CHAPTER 5

Probability

CBSE · Applied Mathematics · Class 11

WHAT THIS CHAPTER DOES

Boards prep that builds confidence, not anxiety.

TODAY'S MISSION

Today's Mission

WHY THIS MATTERS

The Whole Chapter on One Page

TOPIC

Vocabulary you MUST own before slide 6

TOPIC

A

Part A — Classical Probability

TOPIC

Classical definition + the four standard experiments

POINT 1	POINT 2	POINT 3	POINT 4

WORKED EXAMPLE

Worked Example — Two dice, sum is 7 OR 11

1. Step 1 — Sample space: $|S| = 6 \times 6 = 36$.
2. Step 2 — Event A (sum 7): $\{(1,6),(2,5),(3,4),(4,3),(5,2),(6,1)\} \rightarrow n(A) = 6$.
3. Step 3 — Event B (sum 11): $\{(5,6),(6,5)\} \rightarrow n(B) = 2$.
4. Step 4 — A and B are mutually exclusive (a single throw can't give sum 7 and sum 11 simultaneously), so $P(A \cup B) = P(A) + P(B) = 6/36 + 2/36 = 8/36$.
5. Step 5 — Simplify: $P(A \cup B) = 2/9$.

TOPIC

Two-dice sample space — the 36 outcomes

TRY IT · SOLVE BEFORE YOU PEEK

Quick Test — 60 seconds

Work it out before you flip the answer.

SOLUTION

TOPIC

B

Part B — Addition Rule & Complement

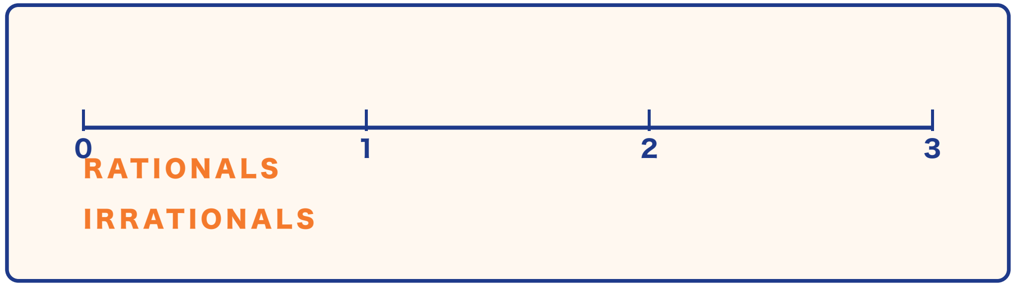
TOPIC

The three rules that finish 50% of PYQs

POINT 1

POINT 2

POINT 3



WORKED EXAMPLE

Worked Example — King OR heart from a pack

1. Step 1 — Let A = 'king drawn', B = 'heart drawn'.
2. Step 2 — $P(A) = 4/52$, $P(B) = 13/52$.
3. Step 3 — $A \cap B$ = {king of hearts}, so $P(A \cap B) = 1/52$.
4. Step 4 — Apply general addition rule: $P(A \cup B) = 4/52 + 13/52 - 1/52 = 16/52$.
5. Step 5 — Simplify: $P(A \cup B) = 4/13$.

TOPIC

Mid-deck recap — can you do these in your head?

TOPIC

C

Part C — Conditional Probability & Independence

TOPIC

Conditional probability — the heart of Cl-11 Unit 5

POINT 1	POINT 2	POINT 3	POINT 4

WORKED EXAMPLE

Worked Example — Conditional probability from a bag

1. Step 1 — Let R1 = 'first ball red', R2 = 'second ball red'. We need $P(R1 \cap R2)$.
2. Step 2 — $P(R1) = 5/8$ (5 red out of 8 total).
3. Step 3 — Given R1 occurred, the bag now has 4 red + 3 black = 7 balls, so $P(R2|R1) = 4/7$.
4. Step 4 — Multiplication rule: $P(R1 \cap R2) = P(R1)\cdot P(R2|R1) = (5/8)\cdot(4/7) = 20/56$.
5. Step 5 — Simplify: P(both red) = $5/14$.

TRY IT · SOLVE BEFORE YOU PEEK

Independence check — 30 seconds

Work it out before you flip the answer.

SOLUTION

TOPIC

D

Part D — Bayes' Theorem

THEOREM · LOAD-BEARING RESULT

Bayes' Theorem

> " Suppose $A_1, A_2, \cdots, A_n$ are mutually exclusive and exhaustive events with $P(A_i) > 0$ for all i, and E is any event with $P(E) > 0$. Then for every i: $P(A_i \mid E) = [P(E \mid A_i) \cdot P(A_i)] / [\ \Sigma_j P(E \mid A_j) \cdot P(A_j)\ ]$.

STATEMENT

Suppose $A_1, A_2, \cdots, A_n$ are mutually exclusive and exhaustive events with $P(A_i) > 0$ for all i, and E is any event with $P(E) > 0$. Then for every i: $P(A_i \mid E) = [P(E \mid A_i) \cdot P(A_i)] / [\ \Sigma_j P(E \mid A_j) \cdot P(A_j)\ ]$.

WHY THIS MATTERS

WORKED EXAMPLE

Worked Example — Bayes with two urns

1. Step 1 — Define events: A1 = 'chose Urn I', A2 = 'chose Urn II', E = 'ball drawn is white'. Priors: P(A1) = P(A2) = 1/2.
2. Step 2 — Conditional rates: P(E|A1) = 4/10 = 2/5; P(E|A2) = 7/10.
3. Step 3 — Total probability: P(E) = P(E|A1)P(A1) + P(E|A2)P(A2) = (2/5)(1/2) + (7/10)(1/2) = 2/10 + 7/20 = 4/20 + 7/20 = 11/20.
4. Step 4 — Apply Bayes: P(A2|E) = [P(E|A2)P(A2)] / P(E) = [(7/10)(1/2)] / (11/20) = (7/20) / (11/20) = 7/11.
5. Step 5 — Interpret: given a white ball was drawn, the probability it came from Urn II is 7/11 ≈ 0.636. (Sanity check: Urn II has more whites, so its posterior should be > prior of 1/2. ✓)

PYQ PATTERNS

What CBSE actually asks from this chapter

MARKS DISTRIBUTION

Where the marks live inside this chapter

TOPPER TEMPLATE · MARK-BY-MARK

Topper's 5-mark Bayes template

TOPIC

Trap

TRAP → TRUTH

× **MISTAKE** Mutually exclusive events are the same as independent events.

✓ **CORRECT** Mutually exclusive ⇒ $P(A \cap B) = 0$. Independent ⇒ $P(A \cap B) = P(A)P(B)$. If both $P(A) > 0$ and $P(B) > 0$, mutually exclusive events CANNOT be independent.

TOPIC

Trap

TRAP → TRUTH

× **MISTAKE** P(A or B) is always P(A) + P(B).

✓ **CORRECT** Only when A and B are mutually exclusive. In general $P(A \cup B) = P(A) + P(B) - P(A \cap B)$. Forgetting the overlap is the #1 board mistake.

TOPIC

Trap

TRAP → TRUTH

× **MISTAKE** $P(A|B) = P(B|A)$.

✓ **CORRECT** These are different in general. $P(A|B) = P(A \cap B)/P(B)$ while $P(B|A) = P(A \cap B)/P(A)$. They are equal only when $P(A) = P(B)$. Bayes' theorem is exactly the bridge between the two.

TOPIC

Trap

TRAP → TRUTH

× **MISTAKE** If two events are independent, they are mutually exclusive.

✓ **CORRECT** Opposite. Independent events with positive probabilities MUST overlap: $P(A \cap B) = P(A)P(B) > 0$.

TOPIC

Trap

TRAP → TRUTH

× **MISTAKE** Probability can be greater than 1 if the event is 'very likely'.

✓ **CORRECT** Axiom 1 locks $0 \leqslant P(E) \leqslant 1$. If your answer is > 1, you have double-counted an overlap or mis-listed S.

TOPIC

Trap

TRAP → TRUTH

× **MISTAKE** Drawing 'without replacement' is still independent.

✓ **CORRECT** Removing the first ball changes the sample space for the second draw, so the two draws are dependent. Use conditional probability or multiplication rule.

PYQ PATTERNS

Top PYQ patterns to drill

#1	Two dice are thrown	find P(sum is 7 or 11). (2 marks) — 70%
#2	From a pack of 52 cards, one card is drawn	P(king or heart). (2 marks) — 65%
#3	Bag with R red, B black	two drawn without replacement, P(both red). (3 marks) — 60%
#4	Verify A and B are independent given P(A), P(B), P(A∩B). (2 marks)	55%
#5	Two factories / two urns Bayes problem. (5 marks)	80%

MARKS DISTRIBUTION

10-year marks distribution

10-YEAR PYQ MARKS DISTRIBUTION

1_mark	4%
2_marks	2%
3_marks	1%
5_marks	1%

RECAP · MEMORISE THESE

Probability in 6 lines

1 $P(E) = n(E)/n(S)$ when outcomes are equally likely.

2 $0 \leqslant P(E) \leqslant 1$; $P(S)=1$; $P(\varnothing)=0$.

3 $P(A\cup B) = P(A) + P(B) - P(A\cap B)$; add only when mutually exclusive.

4 $P(A') = 1 - P(A)$ — use it for 'at least one' questions.

5 $P(A|B) = P(A\cap B)/P(B)$; $P(A\cap B) = P(A|B)\cdot P(B)$.

6 Independence: $P(A\cap B) = P(A)\cdot P(B)$. Bayes: $P(Ai|E) = P(E|Ai)P(Ai)/\Sigma P(E|Aj)P(Aj)$.

WHAT'S NEXT

What's next

→

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