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10th – MATHEMATICS

Last minute study questions

Important questions – 2024 -25

Example 1.1 If $A = \{1,3,5\}$ and $B = \{2,3\}$ then (i) find $A \times B$ and $B \times A$. (ii) Is $A \times B = B \times A$? If not why? (iii) Show that $n(A \times B) = n(B \times A) = n(A) \times n(B)$

Example 1.2 If $A \times B = \{(3,2), (3,4), (5,2), (5,4)\}$ then find A and B.

Example 1.3 Let $A = \{x \in \mathbb{N} \mid 1 < x < 4\}$, $B = \{x \in \mathbb{W} \mid 0 \leq x < 2\}$ and $C = \{x \in \mathbb{N} \mid x < 3\}$. Then verify that

(i) $A \times (B \cup C) = (A \times B) \cup (A \times C)$ (ii) $A \times (B \cap C) = (A \times B) \cap (A \times C)$

2. Let $A = \{1,2,3\}$ and $B = \{x \mid x$ is a prime number less than $10\}$. Find $A \times B$ and $B \times A$.

3. If $B \times A = \{(-2,3),(-2,4),(0,3),(0,4),(3,3),(3,4)\}$ find A and B.

4. If $A = \{5,6\}$, $B = \{4,5,6\}$, $C = \{5,6,7\}$, Show that $A \times A = (B \times B) \cap (C \times C)$.

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6. Let $A = \{x \in \mathbb{W} \mid x < 2\}$, $B = \{x \in \mathbb{N} \mid 1 < x \leq 4\}$ and $C = \{3,5\}$. Verify that

(i) $A \times (B \cup C) = (A \times B) \cup (A \times C)$ (ii) $A \times (B \cap C) = (A \times B) \cap (A \times C)$

(iii) $(A \cup B) \times C = (A \times C) \cup (B \times C)$

7. Let A = The set of all natural numbers less than 8, B = The set of all prime numbers less than 8, C = The set of even prime number. Verify that

(i) $(A \cap B) \times C = (A \times C) \cap (B \times C)$ (ii) $A \times (B - C) = (A \times B) - (A \times C)$

Example 1.5 The arrow diagram shows (Fig.1.10) a relationship between the sets P and Q. Write the relation in (i) Set builder form (ii) Roster form (iii) What is the domain and range of R.

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2. Let $A=\{1,2,3,4,\ldots,45\}$ and R be the relation defined as "square is of a number" on A. Write R as a subset of $A \times A$. Also, find the domain and range of R.
3. A Relation R is given by the set $\{(x,y) / y=x+3,\ x \in \{0,1,2,3,4,5\}\}$. Determine its domain and range.
4. Represent each of the given relations by (a) an arrow diagram, (b) a graph and (c) a set in roster form, wherever possible.
   (i) $\{(x,y) | x = 2y,\ x \in \{2,3,4,5\},\ y \in \{1,2,3,4\}\}$
   (ii) $\{(x,y) | y = x+3,\ x, y$ are natural numbers $< 10\}$

1.5 Functions

Among several relations that exist between two non-empty sets, some special relations are important for further exploration. Such relations are called "Functions".

Example 1.9 Given $f(x) = 2x - x^2$,
find (i) $f(1)$ (ii) $f(x+1)$ (iii) $f(x) + f(1)$

3. Given the function $f : x \rightarrow x^2 - 5x + 6$, evaluate
   (i) $f(-1)$ (ii) $f(2a)$
   (iii) $f(2)$ (iv) $f(x-1)$
5. Let $f(x) = 2x+5$. If $x \neq 0$ then find $\frac{f(x+2) - f(2)}{x}$.
6. A function f is defined by $f(x) = 2x - 3$
   (i) find $\frac{f(0) + f(1)}{2}$.
   (ii) find x such that $f(x) = 0$.
   (iii) find x such that $f(x) = x$.
   (iv) find x such that $f(x) = f(1-x)$.

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8. A function f is defined by $f(x) = 3 - 2x$. Find x such that $f(x^2) = (f(x))^2$.
9. A plane is flying at a speed of 500 km per hour. Express the distance 'd' travelled by the plane as function of time t in hours.

Example 1.11 Let $A = \{1,2,3,4\}$ and $B = \{2,5,8,11,14\}$ be two sets. Let $f : A \rightarrow B$ be a function given by $f(x) = 3x - 1$. Represent this function
(i) by arrow diagram (ii) in a table form
(iii) as a set of ordered pairs (iv) in a graphical form

1.7 Types of Functions

In this section, we will discuss the following types of functions with suitable examples.

(i) one – one (ii) many – one (iii) onto (iv) into

Example 1.14 If $A=\{-2,-1,0,1,2\}$ and $f:A\to B$ is an onto function defined by $f(x)=x^2+x+1$ then find B.

1.8 Special Cases of Functions

There are some special cases of a function which will be very useful. We discuss some of them below

(i) Constant function (ii) Identity function (iii) Real – valued function

Example 1.18 If the function $f:\mathbb{R}\to\mathbb{R}$ is defined by $f(x)=\begin{cases}2x+7; & x<-2\\ x^2-2; & -2\le x<3\\ 3x-2; & x\ge 3\end{cases}$, then find the values of

(i) $f(4)$ (ii) $f(-2)$ (iii) $f(4)+2f(1)$ (iv) $\dfrac{f(1)-3f(4)}{f(-3)}$

2. Let $f:A\to B$ be a function defined by $f(x)=\dfrac{x}{2}-1$, where $A=\{2,4,6,10,12\}$, $B=\{0,1,2,4,5,9\}$. Represent f by

(i) set of ordered pairs (ii) a table (iii) an arrow diagram (iv) a graph

5. Show that the function $f:\mathbb{N}\to\mathbb{N}$ defined by $f(m)=m^2+m+3$ is one-one function.

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9. If the function f is defined by $f(x)=\begin{cases}x+2; & x>1\\ 2; & -1\le x\le 1\\ x-1; & -3<x<-1\end{cases}$ find the values of

(i) $f(3)$ (ii) $f(0)$ (iii) $f(-1\cdot 5)$ (iv) $f(2)+f(-2)$

10. A function $f:[-5,9]\to\mathbb{R}$ is defined as follows:

$$f(x)=\begin{cases}6x+1; & -5\le x<2\\ 5x^2-1; & 2\le x<6\\ 3x-4; & 6\le x\le 9\end{cases}$$

Find (i) $f(-3)+f(2)$ (ii) $f(7)-f(1)$ (iii) $2f(4)+f(8)$ (iv) $\dfrac{2f(-2)-f(6)}{f(4)+f(-2)}$

Example 1.21 If $f(x)=3x-2$, $g(x)=2x+k$ and if $f\circ g=g\circ f$, then find the value of k.

Example 1.22 Find k if $f\circ f(k)=5$ where $f(k)=2k-1$.

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1. Using the functions f and g given below, find $f \circ g$ and $g \circ f$. Check whether $f \circ g = g \circ f$.

(i) $f(x) = x - 6,\ g(x) = x^2$

(ii) $f(x) = \frac{2}{x},\ g(x) = 2x^2 - 1$

(iii) $f(x) = \frac{x+6}{3},\ g(x) = 3 - x$

(iv) $f(x) = 3 + x,\ g(x) = x - 4$

(v) $f(x) = 4x^2 - 1,\ g(x) = 1 + x$

4. If $f(x) = x^2 - 1,\ g(x) = x - 2$ find a, if $g \circ f(a) = 1$.

10. In electrical circuit theory, a circuit $C(t)$ is called a linear circuit if it satisfies the superposition principle given by $C(at_1 + bt_2) = aC(t_1) + bC(t_2)$, where a, b are constants. Show that the circuit $C(t) = 3t$ is linear.

Example 2.5 Find the greatest number that will divide 445 and 572 leaving remainders 4 and 5 respectively.

Example 2.6 Find the HCF of 396, 504, 636.

Two positive integers are said to be relatively prime or co prime if their Highest Common Factor is 1.

2. A man has 532 flower pots. He wants to arrange them in rows such that each row contains 21 flower pots. Find the number of completed rows and how many flower pots are left over.

7. Find the largest number which divides 1230 and 1926 leaving remainder 12 in each case.

10. Prove that two consecutive positive integers are always coprime.

Example 2.10 'a' and 'b' are two positive integers such that $a^b \times b^a = 800$. Find 'a' and 'b'.

2. If m, n are natural numbers, for what values of m, does $2^n \times 5^m$ ends in 5?

3. Find the HCF of 252525 and 363636.

4. If $13824 = 2^a \times 3^b$ then find a and b.

6. Find the LCM and HCF of 408 and 170 by applying the fundamental theorem of arithmetic.

9. Find the least number that is divisible by the first ten natural numbers.

Example 2.17 A man starts his journey from Chennai to Delhi by train. He starts at 22.30 hours on Wednesday. If it takes 32 hours of travelling time and assuming that the train is not late, when will he reach Delhi?

7. Today is Tuesday. My uncle will come after 45 days. In which day my uncle will be coming?
8. Prove that $2^n + 6 \times 9^n$ is always divisible by 7 for any positive integer n.
9. Find the remainder when 2^{81} is divided by 17.

Example 2.19 Find the next three terms of the sequences

(i) $\frac{1}{2}, \frac{1}{6}, \frac{1}{10}, \frac{1}{14}, \ldots$ (ii) $5, 2, -1, -4, \ldots$ (iii) $1, 0.1, 0.01, \ldots$

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2. Find the first four terms of the sequences whose n^{th} terms are given by

(i) $a_n = n^3 - 2$ (ii) $a_n = (-1)^{n+1} n(n+1)$ (iii) $a_n = 2n^2 - 6$

6. If $a_1 = 1$, $a_2 = 1$ and $a_n = 2a_{n-1} + a_{n-2}$, $n \geq 3$, $n \in \mathbb{N}$, then find the first six terms of the sequence.

Example 2.26 Find the number of terms in the A.P. 3, 6, 9, 12,..., 111.

Example 2.28 If l^{th}, m^{th} and n^{th} terms of an A.P. are x, y, z respectively, then show that

(i) $x(m-n) + y(n-l) + z(l-m) = 0$ (ii) $(x-y)n + (y-z)l + (z-x)m = 0$

Example 2.30 A mother divides ₹207 into three parts such that the amount are in A.P. and gives it to her three children. The product of the two least amounts that the children had ₹4623. Find the amount received by each child.

4. Find the 19^{th} term of an A.P. $-11, -15, -19, \ldots$

5. Which term of an A.P. 16, 11, 6, 1,... is -54?

7. If nine times ninth term is equal to the fifteen times fifteenth term, show that six times twenty fourth term is zero.

8. If $3+k$, $18-k$, $5k+1$ are in A.P. then find k.

12. The ratio of 6^{th} and 8^{th} term of an A.P. is 7:9. Find the ratio of 9^{th} term to 13^{th} term.

Example 2.35 In an A.P. the sum of first n terms is $\frac{5n^2}{2}+\frac{3n}{2}$. Find the 17^{th} term.

Example 2.36 Find the sum of all natural numbers between 300 and 600 which are divisible by 7.

Example 2.38 The houses of a street are numbered from 1 to 49. Senthil's house is numbered such that the sum of numbers of the houses prior to Senthil's house is equal to the sum of numbers of the houses following Senthil's house. Find Senthil's house number?

7. Find the sum of all natural numbers between 602 and 902 which are not divisible by 4.

9. A man repays a loan of ₹65,000 by paying ₹400 in the first month and then increasing the payment by ₹300 every month. How long will it take for him to clear the loan?

12. Find the sum $\left[\frac{a-b}{a+b}+\frac{3a-2b}{a+b}+\frac{5a-3b}{a+b}+\cdots \text{to 12 terms}\right]$.

Example 2.43 In a Geometric progression, the 4^{th} term is $\frac{8}{9}$ and the 7^{th} term is $\frac{64}{243}$. Find the Geometric Progression.

4. Find x so that $x+6$, $x+12$ and $x+15$ are consecutive terms of a Geometric Progression.

8. If a, b, c are in A.P. then show that $3^a, 3^b, 3^c$ are in G.P.

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10. A man joined a company as Assistant Manager. The company gave him a starting salary of ₹60,000 and agreed to increase his salary 5% annually. What will be his salary after 5 years?

Example 2.47 Find the first term of a G.P. in which $S_6 = 4095$ and $r = 4$.

Example 2.50 Find the rational form of the number $0.6666\ldots$

Example 2.51 Find the sum to n terms of the series $5+55+555+\cdots$

4. Find the sum to infinity of (i) $9+3+1+\cdots$ (ii) $21+14+\frac{28}{3}+\cdots$

6. Find the sum to n terms of the series
(i) $0.4+0.44+0.444+\cdots$ to n terms (ii) $3+33+333+\cdots$ to n terms

9. Find the rational form of the number $0.\overline{123}$.

Example 2.57 Find the sum of (i) $1^3+2^3+3^3+\cdots+16^3$ (ii) $9^3+10^3+\cdots+21^3$

3. If $1^3+2^3+3^3+\cdots+k^3=44100$ then find $1+2+3+\cdots+k$.

4. How many terms of the series $1^3+2^3+3^3+\cdots$ should be taken to get the sum 14400?

6. Rekha has 15 square colour papers of sizes 10 cm, 11 cm, 12 cm,..., 24 cm. How much area can be decorated with these colour papers?

Example 3.1 The father's age is six times his son's age. Six years hence the age of father will be four times his son's age. Find the present ages (in years) of the son and father.

Example 3.3 Solve the following system of linear equations in three variables $3x-2y+z=2$, $2x+3y-z=5$, $x+y+z=6$.

Example 3.9 The sum of thrice the first number, second number and twice the third number is 5. If thrice the second number is subtracted from the sum of first number and thrice the third we get 2. If the third number is subtracted from the sum of twice the first, thrice the second, we get 1. Find the numbers.

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1. Solve the following system of linear equations in three variables

(i) $x+y+z=5$; $2x-y+z=9$; $x-2y+3z=16$

(ii) $\frac{1}{x}-\frac{2}{y}+4=0$; $\frac{1}{y}-\frac{1}{z}+1=0$; $\frac{2}{z}+\frac{3}{x}=14$

(iii) $x+20=\frac{3y}{2}+10=2z+5=110-(y+z)$

5. There are 12 pieces of five, ten and twenty rupee currencies whose total value is ₹105. When first 2 sorts are interchanged in their numbers its value will be increased by ₹20. Find the number of currencies in each sort.

Example 3.11 Find the GCD of $6x^3-30x^2+60x-48$ and $3x^3-12x^2+21x-18$.

Example 3.12 Find the LCM of the following

(i) $8x^4y^2$, $48x^2y^4$ (ii) $5x-10$, $5x^2-20$

(iii) x^4-1, x^2-2x+1 (iv) x^3-27, $(x-3)^2$, x^2-9

2. Find the LCM of the given expressions.

(i) $4x^2y,\ 8x^3y^2$ (ii) $9a^3b^2,\ 12a^2b^2c$ (iii) $16m,\ 12m^2n^2,\ 8n^2$

(iv) $p^2-3p+2,\ p^2-4$ (v) $2x^2-5x-3,\ 4x^2-36$

(vi) $(2x^2-3xy)^2, (4x-6y)^3, 8x^3-27y^3$

3. Find the GCD of each pair of the following polynomials

(i) $12(x^4-x^3),\ 8(x^4-3x^3+2x^2)$ whose LCM is $24x^3(x-1)(x-2)$

(ii) $(x^3+y^3), (x^4+x^2y^2+y^4)$ whose LCM is $(x^3+y^3)(x^2+xy+y^2)$

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Example 3.13 Reduce the rational expressions to its lowest form

(i) $\frac{x-3}{x^2-9}$ (ii) $\frac{x^2-16}{x^2+8x+16}$

Example 3.14 Find the excluded values of the following expressions (if any).

(i) $\frac{x+10}{8x}$ (ii) $\frac{7p+2}{8p^2+13p+5}$ (iii) $\frac{x}{x^2+1}$

1. Reduce each of the following rational expressions to its lowest form.

(i) $\frac{x^2-1}{x^2+x}$ (ii) $\frac{x^2-11x+18}{x^2-4x+4}$ (iii) $\frac{9x^2+81x}{x^3+8x^2-9x}$ (iv) $\frac{p^2-3p-40}{2p^3-24p^2+64p}$

1. Simplify

(i) $\frac{4x^2y}{2z^2}\times\frac{6xz^3}{20y^4}$ (ii) $\frac{p^2-10p+21}{p-7}\times\frac{p^2+p-12}{(p-3)^2}$ (iii) $\frac{5t^3}{4t-8}\times\frac{6t-12}{10t}$

3. Simplify

(i) $\frac{2a^2+5a+3}{2a^2+7a+6}\div\frac{a^2+6a+5}{-5a^2-35a-50}$ (ii) $\frac{b^2+3b-28}{b^2+4b+4}\div\frac{b^2-49}{b^2-5b-14}$

(iii) $\frac{x+2}{4y}\div\frac{x^2-x-6}{12y^2}$ (iv) $\frac{12t^2-22t+8}{3t}\div\frac{3t^2+2t-8}{2t^2+4t}$

5. If a polynomial $p(x) = x^2 - 5x - 14$ is divided by another polynomial $q(x)$ we get $\frac{x-7}{x+2}$, find $q(x)$.

3. Subtract $\frac{1}{x^2+2}$ from $\frac{2x^3+x^2+3}{(x^2+2)^2}$

7. Pari needs 4 hours to complete a work. His friend Yuvan needs 6 hours to complete the same work. How long will it take to complete if they work together?

Example 3.19 Find the square root of the following expressions

(i) $256(x-a)^8(x-b)^4(x-c)^{16}(x-d)^{20}$ (ii) $\frac{144\,a^8\,b^{12}\,c^{16}}{81\,f^{12}g^4\,h^{14}}$

1. Find the square root of the following rational expressions.

(i) $\frac{400x^4y^{12}z^{16}}{100x^8y^4z^4}$ (ii) $\frac{7x^2+2\sqrt{14}x+2}{x^2-\frac{1}{2}x+\frac{1}{16}}$ (iii) $\frac{121(a+b)^8(x+y)^8(b-c)^8}{81(b-c)^4(a-b)^{12}(b-c)^4}$

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Example 3.21 Find the square root of $64x^4 - 16x^3 + 17x^2 - 2x + 1$

Example 3.22 If $9x^4 + 12x^3 + 28x^2 + ax + b$ is a perfect square, find the values of a and b.

1. Find the square root of the following polynomials by division method

(i) $x^4 - 12x^3 + 42x^2 - 36x + 9$ (ii) $37x^2 - 28x^3 + 4x^4 + 42x + 9$

(iii) $16x^4 + 8x^2 + 1$ (iv) $121x^4 - 198x^3 - 183x^2 + 216x + 144$

3. Find the values of m and n if the following polynomials are perfect saures

(i) $36x^4 - 60x^3 + 61x^2 - mx + n$ (ii) $x^4 - 8x^3 + mx^2 + nx + 16$

Example 3.25 Find the sum and product of the roots for each of the following quadratic equations : (i) $x^2 + 8x - 65 = 0$ (ii) $2x^2 + 5x + 7 = 0$

(iii) $kx^2 - k^2x - 2k^3 = 0$

1. Determine the quadratic equations, whose sum and product of roots are

(i) $-9,\ 20$ (ii) $\frac{5}{3},\ 4$ (iii) $\frac{-3}{2},\ -1$ (iv) $-(2-a)^2,\ (a+5)^2$

2. Find the sum and product of the roots for each of the following quadratic equations

(i) $x^2 + 3x - 28 = 0$ (ii) $x^2 + 3x = 0$ (iii) $3 + \frac{1}{a} = \frac{10}{a^2}$ (iv) $3y^2 - y - 4 = 0$

Example 3.35 Solve $pqx^2 - (p+q)^2 x + (p+q)^2 = 0$

1. Solve the following quadratic equations by completing the square method

(i) $9x^2 - 12x + 4 = 0$ (ii) $\frac{5x+7}{x-1} = 3x + 2$

4. A girl is twice as old as her sister. Five years hence, the product of their ages (in years) will be 375. Find their present ages.

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8. There is a square field whose side is 10 m. A square flower bed is prepared in its centre leaving a gravel path all round the flower bed. The total cost of laying the flower bed and gravelling the path at ₹3 and ₹4 per square metre respectively is ₹364. Find the width of the gravel path.

9. The hypotenuse of a right angled triangle is 25 cm and its perimeter 56 cm. Find the length of the smallest side.

1. Determine the nature of the roots for the following quadratic equations

(i) $15x^2 + 11x + 2 = 0$ (ii) $x^2 - x - 1 = 0$ (iii) $\sqrt{2}t^2 - 3t + 3\sqrt{2} = 0$

(iv) $9y^2 - 6\sqrt{2}y + 2 = 0$ (v) $9a^2b^2x^2 - 24abcdx + 16c^2d^2 = 0,\ a \neq 0,\ b \neq 0$

Example 3.46 If α, β are the roots of the equation $2x^2 - x - 1 = 0$, then form the equation whose roots are (i) $\frac{1}{\alpha}, \frac{1}{\beta}$ (ii) $\alpha^2\beta,\ \beta^2\alpha$ (iii) $2\alpha + \beta,\ 2\beta + \alpha$

4. If α, β are the roots of $7x^2 + ax + 2 = 0$ and if $\beta - \alpha = \frac{-13}{7}$. Find the values of a.

Example 3.47 Varshika drew 6 circles with different sizes. Draw a graph for the relationship between the diameter and circumference (approximately related) of each circle as shown in the table and use it to find the circumference of a circle when its diameter is 6 cm.

Diameter (x) cm	1	2	3	4	5
Circumference (y) cm	3.1	6.2	9.3	12.4	15.5

3. Graph the following linear function $y = \frac{1}{2}x$. Identify the constant of variation and verify it with the graph. Also (i) find y when $x = 9$ (ii) find x when $y = 7.5$.

4. The following table shows the data about the number of pipes and the time taken to fill the same tank.

No. of pipes (x)	2	3	6	9
Time Taken (in min) (y)	45	30	15	10

Draw the graph for the above data and hence

(i) find the time taken to fill the tank when five pipes are used

(ii) Find the number of pipes when the time is 9 minutes.

Example 3.51 Discuss the nature of solutions of the following quadratic equations.

(i) $x^2 + x - 12 = 0$ (ii) $x^2 - 8x + 16 = 0$ (iii) $x^2 + 2x + 5 = 0$

Example 3.52 Draw the graph of $y = 2x^2$ and hence solve $2x^2 - x - 6 = 0$

Example 3.54 Draw the graph of $y = x^2 + x - 2$ and hence solve $x^2 + x - 2 = 0$.

Example 3.55 Draw the graph of $y = x^2 - 4x + 3$ and use it to solve $x^2 - 6x + 9 = 0$

1. Graph the following quadratic equations and state their nature of solutions.

(i) $x^2 - 9x + 20 = 0$ (ii) $x^2 - 4x + 4 = 0$ (iii) $x^2 + x + 7 = 0$

(iv) $x^2 - 9 = 0$ (v) $x^2 - 6x + 9 = 0$ (vi) $(2x - 3)(x + 2) = 0$

2. Draw the graph of $y = x^2 - 4$ and hence solve $x^2 - x - 12 = 0$

6. Draw the graph of $y = x^2 - 5x - 6$ and hence solve $x^2 - 5x - 14 = 0$

7. Draw the graph of $y = 2x^2 - 3x - 5$ and hence solve $2x^2 - 4x - 6 = 0$

Example 3.58 Construct a 3×3 matrix whose elements are $a_{ij} = i^2 j^2$

5. If $A = \begin{pmatrix} \sqrt{7} & -3 \\ -\sqrt{5} & 2 \\ \sqrt{3} & -5 \end{pmatrix}$ then find the transpose of $-A$.

6. If $A = \begin{pmatrix} 5 & 2 & 2 \\ -\sqrt{17} & 0.7 & \frac{5}{2} \\ 8 & 3 & 1 \end{pmatrix}$ then verify $(A^T)^T = A$

7. Find the values of x, y and z from the following equations

(i) $\begin{pmatrix} 12 & 3 \\ x & 5 \end{pmatrix} = \begin{pmatrix} y & z \\ 3 & 5 \end{pmatrix}$ (ii) $\begin{pmatrix} x+y & 2 \\ 5+z & xy \end{pmatrix} = \begin{pmatrix} 6 & 2 \\ 5 & 8 \end{pmatrix}$ (iii) $\begin{pmatrix} x+y+z \\ x+z \\ y+z \end{pmatrix} = \begin{pmatrix} 9 \\ 5 \\ 7 \end{pmatrix}$

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6. Find x and y if $x\begin{pmatrix} 4 \\ -3 \end{pmatrix} + y\begin{pmatrix} -2 \\ 3 \end{pmatrix} = \begin{pmatrix} 4 \\ 6 \end{pmatrix}$

8. Solve for x, y : $\begin{pmatrix} x^2 \\ y^2 \end{pmatrix} + 2\begin{pmatrix} -2x \\ -y \end{pmatrix} = \begin{pmatrix} 5 \\ 8 \end{pmatrix}$

Example 3.69 If $A = \begin{pmatrix} 2 & -2\sqrt{2} \\ \sqrt{2} & 2 \end{pmatrix}$ and $B = \begin{pmatrix} 2 & 2\sqrt{2} \\ -\sqrt{2} & 2 \end{pmatrix}$

Example 3.73 If $A = \begin{pmatrix} 1 & 2 & 1 \\ 2 & -1 & 1 \end{pmatrix}$ and $B = \begin{pmatrix} 2 & -1 \\ -1 & 4 \\ 0 & 2 \end{pmatrix}$ show that $(AB)^T = B^T A^T$

8. If $A = \begin{pmatrix} \cos\theta & 0 \\ 0 & \cos\theta \end{pmatrix}$, $B = \begin{pmatrix} \sin\theta & 0 \\ 0 & \sin\theta \end{pmatrix}$ then show that $A^2 + B^2 = I$.

9. If $A = \begin{pmatrix} \cos\theta & \sin\theta \\ -\sin\theta & \cos\theta \end{pmatrix}$ prove that $AA^T = I$.

12. If $A = \begin{pmatrix} 5 & 2 & 9 \\ 1 & 2 & 8 \end{pmatrix}$, $B = \begin{pmatrix} 1 & 7 \\ 1 & 2 \\ 5 & -1 \end{pmatrix}$ verify that $(AB)^T = B^T A^T$

13. If $A = \begin{pmatrix} 3 & 1 \\ -1 & 2 \end{pmatrix}$ show that $A^2 - 5A + 7I_2 = 0$

Example 4.6 In Fig.4.21, QA and PB are perpendiculars to AB. If $AO = 10$ cm, $BO = 6$ cm and $PB = 9$ cm. Find AQ.

3. A vertical stick of length 6 m casts a shadow 400 cm long on the ground and at the same time a tower casts a shadow 28 m long. Using similarity, find the height of the tower.

12. Construct a triangle similar to a given triangle ABC with its sides equal to $\frac{6}{5}$ of the corresponding sides of the triangle ABC (scale factor $\frac{6}{5} > 1$).

13. Construct a triangle similar to a given triangle PQR with its sides equal to $\frac{7}{3}$ of the corresponding sides of the triangle PQR (scale factor $\frac{7}{3} > 1$).

Theorem 1: Basic Proportionality Theorem (BPT) or Thales theorem

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Theorem 3: Angle Bisector Theorem

Example 4.15 In the Fig.4.39, AD is the bisector of $\angle A$. If $BD = 4$ cm, $DC = 3$ cm and $AB = 6$ cm, find AC.

Example 4.16 In the Fig. 4.40, AD is the bisector of $\angle BAC$, if $AB = 10$ cm, $AC = 14$ cm and BC = 6 cm. Find BD and DC.

A

Example 4.18 Construct a triangle ΔPQR such that $QR = 5$ cm, $\angle P = 30°$ and the altitude from P to QR is of length 4.2 cm.

Example 4.19 Draw a triangle ABC of base $BC = 8$ cm, $\angle A = 60°$ and the bisector of $\angle A$ meets BC at D such that $BD = 6$ cm.

1. In ΔABC, D and E are points on the sides AB and AC respectively such that $DE \parallel BC$ (i) If $\frac{AD}{DB} = \frac{3}{4}$ and $AC = 15$ cm find AE.

   (ii) If $AD = 8x - 7$, $DB = 5x - 3$, $AE = 4x - 3$ and $EC = 3x - 1$, find the value of x.

2. ABCD is a trapezium in which $AB \parallel DC$ and P, Q are points on AD and BC respectively, such that $PQ \parallel DC$ if $PD = 18$ cm, $BQ = 35$ cm and $QC = 15$ cm, find AD.

8. Check whether AD is bisector of $\angle A$ of ΔABC in each of the following

(i) $AB = 5$ cm, $AC = 10$ cm, $BD = 1.5$ cm and $CD = 3.5$ cm.

(ii) $AB = 4$ cm, $AC = 6$ cm, $BD = 1.6$ cm and $CD = 2.4$ cm.

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11. Construct a ΔPQR which the base $PQ = 4.5$ cm, $\angle R = 35°$ and the median RG from R to PQ is 6 cm.

12. Construct a ΔPQR in which $QR = 5$ cm, $\angle P = 40°$ and the median PG from P to QR is 4.4 cm. Find the length of the altitude from P to QR.

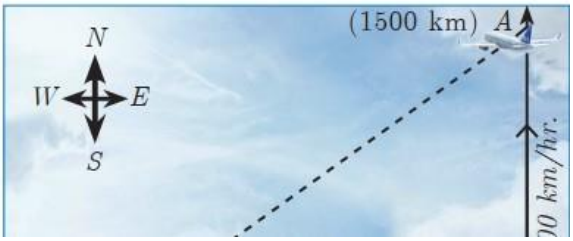
13. Construct a ΔPQR such that $QR = 6.5$ cm, $\angle P = 60°$ and the altitude from P to QR is of length 4.5 cm.

14. Construct a ΔABC such that $AB = 5.5$ cm, $\angle C = 25°$ and the altitude from C to AB is 4 cm.

Theorem 5 : Pythagoras Theorem

In India, Pythagoras Theorem is also referred as "Baudhayana Theorem".

Example 4.23 An Aeroplane after take off from an airport and flies due north at a speed of 1000 km/hr. At the same time, another aeroplane take off from the same airport and flies due west at a speed of 1200 km/hr. How far apart will be the two planes after 1½ hours?



1. A man goes 18 m due east and then 24 m due north. Find the distance of his current position from the starting point?

5. The hypotenuse of a right triangle is 6 m more than twice of the shortest side. If the third side is 2 m less than the hypotenuse, find the sides of the triangle.

The word "tangent" comes from the latin word "tangere" which means "to touch" and was introduced by Danish mathematician, 'Thomas Fineko' in 1583.

Example 4.28 If radii of two concentric circles are 4 cm and 5 cm then find the length of the chord of one circle which is a tangent to the other circle.

Example 4.31 Draw a circle of diameter 6 cm from a point P, which is 8 cm away from its centre. Draw the two tangents PA and PB to the circle and measure their lengths.

Example 4.32 Show that in a triangle, the medians are concurrent.

1. The length of the tangent to a circle from a point P, which is 25 cm away from the centre is 24 cm. What is the radius of the circle?

7. In two concentric circles, a chord of length 16 cm of larger circle becomes a tangent to the smaller circle whose radius is 6 cm. Find the radius of the larger circle.

9. Show that the angle bisectors of a triangle are concurrent.

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12. Draw a circle of radius 4.5 cm. Take a point on the circle. Draw the tangent at that point using the alternate segment theorem.
13. Draw the two tangents from a point which is 10 cm away from the centre of a circle of radius 5 cm. Also, measure the lengths of the tangents.
14. Take a point which is 11 cm away from the centre of a circle of radius 4 cm and draw the two tangents to the circle from that point.
15. Draw the two tangents from a point which is 5 cm away from the centre of a circle of diameter 6 cm. Also, measure the lengths of the tangents.

Example 5.2 Show that the points $P(-1.5, 3)$, $Q(6, -2)$, $R(-3, 4)$ are collinear.

Example 5.3 If the area of the triangle formed by the vertices $A(-1, 2)$, $B(k, -2)$ and $C(7, 4)$ (taken in order) is 22 sq. units, find the value of k.

Example 5.5 The floor of a hall is covered with identical tiles which are in the shapes of triangles. One such triangle has the vertices at $(-3, 2)$, $(-1, -1)$ and $(1, 2)$. If the floor of the hall is completely covered by 110 tiles, find the area of the floor.

Example 5.6 Find the area of the quadrilateral formed by the points $(8, 6)$, $(5, 11)$, $(-5, 12)$ and $(-4, 3)$.

5. Find the area of the quadrilateral whose vertices are at
(i) (–9, –2), (–8, –4), (2, 2) and (1, –3) (ii) (–9, 0), (–8, 6), (–1, –2) and (–6, –3)

7. If the points $A(-3,9)$, $B(a,b)$ and $C(4,-5)$ are collinear and if $a+b=1$, then find a and b.

Example 5.8 (i) What is the slope of a line whose inclination is $30°$?

(ii) What is the inclination of a line whose slope is $\sqrt{3}$?

Example 5.11 The line p passes through the points $(3,-2)$, $(12,4)$ and the line q passes through the points $(6,-2)$ and $(12,2)$. Is p parallel to q?

3. Find the slope of a line joining the points

(i) $\left(5,\sqrt{5}\right)$ with the origin (ii) $(\sin\theta,-\cos\theta)$ and $(-\sin\theta,\cos\theta)$

5. Show that the given points are collinear: $(-3,-4)$, $(7,2)$ and $(12,5)$

7. The line through the points $(-2,a)$ and $(9,3)$ has slope $-\frac{1}{2}$. Find the value of a.

8. The line through the points $(-2,6)$ and $(4,8)$ is perpendicular to the line through the points $(8,12)$ and $(x,24)$. Find the value of x.

12. Let $A(3,-4)$, $B(9,-4)$, $C(5,-7)$ and $D(7,-7)$. Show that $ABCD$ is a trapezium.

13. A quadrilateral has vertices at $A(-4,-2)$, $B(5,-1)$, $C(6,5)$ and $D(-7,6)$. Show that the mid-points of its sides form a parallelogram.

Example 5.19 Calculate the slope and y intercept of the straight line $8x-7y+6=0$

Example 5.23 Find the equation of a straight line passing through $(5,-3)$ and $(7,-4)$.

Example 5.27 A mobile phone is put to use when the battery power is 100%. The percent of battery power 'y' (in decimal) remaining after using the mobile phone for x hours is assumed as $y=-0.25x+1$

(i) Find the number of hours elapsed if the battery power is 40%.

(ii) How much time does it take so that the battery has no power?

3. Find the equation of a line whose inclination is $30°$ and making an intercept -3 on the Y axis.

8. A cat is located at the point $(-6,-4)$ in xy plane. A bottle of milk is kept at $(5,11)$. The cat wish to consume the milk travelling through shortest possible distance. Find the equation of the path it needs to take its milk.

10. Find the equation of a straight line which has slope $\frac{-5}{4}$ and passing through the point $(-1,2)$.

13. Find the intercepts made by the following lines on the coordinate axes.
(i) $3x-2y-6=0$ (ii) $4x+3y+12=0$

Example 5.30 Find the slope of the straight line $6x+8y+7=0$.

Example 5.33 Show that the straight lines $x-2y+3=0$ and $6x+3y+8=0$ are perpendicular.

Example 5.36 Find the equation of a straight line parallel to Y axis and passing through the point of intersection of the lines $4x+5y=13$ and $x-8y+9=0$.

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Example 5.37 The line joining the points $A(0,5)$ and $B(4,1)$ is a tangent to a circle whose centre C is at the point $(4,4)$ find

(i) the equation of the line AB.

(ii) the equation of the line through C which is perpendicular to the line AB.

(iii) the coordinates of the point of contact of tangent line AB with the circle.

4. If the straight lines $12y=-(p+3)x+12$, $12x-7y=16$ are perpendicular then find 'p'.

5. Find the equation of a straight line passing through the point $P(-5,2)$ and parallel to the line joining the points $Q(3,-2)$ and $R(-5,4)$.

8. Find the equation of the perpendicular bisector of the line joining the points $A(-4,2)$ and $B(6,-4)$.

9. Find the equation of a straight line through the intersection of lines $7x+3y=10$, $5x-4y=1$ and parallel to the line $13x+5y+12=0$

Example 6.1 Prove that $\tan^2\theta-\sin^2\theta=\tan^2\theta\sin^2\theta$

Example 6.5 Prove that $\sqrt{\frac{1+\cos\theta}{1-\cos\theta}}=\operatorname{cosec}\theta+\cot\theta$

Example 6.6 Prove that $\frac{\sec\theta}{\sin\theta}-\frac{\sin\theta}{\cos\theta}=\cot\theta$

Example 6.10 Prove that $\frac{\sin A}{1+\cos A}+\frac{\sin A}{1-\cos A}=2\text{cosec}A.$

Example 6.15 Show that $\left(\frac{1+\tan^2 A}{1+\cot^2 A}\right)=\left(\frac{1-\tan A}{1-\cot A}\right)^2$

Example 6.17 If $\frac{\cos^2\theta}{\sin\theta}=p$ and $\frac{\sin^2\theta}{\cos\theta}=q$, then prove that $p^2q^2(p^2+q^2+3)=1$

2. Prove the following identities.

(i) $\frac{1-\tan^2\theta}{\cot^2\theta-1}=\tan^2\theta$ (ii) $\frac{\cos\theta}{1+\sin\theta}=\sec\theta-\tan\theta$

3. Prove the following identities.

(i) $\sqrt{\frac{1+\sin\theta}{1-\sin\theta}}=\sec\theta+\tan\theta$ (ii) $\sqrt{\frac{1+\sin\theta}{1-\sin\theta}}+\sqrt{\frac{1-\sin\theta}{1+\sin\theta}}=2\sec\theta$

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7. (i) If $\sin\theta+\cos\theta=\sqrt{3}$, then prove that $\tan\theta+\cot\theta=1$.

(ii) If $\sqrt{3}\sin\theta-\cos\theta=0$, then show that $\tan 3\theta=\frac{3\tan\theta-\tan^3\theta}{1-3\tan^2\theta}$

10. If $\frac{\cos\theta}{1+\sin\theta}=\frac{1}{a}$, then prove that $\frac{a^2-1}{a^2+1}=\sin\theta$

Example 6.21 Two ships are sailing in the sea on either sides of a lighthouse. The angle of elevation of the top of the lighthouse as observed from the ships are 30° and 45° respectively. If the lighthouse is 200 m high, find the distance between the two ships. ($\sqrt{3}=1.732$)

Example 6.22 From a point on the ground, the angles of elevation of the bottom and top of a tower fixed at the top of a 30 m high building are 45° and 60° respectively. Find the height of the tower. ($\sqrt{3}=1.732$)

1. Find the angle of elevation of the top of a tower from a point on the ground, which is 30 m away from the foot of a tower of height $10\sqrt{3}$ m.

3. To a man standing outside his house, the angles of elevation of the top and bottom of a window are 60° and 45° respectively. If the height of the man is 180 cm and if he is 5 m away from the wall, what is the height of the window? $(\sqrt{3} = 1.732)$

6. The top of a 15 m high tower makes an angle of elevation of 60° with the bottom of an electronic pole and angle of elevation of 30° with the top of the pole. What is the height of the electric pole?

Example 6.27 The horizontal distance between two buildings is 140 m. The angle of depression of the top of the first building when seen from the top of the second building is 30°. If the height of the first building is 60 m, find the height of the second building. $(\sqrt{3} = 1.732)$

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Example 6.30 A man is watching a boat speeding away from the top of a tower. The boat makes an angle of depression of 60° with the man's eye when at a distance of 200 m from the tower. After 10 seconds, the angle of depression becomes 45°. What is the approximate speed of the boat (in km / hr), assuming that it is sailing in still water? $(\sqrt{3} = 1.732)$

1. From the top of a rock $50\sqrt{3}$ m high, the angle of depression of a car on the ground is observed to be 30°. Find the distance of the car from the rock.

5. From the top of a lighthouse, the angle of depression of two ships on the opposite sides of it are observed to be 30° and 60°. If the height of the lighthouse is h meters and the line joining the ships passes through the foot of the lighthouse, show that the distance between the ships is $\frac{4h}{\sqrt{3}}$ m.

Example 6.32 A pole 5 m high is fixed on the top of a tower. The angle of elevation of the top of the pole observed from a point 'A' on the ground is 60° and the angle of depression to the point 'A' from the top of the tower is 45°. Find the height of the tower. $(\sqrt{3} = 1.732)$

1. From the top of a tree of height 13 m the angle of elevation and depression of the top and bottom of another tree are 45° and 30° respectively. Find the height of the second tree. $(\sqrt{3} = 1.732)$

Example 7.1 A cylindrical drum has a height of 20 cm and base radius of 14 cm. Find its curved surface area and the total surface area.

Example 7.2 The curved surface area of a right circular cylinder of height 14 cm is 88 cm^2. Find the diameter of the cylinder.

Example 7.3 A garden roller whose length is 3 m long and whose diameter is 2.8 m is rolled to level a garden. How much area will it cover in 8 revolutions?

Example 7.5 The radius of a conical tent is 7 m and the height is 24 m. Calculate the length of the canvas used to make the tent if the width of the rectangular canvas is 4 m?

Example 7.6 If the total surface area of a cone of radius 7cm is 704 cm^2, then find its slant height.

Example 7.8 Find the diameter of a sphere whose surface area is 154 m^2.

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Example 7.9 The radius of a spherical balloon increases from 12 cm to 16 cm as air being pumped into it. Find the ratio of the surface area of the balloons in the two cases.

Example 7.10 If the base area of a hemispherical solid is 1386 sq. metres, then find its total surface area?

Example 7.12 A sphere, a cylinder and a cone are of the same height which is equal to its radius, where as cone and cylinder are of same height. Find the ratio of their curved surface areas.

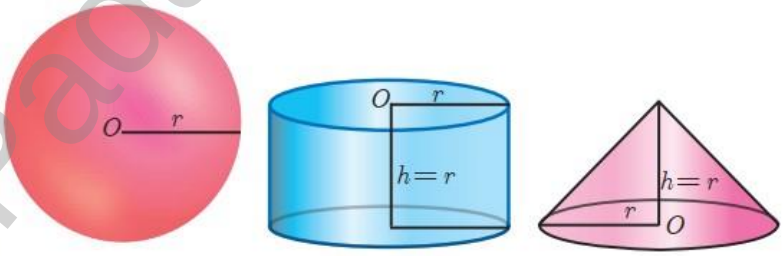
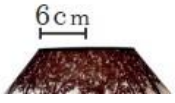


Fig. 7.20

1. The radius and height of a cylinder are in the ratio 5:7 and its curved surface area is 5500 sq.cm. Find its radius and height.

8. The radius of a sphere increases by 25%. Find the percentage increase in its surface area.

9. The internal and external diameters of a hollow hemispherical vessel are 20 cm and 28 cm respectively. Find the cost to paint the vessel all over at ₹ 0.14 per cm^2.



Example 7.15 Find the volume of a cylinder whose height is 2 m and whose base area is 250 m^2.

Example 7.19 The volume of a solid right circular cone is 11088 cm^3. If its height is 24 cm then find the radius of the cone.

Example 7.20 The ratio of the volumes of two cones is 2:3. Find the ratio of their radii if the height of second cone is double the height of the first.

Example 7.21 The volume of a solid hemisphere is 29106 cm^3. Another hemisphere whose volume is two-third of the above is carved out. Find the radius of the new hemisphere.

Example 7.23 If the radii of the circular ends of a frustum which is 45 cm high are 28 cm and 7 cm, find the volume of the frustum.

3. If the circumference of a conical wooden piece is 484 cm then find its volume when its height is 105 cm.

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6. The volumes of two cones of same base radius are 3600 cm^3 and 5040 cm^3. Find the ratio of heights.
7. If the ratio of radii of two spheres is 4:7, find the ratio of their volumes.
10. A container open at the top is in the form of a frustum of a cone of height 16 cm with radii of its lower and upper ends are 8 cm and 20 cm respectively. Find the cost of milk which can completely fill a container at the rate of ₹40 per litre.

Example 7.26 Arul has to make arrangements for the accommodation of 150 persons for his family function. For this purpose, he plans to build a tent which is in the shape of cylinder surmounted by a cone. Each person occupies 4 sq. m of the space on ground and 40 cu. meter of air to breathe. What should be the height of the conical part of the tent if the height of cylindrical part is 8 m?

2. Nathan, an engineering student was asked to make a model shaped like a cylinder with two cones attached at its two ends. The diameter of the model is 3 cm and its length is 12 cm. If each cone has a height of 2 cm, find the volume of the model that Nathan made.

Example 7.29 A metallic sphere of radius 16 cm is melted and recast into small spheres each of radius 2 cm. How many small spheres can be obtained?

Example 7.31 A right circular cylindrical container of base radius 6 cm and height 15 cm is full of ice cream. The ice cream is to be filled in cones of height 9 cm and base radius 3 cm, having a hemispherical cap. Find the number of cones needed to empty the container.

3. A conical flask is full of water. The flask has base radius r units and height h units, the water is poured into a cylindrical flask of base radius xr units. Find the height of water in the cylindrical flask.

8. A hemispherical bowl is filled to the brim with juice. The juice is poured into a cylindrical vessel whose radius is 50% more than its height. If the diameter is same for both the bowl and the cylinder then find the percentage of juice that can be transferred from the bowl into the cylindrical vessel.

Example 8.1 Find the range and coefficient of range of the following data: 25, 67, 48, 53, 18, 39, 44.

Example 8.5 The amount of rainfall in a particular season for 6 days are given as 17.8 cm, 19.2 cm, 16.3 cm, 12.5 cm, 12.8 cm and 11.4 cm. Find its standard deviation.

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Example 8.7 The amount that the children have spent for purchasing some eatables in one day trip of a school are 5, 10, 15, 20, 25, 30, 35, 40. Using step deviation method, find the standard deviation of the amount they have spent.

Example 8.10 Find the mean and variance of the first n natural numbers.

1. Find the range and coefficient of range of the following data.
   (i) 63, 89, 98, 125, 79, 108, 117, 68
   (ii) 43.5, 13.6, 18.9, 38.4, 61.4, 29.8

4. A teacher asked the students to complete 60 pages of a record note book. Eight students have completed only 32, 35, 37, 30, 33, 36, 35 and 37 pages. Find the standard deviation of the pages completed by them.

7. Find the standard deviation of first 21 natural numbers.

15. The mean and variance of seven observations are 8 and 16 respectively. If five of these are 2, 4, 10, 12 and 14, then find the remaining two observations.

5. Find the coefficient of variation of 24, 26, 33, 37, 29, 31.

6. The time taken (in minutes) to complete a homework by 8 students in a day are given by 38, 40, 47, 44, 46, 43, 49, 53. Find the coefficient of variation.

7. The total marks scored by two students Sathya and Vidhya in 5 subjects are 460 and 480 with standard deviation 4.6 and 2.4 respectively. Who is more consistent in performance?

Example 8.19 Two dice are rolled. Find the probability that the sum of outcomes is (i) equal to 4 (ii) greater than 10 (iii) less than 13

Example 8.20 Two coins are tossed together. What is the probability of getting different faces on the coins?

Example 8.21 What is the probability that a leap year selected at random will contain 53 saturdays.

Example 8.22 A die is rolled and a coin is tossed simultaneously. Find the probability that the die shows an odd number and the coin shows a head.

4. A coin is tossed thrice. What is the probability of getting two consecutive tails?

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8. Three fair coins are tossed together. Find the probability of getting
   (i) all heads (ii) atleast one tail
   (iii) atmost one head (iv) atmost two tails

9. A bag contains 5 red balls, 6 white balls, 7 green balls, 8 black balls. One ball is drawn at random from the bag. Find the probability that the ball drawn is
   (i) white (ii) black or red
   (iii) not white (iv) neither white nor black

Example 8.30 In a class of 50 students, 28 opted for NCC, 30 opted for NSS and 18 opted both NCC and NSS. One of the students is selected at random. Find the probability that
   (i) The student opted for NCC but not NSS.
   (ii) The student opted for NSS but not NCC.
   (iii) The student opted for exactly one of them.

Example 8.31 A and B are two candidates seeking admission to IIT. The probability that A getting selected is 0.5 and the probability that both A and B getting selected is 0.3. Prove that the probability of B being selected is atmost 0.8.

6. Two dice are rolled once. Find the probability of getting an even number on the first die or a total of face sum 8.

7. A box contains cards numbered 3, 5, 7, 9, ... 35, 37. A card is drawn at random from the box. Find the probability that the drawn card have either multiples of 7 or a prime number.

11. A coin is tossed thrice. Find the probability of getting exactly two heads or atleast one tail or two consecutive heads.

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