PHOTON ACADEMY · IB MATH AA HL CHEATSHEET

Probability Distributions

SL 4.7–4.9, AHL 4.14–4.18

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FORMULAS YOU MUST KNOW

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

Total prob:

$E(X) = \sum x \cdot P(X = x)$

Expectation:

$\mathrm{Var}(X) = E(X^2) - [E(X)]^2$

Variance:

$E(aX + b) = aE(X) + b$

Linear E:

$\mathrm{Var}(aX + b) = a^2\mathrm{Var}(X)$

Linear Var:

$\int_{-\infty}^{\infty} f(x)\,dx = 1$

Total prob:

$P(a \le X \le b) = \int_a^b f(x)\,dx$

Interval prob:

maximum of $f(x)$

Mode:

$\int_{-\infty}^{m} f(x)\,dx = \frac{1}{2}$

Median m:

$P(X = k) = 0$ (always, for continuous)

Point prob:

$E(X) = np$

Mean:

$\mathrm{Var}(X) = np(1-p)$

Variance:

KEY METHODS

- State the BINS conditions explicitly in your working to earn the M1 mark. Write "Let $X \sim B(n, p)$" before any GDC calculation.
- "At least 1" questions almost always use the complement: $P(X \ge 1) = 1 - P(X = 0) = 1 - (1-p)^n$. This avoids summing many CDF terms.
- If both $E(X)$ and $\mathrm{Var}(X)$ are given, divide: $\frac{\mathrm{Var}(X)}{E(X)} = 1 - p$. This avoids the quadratic entirely.
- On Paper 1 (no GDC), identify $\mu \pm k\sigma$ values first, then apply the empirical rule and symmetry. This is faster than trying to derive probabilities from scratch.
- Standardisation converts any normal distribution to the standard normal $Z \sim N(0, 1)$. This allows comparison of values from different normal

EXAM TRAPS TO AVOID

- Don't confuse $P(X \le r)$ (CDF) with $P(X = r)$ (PDF). For continuous variables, individual point probabilities are always zero — use intervals.
- When solving $np(1-p) = k$ for p, remember there are two solutions: $p = \frac{n \pm \sqrt{n^2 - 4nk}}{2n}$. Award both answers unless context restricts p.
- $\mathrm{Var}(aX + b) = a^2\mathrm{Var}(X)$, not $a \cdot \mathrm{Var}(X)$. The coefficient is always squared.
- Write $X \sim N(\mu, \sigma^2)$ with σ^2 (variance), not σ (standard deviation). This is a common notation error that loses marks.
- On Casio calculators, enter σ before μ — the opposite order to TI-84. This is a common source of error in exams.

distributions using z-scores — larger $|z|$ means more standard deviations from the mean.

- When given the IQR, use $\sigma = \text{IQR}/(2 \times 0.6745)$ to find σ directly. Then find μ from any single probability condition.
- When you see "a sample of n is selected..." after a normal-distribution question, this is the trigger to switch to a Binomial model with p from the normal calculation.