

# Probability Formulas Sheet

All the key probability formulas in one place. From basic probability to permutations and combinations.

## Basic Probability

**P(A):** Favorable outcomes / Total outcomes

**Range:**  $0 \leq P(A) \leq 1$

**Certain event:**  $P(A) = 1$

**Impossible:**  $P(A) = 0$

**Complement:**  $P(\text{not } A) = 1 - P(A)$

## Addition Rule

**General:**  $P(A \text{ or } B) = P(A) + P(B) - P(A \text{ and } B)$

**Mutually exclusive:**  $P(A \text{ or } B) = P(A) + P(B)$

**Key idea:** Subtract overlap to avoid double-counting

## Counting Methods

**Permutations:**  $nPr = n! / (n - r)!$

**Use when:** Order matters

**Combinations:**  $nCr = n! / (r!(n - r)!)$

**Use when:** Order does not matter

**Factorial:**  $n! = n \times (n-1) \times \dots \times 2 \times 1$

**Note:**  $0! = 1$  by definition

## Multiplication Rule

**Independent:**  $P(A \text{ and } B) = P(A) \times P(B)$

**Dependent:**  $P(A \text{ and } B) = P(A) \times P(B|A)$

**Independent test:**  $P(A|B) = P(A)$

## Conditional Probability

**Formula:**  $P(A|B) = P(A \text{ and } B) / P(B)$

**Read as:** Probability of A given B has occurred

**Requires:**  $P(B) > 0$

## Expected Value

**Formula:**  $E(X) = \text{Sum of } x \times P(x)$

**Meaning:** Long-run average outcome

**Fair game:**  $E(X) = 0$  (no advantage)

**Linearity:**  $E(aX + b) = aE(X) + b$

Ask yourself: does order matter? If yes, use permutations. If no, use combinations. This single question solves most counting problems.