9

PROBABILITY

Probability theory is nothing more than common sense reduced to calculation. - *Pierre Simon Laplace.*

Richard Von Mises
(AD (CE) 1883-1953)

The statistical or empirical, attitude towards probability has been developed mainly by R.F.Fisher and R.Von Mises. The notion of sample space comes from R.Von Mises. This notion made it possible to build up a strictly mathematical theory of probability based on measure theory. Such an approach emerged gradually in the last century under the influence of many authors.

Learning Outcomes

- To understand the basic concepts of probability.
- To understand the classical and empirical approach of probability.
- To familiarise the types of events in probability.

G1RPCP

9.1 Introduction

To understand the notion of probability, we look into some real life situations that involve some traits of uncertainty.

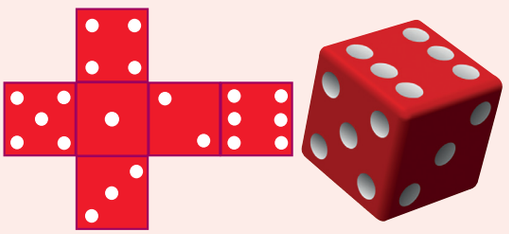
A life-saving drug is administered to a patient admitted in a hospital. The patient's relatives may like to know the probability with which the drug will work; they will be happy if the doctor tells that out of 100 patients treated with the drug, it worked well with more than 80 patients. This percentage of success is illustrative of the concept of probability; it is based on the frequency of occurrence. It helps one to arrive at a conclusion under uncertain conditions. Probability is thus a way of quantifying or measuring uncertainty.

You should be familiar with the usual complete pack of 52 playing cards. It has 4 suits(Hearts ♥, Clubs ♣, Diamonds ♦, Spades♠), each with 13 cards. Choose one of the suits or cards, say spades. Keep these 13 cards facing downwards on the table. Shuffle them well and pick up any one card. What is the chance that it will be a King? Will the chances vary if you do not want a King but an Ace? You will be quick to see that in either case, the chances are 1 in 13 (Why?). It will be the same whatever single card you choose to pick up. The word 'Probability' means precisely the same thing as 'chances' and has the same value, but instead of saying 1 in 13 we write it as a fraction $\frac{1}{13}$. (It would be easy to manipulate with fractions when we combine probabilities). It is 'the ratio of the favourable cases to the total number of possible cases'.

Have you seen a 'dice' ? (Some people use the word 'die' for a single 'dice'; we use 'dice' here, both for the singular and plural cases). A standard dice is a cube, with each side having a different number of spots on it, ranging from one to six, rolled and used in gambling and other games involving chance.

Note

In a fair die the sum of the numbers turning on the opposite sides will always be equal to 7.



If you throw a dice, what is the probability of getting a five? a two? a seven?

In all the answers you got for the questions raised above, did you notice anything special about the concept of probability? Could there be a maximum value for probability? or the least value? If you are sure of a certain occurrence what could be its probability? For a better clarity, we will try to formalize the notions in the following paragraphs.

9.2 Basic Ideas

When we carry out experiments in science repeatedly under identical conditions, we get almost the same result. Such experiments are known as *deterministic*. For example, the experiments to verify Archimedes principle or to verify Ohm's law are *deterministic*. The outcomes of the experiments can be predicted well in advance.

But, there are experiments in which the outcomes may be different even when performed under identical conditions. For example, when a fair dice is rolled, a fair coin is flipped or while selecting the balls from an urn, we cannot predict the exact outcome

of these experiments; these are *random experiments*. Each performance of a random experiment is called a trial and the result of each trial is called an outcome. (*Note: Many statisticians use the words 'experiment' and 'trial' synonymously.*)

Now let us see some of the important terms related to probability.

Trial : Rolling a dice and flipping a coin are trials. A *trial* is an action which results in one or several outcomes.

Outcome : While flipping a coin we get Head or Tail . Head and Tail are called outcomes. The result of the trial is called an *outcome*.

Sample point : While flipping a coin, each outcome H or T are the sample points. Each outcome of a random experiment is called a *sample point*.

Sample space : In a single flip of a coin, the collection of sample points is given by $S = \{H, T\}$.

If two coins are tossed the collection of sample points $S=\{(HH),(HT),(TH),(TT)\}$.

The set of all possible outcomes (or Sample points) of a random experiment is called the *Sample space*. It is denoted by S. The number of elements in it are denoted by $n(S)$.

Event : If a dice is rolled, it shows 4 which is called an outcome (since, it is a result of a single trial). In the same experiment the event of getting an even number is {2,4,6}. So any subset of a sample space is called an *event*. Hence an event can be one or more than one outcome.

For example

(i) Random experiment : Flipping a coin

Possible outcomes : Head(H) or Tail(T)

Sample space : $S = \{H, T\}$

Subset of S : $A=\{H\}$ or $A=\{T\}$

Thus, in this example A is an event.

(ii) When we roll a single dice, the collection of all sample points is $S = \{1,2,3,4,5,6\}$. (iii) When we select a day in a week the collection of sample points is S = {Sunday, Monday, Tuesday, Wednesday, Thursday, Friday, Saturday}.

Activity - 1

Perform the experiment of tossing two coins at a time. List out the following in the above experiment.	Perform the experiment of throwing two dice at a time. List out the following in this experiment also.
Random experiment : Possible outcomes : Sample space : Any three subsets of S : (or any 3 events)	Random experiment : Possible outcomes : Sample space : Any three subsets of S : (or any 3 events)

Activity - 2

Each student is asked to flip a coin 10 times and tabulate the number of heads and tails obtained in the following table.

Number of tosses	Number of times head comes up	Number of times tail comes up
⋮	⋮	⋮

(i) Fraction 1 : $\dfrac{\textit{Number of times head comes up}}{\textit{Total number of times the coin is tossed}}$

(ii) Fraction 2 : $\dfrac{\textit{Number of times tail comes up}}{\textit{Total number of times the coin is tossed}}$

Repeat it by tossing the coin 20, 30, 40, 50 times and find the fractions.

Activity - 3

Divide the class students into groups of pairs. In each pair, the first one tosses a coin 50 times, and the second one records the outcomes of tosses. Then prepare a table given below.

Group	Number of times head comes up	Number of times tail comes up	$\dfrac{\text{Number of times head comes up}}{\text{Total number of times the coin is tossed}}$	$\dfrac{\text{Number of times tail comes up}}{\text{Total number of times the coin is tossed}}$
1				
2				
3				
⋮	⋮	⋮	⋮	⋮

9.3 Classical Approach

The chance of an event happening when expressed quantitatively is probability.

For example, An urn contains 4 Red balls and 6 Blue balls. You choose a ball at random from the urn. What is the probability of choosing a Red ball?

The phrase 'at random' assures you that each one of the 10 balls has the same chance (that is, probability) of getting chosen. You may be blindfolded and the balls may be mixed up for a "fair" experiment. This makes the outcomes "equally likely".

The probability that the Red Ball is chosen is $\frac{4}{10}$ (You may also give it as $\frac{2}{5}$ or 0.4).

What would be the probability for choosing a Blue ball? It is $\frac{6}{10}$ (or $\frac{3}{5}$ or 0.6).

Note that the sum of the two probabilities is 1. This means that no other outcome is possible.

The approach we adopted in the above example is classical. It is calculating a *priori probability*. (The Latin phrase a *priori* means '*without investigation or sensory experience*'). Note that the above treatment is possible only when the outcomes are equally likely.

Thinking Corner

If the probability of success of an experiment is 0.4, what is the probability of failure?

Classical probability is so named, because it was the first type of probability studied formally by mathematicians during the 17th and 18th centuries.

Let S be the set of all equally likely outcomes of a random experiment. (S is called the sample space for the experiment.)

Let E be some particular outcome or combination of outcomes of an experiment. (E is called an event.)

The probability of an event E is denoted as $P(E)$.

$$P(E) = \frac{\text{Number of favourable outcomes}}{\text{Total number of outcomes}} = \frac{n(E)}{n(S)}$$

G21KEC

The empirical approach (relative frequency theory) of probability holds that if an experiment is repeated for an extremely large number of times and a particular outcome occurs at a percentage of the time, then that particular percentage is close to the probability of that outcome.

9.4 Empirical Approach

For example, A manufacturer produces 10,000 electric switches every month and1,000 of them are found to be defective. What is the probability of the manufacturer producing a defective switch every month?

The required probability, according to relative frequency concept, is nearly 1000 out of 10000, which is 0.1

Let us formalize the definition: "If, the total number of trials, say n, we find r of the outcomes in an event E, then the probability of event E, denoted by $P(E)$, is given by

$$P(E) = \frac{r}{n}.$$

Note

The number of trials has to be large to decide this probability. The larger the number of trials, the better will be the estimate of probability.

Is there a guarantee that this value will settle down to a constant value when the number of trials gets larger and larger? One cannot say; the concept being experimental, it is quite possible to get distinct relative frequency each time the experiment is repeated.

However, there is a security range: the value of probability can at the least take the value 0 and at the most take the value 1. We can state this mathematically as

$$0 \leq P(E) \leq 1.$$

Let us look at this in a little detail.

First, we know that r cannot be larger than n.

This means $\frac{r}{n} < 1$. That is $P(E) < 1$. … (1)

Thinking Corner

For a question on probability the student's answer was $\frac{3}{2}$. The teacher told that the answer was wrong. Why?

Next, if $r = 0$, it means either the event cannot happen or has not occurred in a large number of trials. (Can you get a 7, when you roll a dice?).

Thus , in this case $\frac{r}{n} = \frac{0}{n} = 0$. … (2)

Lastly, if $r = n$, the event must occur (in every trial or in a large number of trials).

In such a situation, $\frac{r}{n} = \frac{n}{n} = 1$. … (3)
(getting any number from 1 to 6 when you roll a dice)

From (1), (2) and (3) we find $0 \leq P(E) \leq 1$.

Progress Check

A random experiment was conducted. Which of these cannot be considered as a probability of an outcome?

(i) 1/5 (ii) – 1/7 (iii) 0.40 (iv) – 0.52 (v) 0

(vi) 1.3 (vii) 1 (viii) 72% (ix) 107%

Example 9.1

When a dice is rolled, find the probability to get the number which is greater than 4?

Solution

The outcomes $S = \{1,2,3,4,5,6\}$

Let E be the event of getting a number greater than 4

$E = \{5,6\}$

$$P(E) = \frac{\text{Number of favourable outcomes}}{\text{Total number of outcomes}}$$

$$P(E) = \frac{n(E)}{n(S)} = \frac{2}{6} = 0.333...$$

G2AGFZ

Example 9.2

In an office, where 42 staff members work, 7 staff members use cars, 20 staff members use two-wheelers and the remaining 15 staff members use cycles. Find the relative frequencies.

Solution

Total number of staff members = 42.

The relative frequencies:

$$\text{Car users} = \frac{7}{42} = \frac{1}{6}$$

$$\text{Two-wheeler users} = \frac{20}{42} = \frac{10}{21}$$

$$\text{Cycle users} = \frac{15}{42} = \frac{5}{14}$$

In this example note that the total probability does not exceed 1 that is,

$$\frac{1}{6} + \frac{10}{21} + \frac{5}{14} = \frac{7}{42} + \frac{20}{42} + \frac{15}{42} = 1$$

Example 9.3

Team I and Team II play 10 cricket matches each of 20 overs. Their total scores in each match are tabulated in the table as follows:

Match numbers	1	2	3	4	5	6	7	8	9	10
Team I	200	122	111	88	156	184	99	199	121	156
Team II	143	123	156	92	164	72	100	201	98	157

What is the relative frequency of Team I winning?

Solution

In this experiment, each trial is a match where Team I faces Team II.

We are concerned about the winning status of Team I.

There are 10 trials in total; out of which Team I wins in the 1st, 6th and 9th matches.

The relative frequency of Team I winning the matches $= \frac{3}{10}$ or 0.3.

(**Note :** The relative frequency depends on the sequence of outcomes that we observe during the course of the experiment).

Exercise 9.1

1. You are walking along a street. If you just choose a stranger crossing you, what is the probability that his next birthday will fall on a sunday?

2. What is the probability of drawing a King or a Queen or a Jack from a deck of cards?

3. What is the probability of throwing an even number with a single standard dice of six faces?

4. There are 24 balls in a pot. If 3 of them are Red, 5 of them are Blue and the remaining are Green then, what is the probability of picking out (i) a Blue ball, (ii) a Red ball and (iii) a Green ball?

5. When two coins are tossed, what is the probability that two heads are obtained?

6. Two dice are rolled, find the probability that the sum is

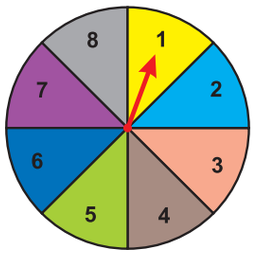
   i) equal to 1 ii) equal to 4 iii) less than 13

7. A manufacturer tested 7000 LED lights at random and found that 25 of them were defective. If a LED light is selected at random, what is the probability that the selected LED light is a defective one.

8. In a football match, a goalkeeper of a team can stop the goal, 32 times out of 40 attempts tried by a team. Find the probability that the opponent team can convert the attempt into a goal.

9. What is the probability that the spinner will not land on a multiple of 3?

10. Frame two problems in calculating probability, based on the spinner shown here.



9.5 Types of Events

We have seen some important cases of events already.

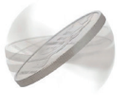
When the likelihood of happening of two events are same they are known as equally likely events.

- If we toss a coin, getting a head or a tail are equally likely events.
- If a dice is rolled, then getting an odd number and getting an even number are equally likely events, whereas getting an even number and getting 1 are not equally likely events.

When probability is 1, the event is sure to happen. Such an event is called a sure or certain event. The other extreme case is when the probability is 0, which is known as an impossible event.

If $P(E) = 1$ then E is called Certain event or Sure event.

If $P(E) = 0$ then E is known is an Impossible event.



Consider a "coin flip". When you flip a coin, you cannot get both heads and tails simultaneously. (Of course, the coin must be fair; it should not have heads or tails on both sides!). If two events cannot occur simultaneously (at the same time), in a single trial they are said to be mutually exclusive events. Are rain and sunshine mutually exclusive? What about choosing Kings and Hearts from a pack of 52 cards?

A dice is thrown. Let E be the event of getting an "even face". That is getting 2, 4 or 6. Then the event of getting an "odd face" is complementary to E and is denoted by E' or E^c. In the above sense E and E' are complementary events.

Note

- The events E and E' are mutually exclusive. (how?)
- The probability of E + the probability of E' =1. Also E and E' are mutually exclusive and exhaustive.
- Since $P(E)+P(E')=1$, if you know any one of them, you can find the other.

Progress Check

Which among the following are mutually exclusive?

Sl.No.	Trial	Event 1	Event 2
1	Roll a dice	getting a 5	getting an odd number
2	Roll a dice	getting a 5	getting an even number
3	Draw a card from a standard pack	getting a Spade Card	getting a black
4	Draw a card from a standard pack	getting a Picture Card	getting a 5
5	Draw a card from a standard pack	getting a Heart Card	getting a 7

Example 9.4

The probability that it will rain tomorrow is $\frac{91}{100}$. What is the probability that it will not rain tomorrow?

Solution

Let E be the event that it will rain tomorrow. Then E' is the event that it will not rain tomorrow.

Since $P(E) = 0.91$, we have $P(E') = 1-0.91$ (how?)

$= 0.09$

Therefore, the probability that it will not rain tomorrow

$= 0.09$

Example 9.5

In a recent year, of the 1184 centum scorers in various subjects in tenth standard public exams, 233 were in mathematics. 125 in social science and 106 in science. If one of the student is selected at random, find the probability of that selected student,

(i) is a centum scorer in Mathematics (ii) is not a centum scorer in Science

Solution

Total number of centum scorers =1184

Therefore n = 1184

(i) Let E_1 be the event of getting a centum scorer in Mathematics.

Therefore $n(E_1) = 233$, That is, $r_1 = 233$

$$P(E_1) = \frac{r_1}{n} = \frac{233}{1184}$$

(ii) Let E_2 be the event of getting a centum scorer in Science.

Therefore $n(E_2) = 106$, That is, $r_2 = 106$

$$P(E_2) = \frac{r_2}{n} = \frac{106}{1184}$$

$$P(E_2') = 1 - P(E_2)$$

$$= 1 - \frac{106}{1184}$$

$$= \frac{1078}{1184}$$

Exercise 9.2

1. A company manufactures 10000 Laptops in 6 months. Out of which 25 of them are found to be defective. When you choose one Laptop from the manufactured, what is the probability that selected Laptop is a good one.

2. In a survey of 400 youngsters aged 16-20 years, it was found that 191 have their voter ID card. If a youngster is selected at random, find the probability that the youngster does not have their voter ID card.

3. The probability of guessing the correct answer to a certain question is $\frac{x}{3}$. If the probability of not guessing the correct answer is $\frac{x}{5}$, then find the value of x.

4. If a probability of a player winning a particular tennis match is 0.72. What is the probability of the player loosing the match?

5. 1500 families were surveyed and following data was recorded about their maids at homes

Type of maids	Only part time	Only full time	Both
Number of families	860	370	250

A family is selected at random. Find the probability that the family selected has

(i)Both types of maids (ii) Part time maids (iii)No maids

Exercise 9.3

Multiple choice questions

1. A number between 0 and 1 that is used to measure uncertainty is called

(1) Random variable (2) Trial (3) Simple event (4) Probability

2. Probability lies between

(1) −1 and +1 (2) 0 and 1 (3) 0 and n (4) 0 and ∞

3. The probability based on the concept of relative frequency theory is called

(1) Empirical probability (2) Classical probability
(3) Both (1) and (2) (4) Neither (1) nor (2)

4. The probability of an event cannot be

(1) Equal to zero (2) Greater than zero (3) Equal to one (4) Less than zero

5. The probability of all possible outcomes of a random experiment is always equal to

(1) One (2) Zero (3) Infinity (4) Less than one

6. If A is any event in S and its complement is A' then, $P(A')$ is equal to

(1) 1 (2) 0 (3) $1-A$ (4) $1-P(A)$

7. Which of the following cannot be taken as probability of an event?

(1) 0 (2) 0.5 (3) 1 (4) −1

8. A particular result of an experiment is called

(1) Trial (2) Simple event (3) Compound event (4) Outcome

9. A collection of one or more outcomes of an experiment is called

(1) Event (2) Outcome (3) Sample point (4) None of the above

10. The six faces of the dice are called equally likely if the dice is

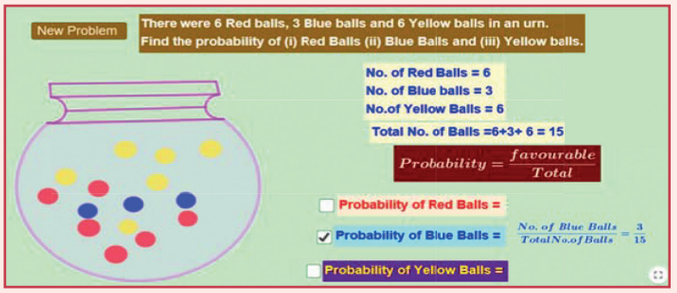
(1) Small (2) Fair (3) Six-faced (4) Round

Points to Remember

- If we are able to predict the exact outcome of an experiment then it is called deterministic experiment.
- If we cannot predict the exact outcome of an experiment then it is called random experiment.
- Sample space S for a random experiment is the set of all possible outcomes of a random experiment.
- An event is a particular outcome or combination of outcomes of an experiment.
- Empirical probability states that probability of an outcome is close to the percentage of occurrence of the outcome.
- If the likelyhood of happening of two events are same then they are known as equally likely events.
- If two events cannot occur simultaneously in single trial then they are said to be mutually exclusive events.
- Two events E and E' are said to be complementary events if $P(E)+P(E')=1$.
- An event which is sure to happen is called certain or sure event. The probability of a sure event is always one.
- An event which never happen is called impossible event. The probability of an impossible event is always zero.

ICT Corner

Expected Result is shown in this picture



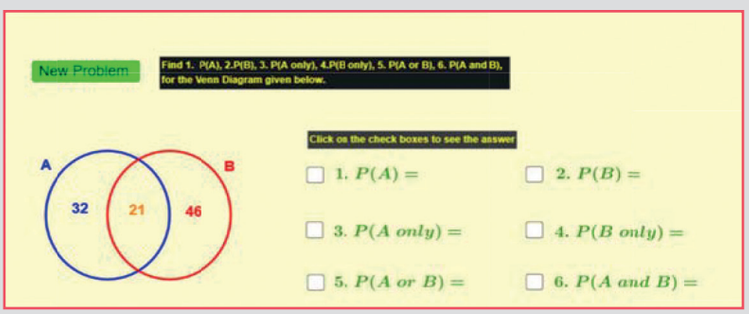
Step – 1

Open the Browser by typing the URL Link given below (or) Scan the QR Code. GeoGebra work sheet named "Probability" will open. There are two worksheets under the title Venn diagram and Basic probability.

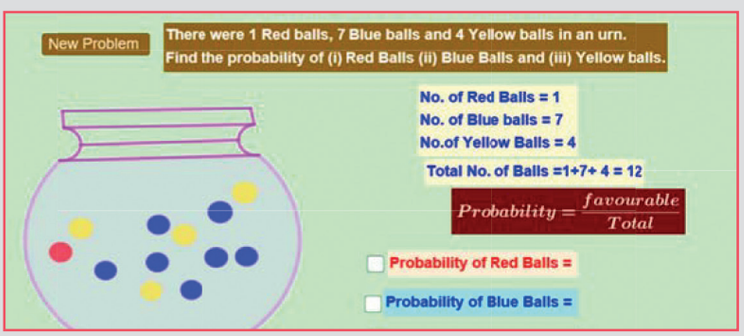
Step - 2

Click on "New Problem". Work out the solution, and click on the respective check box and check the answer.

Step 1



Step 2



Browse in the link

Probability: https://ggbm.at/mj887yua or Scan the QR Code.

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ANSWERS

1 Set Language

Exercise 1.1

1. (i) set (ii) not a set (iii) Set (iv) not a set

2. (i) {I, N, D, A} (ii) {P, A, R, L, E, O, G, M} (iii) {M, I, S, P}

   (iv) {C, Z, E, H, O, S, L, V, A, K, I}

3. (a) (i) True (ii) True (iii) False (iv) True (v) False (vi) False

   (b) (i) A (ii) C (iii) $\notin$ (iv) $\in$

4. (i) $A = \{2, 4, 6, 8, 10, 12, 14, 16, 18\}$ (ii) $B = \left\{\frac{1}{2}, \frac{1}{4}, \frac{1}{6}, \frac{1}{8}, \frac{1}{10}\right\}$

   (iii) $C = \{64, 125\}$ (iv) $D = \{-4, -3, -2, -1, 0, 1, 2\}$

5. (i) $B = \{x : x$ is an Indian player who scored double centuries in One Day International$\}$

   (ii) $C = \left\{x : x = \frac{n}{n+1}, n \in \mathbb{N}\right\}$ (iii) $D = \{x : x$ is a tamil month in a year$\}$

   (iv) $E = \{x : x$ is an odd whole number less than 9$\}$

6. (i) P = The set of English months starting with letter 'J'

   (ii) Q = The set of Prime numbers between 5 and 31

   (iii) R = The set of natural numbers less than 5

   (iv) S = The set of English consonants

Exercise 1.2

1. (i) $n(M) = 6$ (ii) $n(P) = 5$ (iii) $n(Q) = 3$ (iv) $n(R) = 10$ (v) $n(S) = 5$

2. (i) finite (ii) infinite (iii) infinite (iv) finite

3. (i) Equivalent sets (ii) Unequal sets (iii) Equal sets (iv) Equivalent sets

4. (i) null set (ii) null set (iii) singleton set (iv) null set

5. (i) overlapping (ii) disjoint (iii) overlapping

6. (i) {square, rhombus} (ii) {circle} (iii) {triangle} (iv) { }

7. { }, {a}, {a, b}, {a, {a, b}}

8. (i) {{ }, {a}, {b}, {a, b}}

(ii) {{ }, {1}, {2}, {3}, {1, 2}, {1, 3}, {2, 3 }, {1, 2, 3}}

(iii) {{ }, {p}, {q} {r}, {s}, {p, q}, {p, r}, {p, s}, {q, r}, {q, s}, {r, s}, {p, q, r}, {p, q, s}, {p, r, s}, {q, r, s}, {p, q, r, s}} (iv) $P(E)$= {{ }}

9. (i) 8, 7 (ii) 1024, 1023

10. (i) 16 (ii) 1 (iii) 8

Exercise 1.3

1. (i) {2, 4, 7, 8, 10} (ii) {3, 4, 6, 7, 9, 11} (iii) {2, 3, 4, 6, 7, 8, 9, 10, 11}

(iv) {4, 7} (v) {2, 8, 10} (vi) {3, 6, 9, 11}

(vii) {1, 3, 6, 9, 11, 12} (viii) {1, 2, 8, 10, 12}

(ix) {1, 2, 3, 4, 6, 7, 8, 9, 10, 11, 12}

2. (i) {2, 5, 6, 10, 14, 16}, {2, 14}, {6, 10}, {5, 16}

(ii) {a, b, c, e, i, o, u}, {a, e, u}, {b, c}, {i, o}

(iii) {0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10}, {1, 2, 3, 4, 5}, {6, 7, 8, 9, 10,}, {0}

(iv) {m, a, t, h, e, i, c, s, g, o, r, y}, {e, m, t,}, {a, h, i, c, s}, {g, o, r, y}

3. (i) {a, c, e, g} (ii) {b, c, f, g} (iii) {a, b, c, e, f, g} (iv) {c, g} (v) {c, g}

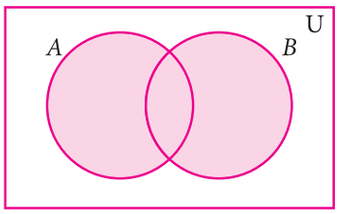
(vi) {a, b, c, e, f, g} (vii) {b, d, f, h} (viii) {a, d, e, h}

4. (i) {0, 2, 4, 6} (ii) {1, 4, 6} (iii) {0, 1, 2, 4, 6} (iv) {4, 6} (v) {4, 6}

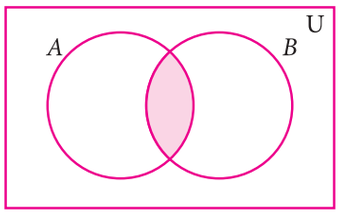
(vi) {0, 1, 2, 4, 6} (vii) {1, 3, 5, 7} (viii) {0, 2, 3, 5, 7}

5. (i) {1, 2, 7} (ii) {*m*, *o*, *p*, *q*, *j*} (iii) {6, 9, 10}

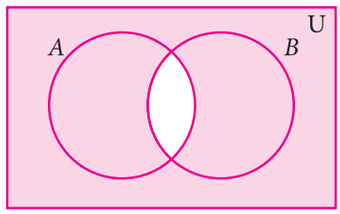
6. (i) $Y-X$ (ii) $(X \cup Y)'$ (iii) $(X - Y) \cup (Y - X)$

7. (i) 

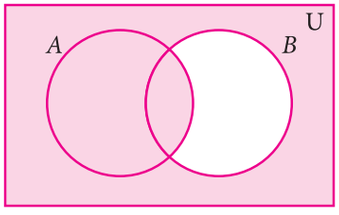
$A \cup B$

(ii) 

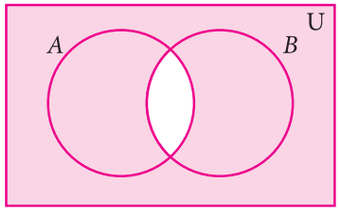
$A \cap B$

(iii) 

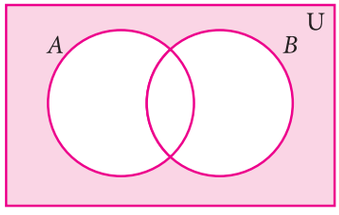
$(A \cap B)'$

(iv) 

$(B-A)'$

(v) 

$A' \cup B'$

(vi) 

$A' \cap B'$

(vii) $(A \cap B)' = A' \cup B'$

Exercise 1.4

1. (i) {1,2,3,4,5,7,9,11} (ii) {2,5} (iii) {3,5 }

Exercise 1.5

1. (i) $\{3, 4, 6\}$ (ii) $\{-1, 5, 7\}$ (iii) $\{-3, 0, 1, 2, 3, 4, 5, 6, 7, 8\}$

(iv) $\{-3, 0, 1, 2\}$ (v) $\{1, 2, 4, 6\}$ (vi) $\{4, 6\}$ (vii) $\{-1, 3, 4, 6\}$

2. (i) { a, b, c, d, e, f } (ii) { a, b, d } (iii) { a,b,c,d,e,f } (iv) {a, b, d }

Exercise 1.6

1. (i) 15, 65 (ii) 250, 600 4. (1) 17 (ii) 22 (iii) 47

5. (i) 10 (ii) 10 (iii) 25 6. 1000 7. 8 8. Not correct

9. (i) 185 (ii) 141 (iii) 326 10. 70

11. $x = 20$, $y = 40$, $z = 30$ 12. (i) 5 (ii) 7

(iii) 8 13. 5

Exercise 1.7

1. (2) 2. (1) 3. (3) 4. (2) 5. (4) 6. (1) 7. (2) 8. (4) 9. (3) 10. (4)

11. (2) 12. (1) 13. (1) 14. (3) 15. (4) 16. (1) 17. (4) 18. (3) 19. (3) 20. (1)

2 Real Numbers

Exercise 2.1

1. D 2. $-\frac{6}{11}, -\frac{5}{11}, -\frac{4}{11}, \ldots \frac{1}{11}$

3. (i) $\frac{9}{40}, \frac{19}{80}, \frac{39}{160}, \frac{79}{320}, \frac{159}{640}$;
The given answer is one of the answers. There can be many more answers

(ii) 0.101, 0.102, ... 0.109
The given answer is one of the answers. There can be many more answers

(iii) $-\frac{3}{2}, -\frac{5}{4}, -\frac{9}{8}, -\frac{17}{16}, -\frac{33}{32}$
The given answer is one of the answers. There can be many more answers

Exercise 2.2

1. (i) 0.2857142..., Non terminating and recurring (ii) $-5.\overline{27}$, Non terminating and recurring
(iii) $7.\overline{3}$, Non terminating and recurring (iv) 1.635, Terminating

2. $0.\overline{076293}$, 6 3. $0.03\overline{03}$, $2.\overline{15}$

4. (i) $\frac{24}{99}$ (ii) $\frac{2325}{999}$ (iii) $-\frac{1283}{250}$ (iv) $\frac{143}{45}$ (v) $\frac{5681}{330}$ (vi) $-\frac{190924}{9000}$

5. (i) Terminating (ii) Terminating (iii) Non terminating (iv) Non terminating

Exercise 2.3

2. (i) 0.301202200222..., 0.301303300333... (ii) 0.8616611666111 ..., 0.8717711777111 ...
(iii) 1.515511555..., 1.616611666...

3. 2.2362, 2.2363

Exercise 2.5

1.(i) 5^4 (ii) 5^{-1} (iii) $5^{\frac{1}{2}}$ (iv) $5^{\frac{3}{2}}$

2.(i) 4^2 (ii) $4^{\frac{3}{2}}$ (iii) $4^{\frac{5}{2}}$

3.(i) 7 (ii) 9 (iii) $\frac{1}{27}$ (iv) $\frac{25}{16}$

4.(i) $5^{\frac{1}{2}}$ (ii) $7^{\frac{1}{2}}$ (iii) $7^{\frac{10}{3}}$ (iv) $10^{\frac{-14}{3}}$

5.(i)2 (ii) 3 (iii) 10 (iv) $\frac{4}{5}$

Exercise 2.6

1.(i) $21\sqrt{3}$ (ii) $3\sqrt[3]{5}$ (iii) $26\sqrt{3}$ (iv) $8\sqrt[3]{5}$

2. (i) $\sqrt{30}$ (ii) $\sqrt{5}$ (iii) 30 (iv) $49a - 25b$

(v) $\frac{5}{16}$ 3.(i) 1.852 (ii) 23.978

4. (i) $\sqrt[3]{5} > \sqrt[6]{3} > \sqrt[9]{4}$ (ii) $\sqrt{\sqrt{3}} > \sqrt[2]{\sqrt[3]{5}} > \sqrt[3]{\sqrt[4]{7}}$

5. (i) yes (ii) yes (iii) yes (iv) yes

6. (i) yes (ii) yes (iii) yes (iv) yes

Exercise 2.7

1.(i) $\frac{\sqrt{2}}{10}$ (ii) $\frac{\sqrt{5}}{3}$ (iii) $\frac{5\sqrt{6}}{6}$ (iv) $\frac{\sqrt{30}}{2}$

2. (i) $\frac{4}{3}(5 + 2\sqrt{6})$ (ii) $13 - 4\sqrt{6}$ (iii) $\frac{9 + 4\sqrt{30}}{21}$ (iv) $-2\sqrt{5}$

3. $a = \frac{-4}{3}, b = \frac{11}{3}$ 4. $x^2 + \frac{1}{x^2} = 18$ 5. 5.414

Exercise 2.8

1. (i) 5.6943×10^{11} (ii) 2.00057×10^{3} (iii) 6.0×10^{-7} (iv) 9.000002×10^{-4}

2. (i) 3459000 (ii) 56780 (iii) 0.0000100005 (iv) 0.0000002530009

3. (i) 1.44×10^{28} (ii) 8.0×10^{-60} (iii) 2.5×10^{-36} 4.(i) 7.0×10^{9}

(ii) 9.4605284×10^{15} km (iii) $9.1093822 \times 10^{-31}$ kg

5. (i) 1.505×10^{8} (ii) 1.5522×10^{17} (iii) 1.224×10^{7} (iv) 1.9558×10^{-1}

Exercise 2.9

1. (4) 2. (3) 3. (2) 4. (1) 5. (4) 6. (2) 7. (2) 8. (2) 9. (4) 10. (1)

11. (4) 12. (4) 13. (4) 14. (2) 15. (2) 16. (3) 17. (2) 18. (4) 19. (2) 20. (3)

3 Algebra

Exercise 3.1

1. (i) not a polynomial (ii) polynomial (iii) not a polynomial (iv) polynomial (v) polynomial (vi) not a polynomial

2.

	Cooefficient of x^2	Cooefficient of x
(i)	$\frac{2}{5}$	-3
(ii)	-2	$-\sqrt{7}$
(iii)	π	-1
(iv)	$\sqrt{3}$	$\sqrt{2}$
(v)	1	$-\frac{7}{2}$

3. (i) 7 (ii) 4 (iii) 5 (iv) 6 (v) 4

4.

	Descending order	Ascending order
(i)	$\sqrt{7}\,x^3 + 6x^2 + x - 9$	$-9 + x + 6x^2 + \sqrt{7}\,x^3$
(ii)	$-\frac{7}{2}x^4 - 5x^3 + \sqrt{2}\,x^2 + x$	$x + \sqrt{2}\,x^2 - 5x^3 - \frac{7}{2}x^4$
(iii)	$7x^3 - \frac{6}{5}x^2 + 4x - 1$	$-1 + 4x - \frac{6}{5}x^2 + 7x^3$
(iv)	$9y^4 + \sqrt{5}\,y^3 + y^2 - \frac{7}{3}y - 11$	$-11 - \frac{7}{3}y + y^2 + \sqrt{5}\,y^3 + 9y^4$

5. (i) $6x^3+6x^2-14x+17$, 3 (ii) $7x^3+7x^2+11x-8$, 3 (iii) $16x^4-6x^3-5x^2+7x-6$, 4

6. (i) $7x^2+8$, 2 (ii) $-y^3+6y^2-14y+2$, 3 (iii) $z^5-6z^4-6z^2-9z+7$, 5

7. $x^3-8x^2+11x+7$ 8. $2x^4-3x^3+5x^2-5x+6$

9. (i) $6x^4+7x^3-56x^2-63x+18$, 4 (ii) $105x^2-33x-18$, 2 (iii) $30x^3-77x^2+54x-7$, 3

10. x^2+y^2+2xy, ₹ 225 11. $9x^2-4$, 3596 sq. units

12. cubic polynomial or polynomial of degree 3

Exercise 3.2

1. (i) 6 (ii) −6 (iii) 3 2. 1 3. (i) 3 (ii) $-\frac{5}{2}$ (iii) $\frac{3}{2}$ (iv) 0 (v) 0 (vi) $-\frac{b}{a}$

4. (i) $\frac{6}{5}$ (ii) −3 (iii) $-\frac{9}{10}$ (iv) $\frac{4}{9}$

6. (i) 2 (ii) 3 (iii) 0 (iv) 1 (v) 1

Exercise 3.3

1. $p(x)$ is not a multiple of $g(x)$

2. (i) Remainder : 0 (ii) Remainder : $\frac{3}{2}$ (iii) Remainder : 62

3. Remainder : −143 4. Remainder : 2019 5. $K = 8$

6. $a = -3$, Remainder : 27 7. (i) $(x-1)$ is a factor (ii) $(x-1)$ is not a factor
8. $(x-5)$ is a factor of $p(x)$ 9. $m = 10$ 11. $k = 3$ 12. Yes

Exercise 3.4

1. (i) $4x^2 + 9y^2 + 16z^2 + 12xy + 24yz + 16xz$ (ii) $p^2 + 4q^2 + 9r^2 - 4pq + 12qr - 6pr$
(iii) $8p^3 - 24p^2 - 14p + 60$ (iv) $27a^3 + 27a^2 - 18a - 8$

2.(i) 18,107,210 (ii) −32, −6, +90

3. (i) 14 (ii) $\frac{59}{70}$ (iii) 78 (iv) $\frac{78}{70}$

4. (i) $27a^3 - 64b^3 - 108a^2b + 144ab^2$ (ii) $x^3 + \frac{1}{y^3} + \frac{3x^2}{y} + \frac{3x}{y^2}$

5.(i) 941192 (ii) 1003003001

6. 29 7. 280 8. 335 9. 198 10. $\pm 5, \pm 110$

11. 36 12.(i) $8a^3 + 27b^3 + 64c^3 - 72abc$ (ii) $x^3 - 8y^3 + 27z^3 + 18xyz$

13.(i) −630 (ii) $\frac{-9}{4}$

14. 72xyz

Exercise 3.5

1.(i) $2a^2(1 + 2b + 4c)$ (ii) $(a-m)(b-c)$

2.(i) $(x+2)^2$ (ii) $3(a-4b)^2$

(iii) $x(x+2)(x-2)(x^2+4)$ (iv) $\left(m + \frac{1}{m} + 5\right)\left(m + \frac{1}{m} - 5\right)$

(v) $6(1+6x)(1-6x)$ (vi) $\left(a - \frac{1}{a} + 4\right)\left(a - \frac{1}{a} - 4\right)$

3. (i) $(2x + 3y + 5z)^2$

(ii) $(-5x + 2y + 3z)^2$ (or) $(5x - 2y - 3z)^2$

4. (i) $(2x + 5y)(4x^2 - 10xy + 25y^2)$

(ii) $(3x - 2y)(9x^2 + 6xy + 4y^2)$

(iii) $(a+2)(a-2)(a^2 + 4 - 2a)(a^2 + 4 + 2a)$

5. (i) $(x + 2y - 1)(x^2 + 4y^2 + 1 - 2xy + 2y + x)$

(ii) $(l - 2m - 3n)(l^2 + 4m^2 + 9n^2 + 2lm - 6mn + 3ln)$

Exercise 3.6

1.(i) $(x+6)(x+4)$

(ii) $(z+6)(z-2)$

(iii) $(p-8)(p+2)$

(iv) $(t-9)(t-8)$

(v) $(y-20)(y+4)$

(vi) $(a+30)(a-20)$

2. (i) $(2a+5)(a+2)$

(ii) $(x-7y)(5x+6y)$ (iii) $(2x-3)(4x-3)$ (iv) $2(3x+2y)(x+2y)$

(v) $3x^2(3y+2)^2$ (vi) $(a+b+6)(a+b+3)$

3. (i) $(p-q-8)(p-q+2)$

(ii) $(m+6n)(m-4n)$ (iii) $\left(a+\sqrt{5}\right)\left(\sqrt{5}a-3\right)$ (iv) $(a+1)(a-1)(a^2-2)$

(v) $m(4m+5n)(2m-3n)$

(vi) $\left(\frac{1}{x}+\frac{1}{y}\right)^2$

Exercise 3.7

1. (i) Quotient : $4x^2-6x-5$, Remainder : 33 (ii) Quotient : $4y^2-6y+5$, Remainder : -10

(iii) Quotient : $4x^2+2x+1$, Remainder : 0 (iv) Quotient : $8z^2-6z+2$, Remainder : 10

2. Length : $x+4$ 3. Height : $5x-4$ 4. Mean : $x^2-5x+25$

5. (i) x^2+4x+5, 12 (ii) (x^2-1), -2

(iii) $3x^2-11x+40$, -125 (iv) $2x^3-\frac{x^2}{2}-\frac{3x}{8}+\frac{51}{32}$, $\frac{109}{32}$

6. $4x^3-2x^2+3$, $p=-2$, $q=0$, remainder=-10

7. $a=20$, $b=94$ & remainder=388

Exercise 3.8

1.(i) $(x-2)(x+3)(x-4)$ (ii) $(x+1)(x-2)(2x-1)$

(iii) $(x-1)(2x-1)(2x+3)$ (iv) $(x+2)(x+3)(x-4)$

(v) $(x-1)(x-2)(x+3)$ (vi) $(x-1)(x-10)(x+1)$

Exercise 3.9

1. (i) p^5 (ii) 1 (iii) $3a^2b^2c^3$ (iv) $16x^6$

(v) abc (vi) $7xyz^2$ (vii) 25ab (viii) 1

2. (i) 1 (ii) a^{m+1} (iii) $(2a+1)$ (iv) 1

(v) $(x+1)(x-1)$ (vi) $(a-3x)$

Exercise 3.10

2. (i) (5,2) (ii) Infinite number of solutions (iii) no solution

(iv) (−3, −3) (v) (1,3) (vi) (−3, 3)

3. 75*km/hr*, 25*km/hr*

Exercise 3.11

1.(i)(2, −1) (ii) (4,2) (iii) (40,100) (iv) $\left(\sqrt{8},\sqrt{3}\right)$

(2) 45 (3) 409

Exercise 3.12

1.(i) (2,1) (ii) (7,2) (iii) (80,30) (iv) $\left(1,\frac{3}{2}\right)$

(v) $\left(\frac{1}{3},-1\right)$ (vi) (2,4) (2) ₹30000, ₹40000 (3) 75, 15

Exercise 3.13

1.(i) (3,4) (ii) (3, −1) (iii) $\left(-\frac{1}{2},\frac{1}{3}\right)$

(2) Number of 2 rupee coins 60; Number of 5 rupee coins 20

(3) Larger pipe 40 hours; Smaller pipe 60 hours

Exercise 3.14

1. 64
2. $\frac{5}{7}$
3. $\angle A=120°$, $\angle B=70°$, $\angle C=60°$, $\angle D=110°$
4. Price of TV = ₹20000; Price of fridge = ₹10000
5. 40, 48
6. 1 Indian – 18 days; 1 Chinese – 36 days

Exercise 3.15

1. (4) 2. (3) 3. (4) 4. (4) 5. (2) 6. (1) 7. (4) 8. (4) 9. (4) 10. (3)

11. (2) 12. (3) 13. (3) 14. (2) 15. (2) 16. (3) 17. (3) 18. (4) 19. (2) 20. (3)

21. (2) 22. (4) 23. (3) 24. (2) 25. (1) 26. (2) 27. (3) 28. (1) 29. (3) 30. (2)

4 Geometry

Exercise 4.1

1. (i) 70° (ii) 288° (iii) 89° 2. 30°, 60°, 90° 5. 80°, 85 °, 15 °

Exercise 4.2

1. (i) 40°, 80°, 100°, 140° 2. 62°, 114° , 66° 3. 44° 4. 10cm

7. (i) 30° (ii) 105° (iii) 75° (iv) 105° 8. 122° , 29°

9. Ratios are equal 10. d = 7.6

Exercise 4.3

1. 24cm 2. 17cm 3. 8cm, 45°, 45°

4. 18cm 5. 14 cm 6. 6 cm

7. (i) 45° (ii) 10° (iii) 55° (iv) 120° (v) 60°

8. $\angle BDC = 25°, \angle DBA = 65°, \angle COB = 50°$

Exercise 4.4

1. 30° 2.(i) $\angle ACD = 55°$ (ii) $\angle ACB = 50°$ (iii) $\angle DAE = 25°$

3. $\angle A = 64°$; $\angle B = 80°$; $\angle C = 116°$; $\angle D = 100°$

4.(i) $\angle CAD = 40°$ (ii) $\angle BCD = 80°$ 5. Radius=5cm 6. 3.25m

7. $\angle OAC = 30°$ 8. 5.6m 9. $\angle RPO = 60°$

Exercise 4.7

1. (2) 2. (3) 3. (1) 4. (4) 5. (4) 6. (3) 7. (2) 8. (2) 9. (4) 10. (2)

11. (1) 12. (3) 13. (1) 14. (1) 15. (4) 16. (2) 17. (2) 18. (3) 19. (2) 20. (4)

5 Coordinate Geometry

Exercise 5.1

1. $P(-7,6)$ = II Quadrant; $Q(7,-2)$ = IV Quadrant; $R(-6,-7)$ = III Quadrant; $S(3,5)$ = I Quadrant; and $T(3,9)$ = I Quadrant

2. (i) $P = (-4,4)$ (ii) $Q = (3,3)$ (iii) $R=(4,-2)$ (iv) $S = (-5,-3)$

3. (i) Straight line parallel to x-axis (ii) Straight line which lie on y-axis.

4. (i) Square (ii) Trapezium

Exercise 5.2

1. (i) $\sqrt{10}$ units (ii) $2\sqrt{26}$ units (iii) $c-a$ (iv)13 units

2. (i) Collinear (ii) Collinear 7. 5 or 1

8. Coordinates of A $(9, 9)$ or $(-5,-5)$ 9. $y = 4x+9$ 10. Coordinates of $P(2,0)$

12. $30\sqrt{2}$

Exercise 5.3

1.(i) $(-4,-1)$ (ii) $(0,-1)$ (iii) $(a+b,a)$ (iv) $(1,-1)$

2. $(-5,-3)$ 3. $P=-15$ 4. $(9,3)(-5,5)$ and $(1,1)$

5. $\left(\frac{9}{2},\frac{3}{2}\right)$ 6. $(1,8)$

Exercise 5.4

1. $(7,3)$ 2. 5:2 3. $(3,4)$

4. $(-2,3),(1,0)$ 5. $\left(\frac{19}{2},\frac{13}{2}\right),\left(\frac{-9}{2},\frac{-15}{2}\right)$ 7. $(3,2)$

Exercise 5.5

1.(i) $(2,-3)$ (ii) $\left(\frac{-8}{3},\frac{-11}{3}\right)$ 2. $(4,-6)$ 3. 5 units

4. 20 5. $3\sqrt{\frac{5}{2}}$ units 6. $(1,0)$ 7. $(5,-2)$

Exercise 5.6

1. (3) 2. (3) 3. (3) 4. (2) 5. (2) 6. (4) 7. (3) 8. (3) 9. (3) 10. (3)

11. (4) 12. (1) 13. (3) 14. (4) 15. (2) 16. (3) 17. (2) 18. (2) 19. (4) 20. (2)

6 Trigonometry

Exercise 6.1

1. $\sin B = \frac{9}{41}; \cos B = \frac{40}{41}; \tan B = \frac{9}{40};\ \text{cosec}B = \frac{41}{9}; \sec B = \frac{41}{40}; \cot B = \frac{40}{9}$

2. (i) $\sin B = \frac{12}{13}$ (ii) $\sec B = \frac{13}{5}$ (iii) $\cot B = \frac{5}{12}$ (iv) $\cos C = \frac{4}{5}$
(v) $\tan C = \frac{3}{4}$ (vi) $\text{cosec}C = \frac{5}{3}$

3. $\sin\theta = \frac{1}{2}; \cos\theta = \frac{\sqrt{3}}{2}; \tan\theta = \frac{1}{\sqrt{3}};\ \text{cosec}\theta = \frac{2}{1}; \sec\theta = \frac{2}{\sqrt{3}}; \cot\theta = \sqrt{3}$

4. $\frac{3}{40}$ 5. $\sin A = \frac{1-x^2}{1+x^2}; \tan A = \frac{1-x^2}{2x}$ 7. $\frac{1}{2}$

8. $\frac{1}{2}$ 9. $\sin\alpha = \frac{4}{5}; \cos\beta = \frac{4}{5}; \tan\phi = \frac{4}{3}$ 10. 7m

Exercise 6.2

2.(i) 0 (ii) $\frac{7}{4}$ (iii) 3 4. 2

Exercise 6.3

1.(i) 1 (ii) 1 (iii) 1 (iv) 2

Exercise 6.4

1.(i) 0.7547 (ii) 0.2648 (iii) 1.3985 (iv) 0.3641
(v) 0.8302 (vi) 2.7907 2.(i) 85°57′ (or) 85°58′ (or) 85°59′
(ii) 47°27′ (iii) 4°7′ (iv) 87°39′ (v) 82°30′
3.(i) 1.9970 (ii) 2.8659 4. 18.81 cm^2 5. 36°52′
6. 54.02 m

Exercise 6.5

1. (1) 2. (2) 3. (2) 4. (3) 5. (2) 6. (3) 7. (3) 8. (1) 9. (2) 10. (2)

7 Mensuration

Exercise 7.1

1.(i) 120 cm^2 (ii) 7.2 m^2 2. 1320 m^2, ₹26400 3. 12000 m^2
4. 1558.8 cm^2 5. ₹ 1050 6. 240 cm^2 7. 138 cm^2
8. 354m^2 9. 1536 m^2 10. 672 m^2

Exercise 7.2

1. 1160cm^2, 560cm^2 2. ₹1716 3. ₹3349

4.(i) 384 m^2, 256 m^2 (ii) 2646 cm^2, 1764 cm^2 (iii) 337.5 cm^2, 225 cm^2

5. 1600 cm^2 6. 253.50m^2, ₹6084 7. 224cm^2, 128cm^2

Exercise 7.3

1.(i) 576 cm^3 (ii) 2250 m^3 2. 630 cm^3

3. 25 cm, 20 cm, 15 cm 4. 2624000 *litres* 5. 25000

6. 12 m 7.(i) 125 cm^3 (ii) 42.875 m^3 (iii) 9261 cm^3

8. 5 m 9. 15 cm

Exercise 7.4

1. (3) 2. (2) 3. (4) 4. (3) 5. (3) 6. (1) 7. (2) 8. (3) 9. (4) 10. (1)

8 Statistics

Exercise 8.1

1. $27°C$ 2. 44kg 3. 56.96 (or) 57 (approximately)

4. 142.5 mm^3 5. $p = 20$ 6. 40.2 7. 29.29 8. 29.05

Exercise 8.2

1. 47 2. 44 3. 21 4. 32

5. 31 6. 38

Exercise 8.3

1. 6600, 7000, 7000 2. 3.1 and 3.3 (bimodal) 3. 15

4. 40 5. 24 6. 58.5

Exercise 8.4

1. (1) 2. (3) 3. (3) 4. (2) 5. (1) 6. (4) 7. (1) 8. (2) 9. (2) 10. (3)

9 Probability

Exercise 9.1

1. $\frac{1}{7}$ 2. $\frac{3}{13}$ 3. $\frac{1}{2}$ 4.(i) $\frac{5}{24}$

(ii) $\frac{1}{8}$ (iii) $\frac{2}{3}$ 5. $\frac{1}{4}$ 6.(i) 0

(ii) $\frac{1}{12}$ (iii) 1 7. $\frac{1}{280}$ 8. $\frac{1}{5}$

9. $\frac{3}{4}$

Exercise 9.2

1. 0.9975 2. $\frac{209}{400}$ 3. $\frac{15}{8}$ 4. 0.28

5.(i) $\frac{1}{6}$ (ii) $\frac{43}{75}$ (iii) $\frac{1}{75}$

Exercise 9.3

1. (4) 2. (2) 3. (1) 4. (4) 5. (1) 6. (4) 7. (4) 8. (4) 9. (1) 10. (2)

MATHEMATICAL TERMS

Abscissa	X-அச்சின் தொலைவு (கிடைஅச்சுத் தொலைவு)
Acute triangle	குறுங்கோண முக்கோணம்
Adjacent angles	அடுத்துள்ள கோணங்கள்
Algebraic expression	இயற்கணிதக் கோவை
Alternate angles	ஒன்றுவிட்ட கோணங்கள்
Altitudes of a triangle	முக்கோணத்தின் குத்துக்கோடுகள்
Angle	கோணம்
Angle of elevation	ஏற்றக் கோணம்
Arithmetic mean	கூட்டுச் சராசரி
Associative property	சேர்ப்புப் பண்பு
Assumed mean	ஊகச் சராசரி
Binomial expression	ஈருறுப்புக் கோவை
Binomial surds	ஈருறுப்பு முறுடுகள்
Cardinal number of a set	கணத்தின் ஆதி எண்
Cartesian plane	கார்டீசியன் தளம்
Cartesian coordinate system	கார்டீசியன் அச்சுத் தொகுப்பு
Centre	மையம்
Centriod	நடுக்கோட்டு மையம்
Chord	நாண்
Circum radius	முக்கோணத்தின் சுற்றுவட்ட ஆரம்
Circumcentre of a triangle	முக்கோணத்தின் சுற்றுவட்டமையம்
Circumcircle	சுற்றுவட்டம்
Circumference	பரிதி
Classical probability	தொன்மை நிகழ்தகவு
Ordinate	Y–அச்சின் தொலைவு (செங்குத்து அச்சுத்தொலைவு)
Co-efficient	கெழு
Coinciding lines	ஒன்றின் மீது ஒன்று பொருந்தும் கோடுகள்
Collections	தொகுப்பு
Commutative property	பரிமாற்றுப் பண்பு
Compound surds	கூட்டு முறுடுகள்
Complement of a set	நிரப்புக் கணம்
Complementary angles	நிரப்புக் கோணங்கள்
Complementary events	நிரப்பு நிகழ்ச்சிகள்
Concentric circle	பொதுமைய வட்டங்கள்
Concurrent lines	ஒரு புள்ளி வழிக் கோடுகள்
Congruent circle	சர்வசம வட்டங்கள்
Congruent triangles	சர்வசம முக்கோணங்கள்
Conjugate	இணை
Consistent	ஒருங்கமைவன
Constant	மாறிலி
Coordinate axes	ஆய அச்சுகள்
Corresponding angles	ஒத்த கோணங்கள்
Cube	கனச் சதுரம்
Cubic polynomial	முப்படி பல்லுறுப்புக் கோவை
Cuboid	கனச் செவ்வகம்
Cyclic Quadrilateral	வட்ட நாற்கரம்
Decimal expansion	தசம விரிவாக்கம்
Decimal representation	தசம குறியீடு
Degree of polynomial	பல்லுறுப்புக்கோவையின் படி
Denseness property	அடர்த்திப் பண்பு
Descriptive form	விவரித்தல் முறை
Deterministic Experiment	உறுதியான சோதனை
Diagonal	மூலைவிட்டம்
Diameter	விட்டம்
Dice	பகடைகள்
Difference of two sets	கணங்களின் வித்தியாசம்
Disjoint sets	வெட்டாக் கணங்கள்
Division algorithm	வகுத்தல் படிமுறை
Division Algoritham of polynomial	பல்லுறுப்புக் கோவையின் வகுத்தல் படிமுறை
Edge	விளிம்பு

Empirical probability	சோதனை நிகழ்தகவு
Empty set/Null set	வெற்றுக் கணம்
Equal sets	சமகணங்கள்
Equally likely event	சமவாய்ப்பு நிகழ்ச்சி
Equiangular triangle	சமகோண முக்கோணம்
Equilateral triangle	சமபக்க முக்கோணம்
Equilibrium	சமநிலை
Equivalent sets	சமான கணங்கள்
Event	நிகழ்ச்சி
Excentre	வெளிவட்ட மையம்
Externally	வெளிப்புறமாக
Face of a solid	ஒரு திண்மத்தின் முகப்பு
Factor theorem	காரணித் தேற்றம்
Factorisation	காரணிப்படுத்துதல்
Finite set	முடிவுறு கணம்
Frequency table	நிகழ்வெண் பட்டியல்
Greatest Common Divisor (G.C.D)	மீப்பெரு பொது வகுத்தி
Grouped data	தொகுக்கப்பட்ட தரவுகள்
Hypotenuse	கர்ணம்
Identities	முற்றொருமைகள்
Impossible event	இயலா நிகழ்ச்சி
Incentre	உள்வட்ட மையம்
Incircle	உள்வட்டம்
Inconsistent	ஒருங்கமையாத
Indices	அடுக்குகள்
Infinite set	முடிவிலி கணம்
Inradius	உள்வட்ட ஆரம்
Interior angles	உட்கோணங்கள்
Internally	உட்புறமாக
Intersecting lines	வெட்டும் கோடுகள்
Intersection of two sets	கணங்களின் வெட்டு

Irrational numbers	விகிதமுறா எண்கள்
Isosceles Trapezium	இருசமபக்க சரிவகம்
Isosceles triangles	இருசமபக்க முக்கோணம்
Lateral surface area	பக்கப் பரப்பு
Linear equations	நேரியச் சமன்பாடுகள்
Linear pair of angles	நேரிய கோணச் சோடிகள்
Linear polynomial expression	நேரியப் பல்லுறுப்புக்கோவை
Major sector	பெரிய வட்டக்கோணப்பகுதி
Mean difference	பொது வித்தியாசம்
Measures of central tendency	மையப்போக்கு அளவைகள்
Median	இடைநிலை
Median of a triangle	முக்கோணத்தின் நடுக்கோடு
Mid point	நடுப்புள்ளி
Minor sector	சிறிய வட்டக் கோணப்பகுதி
Mixed surds	கலப்பு முறுடுகள்
Mode	முகடு
Monomial expression	ஒருறுப்புக் கோவை
Mutually exclusive events	ஒன்றையொன்று விலக்கும் நிகழ்ச்சிகள்
Negative integers	குறை முழுக்கள்
Non-terminating decimals	முடிவுறா தசம எண்கள்
Obtuse traingle	விரிகோண முக்கோணம்
Opposite side	எதிர்ப்பக்கம்
Ortho centre of a triangle	முக்கோணத்தின் செங்கோட்டு மையம்
Outcome	விளைவு
Overlapping sets	வெட்டும் கணங்கள்
Parallel lines	இணை கோடுகள்
Period of decimals	தசம எண்களின் காலமுறைமை
Polygon	பல கோணம்
Polynomial equation	பல்லுறுப்புக்கோவைச் சமன்பாடு

Positive integers	மிகை முழுக்கள்
Power set	அடுக்குக்கணம்
Primary data	முதல்நிலைத் தரவுகள்
Probability	நிகழ்தகவு
Proper sub set	தகு உட்கணம்
Pure surds	முழுமையான முறுடுகள்
Quadrant	காற்பகுதி
Quadratic polynomial	இருபடி பல்லுறுப்புக் கோவை
Quadrilateral	நாற்கரம்
Radical	மூலக்குறியீடு
Radicand	மூல அடிமானம்
Random Experiment	சமவாய்ப்பு சோதனை
Rational numbers	விகிதமுறு எண்கள்
Rationalisation	விகிதப்படுத்துதல்
Raw data	செப்பனிடப்படாத தரவுகள்
Real number	மெய்யெண்கள்
Recurring decimals	சுழல் தன்மையுள்ள தசம எண்கள்
Remainder theroem	மீதித் தேற்றம்
Right triangle	செங்கோண முக்கோணம்
Roots of a polynomial	பல்லுறுப்புக் கோவையின் மூலங்கள்
Sample point	கூறுபுள்ளி
Sample space	கூறுவெளி
Scientific notation	அறிவியல் குறியீடு
Secondary data	இரண்டாம்நிலைத் தரவுகள்
Section formula	பிரிவு வாய்ப்பாடு
Sector	வட்டக்கோணப்பகுதி
Segment	வட்டத்துண்டு
Semi-circle	அரைவட்டம்
Set complementation	கண நிரப்பி
Set difference	கண வித்தியாசம்

Set operations	கணச்செயல்கள்
Sets	கணங்கள்
Singular set/Singleton set	ஒருறுப்புக் கணம்
Square root	வர்க்க மூலம்
Step-deviation method	படி விலக்க முறை
Substitution method	பிரதியிடும் முறை
Subset	உட்கணம்
Surds	முறுடுகள்
Sure event	உறுதியான நிகழ்ச்சி
Symmetric difference of sets	கணங்களின் சமச்சீர் வித்தியாசம்
Synthetic division	தொகுமுறை வகுத்தல்
Terminating Decimals	முடிவுறு தசம எண்கள்
Total surface area	மொத்தப் பரப்பு (அல்லது) மொத்தப் புறப்பரப்பு
Transversal	குறுக்குவெட்டி
Trapezium	சரிவகம்
Trial	முயற்சி
Trigonometry	முக்கோணவியல்
Trinomial expression	மூவுறுப்புக் கோவை
Uncertainty	உறுதியற்ற (அ) நிச்சயமற்ற
Ungrouped data	தொகுக்கப்படாத தரவுகள்
Union of sets	கணங்களின் சேர்ப்பு
Universal set	அனைத்துக் கணம்
Venn Diagram	வென்படம்
Vertically opposite angles	குத்தெதிர் கோணங்கள்
Vertex	முனை
Volume	கன அளவு
Well defined	நன்கு வரையறுக்கப்பட்ட
Zero / Factor	பூச்சியம் / காரணி
Zeros of polynomial	பல்லுறுப்புக்கோவையின் பூச்சியங்கள்

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