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CHAPTER NOTES

Probability Class 11 Notes | CBSE Maths Chapter 14

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Probability Class 11 Notes | CBSE Maths Chapter 14

Probability is Chapter 14 of CBSE Class 11 Maths — the chapter that finally puts numbers on the word “chance.” Whether it is rolling a die, drawing a card, or guessing a multiple-choice answer, probability gives you a precise way to measure how likely an event is. This is the modern, axiomatic approach built on sets, so if you are comfortable with union, intersection, and complement, you are already halfway there.

By the end of these notes you will be able to write the sample space of any random experiment, classify events, apply the axiomatic definition of probability, and use the addition rule confidently for both mutually exclusive and overlapping events. This is a scoring chapter carrying roughly 6–8 marks in boards and a guaranteed question in JEE — and it is the foundation for Class 12 Probability and all of statistics.

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Key Concepts

1. Random Experiment

A **random experiment** is an experiment that has more than one possible outcome and whose result cannot be predicted in advance, even though all possible outcomes are known. Tossing a coin or rolling a die are classic examples — you know what *can* happen, but not *which* will happen.

An **outcome** is a possible result of the experiment. A **trial** is a single performance of the experiment — one toss of a coin is one trial.

2. Sample Space

The **sample space**, denoted by **S** (or Ω), is the set of all possible outcomes of a random experiment. Each individual outcome is called a **sample point**.

- Tossing one coin: **S = {H, T}**

- Rolling one die: $S = \{1, 2, 3, 4, 5, 6\}$
- Tossing two coins: $S = \{HH, HT, TH, TT\}$

Key idea: The number of sample points in S is denoted $n(S)$. For tossing n coins, $n(S) = 2^n$; for rolling n dice, $n(S) = 6^n$.

3. Event

An **event** is any subset of the sample space S . If the outcome of the experiment is an element of the event set, we say the event has **occurred**.

Example: When rolling a die, the event “getting an even number” is the subset $E = \{2, 4, 6\}$, which is a subset of $S = \{1, 2, 3, 4, 5, 6\}$.

Occurrence: An event E associated with experiment S occurs if the actual outcome ω belongs to E , i.e. $\omega \in E$.

4. Types of Events

Events are classified by their structure and how they relate to one another. These definitions are pure set theory applied to outcomes.

- **Impossible event:** the empty set $\emptyset$ — an event that can never occur (rolling a 7 on a normal die).
- **Sure (certain) event:** the whole sample space S — an event that always occurs (rolling a number ≤ 6).
- **Simple (elementary) event:** an event with exactly one sample point, e.g. $\{3\}$.
- **Compound event:** an event with more than one sample point, e.g. $\{2, 4, 6\}$.

Relationships Between Events

- **Complementary event (A' or not A):** $A' = S - A$, the set of outcomes in S that are *not* in A .
 - **Event “A and B” ($A \cap B$):** outcomes common to both A and B — both events occur.
 - **Event “A or B” ($A \cup B$):** outcomes in A , in B , or in both — at least one event occurs.
 - **Mutually exclusive (disjoint) events:** $A \cap B = \emptyset$ — both cannot occur together (getting a head and a tail in one toss).
 - **Exhaustive events:** events whose union is the entire sample space, $A \cup B \cup \dots = S$.
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5. Axiomatic Approach to Probability

The **axiomatic definition** assigns to each event A a real number $P(A)$, called the probability of A , satisfying three axioms (given by Kolmogorov).

- **Axiom 1:** $P(A) \geq 0$ for every event A .
- **Axiom 2:** $P(S) = 1$ (the sure event has probability 1).
- **Axiom 3:** If A and B are mutually exclusive, $P(A \cup B) = P(A) + P(B)$.

From these axioms it follows that $0 \leq P(A) \leq 1$, $P(\emptyset) = 0$, and $P(A') = 1 - P(A)$.

6. Probability of an Event (Equally Likely Outcomes)

When all outcomes of S are **equally likely**, the probability of an event A is the ratio of favourable outcomes to total outcomes.

$$P(A) = n(A) / n(S) = (\text{number of favourable outcomes}) / (\text{total number of outcomes})$$

- Each elementary outcome of a sample space with $n(S)$ equally likely points has probability $1/n(S)$.
- The sum of probabilities of all elementary events equals 1.

Example: Probability of an even number on a die = $n(A)/n(S) = 3/6 = 1/2$.

7. Probability of 'Not' an Event (Complement)

The probability that event A does **not** occur is the complement rule.

$$P(A') = P(\text{not } A) = 1 - P(A)$$

This is one of the most useful shortcuts in the chapter: when "at least one" appears in a question, it is usually faster to find $P(\text{none})$ and subtract from 1.

8. Addition Rule of Probability

The **addition rule** (also called the addition theorem) gives the probability that at least one of two events occurs — the probability of " A or B ."

$$P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

We subtract $P(A \cap B)$ because the outcomes common to both A and B were counted twice.

Mutually Exclusive Events

If A and B are mutually exclusive, then $A \cap B = \emptyset$ and $P(A \cap B) = 0$, so the rule simplifies to:

$$P(A \cup B) = P(A) + P(B)$$

For Three Events

$$P(A \cup B \cup C) = P(A) + P(B) + P(C) - P(A \cap B) - P(B \cap C) - P(C \cap A) + P(A \cap B \cap C).$$

9. Probability of ‘A and B’ and Useful Results

The event “A and B” is $A \cap B$; its probability is $P(A \cap B)$. Rearranging the addition rule gives a handy way to find it when the other quantities are known.

- $P(A \cap B) = P(A) + P(B) - P(A \cup B)$
- $P(\text{A only}) = P(A) - P(A \cap B)$ (A but not B)
- $P(\text{B only}) = P(B) - P(A \cap B)$ (B but not A)
- $P(\text{neither A nor B}) = P(A' \cap B') = 1 - P(A \cup B)$

[DIAGRAM: A Venn diagram of sample space S with two overlapping circles A and B — the lens-shaped overlap is $A \cap B$, the whole shaded region is $A \cup B$, and the area outside both circles is $A' \cap B'$.]

Weightage in Board & Entrance Exams

Exam	Typical Weightage	Most-Tested Areas
CBSE Board (Class 11)	6–8 marks	Sample space, addition rule, complement, types of events
JEE Main	1–2 questions	Addition rule, $P(A \text{ or } B)$, card/dice problems
Other entrance (CUET)	1–2 questions	Equally likely outcomes, complement rule

[TABLE: Question-type split — VSA (1 mark): sample space, definitions; SA (2–3 marks): addition rule, complement numericals; LA (4–5 marks): combined dice/card problems using $P(A \cup B)$.]

Important Definitions

Term	Definition
Random experiment	An experiment with more than one known outcome whose result cannot be predicted
Sample space (S)	The set of all possible outcomes of a random experiment
Sample point	A single element (outcome) of the sample space
Event	Any subset of the sample space S
Impossible event	The empty set $\emptyset$; probability 0
Sure event	The whole sample space S; probability 1
Mutually exclusive events	Events that cannot occur together: $A \cap B = \emptyset$
Exhaustive events	Events whose union is the whole sample space
Probability of an event	$P(A) = n(A)/n(S)$ for equally likely outcomes
Complement rule	$P(A') = 1 - P(A)$
Addition rule	$P(A \cup B) = P(A) + P(B) - P(A \cap B)$

Solved Examples

Example 1

A die is rolled once. Write the sample space and find the probability of getting a number greater than 4.

Answer: $S = \{1, 2, 3, 4, 5, 6\}$, $n(S) = 6$. Favourable = $\{5, 6\}$, $n(A) = 2$. $P(A) = 2/6 = \mathbf{1/3}$.

Example 2

Two coins are tossed together. Find the probability of getting at least one head.

Answer: $S = \{HH, HT, TH, TT\}$, $n(S) = 4$. "At least one head" is the complement of "no head" (TT). $P = 1 - P(TT) = 1 - 1/4 = \mathbf{3/4}$.

Example 3

A card is drawn from a well-shuffled deck of 52 cards. Find the probability that it is a king or a heart.

Answer: $P(\text{King}) = 4/52$, $P(\text{Heart}) = 13/52$, $P(\text{King} \cap \text{Heart}) = 1/52$. By the addition rule, $P(\text{King} \cup \text{Heart}) = 4/52 + 13/52 - 1/52 = 16/52 = \mathbf{4/13}$.

Example 4

If $P(A) = 0.5$, $P(B) = 0.4$ and $P(A \cap B) = 0.2$, find $P(A \cup B)$ and $P(\text{neither } A \text{ nor } B)$.

Answer: $P(A \cup B) = 0.5 + 0.4 - 0.2 = \mathbf{0.7}$. $P(\text{neither}) = 1 - P(A \cup B) = 1 - 0.7 = \mathbf{0.3}$.

Example 5

A and B are mutually exclusive events with $P(A) = 3/8$ and $P(B) = 1/4$. Find $P(A \cup B)$ and $P(A')$.

Answer: Since mutually exclusive, $P(A \cup B) = P(A) + P(B) = 3/8 + 2/8 = \mathbf{5/8}$. $P(A') = 1 - 3/8 = \mathbf{5/8}$.

Example 6

Two dice are thrown. Find the probability that the sum of the numbers is 8.

Answer: $n(S) = 6 \times 6 = 36$. Favourable outcomes for sum 8: $\{(2,6), (3,5), (4,4), (5,3), (6,2)\} \rightarrow n(A) = 5$. $P(A) = \mathbf{5/36}$.

Important Questions for Board Exams

1-Mark Questions (VSA)

1. Define a random experiment and give one example.
2. Write the sample space when a coin is tossed three times.
3. What is the probability of an impossible event?
4. If $P(A) = 0.65$, find $P(\text{not } A)$.
5. When are two events said to be mutually exclusive?

2–3-Mark Questions (SA)

1. State the axiomatic definition of probability and list its three axioms.
2. A die is thrown. Find the probability of getting (i) a prime number, (ii) a number divisible by 3.
3. If $P(A) = 0.42$, $P(B) = 0.48$ and $P(A \cap B) = 0.16$, find $P(A \cup B)$ and $P(\text{not } A \text{ and not } B)$.
4. Distinguish between mutually exclusive and exhaustive events with one example each.

4–5-Mark Questions (LA)

1. State and prove the addition theorem of probability for two events A and B. Hence write its form for mutually exclusive events.
2. A card is drawn from a deck of 52 cards. Find the probability that it is (i) a face card, (ii) a red card, (iii) a face card or a spade.
3. Two dice are rolled. Find the probability that the sum is (i) at least 10, (ii) an even number, (iii) a prime number.

Quick Revision Points

- Random experiment: known outcomes, unpredictable result; outcome = one result, trial = one performance
- Sample space S = set of all outcomes; $n(\text{coins}) = 2^n$, $n(\text{dice}) = 6^n$
- Event = subset of S ; impossible = $\emptyset$, sure = S
- Simple event has one sample point; compound event has more than one
- Mutually exclusive: $A \cap B = \emptyset$; exhaustive: union = S
- Axioms: $P(A) \geq 0$, $P(S) = 1$, $P(A \cup B) = P(A) + P(B)$ if disjoint
- Equally likely: $P(A) = n(A)/n(S)$; always $0 \leq P(A) \leq 1$
- Complement: $P(\text{not } A) = 1 - P(A)$; $P(\emptyset) = 0$
- Addition rule: $P(A \cup B) = P(A) + P(B) - P(A \cap B)$
- Mutually exclusive: $P(A \cup B) = P(A) + P(B)$
- $P(\text{neither } A \text{ nor } B) = 1 - P(A \cup B)$; $P(A \text{ only}) = P(A) - P(A \cap B)$

Next Chapter: Chapter 13 — Statistics



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