$$

or
$$\frac{x}{y} + \frac{60 - 2x}{y} = 5$$

$$x + 60 - 2x = 5y$$

$$x + 5y = 60 \quad ...(1)$$

and
$$\frac{x + 10}{y} + \frac{30 - (x + 10)}{\frac{y}{2}} = 4$$

$$\frac{x + 10}{y} + \frac{60 - 2(x + 10)}{y} = 4$$

$$x + 10 + 60 - 2x - 20 = 4y$$

$$-x + 50 = 4y$$

$$x + 4y = 50 \quad (2)$$

Subtract equation (2) from (1), $y = 10$ km/hr.

Now from (2), $x + 40 = 50 \Rightarrow x = 10$ km

Break down occurred at 10 km and original speed was 10 km/hr.

114. The population of a village is 5000. If in a year, the number of males were to increase by 5% and that of a female by 3% annually, the population would grow to 5202 at the end of the year. Find the number of males and females in the village.

Ans : [Board Term-1 2012]

Let the number of males be x and females be y

Now $x + y = 5,000 \quad ...(1)$

and
$$x + \frac{5}{100}x + y + \frac{3y}{100} = 5202$$

c182

$$\frac{5x + 3y}{100} + 5000 = 5202$$

$$5x + 3y = (5202 - 5000) \times 100$$

$$5x + 3y = 20200 \quad (2)$$

Multiply (1) by 3 we have

$$3x + 3y = 15,000 \quad ...(3)$$

Subtracting (2) from (3) we have

$$2x = 5200 \Rightarrow x = 2600$$

Substituting value of x in (1) we have

$$2600 - y = 5000 \Rightarrow y = 2400$$

Thus no. of males is 2600 and no. of females is 2400.

CASE STUDY QUESTIONS

115. Due to ongoing Corona virus outbreak, Wellness Medical store has started selling masks of decent quality. The store is selling two types of masks currently type A and type B.

The cost of type A mask is Rs. 15 and of type B mask is Rs. 20. In the month of April, 2020, the store sold 100 masks for total sales of Rs. 1650.

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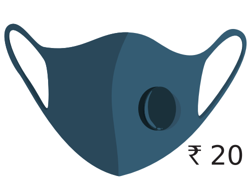

(i) How many masks of each type were sold in the month of April?

(a) 40 masks of type A, and 60 masks of type B

(b) 60 masks of type A, and 40 masks of type B

(c) 70 masks of type A, and 30 masks of type B

(d) 30 masks of type A, and 70 masks of type B

(ii) If the store had sold 50 masks of each type, what would be its sales in the month of April?

(a) Rs 550

(b) Rs 560

(c) Rs 1050

(d) Rs 1750

c401

(iii) Due to great demand and short supply, the store has increased the price of each type by Rs. 5 from May 1, 2020. In the month of May, 2020, the store sold 310 masks for total sales of Rs. 6875. How many masks of each type were sold in the month of May?

(a) 175 masks of type A, and 135 masks of type B

(b) 200 masks of type A, and 110 masks of type B

(c) 110 masks of type A, and 200 masks of type B

(d) 135 masks of type A, and 175 masks of type B

(iv) What percent of masks of each type sale was increased in the month of May, compared with the sale of month April?

(a) 110 % in type A and 180 % in type B

(b) 180 % in type A and 110 % in type B

(c) 350 % in type A and 150 % in type B

(d) 150 % in type A and 350 % in type B

(v) What extra profit did store earn by increasing price in May month.

(a) Rs 1550 (b) Rs 3100

(c) Rs 1650 (d) Rs 1825

Ans :

(i) Let x be the mask of type A sold and y be the type of mask B sold in April.

Now $\quad x+y = 100 \quad$ ...(1)

and $\quad 15x+20y = 1650 \quad$ ...(2)

Multiplying equation (1) by 15 and subtracting from (2) we obtain,

$$5y = 150 \Rightarrow y = 30$$

$$x = 100 - 30 = 70$$

Hence 70 masks of type A, and 30 masks of type B were sold.

Thus (c) is correct option.

(ii) $\quad$ Total Sales $= 50 \times 15 + 50 \times 20 = 1750$

Thus (d) is correct option.

(iii) Let x be the mask of type A sold and y be the type of mask B sold in April.

Now, $\quad x+y = 310 \quad$ ...(1)

and $\quad 20x+25y = 6875 \quad$ ...(ii)

Multiplying equation (1) by 20 and subtracting it from equation (2), we obtain

$$5y = 675 \Rightarrow y = 135$$

$$x = 310 - 135 = 175$$

Thus (a) is correct option.

(iv)Increase in type A $= \dfrac{175-70}{70} \times 100 = 150\,\%$

Increase in type B $= \dfrac{105-30}{30} \times 100 = 350\,\%$

Thus (d) is correct option.

(v) Total sale value in May at old price

$$= 175 \times 15 + 135 \times 20 = 5325$$

Total sale value in May at new price

$$= 6875$$

Extra Profit $= 6875 - 5325 = 1550$

Alternative :

Since extra profit is Rs 5 on per mask and total mask sold are 310, thus extra profit $= 310 \times 5 = 1550$.

Thus (a) is correct option.

116. An architect is a skilled professional who plans and designs buildings and generally plays a key role in their construction. Architects are highly trained in the art and science of building design. Since they bear responsibility for the safety of their buildings'

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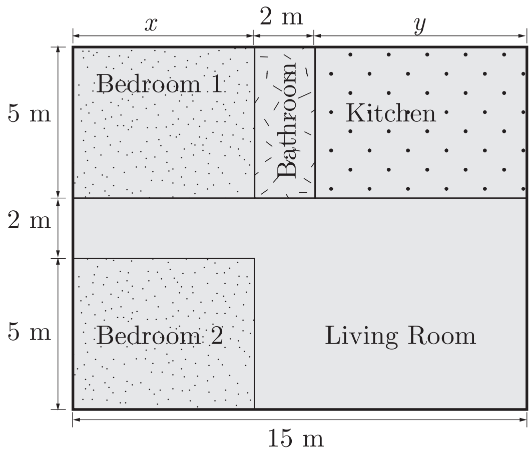
occupants, architects must be professionally licensed.

Varsha is a licensed architect and design very innovative house. She has made a house layout for her client which is given below. In the layout, the design and measurements has been made such that area of two bedrooms and kitchen together is 95 sq. m.



(i) Which pair of linear equations does describe this situation ?
   (a) $2x+y=19$ and $x+y=13$
   (b) $x+2y=19$ and $2x+y=13$
   (c) $2x+y=38$ and $x+y=13$
   (d) $2x+y=38$ and $2x+y=13$

c402

(ii) What is the length of the outer boundary of the layout.
   (a) 24 m   (b) 48 m
   (c) 27 m   (d) 54 m

(iii) What is the area of bedroom 1 ?
   (a) 24 m^2 (b) 30 m^2
   (c) 28 m^2 (d) 24 m^2

(iv) What is the area of living room in the layout ?
   (a) 54 m^2 (b) 48 m^2
   (c) 75 m^2 (d) 24 m^2

(v) What is the cost of laying tiles in Kitchen at the rate of Rs. 50 per sq. m ?
   (a) Rs. 1500   (b) Rs. 2000
   (c) Rs. 1750   (d) Rs. 3000

Ans :

(i) Area of two bedrooms $= 5x+5x = 10x$ m^2

Area of kitchen $= 5y$ m^2

Thus $10x+5y=95 \Rightarrow 2x+y=19$

Also from figure, we have,

$x+2+y=15 \Rightarrow x+y=13$

Thus (a) is correct option.

(ii) Length of outer boundary

$$= 2(5+2+5+15) = 54 \text{ m}$$

Thus (d) is correct option.

(iii) Solving and $2x+y=19$ and $x+y=13$ we get $x=6$ m and $y=7$ m.

Area of bedroom $= 5\times 6 = 30$ sq. m

Area of kitchen $= 5\times 7 = 35$ sq. m

Thus (b) is correct option.

(iv) Area of living room

$$= (15\times 7) - 30 = 105 - 30 = 75 \text{ m}^2$$

Thus (c) is correct option.

(v) Area of kitchen $= 7\times 5 = 35$ sq m

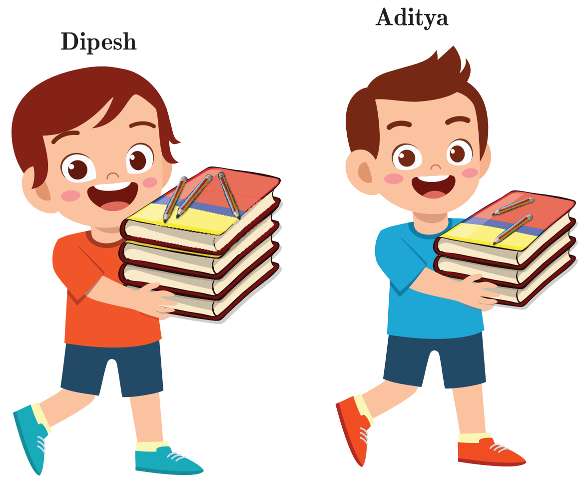
Cost of laying tiles in kitchen = Rs. 50 per m^2

Total cost of laying tiles in kitchen

$$= 50\times 35 = 1750 \text{ Rs}$$

Thus (c) is correct option.

117. Dipesh bought 3 notebooks and 2 pens for Rs. 80. His friend Ramesh said that price of each notebook could be Rs. 25. Then three notebooks would cost Rs.75, the two pens would cost Rs. 5 and each pen could be for Rs. 2.50. Another friend Amar felt that Rs. 2.50 for one pen was too little. It should be at least Rs. 16. Then the price of each notebook would also be Rs.16.



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Aditya also bought the same types of notebooks and pens as Dipesh. He paid 110 for 4 notebooks and 3 pens.

(i) Whether the estimation of Ramesh and Amar is applicable for Aditya?
(a) Ramesh's estimation is wrong but Amar's estimation is correct.
(b) Ramesh's estimation is correct but Amar's estimation is wrong.
(c) Both estimation are correct.
(b) Ramesh's estimation is wrong but Amar's estimation is also wrong.

(ii) Let the cost of one notebook be x and that of pen be y. Which of the following set describe the given problem ?
(a) $2x+3y=80$ and $3x+4y=110$
(b) $3x+2y=80$ and $4x+3y=110$
(c) $2x+3y=80$ and $4x+3y=110$
(d) $3x+2y=80$ and $3x+4y=110$

(iii) What is the exact cost of the notebook?
(a) Rs 10
(b) Rs 20
(c) Rs 16
(d) Rs 24

c403

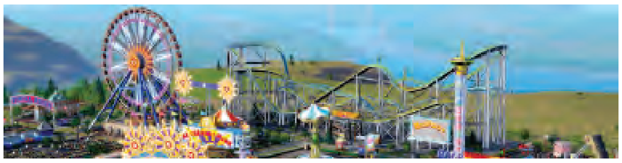
(iv) What is the exact cost of the pen?
(a) Rs 10 (b) Rs 20
(c) Rs 16 (d) Rs 24

(v) What is the total cost if they purchase the same type of 15 notebooks and 12 pens.
(a) Rs 410 (b) Rs 200
(c) Rs 420 (d) Rs 240

Ans :

(i) Consider the prices mentioned by Ramesh.
If the price of one notebook is Rs. 25 and the price of one pen is Rs. 2.50 then,
The cost of 4 notebooks would be : $4\times25=100$ Rs
And the cost for 3 pens would be : $3\times2.5=7.5$ Rs
Aditya should have paid $100+7.5=107.5$ Rs.
But he paid Rs. 110, thus Ramesh's estimation is wrong.
Now, consider the prices mentioned by Amar.
The cost of 4 notebooks, if one is for Rs.16, would be : $4\times16=64$ Rs
And the cost for 3 pens, if one is for Rs. 16, would be : $3\times16=64$ Rs
Aditya should have paid $64+48=112$ Rs but this is more than the price he paid.
Therefore, Amar's estimation is also wrong.
Thus (d) is correct option.
(ii) According to the statement, we have
$3x+2y=80$ and $4x+3y=110$
Thus (b) is correct option.
(iii) Solving $3x+2y=80$ and $4x+3y=110$ we get
$x=20$ and $y=10$
Thus cost of 1 notebook is 20 Rs and cost of 1 pen is 10 Rs
Thus (b) is correct option.
(iv) Cost of 1 pen = Rs. 10
Thus (a) is correct option.
(v) Total cost $15\times20+12\times10=420$ Rs
Thus (c) is correct option.

118. Mr. RK Agrawal is owner of a famous amusement park in Delhi. The ticket charge for the park is Rs 150 for children and Rs 400 for adult.



Generally he does not go to park and it is managed by team of staff. One day Mr Agrawal decided to random check the park and went there. When he checked the cash counter, he found that 480 tickets were sold and Rs 134500 was collected.

(i) Let the number of children visited be x and the number of adults visited be y. Which of the following is the correct system of equations that model the problem ?
(a) $x+y=480$ and $3x+8y=2690$
(b) $x+2y=480$ and $3x+4y=2690$
(c) $x+y=480$ and $3x+4y=2690$
(d) $x+2y=480$ and $3x+8y=2690$

(ii) How many children visited the park ?
(a) 250
(b) 500
(c) 230
(d) 460

c404

(iii) How many adults visited the park?
(a) 250 (b) 500
(c) 230 (d) 460

(iv) How much amount collected if 300 children and 350 adults visited the park?
(a) Rs 225400 (b) Rs 154000

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(c) Rs 112500 (d) Rs 185000

(v) One day total visited children and adults together is 750 and the total amount collected is Rs 212500. What are the number of children and adults visited the park ?

(a) (700, 800) (b) (350, 400)

(c) (800, 700) (d) (400, 350)

Ans :

(i) Since 480 people visited, we obtain $x + y = 480$.

Collected amount is Rs 134500 thus

$150x + 400y = 134500 \Rightarrow 3x + 8y = 2690$

Thus (a) is correct option.

(ii) Solving the equations $x + y = 480$ and $3x + 8y = 2690$ we get $x = 230$ and $y = 250$

Number of children attended = 230

Number of adults attended = 250

Thus (c) is correct option.

(iii) Number of adults visited the park = 250

Thus (a) is correct option.

a. (iv) Amount $= 150 \times 300 + 400 \times 350 = 185000$ Rs

Thus (d) is correct option.

(v) Solving the equations $x + y = 750$ and $150x + 400y = 212500 \Rightarrow 3x + 8y = 4250$ we have $x = 350$ and $y = 400$

i.e Number of children = 350

Number of adults = 400.

Thus (b) is correct option.

119. Jodhpur is the second-largest city in the Indian state of Rajasthan and officially the second metropolitan city of the state. Jodhpur was historically the capital of the Kingdom of Marwar, which is now part of Rajasthan. Jodhpur is a popular tourist destination, featuring many palaces, forts, and temples, set in the stark landscape of the Thar Desert. It is popularly known as the "Blue City" among people of Rajasthan and all over India. The old city circles the Mehrangarh Fort and is bounded by a wall with several gates. The city has expanded greatly outside the wall, though, over the past several decades. Jodhpur is also known for the rare breed of horses known as Marwari or Malani, which are only found here.

Last year we visited Jodhpur in a group of 25 friends. When we went mehrangarh fort we found following fare for ride :

Ride	Normal Hours Fare	Peak Hours Fare
Horse	Rs 50	3 Times
Elephant	Rs 100	2 Times

Some people choose to ride on horse and rest choose to ride on elephant.

(i) First day we rode in normal hours and we paid Rs 1950 for ride. Let x be the number of horses hired and y be the number elephants hired. Which of the following is the correct system of equation that model the problem ?

(a) $2x + y = 25$ and $2x + y = 49$

(b) $2x + y = 25$ and $2x + y = 39$

(c) $x + y = 25$ and $x + 2y = 39$

(d) $x + y = 25$ and $x + 2y = 49$

c405

(ii) How many horses were hired ?

(a) 9 (b) 14

(c) 16 (d) 11

(iii) How many elephant were hired ?

(a) 9 (b) 14

(c) 16 (d) 11

(iv) Next day we rode in peak hours, then how much total fare was paid by our group?

(a) Rs 2250 (b) Rs 2650

(c) Rs 4450 (d) Rs 3250

(v) What was the increase in total fare because of peak hours ride ?

(a) Rs 2500 (b) Rs 2550

(c) Rs 2200 (d) Rs 1550

Ans :

(i) Let x be the number of horses hired and y be the number of elephant hired, then we have $x + y = 25$ and $50x + 100y = 1950 \Rightarrow x + 2y = 39$

Thus (c) is correct option.

(ii) Solving equations $x + y = 25$ and $x + 2y = 39$ we get $x = 11$ and $y = 14$.

Number of horses hired = 11

Thus (d) is correct option.

(iii) Number of elephant hired = 14.

Thus (b) is correct option.

(iv) For horse riding fare $= 3 \times 50 \times 11 = 1650$ Rs.

For elephant ride fare $= 2 \times 100 \times 14 = 2800$ Rs

Total fare $= 1650 + 2800 = 4450$ Rs

Thus (c) is correct option.

(v) Total fare in normal hour = 1950

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Total fare in peak hour $= 4450$

Extra fare $= 4450 - 1950 = 2500$

Thus (a) is correct option.

120. In the 1961–1962 NBA basketball season, Wilt Chamberlain of the Philadelphia Warriors made 30 baskets. Some of the baskets were free throws (worth 1 point each) and some were field goals (worth 2 points each). The number of field goals was 10 more than the number of free throws.

(i) How many field goals did he make ?

(a) 10 Goals

(b) 20 Goals

(c) 15 Goals

(d) 18 Goals

c406

(ii) How many free throws did he make?

(a) 10 Goals (b) 20 Goals

(c) 15 Goals (d) 18 Goals

(iii) What was the total number of points scored?

(a) 50 (b) 80

(c) 60 (d) 45

(iv) If Wilt Chamberlain played 5 games during this season, what was the average number of points per game?

(a) 5 (b) 8

(c) 10 (d) 4

(v) If Wilt Chamberlain played 10 games during this season, what was the average number of points per game?

(a) 6 (b) 8

(c) 4 (d) 5

Ans :

(i) Let x be the free throw and y be the fixed goal.

As per question

$$x + y = 30$$

$$y = x + 10$$

Solving $x = 10,\ y = 20$

Thus he made 20 fixed goal.

Thus (b) is correct option.

(ii) Free throw $x = 10$

Thus (a) is correct option.

(iii) Point scored $= 10 + 2 \times 20 = 50$

Thus (a) is correct option.

(iv) Average point $\frac{50}{5} = 10$

Thus (c) is correct option.

(v) Average point $\frac{50}{10} = 5$

Thus (d) is correct option.

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CHAPTER 4

QUADRATIC EQUATIONS

ONE MARK QUESTIONS

1. If the sum and product of the zeroes of a quadratic polynomial are 3 and -10 respectively, find the quadratic polynomial.

Ans : [Board 2020 Delhi Basic]

Sum of zeroes, $\alpha + \beta = 3$

and product of zeroes, $\alpha\beta = -10$

d321

Quadratic polynomial,

$$p(x) = x^2 - (\alpha+\beta) + \alpha\beta$$
$$= x^2 - 3x - 10$$

2. If the sum of the zeroes of the quadratic polynomial $kx^2 + 2x + 3k$ is equal to their product, then what is the value of k?

Ans : [Board 2020 OD Basic]

We have $p(x) = kx^2 + 2x + 3k$

Comparing it by $ax^2 + bx + c$, we get $a = k$, $b = 2$ and $c = 3k$.

Sum of zeroes, $\alpha + \beta = -\frac{b}{a} = -\frac{2}{k}$

d322

Product of zeroes, $\alpha\beta = \frac{c}{a} = \frac{3k}{k} = 3$

According to question, we have

$$\alpha + \beta = \alpha\beta$$
$$-\frac{2}{k} = 3 \Rightarrow k = -\frac{2}{3}$$

3. If α and β are the zeroes of the polynomial $x^2 + 2x + 1$, then what is the value of $\frac{1}{\alpha} + \frac{1}{\beta}$?

Ans : [Board 2020 Delhi Basic]

Since α and β are the zeros of polynomial $x^2 + 2x + 1$,

Sum of zeroes, $\alpha + \beta = -\frac{2}{1} = -2$

and product of zeroes, $\alpha\beta = \frac{1}{1} = 1$

d323

Now, $\frac{1}{\alpha} + \frac{1}{\beta} = \frac{\alpha+\beta}{\alpha\beta} = -\frac{2}{1} = -2$

4. If α and β are the zeroes of the polynomial $2x^2 - 13x + 6$, then what is the value of $\alpha + \beta$?

Ans : [Board 2020 Delhi Basic]

We have $p(x) = 2x^2 - 13x + 6$

Comparing it with $ax^2 + bx + c$ we get $a = 2$, $b = -13$ and $a = 6$.

Sum of zeroes $\alpha + \beta = -\frac{b}{a} = -\frac{(-13)}{2} = \frac{13}{2}$

d324

5. Find the roots of the quadratic equation $x^2 - 0.04 = 0$

Ans : [Board 2020 OD Standard]

We have $x^2 - 0.04 = 0$

d325

$$x^2 = 0.04$$
$$x = \pm\sqrt{0.04}$$
$$x = \pm 0.2.$$

6. If ½ is a root of the equation $x^2 + kx - \frac{5}{4} = 0$, then what is the value of k?

Ans : [Board 2009]

We have $x^2 + kx - \frac{5}{4} = 0$

Since, ½ is a root of the given quadratic equation, it must satisfy it.

Thus $\left(\frac{1}{2}\right)^2 + k\left(\frac{1}{2}\right) - \frac{5}{4} = 0$

d326

$$\frac{1}{4} + \frac{k}{2} - \frac{5}{4} = 0$$
$$\frac{1 + 2k - 5}{4} = 0$$
$$2k - 4 = 0 \Rightarrow k = 2$$

7. What are the values of k for which the quadratic equation $2x^2 - kx + k = 0$ has equal roots?

Ans : [Board 2010]

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We have $$2x^2 - kx + k = 0$$

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

For equal roots, the discriminant must be zero.

Thus $$b^2 - 4ac = 0$$

d327

$$(-k)^2 - 4(2)k = 0$$

$$k^2 - 8k = 0$$

$$k(k-8) = 0 \Rightarrow k = 0,\ 8$$

Hence, the required values of k are 0 and 8.

8. If one root of the quadratic equation $ax^2 + bx + c = 0$ is the reciprocal of the other, then show that $a = c$.

Ans : [Board Term - 2 2011]

If one root is α, then the other $\frac{1}{\alpha}$.

d328

Product of roots, $$\alpha \cdot \frac{1}{\alpha} = \frac{c}{a}$$

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

9. Find the nature of roots of the quadratic equation $2x^2 - \sqrt{5}\,x + 1 = 0$.

Ans : [Board Term - 2 2017]

We have $$2x^2 - \sqrt{5x} + 1 = 0$$

Comparing with $ax^2 + bx + c = 0$ we get $a = 2$, $b = -\sqrt{5}$ and $c = 1$,

Now $$b^2 - 4ac = (-\sqrt{5})^2 - 4 \times (2) \times (1)$$

$$= 5 - 8 = -3 < 0$$

Since, discriminant is negative, therefore quadratic equation $2x^2 - \sqrt{5}\,x + 1 = 0$ has no real roots i.e., imaginary roots.

d329

10. What are the real roots of the equation $x^{2/3} + x^{1/3} - 2 = 0$?

Ans : [Board Term - 2 2012]

We have $$x^{2/3} + x^{1/3} - 2 = 0$$

d330

Substituting $x^{1/3} = y$ we obtain,

$$y^2 + y - 2 = 0$$

$$(y-1)(y+2) = 0 \Rightarrow y = 1 \text{ or } y = -2$$

Thus $$x^{1/3} = 1 \Rightarrow x = (1)^3 = 1$$

or $$x^{1/3} = -2 \Rightarrow x = (-2)^3 = -8$$

Hence, the real roots of the given equations are 1, -8.

11. If $x^2 + y^2 = 25$, $xy = 12$, then what is the value of x?

Ans : [Board Term - 2 2016]

We have $$x^2 + y^2 = 25$$

d331

and $$xy = 12$$

$$x^2 + \left(\frac{12}{x}\right)^2 = 25$$

$$x^4 + 144 - 25x^2 = 0$$

$$(x^2 - 16)(x^2 - 9) = 0$$

Hence, $$x^2 = 16 \Rightarrow x = \pm 4$$

and $$x^2 = 9 \Rightarrow x = \pm 3$$

12. Find the nature of roots of the quadratic equation $2x^2 - 3\sqrt{2}\,x + \frac{9}{4} = 0$

Ans : [Board Term - 2 2013]

We have $$2x^2 - 3\sqrt{2}\,x + \frac{9}{4} = 0$$

d332

Here $$a = 2,\ b = -3\sqrt{2},\ c = \frac{9}{4}$$

Discriminant $$D = b^2 - 4ac$$

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

$$= 18 - 18 = 0$$

Thus, $2x^2 - 3\sqrt{2}\,x + \frac{9}{4} = 0$ has real and equal roots.

13. Find the nature of roots of the quadratic equation $x^2 + x - 5 = 0$.

Ans : [Board Term - 2 2015]

We have $$x^2 + x - 5 = 0$$

d333

Here, $$a = 1,\ b = 1,\ c = -5$$

Now, $$D = b^2 - 4ac$$

$$= (1)^2 - 4 \times 1 \times (-5)$$

$$= 21 > 0$$

So $x^2 + x - 5 = 0$ has two distinct real roots.

14. Find the nature of roots of the quadratic equation $x^2 + 3x + 2\sqrt{2} = 0$.

Ans : [Board Term - 2 2014]

We have $$x^2 + 3x + 2\sqrt{2} = 0$$

d334

Here, $$a = 1,\ b = 3 \text{ and } c = 2\sqrt{2}$$

Now, $$D = b^2 - 4ac$$

$$= (3)^2 - 4(1)(2\sqrt{2})$$

$$= 9 - 8\sqrt{2} < 0$$

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Hence, roots of the equation are not real.
Thus (c) is correct option.

15. Find the nature of roots of the quadratic equation $5x^2 - 3x + 1 = 0$.

Ans : [Board Term - 2 2012]

We have $5x^2 - 3x + 1 = 0$

Here $a = 5,\ b = -3,\ c = 1$

Now, $D = b^2 - 4ac = (-3)^2 - 4(5)(1)$

$= 9 - 20 < 0$

d335

Hence, roots of the equation are not real.
Thus (c) is correct option.

16. Find the nature of roots of the quadratic equation $x^2 - 4x + 3\sqrt{2} = 0$.

Ans : [Board Term-2 2011]

We have $x^2 - 4x + 3\sqrt{2} = 0$

Here $a = 1,\ b = -4$ and $c = 3\sqrt{2}$

Now $D = b^2 - 4ac = (-4)^2 - 4(1)(3\sqrt{2})$

$= 16 - 12\sqrt{2}$

$= 16 - 12 \times (1.41)$

$= 16 - 16.92 = -0.92$

$b^2 - 4ac < 0$

d336

Hence, the given equation has no real roots.

17. Find the nature of roots of the quadratic equation $x^2 + 4x - 3\sqrt{2} = 0$.

Ans : [Board Term - 2 2016]

We have $x^2 + 4x - 3\sqrt{2} = 0$

Here $a = 1,\ b = 4$ and $c = -3\sqrt{2}$

Now $D = b^2 - 4ac = (4)^2 - 4(1)(-3\sqrt{2})$

$= 16 + 12\sqrt{2} > 0$

d337

Hence, the given equation has two distinct real roots,

18. Find the nature of roots of the quadratic equation $x^2 - 4x - 3\sqrt{2} = 0$

Ans : [Board Term - 2 2015]

We have $x^2 - 4x - 3\sqrt{2} = 0$

Here $a = 1,\ b = -4$ and $c = -3\sqrt{2}$

Now $D = b^2 - 4ac$

$= (-4)^2 - 4(1)(-3\sqrt{2})$

$= 16 + 12\sqrt{2} > 0$

d338

Hence, the given equation has two distinct real roots.

19. Find the nature of roots of the quadratic equation $3x^2 + 4\sqrt{3}x + 4$.

Ans : [Board Term - 2 Delhi 2014]

We have $3x^2 + 4\sqrt{3}x + 4 = 0$

Here, $a = 3,\ b = 4\sqrt{3}$ and $c = 4$

Now $D = b^2 - 4ac = (4\sqrt{3})^2 - 4(3)(4)$

$= 48 - 48 = 0$

d339

Hence, the equation has real and equal roots.

20. Value of the roots of the quadratic equation, $x^2 - x - 6 = 0$ are ....

Ans : [Board 2020 OD Basic]

$x^2 - x - 6 = 0$

$x^2 - 3x + 2x - 6 = 0$

$x(x-3) + 2(x-3) = 0$

$(x-3)(x+2) = 0 \Rightarrow x = 3$ and $x = -2$

d287

21. If quadratic equation $3x^2 - 4x + k = 0$ has equal roots, then the value of k is ....

Ans : [Board 2020 Delhi Basic]

Given, quadratic equation is $3x^2 - 4x + k = 0$

Comparing with $ax^2 + bx + c = 0$, we get $a = 3$, $b = -4$ and $c = k$

For equal roots, $b^2 - 4ac = 0$

$(-4)^2 - 4(3)(k) = 0$

$16 - 12k = 0$

$k = \frac{16}{12} = \frac{4}{3}$

d288

22. Find the positive root of $\sqrt{3x^2 + 6} = 9$.

Ans : [Board Term-2, 2015]

We have $\sqrt{3x^2 + 6} = 9$

$3x^2 + 6 = 81$

$3x^2 = 81 - 6 = 75$

$x^2 = \frac{75}{3} = 25$

d101

Thus $x = \pm 5$

Hence 5 is positive root.

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23. If $x = -\frac{1}{2}$, is a solution of the quadratic equation $3x^2 + 2kx - 3 = 0$, find the value of k.

Ans : [Board Term-2, Delhi 2015]

We have $3x^2 + 2kx - 3 = 0$

Substituting $x = -\frac{1}{2}$ in given equation we get

$$3\left(-\frac{1}{2}\right)^2 + 2k\left(-\frac{1}{2}\right) - 3 = 0$$

d102

$$\frac{3}{4} - k - 3 = 0$$

$$k = \frac{3}{4} - 3 = \frac{3-12}{4} = \frac{-9}{4}$$

Hence $k = \frac{-9}{4}$

24. Find the roots of the quadratic equation $\sqrt{3}x^2 - 2x - \sqrt{3} = 0$

Ans : [Board Term-2, 2012, 2011]

We have $\sqrt{3}x^2 - 2x - \sqrt{3} = 0$

$$\sqrt{3}x^2 - 3x + x - \sqrt{3} = 0$$

d103

$$\sqrt{3}x(x - \sqrt{3}) + 1(x - \sqrt{3}) = 0$$

$$(x - \sqrt{3})(\sqrt{3}x + 1) = 0$$

Thus $x = \sqrt{3}, \frac{-1}{\sqrt{3}}$

25. Find the value of k, for which one root of the quadratic equation $kx^2 - 14x + 8 = 0$ is six times the other.

Ans : [Board Term-2, 2016]

We have $kx^2 - 14x + 8 = 0$

d104

Let one root be α and other root be 6α.

Sum of roots, $\alpha + 6\alpha = \frac{14}{k}$

$$7\alpha = \frac{14}{k} \text{ or } \alpha = \frac{2}{k} \quad ...(1)$$

Product of roots , $\alpha(6\alpha) = \frac{8}{k}$ or $6\alpha^2 = \frac{8}{k}$ ...(2)

Solving (1) and (2), we obtain

$$6\left(\frac{2}{k}\right)^2 = \frac{8}{k}$$

$$6 \times \frac{4}{k^2} = \frac{8}{k}$$

$$\frac{3}{k^2} = \frac{1}{k}$$

$$3k = k^2$$

$$3k - k^2 = 0$$

$$k[3 - k] = 0$$

$$k = 0 \text{ or } k = 3$$

Since $k = 0$ is not possible, therefore $k = 3$.

26. If one root of the quadratic equation $6x^2 - x - k = 0$ is $\frac{2}{3}$, then find the value of k.

Ans : [Board Term-2 Foreign 2017]

We have $6x^2 - x - k = 0$

Substituting $x = \frac{2}{3}$, we get

d105

$$6\left(\frac{2}{3}\right)^2 - \frac{2}{3} - k = 0$$

$$6 \times \frac{4}{9} - \frac{2}{3} - k = 0$$

$$\frac{8}{3} - \frac{2}{3} - k = 0$$

$$\frac{8-2}{3} - k = 0$$

$$2 - k = 0$$

Thus $k = 2$.

27. Find the value(s) of k if the quadratic equation $3x^2 - k\sqrt{3}x + 4 = 0$ has real roots.

Ans : [Board SQP 2017]

If discriminant $D = b^2 - 4ac$ of quadratic equation is equal to zero, or more than zero, then roots are real.

We have $3x^2 - k\sqrt{3}x + 4 = 0$

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

$$a = 3, b = -k\sqrt{3} \text{ and } c = 4$$

d106

For real roots $b^2 - 4ac \geq 0$

$$(-k\sqrt{3})^2 - 4 \times 3 \times 4 \geq 0$$

$$3k^2 - 48 \geq 0$$

$$k^2 - 16 \geq 0$$

$$(k-4)(k+4) \geq 0$$

Thus $k \leq -4$ and $k \geq 4$

TWO MARKS QUESTIONS

28. For what values of k, the roots of the equation

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$x^2+4x+k=0$ are real?

Ans : [Board 2019 Delhi]

We have $x^2+4x+k=0$.

Comparing the given equation with $ax^2+bx+c=0$ we get $a=1$, $b=4$, $c=k$.

Since, given the equation has real roots,

$$D \geqslant 0$$
$$b^2-4ac \geqslant 0$$
$$4^2-4\times 1\times k \geqslant 0$$
$$4k \leqslant 16$$
$$k \leqslant 4$$

d308

29. Find the value of k for which the roots of the equations $3x^2-10x+k=0$ are reciprocal of each other.

Ans : [Board 2019 Delhi]

We have $3x^2-10x+k=0$

Comparing the given equation with $ax^2+bx+c=0$ we get $a=3$, $b=-10$, $c=k$

Let one root be α so other root is $\frac{1}{\alpha}$.

d309

Now product of roots $\alpha\times\frac{1}{\alpha}=\frac{c}{a}$

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

Hence, value of k is 3.

30. Find the value of k such that the polynomial $x^2-(k+6)x+2(2k+1)$ has sum of its zeros equal to half of their product.

Ans : [Board 2019 Delhi]

Let α and β be the roots of given quadratic equation

$$x^2-(k+6)x+2(2k+1)=0$$

Now sum of roots,. $\alpha+\beta=-\frac{-(k+6)}{1}=k+6$

Product of roots, $\alpha\beta=\frac{2(2k+1)}{1}=2(2k+1)$

According to given condition,

$$\alpha+\beta=\frac{1}{2}\alpha\beta$$

d310

$$k+6=\frac{1}{2}[2(2k+1)]$$
$$k+6=2k+1 \Rightarrow k=5$$

Hence, the value of k is 5.

31. Find the nature of roots of the quadratic equation $2x^2-4x+3=0$.

Ans : [Board 2019 OD]

We have $2x^2-4x+3=0$

Comparing the given equation with $ax^2+bx+c=0$ we get $a=2$ $b=-4$, $c=3$

Now $D=b^2-4ac$

d311

$$=(-4)^2-4(2)\times(3)$$
$$=-8<0 \text{ or } (-\text{ve})$$

Hence, the given equation has no real roots.

32. Find the roots of the quadratic equation $6x^2-x-2=0$.

Ans : [Board Term-2 Delhi 2012]

We have $6x^2-x-2=0$

$$6x^2+3x-4x-2=0 \qquad (3\times 4=2\times 6)$$
$$3x(2x+1)-2(2x+1)=0$$
$$(2x+1)(3x-2)=0$$
$$3x-2=0 \text{ or } 2x+1=0$$
$$x=\frac{2}{3} \text{or } x=-\frac{1}{2}$$

Hence roots of equation are $\frac{2}{3}$ and $-\frac{1}{2}$.

d107

33. Find the roots of the following quadratic equation :

$15x^2-10\sqrt{6}x+10=0$

Ans : [Board Term-2 OD 2012]

We have $15x^2-10\sqrt{6}x+10=0$

$$3x^2-2\sqrt{6}x+2=0$$

d108

$$3x^2-\sqrt{6}x-\sqrt{6}x+2=0$$
$$\sqrt{3}x(\sqrt{3}x-\sqrt{2})-\sqrt{2}(\sqrt{3}x-\sqrt{2})=0$$
$$(\sqrt{3}x-\sqrt{2})(\sqrt{3}x-\sqrt{2})=0$$

Thus $x=\frac{\sqrt{2}}{\sqrt{3}},\frac{\sqrt{2}}{\sqrt{3}}$

34. Solve the following quadratic equation for x :

$4\sqrt{3}x^2+5x-2\sqrt{3}=0$

Ans : [Board Term-2, 2013, 2012]

We have $4\sqrt{3}x^2+5x-2\sqrt{3}=0$

$$4\sqrt{3}x^2+8x-3x-2\sqrt{3}=0$$
$$4x(\sqrt{3}x+2)-\sqrt{3}(\sqrt{3}x+2)=0$$

d109

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

Thus $x = -\frac{2}{\sqrt{3}}, \frac{\sqrt{3}}{4}$

35. Solve for x : $x^2-(\sqrt{3}+1)x+\sqrt{3} = 0$

Ans : [Board Term-2 Foreign 2015]

We have

$$x^2-(\sqrt{3}+1)x+\sqrt{3} = 0$$
$$x^2-\sqrt{3}x-1x+\sqrt{3} = 0$$
$$x(x-\sqrt{3})-1(x-\sqrt{3}) = 0$$
$$(x-\sqrt{3})(x-1) = 0$$

d110

Thus $x = \sqrt{3}, x = 1$

36. Find the roots of the following quadratic equation :
$(x+3)(x-1) = 3\left(x-\frac{1}{3}\right)$

Ans : [Board Term-2 2012]

We have $(x+3)(x-1) = 3\left(x-\frac{1}{3}\right)$

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

d111

Thus $x = 2, -1$

37. Find the roots of the following quadratic equation :
$\frac{2}{5}x^2-x-\frac{3}{5} = 0$

Ans : [Board Term-2, 2012]

We have $\frac{2}{5}x^2-x-\frac{3}{5} = 0$

$$\frac{2x^2-5x-3}{5} = 0$$
$$2x^2-5x-3 = 0$$
$$2x^2-6x+x-3 = 0$$
$$2x(x-3)+1(x-3) = 0$$
$$(2x+1)(x-3) = 0$$

d112

Thus $x = -\frac{1}{2}, 3$

38. Solve the following quadratic equation for x :
$4x^2-4a^2x+(a^4-b^4) = 0$

Ans : [Board Term-2 Delhi 2015]

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

Comparing with $Ax^2+Bx+C = 0$ we have

$$A = 4, B = -4a^2, C = (a^4-b^4)$$

d113

$$x = \frac{-B\pm\sqrt{B^2-4AC}}{2A}$$
$$= \frac{4a^2\pm\sqrt{(-4a^2)^2-4\times4(a^4-b^4)}}{2\times4}$$
$$= \frac{4a^2\pm\sqrt{16a^2-16a^4+16b^4}}{8}$$
$$= \frac{4a^2\pm\sqrt{16b^4}}{8}$$

or, $x = \frac{4a^2\pm4b^2}{8} = \frac{a^2\pm b^2}{2}$

Thus either $x = \frac{a^2+b^2}{2}$ or $x = \frac{a^2-b^2}{2}$

39. Solve the following quadratic equation for x :
$9x^2-6b^2x-(a^4-b^4) = 0$

Ans : [Board Term-2, Delhi 2015]

We have $9x^2-6b^2x-(a^4-b^4) = 0$

Comparing with $Ax^2+Bx+C = 0$ we have

$$A = 9, B = -6b^2, C = -(a^4-b^4)$$

d114

$$x = \frac{-B\pm\sqrt{B^2-4AC}}{2A}$$
$$x = \frac{6b^2\pm\sqrt{(-6b^2)^2-4\times9\times\{(a^4-b^4)\}}}{2\times9}$$
$$= \frac{6b^2\pm\sqrt{36b^4+36a^4-36b^4}}{18}$$
$$= \frac{6b^2\pm\sqrt{36a^4}}{18} = \frac{6b^2\pm6a^2}{18}$$

Thus $x = \frac{a^2+b^2}{3}, \frac{b^2-a^2}{3}$

40. Solve the following equation for x :
$4x^2+4bx-(a^2-b^2) = 0$

Ans : [Board Term-2

d115

We have $4x^2+4bx+b^2-a^2 = 0$

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

$$(2x+b+a)(2x+b-a) = 0$$

Thus $x = \frac{-(a+b)}{2}$ and $x = \frac{a-b}{2}$

41. Solve the following quadratic equation for x :

$$x^2 - 2ax - (4b^2 - a^2) = 0$$

Ans : [Board Term-2, 2015]

We have $x^2 - 2ax - (4b^2 - a^2) = 0$

$$x^2 - 2ax + a^2 - 4b^2 = 0$$

$$(x-a)^2 - (2b)^2 = 0$$

$$(x-a+2b)(x-a-2b) = 0$$

d116

Thus $x = a-2b, x = a+2b$

42. Solve the quadratic equation, $2x^2 + ax - a^2 = 0$ for x.

Ans : [Board Term-2 Delhi 2014]

We have $2x^2 + ax - a^2 = 0$

Comparing with $Ax^2 + Bx + C = 0$ we have

$$A = 2, B = a, C = -a^2$$

d117

Now $x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$

$$= \frac{-a \pm \sqrt{a^2 - 4 \times 2 \times (-a^2)}}{2 \times 2}$$

$$= \frac{-a \pm \sqrt{a^2 + 8a^2}}{4}$$

$$= \frac{-a \pm \sqrt{9a^2}}{4} = \frac{-a \pm 3a}{4}$$

$$x = \frac{-a+3a}{4}, \frac{-a-3a}{4}$$

Thus $x = \frac{a}{2}, -a$

43. Find the roots of the quadratic equation $4x^2 - 4px + (p^2 - q^2) = 0$

Ans : [Board Term-2, 2014]

We have $4x^2 - 4px + (p^2 - q^2) = 0$

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

$$a = 4, b = -4p, c = (p^2 - q^2)$$

The roots are given by the quadratic formula,

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

$$= \frac{4p \pm \sqrt{16p^2 - 4 \times 4 \times (p^2 - q^2)}}{2 \times 4}$$

$$= \frac{4p \pm \sqrt{16p^2 - 16p^2 + 16q^2}}{8}$$

$$= \frac{4p \pm 4q}{8}$$

d118

Thus roots are $\frac{p+q}{2}, \frac{p-q}{2}$.

44. Solve for x (in terms of a and b) :

$$\frac{a}{x-b} + \frac{b}{x-a} = 2, x \neq a, b$$

Ans : [Board Term-2 Foreign 2016]

We have $\frac{a(x-a) + b(x-b)}{(x-b)(x-a)} = 2$

d120

$$a(x-a) + b(x-b) = 2[x^2 - (a+b)x + ab]$$

$$ax - a^2 + bx - b^2 = 2x^2 - 2(a+b)x + 2ab$$

$$2x^2 - 3(a+b)x + (a+b)^2 = 0$$

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

$$[2x - (a+b)][x - (a+b)] = 0$$

Thus $x = a+b, \frac{a+b}{2}$

45. Solve for x : $\sqrt{3}x^2 - 2\sqrt{2}x - 2\sqrt{3} = 0$

Ans : [Board Term-2 Foreign 2016]

We have

$$\sqrt{3}x^2 - 3\sqrt{2}x + \sqrt{2}x - 2\sqrt{3} = 0$$

d121

$$\sqrt{3}x[x - \sqrt{6}] + \sqrt{2}[x - \sqrt{6}] = 0$$

$$(x - \sqrt{6})(\sqrt{3}x + \sqrt{2}) = 0$$

Thus $x \sqrt{6}, -\sqrt{\frac{2}{3}}$

46. If $x = \frac{2}{3}$ and $x = -3$ are roots of the quadratic equation $ax^2 + 7x + b = 0$, find the values of a and b.

Ans : [Board Term-2 Delhi 2016]

We have $ax^2 + 7x + b = 0$ (1)

Substituting $x = \frac{2}{3}$ in above equation we obtain

$$\frac{4}{9}a + \frac{14}{3} + b = 0$$

d122

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$$4a+42+9b=0$$

$$4a+9b=-42 \quad (2)$$

and substituting $x=-3$ in (1) we obtain

$$9a-21+b=0$$

$$9a+b=21 \quad (3)$$

Solving (2) and (3), we get $a=3$ and $b=-6$

47. Solve for x : $\sqrt{6x+7}-(2x-7)=0$

Ans : [Board Term-2 OD 2016]

We have $\sqrt{6x+7}-(2x-7)=0$

or, $\sqrt{6x+7}=(2x-7)$

d123

Squaring both sides we get

$$6x+7=(2x-7)^2$$

$$6x+7=4x^2-28x+49$$

$$4x^2-34x+42=0$$

$$2x^2-17x+21=0$$

$$2x^2-14x-3x+21=0$$

$$2x(x-7)-3(x-7)=0$$

$$(x-7)(2x-3)=0$$

Thus $x=7$ and $x=\frac{2}{3}$.

48. Find the roots of $x^2-4x-8=0$ by the method of completing square.

Ans : [Board Term-2, 2015]

We have $x^2-4x-8=0$

d124

$$x^2-4x+4-4-8=0$$

$$(x-2)^2-12=0$$

$$(x-2)^2=12$$

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

$$x-2=\pm 2\sqrt{3}$$

$$x=2\pm 2\sqrt{3}$$

Thus $x=2+2\sqrt{3},\ 2-2\sqrt{3}$

49. Solve for x : $\sqrt{2x+9}+x=13$

Ans : [Board Term-2 OD 2016]

We have $\sqrt{2x+9}+x=13$

$$\sqrt{2x+9}=13-x$$

d127

Squaring both side we have

$$2x+9=(13-x)^2$$

$$2x+9=169+x^2-26x$$

$$0=x^2+169-26x-9-2x$$

$$x^2-28x+160=0$$

$$x^2-20x-8x+160=0$$

$$x(x-20)-8(x-20)=0$$

$$(x-8)(x-20)=0$$

Thus $x=8$ and $x=20$.

50. Find the roots of the quadratic equation $\sqrt{2}\,x^2+7x+5\sqrt{2}=0$

Ans : [Board Term-2 OD 2017]

We have $\sqrt{2}\,x^2+7x+5\sqrt{2}=0$

d128

$$\sqrt{2}\,x^2+2x+5x+5\sqrt{2}=0$$

$$\sqrt{2}\,x(x+\sqrt{2})+5(x+\sqrt{2})=0$$

$$(x+\sqrt{2})(\sqrt{2}\,x+5)=0$$

Thus $x=-\sqrt{2}$ and $=-\frac{5}{\sqrt{2}}=-\frac{5}{\sqrt{2}}\times\frac{\sqrt{2}}{\sqrt{2}}=-\frac{5}{2}\sqrt{2}$

51. Find the value of k for which the roots of the quadratic equation $2x^2+kx+8=0$ will have the equal roots ?

Ans : [Board Term-2 OD Compt., 2017]

We have $2x^2+kx+8=0$

d129

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

$$a=2,\ b=k,\ \text{and}\ c=8$$

For equal roots, $D=0$

$$b^2-4ac=0$$

$$k^2-4\times 2\times 8=0$$

$$k^2=64$$

$$k=\pm\sqrt{64}$$

Thus $k=\pm 8$

52. Solve for x : $\sqrt{3}\,x^2+10x+7\sqrt{3}=0$

Ans : [Board Term-2 Foreign 2017]

We have $\sqrt{3}\,x^2+10x+7\sqrt{3}=0$

d130

$$\sqrt{3}\,x^2+3x+7x+7\sqrt{3}=0$$

$$\sqrt{3x}(x+\sqrt{3})+7(x+\sqrt{3})=0$$

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$$(x+\sqrt{3})(\sqrt{3}\,x+7) = 0$$

Thus $x = -\sqrt{3}$ and $x = -\frac{7}{\sqrt{3}}$

53. Find k so that the quadratic equation $(k+1)x^2 - 2(k+1)x + 1 = 0$ has equal roots.

Ans : [Board Term-2, 2016]

We have $(k+1)x^2 - 2(k+1)x + 1 = 0$

Comparing with $Ax^2 + Bx + C = 0$ we get

$A = (k+1), B = -2(k+1), C = 1$

If roots are equal, then $D = 0$, i.e.

$$B^2 = 4AC$$

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

$$k^2 + 2k + 1 = k + 1$$

$$k^2 + k = 0$$

$$k(k+1) = 0$$

$$k = 0, -1$$

d194

$k = -1$ does not satisfy the equation, thus $k = 0$

54. If 2 is a root of the equation $x^2 + kx + 12 = 0$ and the equation $x^2 + kx + q = 0$ has equal roots, find the value of q.

Ans : [Board Term 2 SQP 2016]

We have $x^2 + kx + 12 = 0$

If 2 is the root of above equation, it must satisfy it.

$$(2)^2 + 2k + 12 = 0$$

, $$2k + 16 = 0$$

$$k = -8$$

d195

Substituting $k = -8$ in $x^2 + kx + q = 0$ we have

$$x^2 - 8x + q = 0$$

For equal roots,

$$(-8)^2 - 4(1)q = 0$$

$$64 - 4q = 0$$

$$4q = 64 \Rightarrow q = 16$$

55. Find the values of k for which the quadratic equation $9x^2 - 3kx + k = 0$ has equal roots.

Ans : [Board Term-2 Delhi OD 2014]

We have $9x^2 - 3kx + k = 0$

d196

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

$$a = 9, b = -3k, c = k$$

Since roots of the equation are equal, $b^2 - 4ac = 0$

$$(-3k)^2 - (4 \times 9 \times k) = 0$$

$$9k^2 - 36k = 0$$

$$k^2 - 4k = 0$$

$$k(k-4) = 0 \Rightarrow k = 0 \text{ or } k = 4$$

Hence, $k = 4$.

56. If the equation $kx^2 - 2kx + 6 = 0$ has equal roots, then find the value of k.

Ans : [Board Term-2, 2012]

We have $kx^2 - 2kx + 6 = 0$

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

$$a = k, b = -2k, c = 6$$

Since roots of the equation are equal, $b^2 - 4ac = 0$

$$(-2k)^2 - 4(k)(6) = 0$$

$$4k^2 - 24k = 0$$

$$4k(k-6) = 0$$

$$k = 0, 6$$

d197

But $k \neq 0$, as coefficient of x^2 can't be zero.

Thus $k = 6$

57. Find the positive value of k for which $x^2 - 8x + k = 0$, will have real roots.

Ans : [Board Term-2, 2014]

We have $x^2 - 8x + k = 0$

Comparing with $Ax^2 + Bx + C = 0$ we get

d214

$A = 1, B = -8, C = k$

Since the given equation has real roots, $B^2 - 4AC > 0$

$$(-8)^2 - 4(1)(k) \geq 0$$

$$64 - 4k \geq 0$$

$$16 - k \geq 0$$

$$16 \geq k$$

Thus $k \leq 16$

58. Find the values of p for which the quadratic equation $4x^2 + px + 3 = 0$ has equal roots.

Ans : [Board Term-2, 2014]

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We have $4x^2 + px + 3 = 0$

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

$$a = 4, b = p, c = 3$$

d198

Since roots of the equation are equal,

$$b^2 - 4ac = 0$$

$$p^2 - 4 \times 4 \times 3 = 0$$

$$p^2 - 48 = 0$$

$$p^2 = 48$$

$$p = \pm 4\sqrt{3}$$

59. Find the nature of the roots of the quadratic equation : $13\sqrt{3}x^2 + 10x + \sqrt{3} = 0$

Ans : [Board Term-2, 2012]

We have $13\sqrt{3}x^2 + 10x + \sqrt{3} = 0$

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

$$a = 13\sqrt{3}, b = 10, c = \sqrt{3}$$

d199

$$b^2 - 4ac = (10)^2 - 4(13\sqrt{3})(\sqrt{3})$$

$$= 100 - 156$$

$$= -56$$

As $D < 0$, the equation has not real roots.

THREE MARKS QUESTIONS

60. Solve the following equation: $\frac{1}{x} - \frac{1}{x-2} = 3,\ x \neq 0, 2$

Ans : [Board 2020 SQP Standard]

We have $\frac{1}{x} - \frac{1}{x-2} = 3 \qquad (x \neq 0, 2)$

d291

$$\frac{x-2-x}{x(x-2)} = 3$$

$$\frac{-2}{x(x-2)} = 3$$

$$3x(x-2) = -2$$

$$3x^2 - 6x + 2 = 0$$

Comparing it by $ax^2 + bx + c$, we get $a = 3$, $b = -6$ and $c = 2$.

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

$$= \frac{-(-6) \pm \sqrt{(-6)^2 - 4(3)(2)}}{2(3)}$$

$$= \frac{6 \pm \sqrt{36 - 24}}{6} = \frac{6 \pm \sqrt{12}}{6}$$

$$= \frac{6 \pm 2\sqrt{3}}{6}$$

$$= \frac{3 + \sqrt{3}}{3}, \frac{3 - \sqrt{3}}{3}$$

61. Find the values of k for which the quadratic equation $x^2 + 2\sqrt{2k}\,x + 18 = 0$ has equal roots.

Ans : [Board 2020 SQP Standard]

We have $x^2 + 2\sqrt{2k}\,x + 18 = 0$

Comparing it by $ax^2 + bx + c$, we get $a = 1$, $b = 2\sqrt{2k}$ and $c = 18$.

Given that, equation $x^2 + 2\sqrt{2}\,kx + 18 = 0$ has equal roots.

$$b^2 - 4ac = 0$$

$$(2\sqrt{2}\,k)^2 - 4 \times 1 \times 18 = 0$$

d293

$$8k^2 - 72 = 0$$

$$8k^2 = 72$$

$$k^2 = \frac{72}{8} = 9$$

$$k = \pm 3$$

62. If α and β are the zeroes of the polynomial $f(x) = x^2 - 4x - 5$ then find the value of $\alpha^2 + \beta^2$

Ans : [Board 2020 Delhi Basic]

We have $p(x) = x^2 - 4x - 5$

Comparing it by $ax^2 + bx + c$, we get $a = 1$, $b = -4$ and $c = -5$

Since, given α and β are the zeroes of the polynomial,

Sum of zeroes, $\alpha + \beta = -\frac{b}{a} = \frac{-(-4)}{1} = 4$

and product of zeroes, $\alpha\beta = \frac{c}{a} = \frac{-5}{1} = -5$

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

d294

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

$$= 16 + 10 = 26$$

63. Find the quadratic polynomial, the sum and product of whose zeroes are -3 and 2 respectively. Hence find

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the zeroes.

Ans : [Board 2020 OD Basic]

Sum of zeroes $\alpha + \beta = -3$ ...(1)

and product of zeroes $\alpha\beta = 2$

Thus quadratic equation is

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

$$x^2 - (-3)x + 2 = 0$$

$$x^2 + 3x + 2 = 0$$

d296

Thus quadratic equation is $x^2 + 3x + 2 = 0$.

Now above equation can be written as

$$x^2 + 2x + x + 2 = 0$$

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

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

Hence, zeroes are -2 and -1.

64. If α and β are the zeroes of the polynomial $f(x) = 5x^2 - 7x + 1$ then find the value of $\left(\frac{\alpha}{\beta} + \frac{\beta}{\alpha}\right)$

Ans : [Board 2020 OD Basic]

Since, α and β are the zeroes of the quadratic polynomial $f(x) = 5x^2 - 7x + 1$,

Sum of zeros, $\alpha + \beta = -\left(\frac{-7}{5}\right) = \frac{7}{5}$ ...(1)

Product of zeros, $\alpha\beta = \frac{1}{5}$ ...(2)

Now, $$\frac{\alpha}{\beta} + \frac{\beta}{\alpha} = \frac{\alpha^2 + \beta^2}{\alpha\beta} = \frac{(\alpha+\beta)^2 - 2\alpha\beta}{\alpha\beta}$$

$$= \frac{\left(\frac{7}{5}\right)^2 - 2 \times \frac{1}{5}}{\frac{1}{5}}$$

$$= \frac{49 - 2\times 5}{5} = \frac{39}{5}$$

d300

65. Find the zeroes of the quadratic polynomial $6x^2 - 3 - 7x$ and verify the relationship between the zeroes and the coefficients.

Ans : [Board 2020 Delhi Basic]

We have $p(x) = 6x^2 - 3 - 7x$

For zeroes of polynomial, $p(x) = 0$,

$$6x^2 - 7x - 3 = 0$$

$$6x^2 - 9x + 2x - 3 = 0$$

$$3x(2x-3) + 1(2x-3) = 0$$

$$(2x-3)(3x+1) = 0$$

d301

Thus $2x - 3 = 0$ and $3x + 1 = 0$

Hence $x = \frac{3}{2}$ and $x = -\frac{1}{3}$

Therefore $\alpha = \frac{3}{2}$ and $\beta = -\frac{1}{3}$ are the zeroes of the given polynomial.

Verification :

Sum of zeroes, $$\alpha + \beta = \frac{3}{2} + \left(-\frac{1}{3}\right) = \frac{3}{2} - \frac{1}{3} = \frac{7}{6}$$

$$= -\frac{\text{coefficient of } x}{\text{coefficient of } x^2}$$

and product of zeroes

$$\alpha\beta = \left(\frac{3}{2}\right)\left(-\frac{1}{3}\right) = -\frac{1}{2}$$

$$= \frac{\text{constant term}}{\text{coefficient of } x^2}$$

66. Find the zeroes of the quadratic polynomial $x^2 + 7x + 10$, and verify the relationship between the zeroes and the coefficients.

Ans : [Board 2020 Delhi Basic]

Let, $p(x) = x^2 + 7x + 10$

For zeroes of polynomial $p(x) = 0$,

$$x^2 + 7x + 10 = 0$$

$$x^2 + 5x + 2x + 10 = 0$$

$$x(x+5) + 2(x+5) = 0$$

$$(x+5)(x+2) = 0$$

d302

So, $x = -2$ and $x = -5$

Therefore, $\alpha = -2$ and $\beta = -5$ are the zeroes of the given polynomial.

Verification:

Sum of zeroes, $\alpha + \beta = -2 + (-5)$

$$= -7 = \frac{-7}{1}$$

$$= -\frac{\text{coefficient of } x}{\text{coefficient of } x^2}$$

and product of zeroes,

$$\alpha\beta = (-2)(-5) = 10$$

$$= \frac{10}{1}$$

$$= \frac{\text{contant term}}{\text{coefficient of } x^2}$$

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67. Solve for x : $\frac{1}{x+4} - \frac{1}{x+7} = \frac{11}{30}$ $x \neq -4, \ -7.$

Ans : [Board 2020 OD Standard]

We have
$$\frac{1}{x+4} - \frac{1}{x+7} = \frac{11}{30}$$
$$\frac{x+7-x-4}{(x+4)(x+7)} = \frac{11}{30}$$
$$\frac{3}{x^2+4x+7x+28} = \frac{11}{30}$$
$$\frac{3}{x^2+11x+28} = \frac{11}{30}$$
$$11x^2+121x+308 = 90$$
$$11x^2+121x+218 = 0$$

d305

Comparing with $ax^2+bx+c=0$, we get $a=11$, $b=121$ and $c=218$ we obtain
$$x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}$$
$$= \frac{-121 \pm \sqrt{14641-9592}}{22}$$
$$x = \frac{-121 \pm \sqrt{5049}}{22}$$
$$= \frac{-121 \pm 71.06}{22}$$
$$x = \frac{-49.94}{22}, \frac{-192.06}{22}$$
$$x = -2.27, \ -8.73.$$

68. Solve for x :
$$\frac{x+1}{x-1} + \frac{x-2}{x+2} = 4 - \frac{2x+3}{x-2}; x \neq 1, -2, 2$$

Ans : [Board Term-2 OD 2016]

We have
$$\frac{x+1}{x-1} + \frac{x-2}{x+2} = 4 - \frac{2x+3}{x-2}$$
$$\frac{x^2+3x+2+x^2-3x+2}{x^2+x-2} = \frac{4x-8-2x-3}{x-2}$$
$$\frac{2x^2+4}{x^2+x-2} = \frac{2x-11}{x-2}$$
$$(2x^2+4)(x-2) = (2x-11)(x^2+x-2)$$
$$5x^2+19x-30 = 0$$
$$(5x-6)(x+5) = 0$$
$$x = -5, \ \frac{6}{5}$$

d131

69. Solve for x :
$$\frac{2x}{x-3} + \frac{1}{2x+3} + \frac{3x+9}{(x-3)(2x+3)} = 0, x \neq 3, -\frac{3}{2}$$

Ans : [Board Term-2, Delhi 2016]

We have
$$\frac{2x}{x-3} + \frac{1}{2x+3} + \frac{3x+9}{(x-3)(2x+3)} = 0$$
$$2x(2x+3)+(x-3)+(3x+9) = 0$$
$$4x^2+6x+x-3+3x+9 = 0$$
$$4x^2+10x+6 = 0$$
$$2x^2+5x+3 = 0$$
$$(x+1)(2x+3) = 0$$

d132

Thus $x = -1, x = -\frac{3}{2}$

70. Solve for x : $\frac{1}{x} + \frac{2}{2x-3} = \frac{1}{x-2}, x \neq 0, \ \frac{2}{3}, \ 2.$

Ans : [Board Term-2, Foreign 2016]

We have
$$\frac{1}{x} + \frac{2}{2x-3} = \frac{1}{x-2}$$
$$\frac{2x-3+2x}{x(2x-3)} = \frac{1}{x-2}$$
$$\frac{4x-3}{x(2x-3)} = \frac{1}{x-2}$$
$$(x-2)(4x-3) = 2x^2-3x$$
$$4x^2-11x+6 = 2x^2-3x$$
$$2x^2-8x+6 = 0$$
$$x^2-4x+3 = 0$$
$$(x-1)(x-3) = 0$$

d133

Thus $x = 1, 3$

71. Solve the following quadratic equation for x :
$$x^2 + \left(\frac{a}{a+b} + \frac{a+b}{a}\right)x + 1 = 0$$

Ans : [Board Term-2 OD 2016]

We have
$$x^2 + \left(\frac{a}{a+b} + \frac{a+b}{a}\right)x + 1 = 0$$
$$x^2 + \frac{a}{a+b}x + \frac{a+b}{a}x + 1 = 0$$
$$x\left(x + \frac{a}{a+b}\right) + \frac{a+b}{a}\left(x + \frac{a}{a+b}\right) = 0$$
$$\left(x + \frac{a}{a+b}\right)\left(x + \frac{a+b}{a}\right) = 0$$

d134

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Thus $x = \frac{-a}{a+b}, \frac{-(a+b)}{a}$

72. Solve for x :

$$\frac{1}{(x-1)(x-2)} + \frac{1}{(x-2)(x-3)} = \frac{2}{3}; x \neq 1,2,3$$

Ans : [Board Term-2 OD 2016]

We have $\frac{1}{(x-1)(x-2)} + \frac{1}{(x-2)(x-3)} = \frac{2}{3}$

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

$$\frac{2x-4}{(x-1)(x-2)(x-3)} = \frac{2}{3}$$

$$\frac{2(x-2)}{(x-1)(x-2)(x-3)} = \frac{2}{3}$$

$$\frac{2}{(x-1)(x-3)} = \frac{2}{3}$$

$$3 = (x-1)(x-3)$$

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

$$x^2 - 4x = 0$$

$$x(x-4) = 0$$

Thus $x = 0$ or $x = 4$

d135

73. Solve for x : $\sqrt{3}\,x^2 - 2\sqrt{2}\,x - 2\sqrt{3} = 0$

Ans : [Board Term-2, OD 2015, Foreign 2014]

We have $\sqrt{3}\,x^2 - 2\sqrt{2}\,x - 2\sqrt{3} = 0$

$$\sqrt{3}\,x^2 - [3\sqrt{2} - \sqrt{2}]x - 2\sqrt{3} = 0$$

$$\sqrt{3}\,x^2 - 3\sqrt{2}\,x + \sqrt{2}\,x - 2\sqrt{3} = 0$$

$$\sqrt{3}\,x^2 - \sqrt{3}\sqrt{3}\sqrt{2}\,x + \sqrt{2}\,x - \sqrt{2}\sqrt{2}\sqrt{3} = 0$$

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

$$\sqrt{3}\,x[x - \sqrt{6}] + \sqrt{2}[x - \sqrt{6}] = 0$$

$$(x - \sqrt{6})(\sqrt{3}\,x + \sqrt{2}) = 0$$

Thus $x = \sqrt{6} = -\sqrt{\frac{2}{3}}$

d136

74. Solve for x : $2x^2 + 6\sqrt{3}\,x - 60 = 0$

Ans : [Board Term-2, OD 2015]

We have $2x^2 + 6\sqrt{3}\,x - 60 = 0$

$$x^2 + 3\sqrt{3}\,x - 30 = 0$$

$$x^2 + 5\sqrt{3}\,x - 2\sqrt{3}\,x - 30 = 0$$

d137

$$x(x + 5\sqrt{3}) - 2\sqrt{3}(x + 5\sqrt{3}) = 0$$

$$(x + 5\sqrt{3})(x - 2\sqrt{3}) = 0$$

Thus $x = -5\sqrt{3}, 2\sqrt{3}$

75. Solve for x : $x^2 + 5x - (a^2 + a - 6) = 0$

Ans : [Board Term-2 Foreign 2015]

We have $x^3 + 5x - (a^2 + a - 6) = 0$

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

d138

Thus $x = \frac{-5 \pm \sqrt{25 + 4(a^2 + a - 6)}}{2}$

$$= \frac{-5 \pm \sqrt{25 + 4a^2 + 4a - 24}}{2}$$

$$= \frac{-5 \pm \sqrt{4a^2 + 4a + 1}}{2}$$

$$= \frac{-5 \pm (2a+1)}{2}$$

$$= \frac{2a-4}{2}, \frac{-2a-6}{2}$$

Thus $x = a - 2,\; x = -(a+3)$

76. Solve for x : $x^2 - (2b-1)x + (b^2 - b - 20) = 0$

Ans : [Board Term-2 Foreign 2015]

We have $x^2 - (2b-1)x + (b^2 - b - 20) = 0$

Comparing with $Ax^2 + Bx + C = 0$ we have

$$A = 1, B = -(2b-1), C = (b^2 - b - 20)$$

$$x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$

d139

$$x = \frac{(2b-1) \pm \sqrt{(2b-1)^2 - 4(b^2 - b - 20)}}{2}$$

$$= \frac{(2b-1) \pm \sqrt{4b^2 - 4b + 1 - 4b^2 + 4b + 80}}{2}$$

$$= \frac{(2b-1) \pm \sqrt{81}}{2} = \frac{(2b-1) \pm 9}{2}$$

$$= \frac{2b+8}{2}, \frac{2b-10}{2}$$

$$= b+4,\; b-5$$

Thus $x = b + 4$ and $x = b - 5$

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77. Solve for x : $\frac{16}{x} - 1 = \frac{15}{x+1}$; $x \neq 0, -1$

Ans : [Board Term-2, OD 2014]

We have
$$\frac{16}{x} - 1 = \frac{15}{x+1}$$
$$\frac{16}{x} - \frac{15}{x+1} = 1$$

d140

$$16(x+1) - 15x = x(x+1)$$
$$16x + 16 - 15x = x^2 + x$$
$$x + 16 = x^2 + x$$
$$x^2 - 16 = 0$$
$$x^2 = 16$$
$$x = \pm 4$$

Thus $x = -4$ and $x = +4$

78. Solve the quadratic equation $(x-1)^2 - 5(x-1) - 6 = 0$

Ans : [Board Term-2, 2015]

We have
$$(x-1)^2 - 5(x-1) - 6 = 0$$
$$x^2 - 2x + 1 - 5x + 5 - 6 = 0$$

d141

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

Thus $x = 0, 7$

79. Solve the equation for x : $\frac{4}{x} - 3 = \frac{5}{2x+3}$; $x \neq 0, \frac{-3}{2}$

Ans : [Board Term-2 Delhi 2014]

We have
$$\frac{4}{x} - 3 = \frac{5}{2x+3}$$
$$\frac{4}{x} - \frac{5}{2x+3} = 3$$

d142

$$\frac{4(2x+3) - 5x}{x(2x+3)} = 3$$
$$8x + 12 - 5x = 3x(2x+3)$$
$$3x + 12 = 6x^2 + 9x$$
$$6x^2 + 6x - 12 = 0$$
$$x^2 + x - 2 = 0$$
$$x^2 + 2x - x - 2 = 0$$
$$x(x+2) - (x+2) = 0$$
$$(x+2)(x-1) = 0$$

Thus $x = 1, -2$

80. Find the roots of the equation $2x^2 + x - 4 = 0$, by the method of completing the squares.

Ans : [Board Term-2 OD 2014]

We have
$$2x^2 + x - 4 = 0$$
$$x^2 + \frac{x}{2} - 2 = 0$$

d143

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

Adding and subtracting $\left(\frac{1}{4}\right)^2$, we get
$$x^2 + 2x\left(\frac{1}{4}\right) + \left(\frac{1}{4}\right)^2 - \left(\frac{1}{4}\right)^2 - 2 = 0$$
$$\left(x + \frac{1}{4}\right)^2 - \left(\frac{1}{16} + 2\right) = 0$$
$$\left(x + \frac{1}{4}\right)^2 - \left(\frac{1+32}{16}\right) = 0$$
$$\left(x + \frac{1}{4}\right)^2 - \frac{33}{16} = 0$$
$$\left(x + \frac{1}{4}\right)^2 = \frac{33}{16}$$
$$\left(x + \frac{1}{4}\right) = \pm\frac{\sqrt{33}}{4}$$

Thus roots are $x = \frac{-1+\sqrt{33}}{4}, \frac{-1-\sqrt{33}}{4}$

81. Solve for x : $9x^2 - 6ax + (a^2 - b^2) = 0$

Ans : [Board Term-2 2012]

We have $9x^2 - 6ax + a^2 - b^2 = 0$

Comparing with $Ax^2 + Bx + C = 0$ we have
$$A = 9, B = -6a, C = (a^2 - b^2)$$

d144

$$x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$
$$x = \frac{6a \pm \sqrt{(-6a)^2 - 4 \times 9k(a^2 - b^2)}}{2 \times 9}$$
$$= \frac{6a \pm \sqrt{36a^2 - 36a^2 + 36b^2}}{18}$$
$$= \frac{6a \pm \sqrt{36b^2}}{18} = \frac{6a \pm 6b}{18}$$
$$= \frac{a \pm b}{3}$$

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$$x = \frac{(a+b)}{3}, \frac{(a-b)}{3}$$

Thus $x = \frac{a+b}{3}, x = \frac{a-b}{3}$

82. Solve the equation $\frac{1}{x+4} - \frac{1}{x-7} = \frac{11}{30}$, $x \neq -4, 7$ for x.

Ans : [Board Term-2, 2012]

We have,
$$\frac{1}{x+4} - \frac{1}{x-7} = \frac{11}{30}$$
$$\frac{x-7-x-4}{(x+4)(x-7)} = \frac{11}{30}$$
$$\frac{-11}{(x+4)(x-7)} = \frac{11}{30}$$
$$\frac{-1}{(x+4)(x-7)} = \frac{1}{30}$$
$$(x+4)(x-7) = -30$$
$$x^2 - 3x - 28 = -30$$
$$x^2 - 3x + 2 = 0$$
$$x^2 - 2x - x + 2 = 0$$
$$(x-1)(x-2) = 0$$

d145

Thus $x = 1, 2$.

83. Find the roots of the quadratic equation :
$$a^2b^2x^2 + b^2x - a^2x - 1 = 0$$

Ans : [Board Term-2, 2012]

We have
$$a^2b^2x^2 + b^2x - a^2x - 1 = 0$$
$$b^2x(a^2x+1) - 1(a^2x+1) = 0$$
$$(b^2x-1)(a^2x+1) = 0$$
$$x = \frac{1}{b^2} \text{ or } x = -\frac{1}{a^2}$$

d146

Hence, roots are $\frac{1}{b^2}$ and $-\frac{1}{a^2}$.

84. If $(x^2+y^2)(a^2+b^2) = (ax+by)^2$, prove that $\frac{x}{a} = \frac{y}{b}$

Ans : [Board Term-2, 2014]

We have
$$(x^2+y^2)(a^2+b^2) = (ax+by)^2$$
$$x^2a^2 + x^2b^2 + y^2a^2 + y^2b^2 = a^2x^2 + b^2y^2 + 2abxy$$
$$x^2b^2 + y^2a^2 - 2abxy = 0$$
$$(xb - ya)^2 = 0$$
$$xb = ya$$

d152

Thus
$$\frac{x}{a} = \frac{y}{b}$$
Hence Proved.

85. Solve the following quadratic equation for x :
$$p^2x^2 + (p^2 - q^2)x - q^2 = 0$$

Ans : [Board Term-2, 2012]

We have
$$p^2x^2 + (p^2-q^2)x - q^2 = 0$$

Comparing with $ax^2 + bx + c = 0$ we get
$$a = p^2, b = p^2 - q^2, c = -q^2$$

d147

The roots are given by the quadratic formula
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$
$$= \frac{-(p^2-q^2) - \sqrt{(p^2-q^2)^2 - 4(p^2)(-q^2)}}{2p^2}$$
$$= \frac{-(p^2-q^2) - \sqrt{p^4 + q^4 - 2p^2q^2 + 4p^2q^2}}{2p^2}$$
$$= \frac{-(p^2-q^2) - \sqrt{p^4 + q^4 + 2p^2q^2}}{2p^2}$$
$$= \frac{-(p^2-q^2) - \sqrt{(p^2+q^2)^2}}{2p^2}$$
$$= \frac{-(p^2-q^2) \pm (p^2+q^2)}{2p^2}$$

Thus
$$x = \frac{-(p^2-q^2) + (p^2+q^2)}{2p^2} = \frac{2q^2}{2p^2} = \frac{q^2}{p^2}$$

and
$$x = \frac{-(p^2-q^2) - (p^2+q^2)}{2p^2} = \frac{-2p^2}{2p^2} = -1$$

Hence, roots are $\frac{q^2}{p^2}$ and -1.

86. Solve the following quadratic equation for x :
$$9x^2 - 9(a+b)x + 2a^2 + 5ab + 2b^2 = 0$$

Ans : [Board Term-2, Foreign 2016]

We have
$$9x^2 - 9(a+b)x + 2a^2 + 5ab + 2b^2 = 0$$

Now
$$2a^2 + 5ab + 2b^2 = 2a^2 + 4ab + ab + 2b^2$$
$$= 2a[a+2b] + b[a+2b]$$
$$= (a+2b)(2a+b)$$

Hence the equation becomes
$$9x^2 - 9(a+b)x + (a+2b)(2a+b) = 0$$
$$9x^2 - 3[3a+3b]x + (a+2b)(2a+b) = 0$$
$$9x^2 - 3[(a+2b) + (2a+b)]x + (a+2b)(2a+b) = 0$$

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$$9x^2-3(a+2b)x-3(2a+b)x+(a+2b)(2a+b)=0$$

$$3x[3x-(a+2b)]-(2a+b)[3x-(a+2b)]=0$$

$$[3x-(a+2b)][3x-(2a+b)]=0$$

$$3x-(2a+b)=0$$

$$x=\frac{a+2b}{3}$$

d148

$$3x-(2a+b)=0$$

$$x=\frac{2a+b}{3}$$

Hence, roots are $\frac{a+2b}{3}$ and $\frac{2a+b}{3}$.

87. Solve for x : $x^2+6x-(a^2+2a-8)$

Ans : [Board Term-2, Foreign 2015]

We have $x^2+6x-(a^2+2a-8)=0$

Comparing with $Ax^2+Bx+C=0$ we get

$$A=1, B=6, C=(a^2+2a-8)$$

The roots are given by the quadratic formula

$$x=\frac{-B\pm\sqrt{B^2-4AC}}{2A}$$

d149

$$=\frac{-6\pm\sqrt{36+4(a^2+2a-8)}}{2}$$

$$=\frac{-6\pm(2a+2)}{2}$$

Thus $x=\frac{-6+(2a+2)}{2}=a-2$

and $x=\frac{-6-(2a+2)}{2}=-a-4$

Thus $x=a-2,-a-4$

88. If the roots of the equation $(a^2+b^2)x^2-2(ac+bd)x+(c^2+d^2)=0$ are equal, prove that $\frac{a}{b}=\frac{c}{d}$.

Ans : [Board Term-2 2016]

We have $(a^2+b^2)x^2-2(ac+bd)x+(c^2+d^2)=0$

Comparing with $Ax^2+Bx+C=0$ we get

$A=(a^2+b^2), B=-2(ac+bd), C=(c^2+d^2)$

If roots are equal, $D=B^2-4AC=0$

or $B^2=4AC$

d157

Now $[-2(ac+bd)]^2=4(a^2+b^2)(c^2+d^2)$

$$4(a^2c^2+2abcd+b^2d^2)=4(a^2c^2+a^2d^2+b^2c^2+b^2d^2)$$

$$a^2c^2+2abcd+b^2d^2=a^2c^2+a^2d^2+b^2c^2+b^2d^2$$

$$2abcd=a^2d^2+b^2c^2$$

$$0=a^2d^2-2abcd+b^2c^2$$

$$0=(ad-bc)^2$$

$$0=ad-bc$$

Thus $ad=bc$

$\frac{a}{b}=\frac{c}{d}$ Hence Proved

89. If 2 is a root of the quadratic equation $3x^2+px-8=0$ and the quadratic equation $4x^2-2px+k=0$ has equal roots, find k.

Ans : [Board Term-2 Foreign 2014]

We have $3x^2+px-8=0$

Since 2 is a root of above equation, it must satisfy it.

Substituting $x=2$ in $3x^2+px-8=0$ we have

$$12+2p-8=0$$

$$p=-2$$

d200

Since $4x^2-2px+k=0$ has equal roots,

or $4x^2+4x+k=0$ has equal roots,

$$D=b^2-4ac=0$$

$$4^2-4(4)(k)=0$$

$$16-16k=0$$

$$16k=16$$

Thus $k=1$

90. For what value of k, the roots of the quadratic equation $kx(x-2\sqrt{5})+10=0$ are equal ?

Ans : [Board Term-2 Delhi 2014, 2013]

We have $kx(x-2\sqrt{5})+10=0$

or, $kx^2-2\sqrt{5}\,kx+10=0$

d201

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

$$a=k, b=-2\sqrt{5}\,k \text{ and } c=10$$

Since, roots are equal, $D=b^2-4ac=0$

$$(-2\sqrt{5}\,k)^2-4\times k\times 10=0$$

$$20k^2-40k=0$$

$$20k(k-2)=0$$

$$k(k-2)=0$$

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Since $k \neq 0$, we get $k = 2$

91. Find the nature of the roots of the following quadratic equation. If the real roots exist, find them : $3x^2 - 4\sqrt{3}x + 4 = 0$

Ans : [Board Term-2, 2012]

We have $3x^2 - 4\sqrt{3}x + 4 = 0$

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

d202

$$a = 3,\ b = -4\sqrt{3},\ c = 4$$

$$b^2 - 4ac = (-4\sqrt{3})^2 - 4(3)(4)$$

$$= 48 - 48 = 0$$

Thus roots are real and equal.

Roots are $\left(-\frac{b}{2a}\right), \left(-\frac{b}{2a}\right)$ or $\frac{2\sqrt{3}}{3}, \frac{2\sqrt{3}}{3}$

92. Determine the positive value of k for which the equation $x^2 + kx + 64 = 0$ and $x^2 - 8x + k = 0$ will both have real and equal roots.

Ans : [Board Term-2, 2012, 2014]

We have $x^2 + kx + 64 = 0$

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

d203

$$a = 1, b = k, c = 64$$

For real and equal roots, $b^2 - 4ac = 0$

Thus $k^2 - 4 \times 1 \times 64 = 0$

$$k^2 - 256 = 0 \Rightarrow k = \pm 16 \qquad (1)$$

Now for equation $x^2 - 8x + k = 0$ we have

$$b^2 - 4ac = 0$$

$$(-8)^2 - 4 \times 1 \times k = 0$$

$$64 = 4k$$

$$k = \frac{64}{4} = 16 \qquad (2)$$

From (1) and (2), we get $k = 16$. Thus for $k = 16$, given equations have equal roots.

93. Find that non-zero value of k, for which the quadratic equation $kx^2 + 1 - 2(k-1)x + x^2 = 0$ has equal roots. Hence find the roots of the equation.

Ans : [Board Term-2 Delhi 2015]

We have $kx^2 + 1 - 2(k-1)x + x^2 = 0$

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

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

d204

$$a = k+1, b = -2(k-1), c = 1$$

For real and equal roots, $b^2 - 4ac = 0$

$$4(k-1)^2 - 4(k+1) \times 1 = 0$$

$$4k^2 - 8k + 4 - 4k - 4 = 0$$

$$4k^2 - 12k = 0$$

$$4k(k-3) = 0$$

As k can't be zero, thus $k = 3$.

94. Find the value of k for which the quadratic equation $(k-2)x^2 + 2(2k-3)x + (5k-6) = 0$ has equal roots.

Ans : [Board Term-2, 2015]

We have $(k-2)x^2 + 2(2k-3)x + (5k-6) = 0$

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

$$a = k-2, b = 2(2k-3), c = (5k-6)$$

For real and equal roots, $b^2 - 4ac = 0$

d205

$$\{2(2k-3)\}^2 - 4(k-2)(5k-6) = 0$$

$$4(4k^2 - 12k + 9) - 4(k-2)(5k-6) = 0$$

$$4k^2 - 12k + 9 - 5k^2 + 6k + 10k - 12 = 0$$

$$k^2 - 4k + 3 = 0$$

$$k^2 - 3k - k + 3 = 0$$

$$k(k-3) - 1(k-3) = 0$$

$$(k-3)(k-1) = 0$$

Thus $k = 1, 3$

95. If the roots of the quadratic equation $(a-b)x^2 + (b-c)x + (c-a) = 0$ are equal, prove that $2a = b + c$.

Ans : [Board Term-2 Delhi 2016]

We have $(a-b)x^2 + (b-c)x + (c-a) = 0$

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

d206

$$a = (a-b,),\ b = (b-c),\ c = c-a$$

For real and equal roots, $b^2 - 4ac = 0$

$$(b-c)^2 - 4(a-b)(c-a) = 0$$

$$b^2 + c^2 - 2bc - 4(ac - a^2 - bc + ab) = 0$$

$$b^2 + c^2 - 2bc - 4ac + 4a^2 + 4bc - 4ab = 0$$

$$4a^2 + b^2 + c^2 + 2bc - 4ab - 4ac = 0$$

Using $a^2 + b^2 + c^2 + 2ab + 2bc + 2ca = (a+b+c)^2$,

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$$(-2a+b+c)^2 = 0$$

$$-2a+b+c = 0$$

Hence, $b+c = 2a$

96. If the quadratic equation, $(1+a^2)b^2x^2+2abcx+(c^2-m^2)=0$ in x has equal roots, prove that $c^2 = m^2(1+a^2)$

Ans : [Board Term-2, 2014]

We have $(1+a^2)b^2x^2+2abcx+(c^2-m^2)=0$

Comparing with $Ax^2+Bx+C=0$ we get

$$A=(1+a^2)b^2, B=2abc, C=(c^2-m^2)$$

If roots are equal, $B^2-4AC=0$

d207

$$(2abc)^2-4(1+a^2)b^2(c^2-m^2) = 0$$

$$4a^2b^2c^2-(4b^2+4a^2b^2)(c^2-m^2) = 0$$

$$4a^2b^2c^2-[4b^2c^2-4b^2m^2+4a^2b^2c^2-4a^2b^2m^2] = 0$$

$$4a^2b^2c^2-4b^2c^2+4b^2m^2-4a^2b^2c^2+4a^2b^2m^2 = 0$$

$$4b^2[a^2m^2+m^2-c^2] = 0$$

$$c^2 = a^2m^2+m^2$$

$$c^2 = m^2(1+a^2)$$

97. If -3 is a root of quadratic equation $2x^2+px-15=0$, while the quadratic equation $x^2-4px+k=0$ has equal roots. Find the value of k.

Ans : [Board Term-2 OD Compt. 2017]

Given -3 is a root of quadratic equation.

We have $2x^2+px-15 = 0$

Since 3 is a root of above equation, it must satisfy it. Substituting $x=3$ in above equation we have

$$2(-3)^2+p(-3)-15 = 0$$

$$2\times 9-3p-15 = 0 \Rightarrow p = 1$$

d208

Since $x^2-4px+k = 0$ has equal roots,

or $x^2-4x+k = 0$ has equal roots,

$$b^2-4ac = 0$$

$$(-4)^2-4k = 0$$

$$16-4k = 0 \Rightarrow 4k = 16 \Rightarrow k = 4$$

98. If $ad \neq bc$, then prove that the equation $(a^2+b^2)x^2+2(ac+bd)x+(c^2+d^2)=0$ has no real roots.

Ans : [Board Term-2 OD 2017]

We have $(a^2+b^2)x^2+2(ac+bd)x+(c^2+d^2)=0$

Comparing with $Ax^2+Bx+C=0$ we get

$$A=(a^2+b^2), B=2(ac+bd) \text{ and } C=(c^2+d^2)$$

For no real roots, $D=B^2-4AC<0$

d209

$$D = B^2-4AC$$

$$=[2(ac+bd)]^2-4(a^2+b^2)(c^2+d^2)$$

$$=4[a^2c^2+2abcd+b^2d^2]-4[a^2c^2+a^2d^2+b^2c^2+b^2d^2]$$

$$=4[a^2c^2+2abcd+b^2d^2-a^2c^2-a^2d^2-b^2c^2-b^2d^2]$$

$$=-4[a^2d^2+b^2c^2-2abcd]$$

$$=-4(ad-bc)^2$$

Since $ad \neq bc$, therefore $D \neq 0$ and always negative. Hence the equation has no real roots.

99. Find the value of c for which the quadratic equation $4x^2-2(c+1)x+(c+1)=0$ has equal roots.

Ans : [Board Term-2 Delhi 2017]

We have $4x^2-2(c+1)x+(x+1)=0$

Comparing with $Ax^2+Bx+C=0$ we get

d210

$$A=4, B=2(c+1), C=(c+1)$$

If roots are equal, $B^2-4AC=0$

$$[2(c+1)]^2-4\times 4(c+1) = 0$$

$$4(c^2+2c+1)-4(4c+4) = 0$$

$$4(c^2+2c+1-4c-4) = 0$$

$$c^2-2c-3 = 0$$

$$c^2-3c+c-3 = 0$$

$$c(c-3)+1(c-3) = 0$$

$$(c-3)(c+1) = 0$$

$$c = 3, -1$$

Hence for equal roots $c=3,-1$.

100. Show that if the roots of the following equation are equal then $ad=bc$ or $\frac{a}{b}=\frac{c}{d}$.

$$x^2(a^2+b^2)+2(ac+bd)x+c^2+d^2 = 0$$

Ans : [Board Term-2 OD Compt. 2017]

We have $x^2(a^2+b^2)+2(ac+bd)x+c^2+d^2=0$

Comparing with $Ax^2+Bx+C=0$ we get

$$A=a^2+b^2, B=2(ac+bd), C=c^2+d^2$$

If roots are equal, $B^2-4AC=0$

d211

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$$[2(ac+bd)]^2 - 4(a^2+b^2)(c^2+d^2) = 0$$

$$4(a^2c^2+2abcd+b^2d^2) - 4(a^2c^2+a^2d^2+b^2c^2+b^2d^2) = 0$$

$$4(a^2c^2+2abcd+b^2d^2-a^2c^2-a^2d^2-b^2c^2-b^2d^2) = 0$$

$$-4(a^2d^2+b^2c^2-2abcd) = 0$$

$$(ad-bc)^2 = 0$$

Thus $\qquad ad = bc$

$$\frac{a}{b} = \frac{c}{d} \qquad \text{Hence Proved.}$$

101. Solve $\frac{1}{(a+b+x)} = \frac{1}{a}+\frac{1}{b}+\frac{1}{x},\ a+b \neq 0.$

Ans : [Board Term-2 SQP 2016]

We have

$$\frac{1}{a+b+x} = \frac{1}{a}+\frac{1}{b}+\frac{1}{x}$$

$$\frac{1}{a+b+x} - \frac{1}{x} = \frac{1}{a}+\frac{1}{b}$$

d228

$$\frac{x-(a+b+x)}{x(a+b+x)} = \frac{a+b}{ab}$$

$$\frac{x-a-b-x}{x(a+b+x)} = \frac{a+b}{ab}$$

$$\frac{-(a+b)}{x(a+b+x)} = \frac{a+b}{ab}$$

$$x(a+b+x) = -ab$$

$$x^2+(a+b)x+ab = 0$$

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

$$x = -a \text{ or } x = -b$$

FIVE MARKS QUESTIONS

102. Solve for x : $\left(\frac{2x}{x-5}\right)^2 + \left(\frac{2x}{x-5}\right) - 24 = 0, x \neq 5$

Ans : [Board Term-2 2016]

We have $\qquad \left(\frac{2x}{x-5}\right)^2 + 5\left(\frac{2x}{x-5}\right) - 24 = 0$

Let $\frac{2x}{x-5} = y$ then we have

$$y^2+5y-24 = 0$$

$$(y+8)(y-3) = 0$$

d158

$$y = 3, -8$$

Taking $y = 3$ we have

$$\frac{2x}{x-5} = 3$$

$$2x = 3x-15 \Rightarrow x = 15$$

Taking $y = -8$ we have

$$\frac{2x}{x-5} = -8$$

$$2x = -8x+40$$

$$10x = 40 \Rightarrow x = 4$$

Hence, $x = 15, 4$

103. Solve for x : $\frac{1}{x+1}+\frac{2}{x+2} = \frac{4}{x+4} \quad x \neq -1, -2, -4$

Ans : [Board Term-2 OD 2016]

We have $\qquad \frac{1}{x+1}+\frac{2}{x+2} = \frac{4}{x+4}$

$$\frac{x+2+2(x+1)}{(x+1)(x+2)} = \frac{4}{x+4}$$

d159

$$\frac{3x+4}{x^2+3x+2} = \frac{4}{x+4}$$

$$(3x+4)(x+4) = 4(x^2+3x+2)$$

$$3x^2+16x+16 = 4x^2+12x+8$$

$$x^2-4x-8 = 0$$

Now $\qquad x = \frac{-b\sqrt{b^2+4ac}}{2a}$

$$= \frac{-(-4) \pm \sqrt{(-4)^2-4(1)(-8)}}{2 \times 1}$$

$$= \frac{4 \pm \sqrt{16+32}}{2}$$

$$= \frac{4 \pm \sqrt{48}}{2} = \frac{4 \pm 4\sqrt{3}}{2}$$

$$= 2 \pm 2\sqrt{3}$$

Hence, $x = 2+2\sqrt{3}$ and $2-2\sqrt{3}$

104. Find x in terms of a, b and c :

$$\frac{a}{x-a}+\frac{b}{x-b} = \frac{2c}{x-c}, x \neq a, b, c$$

d160

Ans : [Board Term-2, Delhi 2016]

We have $\qquad \frac{a}{x-a}+\frac{b}{x-b} = \frac{2c}{x-c}$

$$a(x-b)(x-c)+b(x-a)(x-c) = 2c(x-a)(x-b)$$

$$ax^2-abx-acx+abc+bx^2-bax-bcx+abc$$

$$= 2cx^2-2cxb-2cxa+2abc$$

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$$ax^2+bx^2-2cx^2-abx-acx-bax-bcx+2cbx+2acx = 0$$

$$x^2(a+b-2c)-2abx+acx+bcx = 0$$

$$x^2(a+b-2c)+x(-2ab+ac+bc) = 0$$

Thus $x = -\left(\dfrac{ac+bc-2ab}{a+b-2c}\right)$

105. Solve for x : $\dfrac{3}{x+1}+\dfrac{4}{x-1} = \dfrac{29}{4x-1}$; $x \neq -1,\ 1,\ \dfrac{1}{4}$

Ans : [Board Term-2 Delhi 2015]

We have $\dfrac{3}{x+1}+\dfrac{4}{x-1} = \dfrac{29}{4x-1}$

d161

$$\frac{3x-3+4x+4}{x^2-1} = \frac{29}{4x-1}$$

$$\frac{7x+1}{x^2-1} = \frac{29}{4x-1}$$

$$(7x+1)(4x-1) = 29x^2-29$$

$$28x^2-7x+4x-1 = 29x^2-29$$

$$-3x = x^2-28$$

$$x^2+3x-28 = 0$$

$$x^2+7x-4x-28 = 0$$

$$x(x+7)-4(x+7) = 0$$

$$(x+7)(x-4) = 0$$

Hence, $x = 4, -7$

106. Solve for x : $\dfrac{x-1}{2x+1}+\dfrac{2x+1}{x-1} = 2$ where $x \neq -\dfrac{1}{2},\ 1$

Ans : [Board Term-2, OD 2015]

We have $\dfrac{x-1}{2x+1}+\dfrac{2x+1}{x-1} = 2$

d179

Let $\dfrac{x-1}{2x+1}$ be y so $\dfrac{2x+1}{x-1} = \dfrac{1}{y}$

Substituting this value we obtain

$$y+\frac{1}{y} = 2$$

$$y^2+1 = 2y$$

$$y^2-2y+1 = 0$$

$$(y-1)^2 = 0$$

$$y = 1$$

Substituting $y = \dfrac{x-1}{2x+1}$ we have

$$\frac{x-1}{2x+1} = 1 \text{ or } x-1 = 2x+1$$

or $x = -2$

107. Find for x : $\dfrac{1}{x-2}+\dfrac{2}{x-1} = \dfrac{6}{x}$; $x \neq 0,\ 1,\ 2$

Ans : [Board Term-2 OD 2017]

We have $\dfrac{1}{x-2}+\dfrac{2}{x-1} = \dfrac{6}{x}$

d180

$$\frac{x-1+2x-4}{(x-2)(x-1)} = \frac{6}{x}$$

$$3x^2-5x = 6x^2-18x+12$$

$$3x^2-13x+12 = 0$$

$$3x^2-4x-9x+12 = 0$$

$$x(3x-4)-3(3x-4) = 0$$

$$(3x-4)(x-3) = 0$$

$$x = \frac{4}{3} \text{ and } 3$$

Hence, $x = 3,\ \dfrac{4}{3}$

108. Solve, for x : $\sqrt{3}\,x^2+10x+7\sqrt{3} = 0$

Ans : [Board Term-2 Foreign 2017]

We have $\sqrt{3}\,x^2+10x+7\sqrt{3} = 0$

d181

$$\sqrt{3}\,x^2+3x+7x+7\sqrt{3} = 0$$

$$(x+\sqrt{3})(\sqrt{3}\,x+7) = 0$$

$$(x+\sqrt{3})(\sqrt{3}\,x+7) = 0$$

$$x = -\sqrt{3} \text{ and } x = \frac{-7}{\sqrt{3}}$$

Hence roots $x = -\sqrt{3}$ and $x = \dfrac{-7}{\sqrt{3}}$

109. Solve for x : $\dfrac{x+3}{x-2}-\dfrac{1-x}{x} = \dfrac{17}{4}$; $x \neq 0,\ 2$

Ans : [Board Term -2 Delhi Compt. 2017]

We have $\dfrac{x+3}{x-2}-\dfrac{1-x}{x} = \dfrac{17}{4}$

d192

$$\frac{x(x+3)-(1-x)(x-2)}{x(x-2)} = \frac{17}{4}$$

$$\frac{(x^2+3x)-(-x^2+3x-2)}{x^2-2x} = \frac{17}{4}$$

$$\frac{2x^2+2}{x^2-2x} = \frac{17}{4}$$

$$8x^2+8 = 17x^2-34x$$

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$$9x^2 - 34x - 8 = 0$$
$$9x^2 - 36x + 2x - 8 = 0$$
$$9x(x-4) + 2(x-4) = 0$$
$$(x-4)(9x+2) = 0$$
$$x = 4 \text{ or } x = -\frac{2}{9}$$

Hence, $x = 4, -\frac{2}{9}$

110. Solve for x : $4x^2 + 4bx - (a^2 - b^2) = 0$

Ans : [Board Term-2 Foreign 2017]

We have $4x^2 + 4bx - (a^2 - b^2) = 0$

Comparing with $Ax^2 + Bx + C = 0$ we get

$$A = 4, B = 4b \text{ and } C = b^2 - a^2$$

$$x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$
$$= \frac{-4b \pm \sqrt{(4b)^2 - 4.4(b^2 - a^2)}}{2.4}$$
$$= \frac{-4b \pm \sqrt{16b^2 - 16b^2 + 16a^2}}{8}$$
$$= \frac{-4b \pm 4a}{8}$$
$$= -\frac{(a+b)}{2}, \frac{(a-b)}{2}$$

d193

Hence the roots are $-\frac{(a+b)}{2}$ and $\frac{(a-b)}{2}$

111. Find the zeroes of the quadratic polynomial $7y^2 - \frac{11}{3}y - \frac{2}{3}$ and verify the relationship between the zeroes and the coefficients.

Ans : [Board 2019 OD]

We have $7y^2 - \frac{11}{3}y - \frac{2}{3} = 0$

$$21y^2 - 11y - 2 = 0 \quad ...(1)$$
$$21y^2 - 14y + 3y - 2 = 0$$
$$7y(3y-2) + (3y-2) = 0$$
$$(3y-2)(7y+1) = 0$$
$$y = \frac{2}{3}, \frac{-1}{7}$$

d312

Hence, zeros of given polynomial are,

$$y = \frac{2}{3} \text{ and } y = \frac{-1}{7}$$

Comparing the given equation with $ax^2 + bx + c = 0$ we get $a = 21$, $b = -11$ and $c = -2$

Now, sum of roots, $\alpha + \beta = \frac{2}{3} + \left(-\frac{1}{7}\right)$

$$= \frac{2}{3} - \frac{1}{7} = \frac{11}{21}$$

Thus $\alpha + \beta = -\frac{b}{a}$ Hence verified

and product of roots, $\alpha\beta = \frac{2}{3} \times \left(-\frac{1}{7}\right) = \frac{-2}{21}$

Thus $\alpha\beta = \frac{c}{a}$ Hence verified

112. Write all the values of p for which the quadratic equation $x^2 + px + 16 = 0$ has equal roots. Find the roots of the equation so obtained.

Ans : [Board 2019 OD]

We have $x^2 + px + 16 = 0$ ...(1)

If this equation has equal roots, then discriminant $b^2 - 4ac$ must be zero.

i.e., $b^2 - 4ac = 0$ ...(2)

Comparing the given equation with $ax^2 + bx + c = 0$ we get $a = 1$, $b = p$ and $c = 16$

Substituting above in equation (2) we have

d313

$$p^2 - 4 \times 1 \times 16 = 0$$
$$p^2 = 64 \Rightarrow p = \pm 8$$

When $p = 8$, from equation (1) we have

$$x^2 + 8x + 16 = 0$$
$$x^2 + 2 \times 4x + 4^2 = 0$$
$$(x+4)^2 = 0 \Rightarrow x = -4, -4$$

Hence, roots are -4 and -4.

When $p = -8$ from equation (1) we have

$$x^2 - 8x + 16 = 0$$
$$x^2 - 2 \times 4x + 4^2 = 0$$
$$(x-4)^2 = 0 \Rightarrow x = 4, 4$$

Hence, the required roots are either $-4, -4$ or $4, 4$

113. Solve for x : $x^2 + 5x - (a^2 + a - 6) = 0$

Ans : [Board 2019 OD]

d315

We have $x^2 + 5x - (a^2 + a - 6) = 0$

$$x^2 + 5x - [a^2 + 3a - 2a - 6] = 0$$
$$x^2 + 5x - [a(a+3) - 2(a+3)] = 0$$
$$x^2 + 5x - (a+3)(a-2) = 0$$

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$$x^2+[a+3-(a-2)]x-(a+3)(a-2)=0$$
$$x^2+(a+3)x-(a-2)x-(a+3)(a-2)=0$$
$$x[x+(a+3)]-(a-2)[x+(a+3)]=0$$
$$[x+(a+3)][x-(a-2)]=0$$

Thus $x=-(a+3)$ and $x=(a-2)$

Hence, roots of given equations are $x=-(a+3)$ and $x=a-2$.

114. Find the nature of the roots of the quadratic equation $4x^2+4\sqrt{3x}+3=0$.

Ans : [Board 2019 OD]

We have $4x^2+4\sqrt{3x}+3=0$

Comparing the given equation with $ax^2+bx+c=0$ we get $a=4$, $b=4\sqrt{3}$ and $c=3$.

Now, $D=b^2-4ac$

$$=(4\sqrt{3})^2-4\times4\times3$$
$$=48-48=0$$

d316

Since, $b^2-4ac=0$, then roots of the given equation are real and equal.

115. If $x=3$ is one root of the quadratic equation $x^2-2kx-6=0$, then find the value of k.

Ans : [Board 2018]

If $x=3$ is one root of the equation $x^2-2kx-6=0$, it must satisfy it.

Thus substituting $x=3$ in given equation we have

$$9-6k-6=0$$
$$k=\frac{1}{2}$$

d317

116. Find the positive values of k for which quadratic equations $x^2+kx+64=0$ and $x^2-8x+k=0$ both will have the real roots.

Ans : [Board Term-2 Foreign 2016]

(1) For $x^2+kx+64=0$ to have real roots

$$k^2-256\geq0$$
$$k^2\geq256$$
$$k\geq16 \text{ or } k<-16$$

d213

(2) For $x^2-8x+k=0$ to have real roots

$$64-4k\geq0$$
$$16-k\geq0$$
$$16\geq k$$

For (1) and (2) to hold simultaneously, $k=16$

117. Find the values of k for which the equation $(3k+1)^2+2(k+1)x+1$ has equal roots. Also find the roots.

Ans : [Board Term-2, 2014]

We have $(3k+1)^2+2(k+1)x+1$

Comparing with $Ax^2+Bx+C=0$ we get

$$A=(3k+1), B=2(k+1), C=1$$

d215

If roots are equal, $B^2-4AC=0$

$$[2(k+1)]^2-4(3k+1)(1)=0$$
$$4(k^2+2k+1)-(12k+4)=0$$
$$4k^2+8k+4-12k-4=0$$
$$4k^2-4k=0$$
$$4k(k-1)=0$$
$$k=0,1.$$

Substituting $k=0$, in the given equation,

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

Again substituting $k=1$, in the given equation,

$$4x^2+4x+1=0$$
$$(2x+1)^2=0$$

or, $x=-\frac{1}{2}$

Hence, roots $=-1,-\frac{1}{2}$

118. Find the values of k for which the quadratic equations $(k+4)x^2+(k+1)x+1=0$ has equal roots. Also, find the roots.

Ans : [Board Term-2 Delhi 2014]

We have $(k+4)x^2+(k+1)x+1=0$

Comparing with $Ax^2+Bx+C=0$ we get

$$A=(k+4), B=(k+1), C=1$$

d216

If roots are equal, $B^2-4AC=0$

$$(k+1)^2-4(k+4)(1)=0$$
$$k^2+1+2k-4k-16=0$$
$$k^2-2k-15=0$$
$$(k-5)(k+3)=0$$
$$k=5,-3$$

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For $k = 5$, equation becomes

$$9x^2 + 6x + 1 = 0$$

$$(3x + 1)^2 = 0$$

or $$x = -\frac{1}{3}$$

For $k = -3$, equation becomes

$$x^2 - 2x + 1 = 0$$

$$(x - 1)^2 = 0$$

$$x = 1$$

Hence roots are 1 and $-\frac{1}{3}$.

119. If $x = -2$ is a root of the equation $3x^2 + 7x + p = 0$, find the value of k so that the roots of the equation $x^2 + k(4x + k - 1) + p = 0$ are equal.

Ans : [Board Term-2 Foreign 2015]

We have $3x^2 + 7x + p = 0$

Since $x = -2$ is the root of above equation, it must satisfy it.

Thus $$3(-2) + 7(-2) + p = 0$$

$$p = 2$$

Since roots of the equation $x^2 + 4kx + k^2 - k + 2 = 0$ are equal,

$$16k^2 - 4(k^2 - k + 2) = 0$$

$$16k^2 - 4k^2 + 4k - 8 = 0$$

$$12k^2 + 4k - 8 = 0$$

$$3k^2 + k - 2 = 0$$

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

$$k = \frac{2}{3}, -1$$

Hence, roots $= \frac{2}{3}, -1$

120. If $x = -4$ is a root of the equation $x^2 + 2x + 4p = 0$, find the values of k for which the equation $x^2 + px(1 + 3k) + 7(3 + 2k) = 0$ has equal roots.

Ans : [Board Term-2 Foreign 2015]

We have $x^2 + 2x + 4p = 0$

Since $x = -4$ is the root of above equation. It must satisfy it.

$$(-4)^2 + (2 \times -4) + 4p = 0$$

$$p = -2$$

Since equation $x^2 - 2(1 + 3k)x + 7(3 + 2k) = 0$ has equal roots.

$$4(1 + 3k)^2 - 28(3 + 2k) = 0$$

$$9k^2 - 8k - 20 = 0$$

$$(9k + 10)(k - 2) = 0$$

$$k \frac{-10}{9}, 2$$

Hence, the value of k are $-\frac{10}{9}$ and 2.

121. Find the value of p for which the quadratic equation $(p + 1)x^2 - 6(p + 1)x + 3(p + 9) = 0$, $p \neq -1$ has equal roots. Hence find the roots of the equation.

Ans : [Board Term-2, 2015]

We have $(p + 1)x^2 - 6(p + 1)x + 3(p + 9) = 0$

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

$$a = p + 1, b = -6(p + 1), c = 3(p + 9)$$

For real and equal roots, $b^2 - 4ac = 0$

$$36(p + 1)^2 - 4(p + 1) \times 3(p + 9) = 0$$

$$3(p^2 + 2p + 1) - (p + 1)(p + 9) = 0$$

$$3p^2 + 6p + 3 - (p^2 + 9p + p + 9) = 0$$

$$2p^2 - 4p - 6 = 0$$

$$p^2 - 2p - 3 = 0$$

$$p^2 - 3p + p - 3 = 0$$

$$p(p - 3) + 1(p - 3) = 0$$

$$(p - 3)(p + 1) = 0$$

$$p = -1, 3$$

Neglecting $p \neq -1$ we get $p = 3$

Now the equation becomes

$$4x^2 - 24x + 36 = 0$$

or $$x^2 - 6x + 9 = 0$$

or, $$(x - 3)(x - 3) = 0$$

$$x = 3, 3$$

Thus roots are 3 and 3.

122. If the equation $(1 + m^2)x^2 + 2mcx + (c^2 - a^2) = 0$ has equal roots, prove that $c^2 = a^2(1 + m^2)$

Ans : [Board Term-2 Delhi 2015]

We have $(1 + m^2)x^2 + 2mcx + (c^2 - a^2) = 0$

Comparing with $Ax^2 + Bx + C = 0$ we get

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$$A = 1 + m^2, B = 2mc, C = (c^2 - a^2)$$

If roots are equal, $B^2 - 4AC = 0$

$$(2mc)^2 - 4(1+m^2)(c^2-a^2) = 0$$

$$4m^2c^2 - 4(1+m^2)(c^2-a^2) = 0$$

$$m^2c^2 - (c^2 - a^2 + m^2c^2 - m^2a^2) = 0$$

$$m^2c^2 - c^2 + a^2 - m^2c^2 + m^2a^2 = 0$$

$$-c^2 + a^2 + m^2a^2 = 0$$

d220

, $$c^2 = a^2(1+m^2)$$

Hence Proved.

123. If (-5) is a root of the quadratic equation $2x^2 + px + 15 = 0$ and the quadratic equation $p(x^2 + x) + k = 0$ has equal roots, then find the values of p and k.

Ans : [Board Term-2 Delhi 2015]

We have $\quad 2x^2 + px - 15 = 0$

Since $x = -5$ is the root of above equation. It must satisfy it.

$$2(-5)^2 + p(-5) - 15 = 0$$

$$50 - 5p - 15 = 0$$

d221

$$5p = 35 \Rightarrow p = 7$$

Now $\quad p(x^2 + x) + k = 0$ has equal roots

or $$7x^2 + 7x + k = 0$$

Taking $b^2 - 4ac = 0$ we have

$$7^2 - 4 \times 7 \times k = 0$$

$$7 - 4k = 0$$

$$k = \frac{7}{4}$$

Hence $p = 7$ and $k = \frac{7}{4}$.

124. If the roots of the quadratic equation $(x-a)(x-b) + (x-b)(x-c) + (x-c)(x-a) = 0$ are equal. Then show that $a = b = c$.

Ans : [Board Term-2 Delhi 2015]

We have

$$(x-a)(x-b) + (x-b)(x-c) + (x-c)(x-a) = 0$$

$$x^2 - ax - bx + ab +$$

$$+ x^2 - bx - cx + bc +$$

$$+ x^2 - cx - ax + ac = 0$$

d222

$$3x^2 - 2ac - 2bx - 2cx + ab + bc + ca = 0$$

For equal roots $B^2 - 4AC = 0$

$$\{-2(a+b+c)\}^2 - 4 \times 3(ab+bc+ca) = 0$$

$$4(a+b+c)^2 - 12(ab+bc+ca) = 0$$

$$a^2 + b^2 + c^2 - 3(ab+bc+ca) = 0$$

$$a^2 + b^2 + c^2 + 2ab + 2bc + 2ac - 3ab - 3bc - 3ac = 0$$

$$a^2 + b^2 + c^2 - ab - ac - bc = 0$$

$$\tfrac{1}{2}[2a^2 + 2b^2 + 2c^2 - 2ab - 2ac - 2bc] = 0$$

$$\tfrac{1}{2}[(a^2 + b^2 - 2ab) + (b^2 + c^2 - 2bc) + (c^2 + a^2 - 2ac)] = 0$$

$$\tfrac{1}{2}[(a-b)^2 + (b-c)^2 + (c-a)^2] = 0$$

or, $$(a-b)^2 + (b-c)^2 + (c-a)^2 = 0$$

If $a \neq b \neq c$

$(a-b)^2 > 0,\ (b-c)^2 > 0,\ (c-a)^2 > 0$

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

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

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

Thus $a = b = c$ Hence Proved

125. If the roots of the quadratic equation $(c^2 - ab)x^2 - 2(a^2 - bc)x + b^2 - ac = 0$ in x are equal then show that either $a = 0$ or $a^3 + b^3 + c^3 = 3abc$

Ans : [Board Term-2 OD 2017]

We have $\quad (c^2 - ab)x^2 - 2(a^2 - bc)x + b^2 - ac = 0$

Comparing with $Ax^2 + Bx + C = 0$ we get

$A = (c^2 - ab), B = (a^2 - bc), C = (b^2 - ac)$

If roots are equal, $B^2 - 4AC = 0$

$$[2(a^2 - bc)]^2 - 4(c^2 - ab)(b^2 - ac) = 0$$

$$4[a^4 + b^2c^2 - 2a^2bc] - 4(b^2c^2 - c^3a - ab^3 - a^2bc) = 0$$

$$4[a^4 + b^2c^2 - 2a^2bc - b^2c^2 + c^3a + ab^3 - a^2bc] = 0$$

$$4[a^4 + ac^3 + ab^3 - 3a^2bc] = 0$$

$$a(a^3 + c^3 + b^3 - 3abc) = 0$$

$$a = 0 \text{ or } a^3 + b^3 + c^3 = 3abc$$

d223

126. Solve for x : $\dfrac{1}{a+b+x} = \dfrac{1}{a} + \dfrac{1}{b} + \dfrac{1}{x}$

where $a + b + x \neq 0$ and $a, b, x \neq 0$

Ans : [Board Term-2 Foreign 2017]

We have $$\frac{1}{a+b+x} - \frac{1}{x} = \frac{1}{a} + \frac{1}{b}$$

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$$\frac{-(a+b)}{x^2+(a+b)x} = \frac{b+a}{ab}$$

$$x^2+(a+b)x+ab = 0$$

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

$$x = -a, x = -b$$

Hence $x = -a, -b$

127. Check whether the equation $5x^2-6x-2=0$ has real roots if it has, find them by the method of completing the square. Also verify that roots obtained satisfy the given equation.

Ans : [Board Term-2 SQP 2017]

We have $5x^2-6x-2=0$

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

$$a=5, b=(-6) \text{ and } c=(-2)$$

$$b^2-4ac = (-6)^2-4\times5\times-2$$

$$= 36+40 = 76 > 0$$

So the equation has real and two distinct roots.

$$5x^2-6x = 2$$

Dividing both the sides by 5 we get

$$\frac{x^2}{5}-\frac{6}{5}x = \frac{2}{5}$$

$$x^2-2x\left(\frac{3}{5}\right) = \frac{2}{5}$$

Adding square of the half of coefficient of x

$$x^2-2x\left(\frac{3}{5}\right)+\frac{9}{25} = \frac{2}{5}+\frac{9}{25}$$

$$\left(x-\frac{3}{5}\right)^2 = \frac{19}{25}$$

$$x-\frac{3}{5} = \pm\frac{\sqrt{19}}{5}$$

$$x = \frac{3+\sqrt{19}}{5} \text{ or } \frac{3-\sqrt{19}}{5}$$

Verification :

$$5\left[\frac{3+\sqrt{19}}{5}\right]^2-6\left[\frac{3+\sqrt{19}}{5}\right]-2$$

$$= \frac{9+6\sqrt{19}+19}{5}-\left(\frac{18+6\sqrt{19}}{5}\right)-2$$

$$= \frac{28+6\sqrt{19}}{5}-\frac{18+6\sqrt{19}}{5}-2$$

$$= \frac{28+6\sqrt{19}-18-6\sqrt{19}-10}{5}$$

$$= 0$$

Similarly

$$5\left[\frac{3-\sqrt{19}}{5}\right]^2-6\left[\frac{3-\sqrt{19}}{5}\right]-2 = 0$$

Hence verified.

CASE STUDY QUESTIONS

128. Riya has a lawn with a flowerbed and grass land. The grass land is in the shape of rectangle while flowerbed is in the shape of square. The length of the grassland is found to be 3 m more than twice the length of the flowerbed. Total area of the whole lawn is 1260 m^2.

(i) If the length of the flowerbed is x m then what is the total length of the lawn ?
- (a) $(2x+3)$ m
- (b) $(3x+3)$ m
- (c) $6x$ m
- (d) $(2x+5)$ m

(ii) What will be the perimeter of the whole field?
- (a) $(8x+6)$ m
- (b) $(6x+8)$ m
- (c) $(4x+3)$ m
- (d) $(4x+3)$ m

(iii) What is the value of x if the area of total lawn is 1260 m^2?
- (a) 21 m
- (b) 10 m
- (c) 20 m
- (d) 15 m

(iv) What is the area of grassland ?
- (a) 180 m^2
- (b) 360 m^2
- (c) 400 m^2
- (d) 860 m^2

(v) What is the ratio of area of flowerbed to area of grassland ?
- (a) $\frac{20}{43}$
- (b) $\frac{23}{40}$
- (c) $\frac{26}{43}$
- (d) $\frac{23}{46}$

Ans :

(i) The length of the grassland is 3 m more than twice the length of the flowerbed. Thus it will be $2x+3$. Now the total length of field is $2x+3+x=3x+3$.

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a. Thus (b) is correct option.

(ii)Perimeter $= 2(3x+3+x)$

$= 2(4x+3) = (8x+6)$

Thus (a) is correct option.

(iii) We have

$$A = (3x+3)x$$
$$1260 = 3x^2+3x$$
$$420 = x^2+x$$
$$x^2+x-420 = 0$$
$$(x+21)(x-20) = 0$$

Thus, $x=20$ is only possible value.

Thus (c) is correct option.

(iv) Area of grassland,

$$A_g = (2x+3)x$$
$$= (2\times 20+3)20$$
$$= 860\text{ m}^2$$

Thus (d) is correct option.

(v) Area of flowerbed,

$$A_f = x^2 = 20^2 = 400\text{ m}^2$$

$$\text{Ratio} = \frac{400}{860} = \frac{20}{43}$$

Thus (a) is correct option.

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

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

(i) Let speed of the current be x km/hr. then speed of the motorboat in upstream will be
(a) 20 km/hr (b) $(20+x)$ km/hr
(c) $(20-x)$ km/hr (d) 2 km/hr

(ii) What is the relation between speed distance and time?
(a) speed = (distance)/time
(b) distance = (speed)/time
(c) time = speed × distance
(d) none of these

(iii) Which is the correct quadratic equation for the speed of the current ?
(a) $x^2+30x-200=0$ (b) $x^2+20x-400=0$
(c) $x^2+30x-400=0$ (d) $x^2-20x-400=0$

(iv) What is the speed of current ?
(a) 20 km/hour (b) 10 km/hour
(c) 15 km/hour (d) 25 km/hour

(v) How much time boat took in downstream ?
(a) 90 minute (b) 15 minute
(c) 30 minute (d) 45 minute

Ans :

(i) In this case speed of the motorboat in upstream will be $(20-x)$ km/hr.
Thus (c) is correct option.
(ii) distance = (speed)/time
Thus (b) is correct option.
(iii) As per question,

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

Thus (c) is correct option.

(iv) We have

$$x^2+30x-400 = 0$$
$$x^2+40x-10x-400 = 0$$
$$x(x+40)-10x(x+40) = 0$$
$$(x+40)(x-10) = 0$$
$$x = 10, -40$$

Here $x=10$ is only possible.

Thus (b) is correct option.
(v) In downstream speed of boat $= 20+10 = 30$ km/hr
Time take to cover distance 15 km will be 30 minutes.
Thus (c) is correct option.

130. Nidhi and Ria are very close friends. Nidhi's parents own a Maruti Alto. Ria's parents own a Toyota Liva. Both the families decide to go for a picnic to Somnath

d402

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temple in Gujrat by their own cars.

Nidhi's car travels x km/h while Ria's car travels 5 km/h more than Nidhi's car. Nidhi's car took 4 hrs more than Ria's car in covering 400 km.

d403

(i) What will be the distance covered by Ria's car in two hour?

(a) $2(x+5)$ km (b) $(x-5)$ km

(c) $2(x+10)$ km (d) $(2x+5)$ km

(ii) Which of the following quadratic equation describe the speed of Nidhi's car?

(a) $x^2-5x-500=0$ (b) $x^2+4x-400=0$

(c) $x^2+5x-500=0$ (d) $x^2-4x+400=0$

(iii) What is the the speed of Nidhi's car?

(a) 20 km/hour (b) 15 km/hour

(c) 25 km/hour (d) 10 km/hour

(iv) How much time did Ria take to travel 400 km?

(a) 20 hour (b) 40 hour

(c) 25 hour (d) 16 hour

(iv) How much time did Nidhi take to travel 400 km?

(a) 20 hour (b) 40 hour

(c) 25 hour (d) 18 hour

Ans :

(i) Nidhi's car travels x km/h while Ria's car travels 5 km/h more than Nidhi's car. Thus Ria's car speed is $x+5$ km/hour. Distance covered in two hour is $2(x+5)$.

Thus (a) is correct option.

(ii) As per question,

$$\frac{400}{x} = \frac{400}{x+5}+4$$

$$400(x+5) = 400x+4x(x+5)$$

$$2000 = 4x^2+20x$$

$$500 = x^2+5x$$

$$x^2+5x-500 = 0$$

Thus (c) is correct option.

(iii) We have $x^2+5x-500 = 0$

$$x^2+25x-20x-500 = 0$$

$$x(x+25)-20(x+25) = 0$$

$$(x+25)(x-20) = 0$$

$$x = 20, -25$$

Since $x = -25$ is not possible, we get $x = 20$

Thus (a) is correct option.

(iv) Rias car speed $= 20+5 = 25$ km/hour

$$\text{Time taken} = \frac{400}{25} = 16 \text{ hour}$$

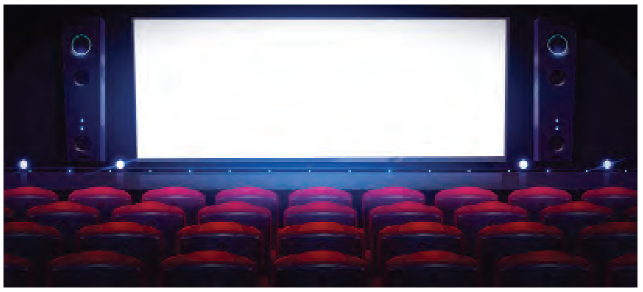
Thus (d) is correct option.

(v) Time Taken by Nidhi $16+4=20$ Hours

Thus (a) is correct option.

131. Auditorium, the part of a public building where an audience sits, as distinct from the stage, the area on which the performance or other object of the audience's attention is presented. In a large theatre an auditorium includes a number of floor levels frequently designed as stalls, private boxes, dress circle, balcony or upper circle, and gallery. A sloping floor allows the seats to be arranged to give a clear view of the stage. The walls and ceiling usually contain concealed light and sound equipment and air extracts or inlets and may be highly decorated.

d404



In an auditorium, seats are arranged in rows and columns. The number of rows are equal to the number of seats in each row. When the number of rows are doubled and the number of seats in each row is reduced by 10, the total number of seats increases by 300.

(i) If x is taken as number of row in original arrangement which of the following quadratic equation describes the situation ?

(a) $x^2-20x-300=0$ (b) $x^2+20x-300=0$

(c) $x^2-20x+300=0$ (d) $x^2+20x+300=0$

(ii) How many number of rows are there in the original arrangement?

(a) 20 (b) 40

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(c) 10 (d) 30

(iii) How many number of seats are there in the auditorium in original arrangement ?

(a) 725 (b) 400

(c) 900 (d) 680

(iv) How many number of seats are there in the auditorium after re-arrangement.

(a) 860 (b) 990

(c) 1200 (d) 960

(v) How many number of columns are there in the auditorium after re-arrangement?

(a) 42 (b) 20

(c) 25 (d) 32

Ans :

(i) Since number of rows are equal to the number of seats in each row in original arrangement, total seats are x^2.

In new arrangement row are $2x$ and seats in each row are $x-10$. Hence total $2x(x-10)$ seats are there.

Total seats are 300 more than previous seats so total number of seats are x^2+300.

Thus $2x(x-10) = x^2+300$

$$2x^2-20x = x^2+300$$

$$x^2-20x-300 = 0$$

Thus (a) is correct option.

(ii) We have $x^2-20x-300 = 0$

$$x^2-30x+10x-300 = 0$$

$$x(x-30)+10(x-30) = 0$$

$$(x-30)(x+10) = 0 \Rightarrow x = 30, -10$$

Thus (d) is correct option.

(iii) Number of seats in original arrangement,

$$x^2 = 30^2 = 900$$

Thus (c) is correct option.

(iv) Total seats in rearrangement $= 30^2+300$

$$= 900+300 = 1200$$

Thus (c) is correct option.

(v) Number of row are 30 in original arrangement. In rearrangement number of rows are $2\times 30 = 60$.

Number of Column after rearrangement,

$$= \frac{\text{Total seats}}{\text{Row}} = \frac{1200}{60} = 20 \text{ Column}$$

Thus (b) is correct option.

132. Raju and his classmates planned a picnic in zoo. The total budget for picnic was Rs 2000 but 5 students failed to attend the picnic and thus the contribution for each student was increased by Rs 20.

The expanse of different item was as follows.

S. No.	Article	Cost per student
1	Entry ticket	Rs 5
2	Coffee	Rs 10
3	Food	Rs 25
4	Travelling cost	Rs 50
5	Ice-cream	Rs 15

d405

(i) If x is the number of students planned for picnic, which is the correct quadratic equation that describe the situation.

(a) $x^2-5x-500=0$ (b) $x^2+4x-400=0$

(c) $x^2+5x-500=0$ (d) $x^2-4x+400=0$

(ii) What is the number of students planned for picnic ?

(a) 30 (b) 40

(c) 25 (d) 20

(iii) What is the number of students who attended the picnic?

(a) 20 (b) 40

(c) 15 (d) 25

(iv) What is the total expanse for this picnic ?

(a) Rs 1500 (b) Rs 2000

(c) Rs 1000 (d) Rs 2100

(v) How much money they spent for travelling ?

(a) Rs 500 (b) Rs 1000

(c) Rs 800 (d) Rs 3750

Ans :

(i) We have $\frac{2000}{x}+20 = \frac{2000}{x-5}$

$$2000(x-5)+20x(x-5) = 2000x$$

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$$-10000 + 20x^2 - 100x = 0$$

$$x^2 - 5x - 500 = 0$$

Thus (a) is correct option.

(ii) We have $x^2 - 5x - 500 = 0$

$$x^2 - 25x + 20x - 500 = 0$$

$$x(x-25) + 20(x-25) = 0$$

$$(x-25)(x+20) = 0$$

$$x = 25, -20$$

Thus (c) is correct option.

(iii) $x = 25 - 5 = 20$ Students attended picnic

Thus (a) is correct option.

(iv) Expanse per student $= 5 + 10 + 25 + 50 + 15$

$$= 105$$

Total expanse, $105 \times 20 = 2100$

Thus (d) is correct option.

(v) Expanse on travelling $50 \times 20 = 1000$

Thus (b) is correct option.

133. Optimal pricing strategy : The director of the Blue Rose Theatre must decide what to charge for a ticket to the comedy drama. If the price is set too low, the theatre will lose money; and if the price is too high, people won't come. From past experience she estimates that the profit P from sales (in hundreds) can be approximated by $P(x) = -x^2 + 22x - 40$ where x is the cost of a ticket and $0 \leq x \leq 25$ hundred rupees.

(i) What is the lowest cost of a ticket that would allow the theatre to break even?
   (a) Rs 3 hundred
   (b) Rs 4 hundred
   (c) Rs 2 hundred
   (d) Rs 1 hundred

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(ii) What is the highest cost that the theatre can charge to break even?
   (a) Rs 16 hundred (b) Rs 14 hundred
   (c) Rs 4 hundred (d) Rs 20 hundred

(iii) If theatre charge Rs 4 hundred for each ticket, what is the profit/loss ?
   (a) Loss Rs 1600 (b) Profit Rs 1600
   (c) Loss Rs 3200 (d) Profit Rs 3200

(iv) If theatre charge Rs 25 hundred for each ticket, what is the profit/loss ?
   (a) Loss Rs 11500 (b) Profit Rs 8500
   (c) Loss Rs 8500 (d) Profit Rs 11500

(v) What is the maximum profit which can be earned by theatre ?
   (a) Rs 4000 (b) Rs 8100
   (c) Rs 6100 (d) Rs 4200

Ans :

(i) At break even $P(x) = 0$, thus

$$-x^2 + 22x - 40 = 0$$

$$x^2 - 22x + 40 = 0$$

$$(x-2)(x-20) = 0 \Rightarrow x = 2, 20$$

Thus (c) is correct option.

(ii) Theatre can charge Rs 20 hundred also. This is also break even point.

Thus (d) is correct option.

(iii) At, $x = 4$, we have

$$P(2) = -(4)^2 + 22 \times 4 - 40 = 32$$

Thus (d) is correct option.

(iv) At, $x = 25$, we have

$$P(5) = -(25)^2 + 22 \times 25 - 40 = -115$$

Thus (a) is correct option.

(v) We have $P(x) = -x^2 + 22x - 40$

Rearranging the profit equation we have

$$P(x) = -(x^2 - 22x + 121 - 81)$$

$$= -(x-11)^2 + 81$$

From above equation it is clear that maximum value of above equation is 81.

Thus (b) is correct option.

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