Cambridge AS & A Level · Mathematics 9709

Mathematics 9709 formulas and definitions: Probability & Statistics 1

All 37 formulas, facts and definitions to learn, by syllabus topic. Formulas the exam gives you are left out.

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5 Probability & Statistics 1

5.1 Representation of data

Variance = (standard deviation)^2

Coded data: $\bar{x} = a + \dfrac{\sum(x-a)}{n}$; sd $= \sqrt{\dfrac{\sum(x-a)^2}{n} - \left(\dfrac{\sum(x-a)}{n}\right)^2}$

$\sum(x-a) = \sum x - na$

Back to totals: $\sum x = n\bar{x}$, $\sum x^2 = n(\sigma^2 + \bar{x}^2)$

Median: the $\frac{n+1}{2}$th value; Q_1, Q_3: medians of the lower and upper halves

Range = largest − smallest; IQR $= Q_3 - Q_1$

Frequency density $= \dfrac{\text{frequency}}{\text{class width}}$

Midpoint $= \frac{1}{2}$(lower boundary + upper boundary)

From a cumulative frequency graph: median at $\frac{n}{2}$, quartiles at $\frac{n}{4}$ and $\frac{3n}{4}$, pth percentile at $\frac{p}{100}n$

5.2 Permutations and combinations

n different objects in a line: $n!$ ways; $0! = 1$

${}^nP_r = \dfrac{n!}{(n-r)!}$, arrangements of r from n different objects

n objects, p alike, q alike, ...: $\dfrac{n!}{p!\,q!\cdots}$ arrangements

${}^nC_r = {}^nC_{n-r}$, and ${}^nP_r = {}^nC_r \times r!$

Together: glue into a block, then × the block's inside orders

Not together: total − together; or arrange the rest, then use the $m+1$ gaps around m objects

Exactly k between two items in n places: $n-k-1$ positions for the pair

Scenarios: multiply within a scenario, add across scenarios

Equal-sized unlabelled groups: divide by $r!$ for r groups of the same size

5.3 Probability

Equally likely outcomes: $\mathrm{P}(A) = \dfrac{\text{outcomes in } A}{\text{all outcomes}}$

$\mathrm{P}(A') = 1 - \mathrm{P}(A)$; $\mathrm{P}(\text{at least one}) = 1 - \mathrm{P}(\text{none})$

Exclusive events: $\mathrm{P}(A \text{ or } B) = \mathrm{P}(A) + \mathrm{P}(B)$

Independent events: $\mathrm{P}(A \cap B) = \mathrm{P}(A) \times \mathrm{P}(B)$

Any events: $\mathrm{P}(A \cap B) = \mathrm{P}(A) \times \mathrm{P}(B \mid A)$ (multiply along a tree)

Conditional probability: $\mathrm{P}(A \mid B) = \dfrac{\mathrm{P}(A \cap B)}{\mathrm{P}(B)}$

Exclusive with $\mathrm{P}(A), \mathrm{P}(B) > 0$: never independent

5.4 Discrete random variables

$\sum P(X = x) = 1$

Standard deviation $= \sqrt{\mathrm{Var}(X)}$

The four conditions for a binomial model (fixed n, two outcomes, constant p, independent trials)

$\mathrm{Geo}(p)$: $P(X > n) = (1-p)^n$ and $P(X \leqslant n) = 1 - (1-p)^n$

rth success on trial n: $\binom{n-1}{r-1} p^r (1-p)^{n-r}$

5.5 The normal distribution

$X \sim N(\mu, \sigma^2)$: mean μ, **variance** σ^2

Standardising: $Z = \dfrac{X - \mu}{\sigma}$

$P(Z > a) = 1 - \Phi(a)$; $P(-a < Z < a) = 2\Phi(a) - 1$

$P(X = a) = 0$ for a continuous variable, so $<$ and $\leqslant$ give the same probability

Normal approximation valid when $np > 5$ and $nq > 5$

$B(n, p) \approx N(np,\ npq)$ with a continuity correction (± 0.5)

Expected number $= n \times$ probability