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CHAPTER NOTES

Introduction to Probability Class 9 Notes | CBSE Maths Chapter 7

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Ask me anything from this chapter. A concept, a numerical, or that one doubt you did not want to raise in class. Pick one to start:

Explain Introduction to Probability simply

What can the board exam ask?

Most important formulas

Quiz me on this chapter

Ask Ira anything...



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Introduction to Probability Class 9 Notes | CBSE Maths Chapter 7

Introduction to Probability is Chapter 7 of CBSE Class 9 Maths. In the new 2026-27 NCERT book, Ganita Manjari (Grade 9, Part I), the chapter is titled "The Mathematics of Maybe: Introduction to Probability". It treats probability as a kind of measurement: length measures how long something is, and probability measures how likely an event is to happen.

The chapter covers randomness and random experiments, the probability scale from 0 to 1, experimental probability from trials and survey data, sampling, theoretical probability for equally likely outcomes, the Law of Large Numbers, the Gambler's Fallacy, sample spaces and events, and tree diagrams for multi-step experiments. In the CBSE Class IX course structure for 2026-27 it sits in Unit VI, Statistics and Probability, and the counting and sample-space skills it builds are used again in Class 10 probability.

Quick Answer - Introduction to Probability

Probability measures how likely an event is to happen, so $0 \leq P(E) \leq 1$. A random experiment has a result. **Experimental probability** = number of trials. **Theoretical probability** = number of favourable outcomes, used when all outcomes are equally likely. **Empirical probability** = number of times an event occurs, $n(S)$ is its size, and $n(E)$ is the number of favourable outcomes of multi-step experiments. We use empirical probability closer to theoretical probability.



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All Key Formulas at a Glance

Idea	Rule or Formula	Remember
Probability scale	$0 \leq P(E) \leq 1$	0 = impossible, 0.5 = even chance, 1 = certain
Experimental probability	Number of times the event occurred / Total number of trials	Also called the relative frequency
Statistical estimate	Number in the sample with the feature / Sample size	50 students, 20 like mango: $20/50 = 0.4$
Estimate for a population	Probability from the sample $\times$ Population size	$0.4 \times 1500 = 600$
Theoretical probability	$P(E) = \frac{\text{Number of favourable outcomes}}{\text{Number of possible outcomes}}$	
Sample size	$n(S) = \text{number of outcomes in } S$	
Event	E is a subset of S	
Multi-step count	Outcomes = (choices at step 1) $\times$ (choices at step 2) $\times$...	
Event not happening	Favourable for "not E" = total - favourable for E	
Law of Large Numbers	More trials: experimental probability $\rightarrow$ theoretical probability	



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Key Concepts

1. Probability, Randomness and Random Experiments

NCERT opens the chapter by calling probability **a type of measurement**. We measure length, area and volume for physical quantities. Probability measures something different: the **likelihood of an event**, or how confident we can be that it will happen.

Think of three everyday questions from the chapter:

- Is it going to rain today?
- Will our school win the inter-school hockey match tomorrow?
- Will I be chosen in the monthly lucky draw to perform at the school assembly? (The names of all students are written on slips of paper and one slip is picked at random.)

In each case we know the **possible outcomes** – it rains or it does not, the team wins, draws or loses; one student is chosen. What we do not know is which outcome will happen. Such events are called **random events**, because they can happen or not happen at random place.

Randomness describes a situation or action which is unpredictable, even though you may know all the possible outcomes.

- **Tossing a coin:** it could be heads or tails in a single toss.
- **Rolling a die:** the possible outcomes are 1, 2, 3, 4, 5, 6, which will appear on a particular roll.

Observations like these are called **experiments**, as something you can repeat, where the result is not known in advance.

Compare this with “Which day comes after today?” It is uncertain, so it is not a random experiment.

Probability is the area of mathematics that deals with the chance of an outcome in a random situation. When you flip a coin, the probability of tails is $\frac{1}{2}$, because each side has an equal likelihood of each outcome, but you cannot predict the outcome.



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Rain as a random event. Rain depends on many atmospheric factors (temperature, humidity, wind patterns, pressure) and is so sensitive to them that it cannot be predicted with total certainty. We can only estimate its likelihood from patterns in data.

Randomness can be useful. A coin toss decides which cricket team bats first. Nobody can predict the result and each captain has an equal chance, so it is fair.

Subjective probability. One friend says, "The sun is shining brightly, so it's unlikely to rain today." Another says, "It's very hot, which makes me think it could rain later." A likelihood based on personal judgement like this is the **subjective probability** of the event. The chapter then shows how to measure probability **objectively**, from evidence.

2. The Probability Scale

Probability is measured on a scale from **0 to 1**. For any event E, the chapter summary writes this as **$0 \leq P(E) \leq 1$** . A probability can also be written as a percentage by multiplying by 100.

Probability	Word on
0	Impossible
Between 0 and 0.5	Less likely
0.5	Even chance (equally likely)
Between 0.5 and 1 (for example 0.75)	More likely
1	Certain

Most events have probabilities strictly between 0 and 1.

The deck of six cards. Imagine six cards, three red and three blue. If none is purple, picking a purple card is impossible (probability 0). If one is purple, picking a purple card is unlikely (probability 1/6). If two are purple, picking a purple card is even chance (probability 1/3). If three are purple, picking a purple card is more likely (probability 1/2). If four are purple, picking a purple card is very likely (probability 2/3). If five are purple, picking a purple card is almost certain (probability 5/6). If all six are purple, picking a purple card is certain (probability 1). As purple cards increase, the probability of picking a purple card increases from 0 to 1.



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The chapter places these five events on the scale:

Event	Place on the scale	Reason
Getting a number greater than 6 on a die	Impossible	A die only has the numbers 1 to 6
Rolling a 3 on a standard die	Less likely	Possible, since one face shows 3, but only one face of six
Flipping a coin and getting heads	Even chance	Heads and tails are equally likely
Drawing any number from 2 to 10 from a deck of 52 cards	More likely	36 of the 52 cards carry numbers from 2 to 10
Choosing a red sweet from a bag of all red sweets	Certain	There are no other options

Check: $36/52 \approx 0.69$ (more likely) and $1/6$

Two checks that catch errors. A probability is always between 0 and 1. If your answer is -0.2 or $7/5$, the work is wrong.

3. Experimental Probability and Relative Frequency

NCERT gives two main ways of estimating probability.

- Using evidence from experience:** collect data by repeating an experiment many times or by analysing statistical data from past experience. The **frequency** of the event in that data. This method is called **empirical probability**. The structure also calls it empirical probability.
- Using theoretical methods:** assume all outcomes are equally likely. Count the favourable outcomes out of possible outcomes.

In an experiment, each result is called an **outcome**. The set of all possible outcomes is called the **sample space**. It is written inside curly braces, like this: {1, 2, 3, 4, 5, 6}.

- A coin is tossed: possible outcomes are {Heads, Tails}.
- A die is rolled: the top face shows 1, 2, 3, 4, 5, 6.



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Experimental Probability = Number of times the event occurred / Total number of trials

NCERT Example 2. You roll a die 50 times and it lands on 4 exactly 8 times. The experimental probability of rolling a 4 is $8/50 = 0.16$, or 16%. We also say the **relative frequency** of rolling a 4 is $8/50 = 0.16$.

Keep two words apart. The **frequency** is the count (8 times). The **relative frequency** is the count divided by the total (8/50).

Activities from the chapter. Toss a coin 20 times, or toss a paper cup 100 times and record whether it lands on its bottom, its top or its side. The three landing positions are not alike, so there is no reason to call them equally likely; the cup’s probabilities must come from experiment.

4. Analysing Statistical Data and Sampling

Collecting evidence through statistical data is used widely in business (marketing, forecasting sales, insurance) and in science and social science. The relative frequency, found from survey or record, is a good estimate of the probability.

NCERT Example 5: favourite fruit. 50 students were asked their favourite fruit. 20 chose mango, 15 chose apple, 10 chose banana, 5 chose grapes. One student is chosen at random. What is the probability that the favourite fruit is mango?
Probability that the favourite fruit is mango = $20/50 = 0.4$, a 40% chance.

Fruit	Number of students
Mango	20
Apple	15
Banana	10
Grapes	5
Total	50

From sample to population. Now suppose we ask every student in the class (the sample of 50 students). Asking every student is usually infeasible (asking every person in the world is not possible). The class of 50 is a **sample**. The whole population is the set of all people in the world.



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students would prefer mango, so you would buy approximately 600 mangoes, and the rest would be apples, bananas and grapes.

Estimate for the population = probability from the sample × population size

Sampling. To be more confident about the estimate, choose a **larger** sample (say 100 students) and make it more **representative**, for example by including students from different classes and grades. This process is called sampling. Sample size and fairness both affect accuracy.

5. Theoretical Probability

Theoretical probability studies the likelihood of an event when **all possible outcomes are equally likely**. It describes what we expect in an ideal, perfectly fair situation, and needs no experiment or data. It is written $P(\text{Event})$ or $P(\text{Outcome})$.

Theoretical Probability $P(E)$ = Number of favourable outcomes / Number of possible outcomes

A **favourable outcome** is an outcome that

NCERT Example 3. A standard 6-sided die is rolled. Find the probability of getting (only the number 4). Possible outcomes: 6

NCERT Example 4. A letter is picked at random from the letters (P, R, O, B, A, B, I, L, I, T, Y), and 2 coins are tossed. Find the probability of getting a vowel and 2 heads. 18.2%. Every letter position is counted, so

Fair and unbiased. When we speak of a coin being fair, it means there is no reason for it to land more often on one side than the other. A **random toss** means the coin falls freely without bias. This depends on this assumption.

Checking for equally likely outcomes. The probability of getting a head or tail has the same chance.



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Experiment	Outcomes listed	Equally likely?
Tossing a fair coin once	H, T	Yes, by symmetry
Rolling a fair 6-sided die	1, 2, 3, 4, 5, 6	Yes, by symmetry
A driver attempts to start a car	Starts, does not start	No: a working car usually starts
A marble from 3 red and 7 blue	Red, Blue	No: 7 blue marbles against 3 red

For the marble bag, each of the 10 marbles is equally likely, so count marbles: $P(\text{red}) = 3/10$ and $P(\text{blue}) = 7/10$. Counting the colours as two outcomes would wrongly give $1/2$ each.

The event not happening. Every outcome either makes E happen or does not. So the favourable outcomes for "not E " = $n(S) - \text{favourable } E$. For example, if E is "rolling a 4", then $P(\text{not } E) = 5/6 = 1 - 1/6$. Use this as a shortcut and don't count the "not E " outcomes.

Extremes: on a die, $P(\text{number less than 7}) = 1$.

6. Experimental vs Theoretical, the Fallacy

Point of comparison	Experimental
Based on	Actual data from records
Needs an experiment?	Yes
Formula	Times event occurs / number of trials
Typical use	Paper cup landing survey data



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Even in a perfectly fair situation, experimental probability can differ from theoretical probability, especially when the number of trials is small. In Example 2 the die gave 0.16 for a 4 against the theoretical $1/6 \approx 0.167$: close, but not equal.

Law of Large Numbers. As the number of trials increases, the experimental probability tends to get closer to the theoretical probability. Ten tosses of a fair coin might give 7 heads (0.7); thousands of tosses usually give a proportion close to 0.5.

Gambler’s Fallacy. Many people think that if one outcome happens many times in a row, the opposite outcome becomes “due”. A fair coin that has shown heads six times in a row still has probability $1/2$ (50%) of tails on the next flip. The coin has no memory: every flip starts afresh. This mistaken belief is called the **Gambler’s Fallacy**.

NCERT Example 6. In Snakes and Ladders you roll three 6s in a row and think, “There is no way I will get a 6 again.” This is the Gambler’s Fallacy. Each roll is an **independent event**, and the probability of a 6 on the next roll is still $1/6$. The textbook writes this as ≈ 0.166 (16.6%); rounded correctly to three decimal places, $1/6 = 0.166666\dots$. Probability describes what happens in the long run.

7. Sample Space and Events

The **sample space**, written **S**, is the list of all possible outcomes. Each possible outcome is an **element** of the sample space.

- S must include every possible outcome
- No outcome should be listed more than once
- The number of elements in S is the **sample size**

Experiment
Whether it rains tomorrow
Result of a team’s match
Tossing a fair coin once
Rolling a standard 6-sided die
Tossing two coins together



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For two coins, HT (coin 1 heads, coin 2 tails) and TH are different outcomes, so both are listed.

Choose the level of detail to match the question. {Rain, No Rain} is enough to ask whether it will rain. To ask about how much rain, expand it to {No Rain, Drizzle, Light Rain, Heavy Rain}. The sample space must be detailed enough for the problem being studied.

Events. An **event** is any single possible result, or a combination of results, of a random action. It is a choice of particular outcomes from all that could occur, so **an event is a subset of the sample space**.

Experiment	Sample space	Event	Event as a set
Tossing two coins	{HH, HT, TH, TT}	At least one coin shows head	$E = \{HH, HT, TH\}$
Rolling a 6-sided die	{1, 2, 3, 4, 5, 6}	The number rolled is	
Picking fruit from a basket	{Apple, Banana, Orange}		

With equally likely outcomes, $P(E) = (\text{number of outcomes in } E) / (\text{total number of outcomes})$. For example, with two coins, $P = 3/4$.

Recording only the number of heads. For outcomes where the number of heads are not equally likely: 1 head happens in 3 of the 8 equally likely outcomes. Probabilities from the 8 equally likely outcomes are:

8. Tree Diagrams and Tables for Multi-Step Experiments

A **multi-step experiment** involves a series of steps. For example, rolling a die three times. A **tree diagram** is a visual representation of a multi-step experiment. Each branch is a possible outcome at a step. Each path shows what can happen at the next step. Each path leads to one of the possible outcomes of the whole experiment.

NCERT Example 7: toss a fair coin two times. List the outcomes of the first toss, H and T. From the end of each outcome, list the outcomes of the second toss, H and T. Reading along each path:



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First toss	Second toss	Outcome (path)	Probability
H	H	HH	1/4
H	T	HT	1/4
T	H	TH	1/4
T	T	TT	1/4

The tree shows 4 possible outcomes, so $S = \{HH, HT, TH, TT\}$. Each branch of a fair coin carries probability $1/2$. $P(HH) = 1/4 = 0.25$, or 25%. The event "one head and one tail" is $\{HT, TH\}$, so its probability is $2/4 = 1/2$.

Counting paths quickly. If step 1 has a choices and step 2 has b choices for each of them, the tree ends in $a \times b$ paths. Two coins: $2 \times 2 = 4$. Three coins: $2 \times 2 \times 2 = 8$. Four coins and a die: $2 \times 2 \times 2 \times 6 = 12$. Two dice: $6 \times 6 = 36$.

Tables do the same job. For two dice, a 6 second die across the top gives all 36 outcomes. Count events such as "sum is 7": (1, 6), (2, 5), (3, 4), (4, 3), (5, 2), (6, 1). $P(\text{sum } 7) = 6/36 = 1/6$.

With and without replacement. A box has 4 balls. Draw one, then another. After the first draw, the box has 3 balls left.

- **With replacement** (the first ball goes back) tree has $4 \times 4 = 16$ paths, from (1, 1) to (4, 4). Repeats like (1, 2), (2, 1), (2, 2), ...
- **Without replacement** (the first ball is kept) tree has $4 \times 3 = 12$ paths. Pairs like (2, 1), (1, 2), (3, 1), (1, 3), ...

Label items of the same colour (R1, R2, ...) to avoid confusion. branch probability is the chance of that step.



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Formula and Theorem Sheet

Result	Statement	When to use it
Probability scale	$0 \leq P(E) \leq 1$; $P(\text{impossible}) = 0$, $P(\text{certain}) = 1$	Check every answer
Experimental probability	Number of times the event occurred / Total number of trials	Data from repeated trials
Estimate for a population	Probability from the sample $\times$ Population size	Scaling a sample result up
Theoretical probability	$P(E) = \text{Number of favourable outcomes} / \text{Number of possible outcomes}$	Equally likely outcomes only
Event not happening	$P(\text{not } E) = 1 - P(E)$	
Counting paths	Total outcomes each step)	
Two draws from n items	With replacement $n \times n$	
Law of Large Numbers	More trials: expected closer to theoretical	



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Important Definitions

Term	Definition
Probability	A measurement of the likelihood of an event, on a scale from 0 (impossible) to 1 (certain)
Randomness	A situation where the possible outcomes are known but the exact result cannot be predicted
Random experiment	Something you can repeat, where the result may differ each time and cannot be known in advance
Sample space (S)	The set of all possible outcomes, each listed exactly once
Event	One outcome or a group of outcomes; a subset of the sample space
Experimental probability	Probability found by experiment
Theoretical probability	Probability found by logic
Equally likely outcomes	Outcomes with the same chance of occurring
Fair (unbiased)	Symmetrical, no bias
Gambler's Fallacy	The false belief that past results affect the probability of the next result



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Solved Examples (NCERT)

Example 1: Ranking events on the scale from 0 to 1

Rank the events on a scale from 0 (Impossible) to 1 (Certain).
(i) The next Monday will come after Sunday.
(ii) A coin will land heads up.
(iii) You will walk through your classroom today.
(iv) You will greet at least one friend at school tomorrow.

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Solution: (i) **Certain (1):** Monday always follows Sunday. (ii) **Impossible, or as close to 0 as an event gets:** Mumbai is warm in July, its monsoon month. (iii) **Close to 0 (nearly impossible):** it could happen only in a very unusual situation. (iv) **More likely:** on a normal school day you meet friends, though illness or a holiday could prevent it. In (ii) to (iv) the reason matters as much as the label.

Example 2: Sweets sample (Exercise Set 7.2, Q1)

A sample of 30 sweets has 10 red, 8 green, 7 yellow and 5 blue. (i) Find the probability that a randomly picked sweet from the sample is green. (ii) If there are 600 sweets in the large bag, estimate how many are yellow.

Solution: Check the total: $10 + 8 + 7 + 5 = 30$. (i) $P(\text{green}) = 8/30 = 4/15 \approx 0.267$. (ii) $P(\text{yellow}) = 7/30$. Estimated yellow sweets = $(7/30) \times 600 = 7 \times 20 = 140$.

Example 3: Favourite club survey (Exercise Set 7.2, Q2)

Of 40 students sampled, 14 prefer Science, 11 prefer Sports, 9 prefer Arts and 6 prefer Music. The school has 800 students. (i) Find the probability that a student prefers Arts. (ii) Estimate how many students prefer Music.

Solution: $14 + 11 + 9 + 6 = 40$. (i) $P(\text{Arts}) = 9/40$. (ii) Estimated students = $(6/40) \times 800 = 120$.

Example 4: Experimental against theoretical probability

A 6-sided die is rolled 12 times and shows a '3' 3 times. (i) Find the experimental probability. (ii) Find the theoretical probability. (iii) Compare the two. (iv) Repeat the experiment 600 or 6000 rolls?

Solution: (i) $3/12 = 1/4 = 0.25$. (ii) One favourable outcome out of 6 possible outcomes, so $1/6 \approx 0.167$. (iii) One small number of trials, and chance variation is large. (iv) As the rolls go up to 60, 600 and 6000, the experimental probability will get closer to the theoretical probability.

Example 5: Writing sample spaces

Write the sample space for: (i) rolling a die, (ii) drawing a card from a pack of 52 cards, (iii) drawing a ball from a bag containing 5 red balls and 5 blue balls.

Solution: (i) $6 \times 2 = 12$ outcomes: $S = \{1H, 1T, 2H, 2T, 3H, 3T, 4H, 4T, 5H, 5T, 6H, 6T\}$.



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(ii) Taking both ends as included: $S = \{-5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5\}$, with $n(S) = 11$. If "between" is read as excluding -5 and 5 , $S = \{-4, \dots, 4\}$ with 9 elements; state which reading you use.

(iii) Recording colour: $S = \{\text{Green, Red}\}$. These two are not equally likely. Labelling the balls, $S = \{G1, G2, G3, G4, G5, R1, R2, R3, R4, R5, R6, R7\}$, 12 equally likely outcomes, so $P(\text{green}) = 5/12$.

Example 6: Snacks and drinks at the fair (Exercise Set 7.3, Q3)

Snacks: Samosa, Pakora, Bhaji. Drinks: Chai or Lassi. (i) List the sample space of all snack and drink combinations. (ii) List the event 'Selecting Samosa as a snack.'

Solution: (i) $3 \times 2 = 6$ combinations: $S = \{(\text{Samosa, Chai}), (\text{Samosa, Lassi}), (\text{Pakora, Chai}), (\text{Pakora, Lassi}), (\text{Bhaji, Chai}), (\text{Bhaji, Lassi})\}$. (ii) $E = \{(\text{Samosa, Chai}), (\text{Samosa, Lassi})\}$.

Example 7: Two fruit baskets (Exercise Set 7.4, Q1)

Basket A has one apple and two oranges. Basket B has one banana and two mangoes. One fruit is picked at random from each basket. Draw a tree diagram for the outcomes. What is the probability of one apple and one banana.

Solution: Label the oranges O1 and O2 so that the outcomes are on the first branches (Apple, O1, O2); from each,

$S = \{(\text{Apple, Banana}), (\text{Apple, Mango}), (\text{O1, Banana}), (\text{O1, Mango}), (\text{O2, Banana}), (\text{O2, Mango})\}$

Only (Apple, Banana) is favourable, so $P = 1/6$.

Example 8: Pens with replacement

A box has 3 red, 4 black and 2 green pens. You and your friend do the same. Find the probability that you and your friend pick the same colour.

Solution: Colour outcomes (you, friend): 3 red, 4 black, 2 green. They are not equally likely: each step has 9 outcomes.

Count with individual pens: 9 pens, replacement: $3 \times 3 = 9$, black $4 \times 4 = 16$, green $2 \times 2 = 4$.



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Example 9: Five quick probabilities (End-of-Chapter, Q4)

(i) Two coins tossed; at least one head. $S = \{HH, HT, TH, TT\}$; $E = \{HH, HT, TH\}$. $P = 3/4$.

(ii) Cards 1 to 10; an even number. $E = \{2, 4, 6, 8, 10\}$. $P = 5/10 = 1/2$.

(iii) A die; a number greater than 4. $E = \{5, 6\}$. $P = 2/6 = 1/3$.

(iv) 3 red, 2 blue, 1 green; not red. Not red = 2 + 1 = 3 of 6 balls. $P = 3/6 = 1/2$.

(v) Three coins; exactly two heads. $S = \{HHH, HHT, HTH, THH, HTT, THT, TTH, TTT\}$; $E = \{HHT, HTH, THH\}$. $P = 3/8$.

Example 10: Tyre life data (End-of-Chapter, Q7)

A tyre company records distances before replacement in 1000 cases: less than 4000 km: 20; 4001 to 9000 km: 210; 9001 to 14000 km: 325; more than 14000 km: 445. Find the probability that a randomly chosen tyre lasts (i) less than 4000 km, (ii) more than 14000 km.

Solution: Check: $20 + 210 + 325 + 445 = 1000$.
 $535/1000 = \mathbf{0.535}$. (iii) $445/1000 = \mathbf{0.445}$.
 probability from records.

Example 11: PEACE cards and the s

PEACE: the 5 cards are P, E, A, C, E. (i) P, = 3 cards, P = $\frac{3}{5}$.

Spinner with equally likely outcomes 1 to 8
 than 2 {3, 4, 5, 6, 7, 8}: $6/8 = \mathbf{3/4}$. (iv) Less
 $2/8 = \mathbf{1/4}$.

Example 12: Two balls without rep

A basket contains 4 red balls and 5 blue balls. A ball is drawn. Find (i) $P(\text{red then blue})$ and (ii) $P(\text{blue then red})$.

Solution: First step: red $\frac{4}{9}$, blue $\frac{5}{9}$. After blue $\frac{5}{8}$. After a blue is removed, 4 red and

A screenshot of a WhatsApp chat interface. At the top, there is a header bar with a dark background. On the left of this bar is a circular profile picture of a woman with dark hair, smiling. To the right of the profile picture, the name 'Ira' is written in white, bold font. Below the name, the text 'Your teacher for Introduction to Prob...' is visible in a smaller white font. The main chat area has a light gray background. It contains two messages from the same person, Ira. The first message is a text bubble with a white background and a thin gray border, containing the text: 'Hi, I am Ira. I teach this syllabus all day, so Introduction to Probability is very much my home ground.' The second message is another text bubble with a white background and a thin gray border, containing the text: 'Ask me anything from this chapter. A concept, a numerical, or that one doubt you did not want to raise in class. Pick one to start:'. At the bottom of the screen, there is a white bar with gray text that reads: 'Free questions, no login needed' followed by 'AI generated, can make mistakes. Cross-check with NCERT.' on the next line.

Path	Probability
Red, Red	$4/9 \times 3/8 = 12/72$
Red, Blue	$4/9 \times 5/8 = 20/72$
Blue, Red	$5/9 \times 4/8 = 20/72$
Blue, Blue	$5/9 \times 4/8 = 20/72$

(i) $P(\text{red then blue}) = 20/72 = 5/18$. (ii) $P(\text{two blue}) = 20/72 = 5/18$. Counting check: with labelled balls there are $9 \times 8 = 72$ ordered draws; red then blue can happen in $4 \times 5 = 20$ ways. The four paths add to $72/72 = 1$.

Example 13: Harder counting (End-of-Chapter, Q12)

(i) Two dice; the sum is a prime number greater than 5 and the primes greater than 5 are 7 and 11. Total outcomes $6 \times 6 = 36$. Favourable 6. $P = 6/36 = 1/6$.

(ii) 4 red, 3 green, 2 blue; two drawn with replacement. Total outcomes $9 \times 9 = 81$. Same colour: $4 \times 4 + 3 \times 3 + 2 \times 2 = 35$. $P = 35/81$.

(iii) Three coins; first coin heads and exactly one tail. Total outcomes $2^3 = 8$. Favourable 3. $P = 3/8$.

(iv) Four-digit number from 1, 2, 3, 4 with repetition. Total outcomes $4^4 = 256$. Last digit is 2 or 4; for each, the first three digits can be anything. Favourable 128. $P = 128/256 = 1/2$.

(v) 3 questions, 4 options each, guessing. Total outcomes $4^3 = 64$. Choose the one wrong question (3 ways). Favourable 3. $P = 3/64$.

Example 14: Which list is a sample space?

Q13. A box has 4 balls numbered 1 to 4 and 4 balls numbered 1 to 4. Outcomes, (1, 1) to (4, 4). Without replacement. Total outcomes $4 \times 3 = 12$. Favourable 4. $P = 4/12 = 1/3$.

Q15. Three coins are tossed and the number of heads is recorded. (i) {1, 2, 3} misses 0 heads (TTT). (ii) {0, 1, 2, 3, 4} contains 4, which cannot happen with three coins.



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Competency-Based Questions (with answers)

1. Case-based: The canteen survey

A student asks 60 students of Class 9 about their favourite canteen item: 24 choose idli, 18 choose sandwich, 12 choose poha and 6 choose fruit chaat. The school has 900 students.

- (a) Find the probability that a student from the sample chooses sandwich. $18/60 = 0.3$.
- (b) Estimate how many idlis the canteen should plan for the whole school. $P(\text{idli}) = 24/60 = 0.4$, so $0.4 \times 900 = 360$.
- (c) Give one way to make the estimate more reliable. Take a larger sample, and include students from all classes so the sample represents the whole school.

2. Case-based: The board game

In a board game a fair 6-sided die is rolled

- (a) Write the event "player enters" as a set
- (b) The player failed on four rolls in a row. The next roll is independent, so P stays $1/3$. Expecting a
- (c) Find the probability that the player do



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3. Source-based: Reading about t

Read: "The coin does not keep track of wh heads or tails stays exactly the same."

- (a) Which word describes flips whose res
- (b) After six heads in a row, what is $P(\text{tail})$
- (c) How does the Law of Large Numbers t the proportion of heads settles near $1/2$. A

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4. Assertion-Reason

Options for Questions 4 to 6: (a) Both A and R are true, and R is the correct explanation of A. (b) Both A and R are true, but R is not the correct explanation of A. (c) A is true, but R is false. (d) A is false, but R is true.

Assertion (A): When a bag has 3 red and 7 blue marbles, the probability of drawing a red marble is $\frac{1}{2}$. **Reason (R):** The theoretical probability formula applies only when the outcomes counted are equally likely.

Answer: (d). A is false: there are 10 equally likely marbles, so $P(\text{red}) = \frac{3}{10}$. R is true, and it is exactly why counting the two colours as outcomes fails.

5. Assertion-Reason

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

Assertion (A): When two coins are tossed and TH are different outcomes because the

Answer: (a). $S = \{HH, HT, TH, TT\}$, and R

6. Assertion-Reason

Options: (a) Both A and R are true, and R is true, but R is not the correct explanation of true.

Assertion (A): A die rolled 50 times showed is 0.16. **Reason (R):** The probability of any

Answer: (b). $\frac{8}{50} = 0.16$, so A is true, and total trials), and R does not explain it.

7. Data reasoning: The paper cup

A group tosses a paper cup 100 times. It landed upside down on its top 12 times.

(a) Assign probabilities to the three outcomes. Side 0.62, bottom 0.28, top 0.12. They add to 1.



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(b) Why can theoretical probability not be used here? The three landing positions have different shapes and areas, so there is no reason to treat them as equally likely.

(c) Another group gets side 58 times in 100 tosses. Is either group wrong? No. Experimental results vary between sets of trials; pooling both gives $120/200 = 0.6$, a better estimate from more trials.

8. Simulation: Guessing a true-false quiz

A student guesses all answers of a 2-question true-false quiz. To model this, she tosses two coins, with H for a correct guess and T for a wrong one.

(a) Why is a coin a fair model for one guess? Each guess has 2 equally likely results, like a fair coin.

(b) Find $P(\text{both correct})$ and $P(\text{exactly one correct})$. $S = \{HH, HT, TH, TT\}$. $P(HH) = 1/4$; $P(\text{exactly one}) = 2/4 = 1/2$.

(c) She repeats the two tosses 40 times and gets 13 correct. Experimental $13/40 = 0.325$, against theoretical 0.25 . More repeats should bring it closer to 0.25 .

Important Questions for

1-Mark Questions

1. "The probability of an impossible event is 0."
2. "The set of all possible outcomes of a random experiment is called the sample space."
3. "Tossing a fair coin has a probability of 0.5 for heads and 0.5 for tails."
4. "When a single 6-sided die is rolled, what is the probability of getting a number less than 3?"
5. "A bag has 3 candies: strawberry, lemon, and orange. What is the probability of picking a strawberry candy?"



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2-Mark Questions

1. "In a survey of 50 students, 15 students said they liked football. The number of students who like football is 15, and the _____ (frequency/relative frequency) is _____." Relative frequency; $15/50 = 3/10 = 0.3$.
2. "What is the probability of getting an even number when rolling a fair 6-sided die?" Favourable {2, 4, 6}: $3/6 = 1/2$.
3. "I throw a pair of 6-sided dice. Write down an event that has a probability of 0 and an outcome that has a probability of 1." Probability 0: "the sum is 13" (the largest sum is 12). Probability 1: "the sum is between 2 and 12, inclusive", which covers all 36 outcomes.

3-Mark Questions

1. "Which of the following experiments have equally likely outcomes? Explain." (i) Car starts or does not start: not equally likely, since it depends on the car's condition. (ii) Fair coin: equally likely. (iii) Fair die: equally likely. (iv) Red or blue from 3 red and 7 blue: not equally likely ($3/10$ against $7/10$). (v) Baby boy or girl: equally likely. (vi) Number of children in a family: not equally likely to expect one more than the other (real life).
2. "A child has 2 shirts (one red and one blue) and 3 pairs of pants (jeans, khakis and shorts). List all the possible combinations of outfits." Red-Jeans, Red-Khakis, Red-Shorts, Blue-Jeans, Blue-Khakis, Blue-Shorts. $2 \times 3 = 6$ outfits.
3. "List the elements of a sample space for a card from a set of 6 cards numbered T4, T5, T6; n(S) = 12. For example, P(h



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5-Mark Questions

1. A coin is tossed three times. (a) Draw a tree diagram showing all possible outcomes. (b) Find P(two heads), P(at least one head) and P(first head followed by two tails). doubles the branches: 8 paths, $S = \{HHH, HHT, HTH, HTT, THH, THT, TTH, TTT\}$. two heads {HHT, HTH, THH}: $3/8$. At least one head {HHT, HTH, THH, HTT, THT, TTH}: $6/8 = 3/4$. exactly two heads {HHT, HTH}: $2/8 = 1/4$.
2. A survey of 80 households in a colony found that 56 use LPG, 16 use PNG, and 8 use electric induction. (a) Find the probability of a household using LPG. (b) Find the probability of a household using PNG. (c) Name this experimental or theoretical probability. (d) Find the probability of a household using electric induction. $56/80 = 0.7$; sum 1. (b) $0.7 \times 2000 = 1400$. representative, drawn from all parts of the colony. (d) from collected data.

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3. **Two dice are rolled. Using a 6 by 6 table, find (a) P(sum 8), (b) P(doublet), (c) P(sum less than 5), (d) P(sum is not 7).** $n(S) = 36$. (a) (2, 6), (3, 5), (4, 4), (5, 3), (6, 2): $5/36$. (b) (1, 1) to (6, 6): $6/36 = 1/6$. (c) Sum 2: 1, sum 3: 2, sum 4: 3, total 6: $6/36 = 1/6$. (d) Sum 7 has 6 outcomes, so $1 - 6/36 = 5/6$.

Common Mistakes and Examiner Tips

1. **Answer outside 0 to 1.** A probability of 1.2 or -0.3 signals an error. Fix: check that the favourable count is not larger than the total.
2. **Counting colours as equally likely outcomes.** 3 red and 7 blue does not give $P(\text{red}) = 1/2$. Fix: count the individual items: $3/10$.
3. **Listing HT and TH once.** Two coins give 4 outcomes. Fix: name coin 1 and coin 2, or draw the tree.
4. **Missing an outcome in S.** For the number of outcomes, list the smallest and largest possible values.
5. **Mixing frequency and relative frequency.**
6. **Dividing by the wrong total in survey questions.** Multiply by the population size for the expected frequency.
7. **Gambler's Fallacy.** After a streak, P for "each trial is independent".
8. **Treating replacement and no replacement the same.** One item fewer, and the branch probability changes.
9. **Ignoring repeated letters.** In PROBABILITY, P is 2, B is 2, I is 2, Y is 1, L is 1, T is 1.
10. **Expecting experimental and theoretical probabilities to be equal.** The Law of Large Numbers in your reasoning.



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Quick Revision Points

- Probability measures the likelihood of an event occurring. It is a number between 0 and 1.
- 0.5 is an even chance; below 0.5 is less likely; above 0.5 is more likely.
- A random experiment can be repeated, and the outcome can be predicted.
- Subjective probability is a personal judgement; this chapter measures probability objectively.

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- Experimental probability = times the event occurred / total trials, also called relative frequency.
- A die rolled 50 times showing 4 eight times: $8/50 = 0.16$.
- Estimate for a population = probability from the sample $\times$ population size.
- Larger, more representative samples give more reliable estimates.
- Theoretical probability = favourable outcomes / possible outcomes, for equally likely outcomes.
- A fair (unbiased) coin or die is symmetrical; no outcome is favoured.
- $P(4 \text{ on a die}) = 1/6 \approx 0.167$; $P(B \text{ from PROBABILITY}) = 2/11$.
- Law of Large Numbers: more trials bring experimental probability closer to theoretical.
- Gambler's Fallacy: past independent trials do not change the next one.
- Sample space S lists every outcome once; $n(S)$ is the sample size.
- An event is a subset of S .
- Coin 2, die 6, two coins 4, three coins 8
- Each full path of a tree diagram is one c
- With replacement: $n \times n$; without replac
- $P(\text{not } E) = 1 - P(E)$.



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Weightage and Exam Pat

Class 9 has no board exam. This chapter is in the yearly exam and the annual exam. In the C 27, it belongs to **Unit VI, Statistics and Pro** theory paper. That 10 is shared between the structure does not split it further. The unit marks of the year are internal assessment portfolio (5) and lab practical (5).

Its listed competencies: describe likelihood probability from data, apply theoretical probability to random experiments by simulation.

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The CBSE Class IX question paper design weights questions by thinking skill: about 54% remembering and understanding, 24% applying, and 22% analysing, evaluating and creating. The 1, 2, 3 and 5-mark grouping above is a practice ladder; the question types in a given school paper are set by that paper.

This chapter is the foundation for probability in Class 10, where the same counting of sample spaces and favourable outcomes is used.



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