★ not in the IB formula booklet — learn it. Everything else is printed in the booklet (its notation may differ slightly).

Prior learning

Area: parallelogram, triangle, trapezoid: $A = bh$, $A = \frac{1}{2}bh$, $A = \frac{1}{2}(a+b)h$

Circle: $A = \pi r^2$, $C = 2\pi r$

Volume: cuboid, cylinder, prism: $V = lwh$, $V = \pi r^2 h$, $V = Ah$

Curved surface of a cylinder: $A = 2\pi rh$

Distance; midpoint: $d = \sqrt{(x_1-x_2)^2 + (y_1-y_2)^2}$, $\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}\right)$

★ Pythagoras: $a^2 + b^2 = c^2$

★ Right-angled trig: $\sin\theta = \frac{\text{opp}}{\text{hyp}}$, $\cos\theta = \frac{\text{adj}}{\text{hyp}}$, $\tan\theta = \frac{\text{opp}}{\text{adj}}$

★ Laws of indices: $a^m a^n = a^{m+n}$, $\frac{a^m}{a^n} = a^{m-n}$, $(a^m)^n = a^{mn}$, $a^{-n} = \frac{1}{a^n}$

1 Number & algebra

★ Standard form: $a \times 10^k$, $1 \le a < 10,\ k \in \mathbb{Z}$

Arithmetic sequence: $u_n = u_1 + (n-1)d$

Arithmetic series: $S_n = \frac{n}{2}\left(2u_1 + (n-1)d\right) = \frac{n}{2}(u_1 + u_n)$

★ Common difference: $d = u_{n+1} - u_n$

Geometric sequence: $u_n = u_1 r^{n-1}$

Geometric series, $r \ne 1$: $S_n = \frac{u_1(r^n-1)}{r-1} = \frac{u_1(1-r^n)}{1-r}$

Compound interest (k times a year, n years, r%): $FV = PV\left(1 + \frac{r}{100k}\right)^{kn}$

★ Depreciation at r% a year: $V = V_0\left(1 - \frac{r}{100}\right)^n$

Loans, annuities, amortisation: use the GDC's TVM solver (N, I%, PV, PMT, FV, P/Y, C/Y); money paid out is negative.

Exponents & logs: $a^x = b \iff x = \log_a b$

★ Log facts: $\log_{10} 10^x = x$, $\ln e^x = x$, $e^{\ln x} = x$

Percentage error: $\varepsilon = \left|\frac{v_A - v_E}{v_E}\right| \times 100\%$

★ Bounds: a value rounded to the nearest u lies in $[x - \frac{u}{2},\ x + \frac{u}{2})$

2 Functions & models

Gradient; forms of a line: $m = \frac{y_2-y_1}{x_2-x_1}$, $y = mx + c$, $ax + by + d = 0$, $y - y_1 = m(x - x_1)$

★ Parallel; perpendicular: $m_1 = m_2$; $m_1 m_2 = -1$

Quadratic: axis of symmetry: $x = -\frac{b}{2a}$

★ Linear; quadratic models: $f(x) = mx + c$; $f(x) = ax^2 + bx + c$

★ Exponential models: $f(x) = ka^x + c$, $f(x) = ka^{-x} + c$, $f(x) = ke^{rx} + c$

★ Direct / inverse variation: $f(x) = ax^n$, $n \in \mathbb{Z}$

★ Cubic model: $f(x) = ax^3 + bx^2 + cx + d$

★ Sinusoidal model (degrees): $f(x) = a\sin(bx) + d$: amplitude $|a|$, period $\frac{360^\circ}{b}$

★ Inverse function: swap x and y; graph reflects in $y = x$; domain of f^{-1} = range of f

★ Horizontal asymptote of $ka^x + c$: $y = c$

3 Geometry & trigonometry

3D distance ($\Delta x = x_1 - x_2$, ...): $d = \sqrt{\Delta x^2 + \Delta y^2 + \Delta z^2}$

3D midpoint: $\left(\frac{x_1+x_2}{2}, \frac{y_1+y_2}{2}, \frac{z_1+z_2}{2}\right)$

Pyramid; cone: $V = \frac{1}{3}Ah$; $V = \frac{1}{3}\pi r^2 h$, curved $A = \pi rl$

Sphere: $V = \frac{4}{3}\pi r^3$, $A = 4\pi r^2$

★ Slant height of a cone: $l = \sqrt{r^2 + h^2}$

Sine rule: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

Cosine rule: $c^2 = a^2 + b^2 - 2ab\cos C$, $\cos C = \frac{a^2+b^2-c^2}{2ab}$

Area of a triangle: $A = \frac{1}{2}ab\sin C$

Arc; sector (θ in degrees): $l = \frac{\theta}{360} \times 2\pi r$, $A = \frac{\theta}{360} \times \pi r^2$

★ Elevation / depression measured from the horizontal; bearings clockwise from north, 3 figures

★ Perpendicular bisector of AB: through the midpoint of AB, gradient $-\frac{1}{m_{AB}}$

★ Voronoi: cell edges lie on perpendicular bisectors of pairs of sites; the point furthest from every site ("toxic waste dump") is at a vertex or on the boundary

4 Statistics & probability

Interquartile range: $IQR = Q_3 - Q_1$

Mean ($n = \sum f_i$): $\bar{x} = \frac{\sum f_i x_i}{n}$

★ Outliers: $x < Q_1 - 1.5\,IQR$ or $x > Q_3 + 1.5\,IQR$

★ Standard deviation: $\sigma = \sqrt{\frac{\sum f(x-\bar{x})^2}{n}}$

★ Data $\times a$ then $+b$: mean $\to a\bar{x} + b$, s.d. $\to |a|\sigma$

★ Regression: $y = ax + b$ (GDC); use to predict y within the data range only

★ $|r|$ near 1: strong linear correlation; Spearman's r_s = PMCC of the ranks

Probability: $P(A) = \frac{n(A)}{n(U)}$, $P(A) + P(A') = 1$

★ Expected number of occurrences: $n \times P(A)$

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

Mutually exclusive: $P(A \cup B) = P(A) + P(B)$

Independent: $P(A \cap B) = P(A)P(B)$

Conditional: $P(A \mid B) = \frac{P(A \cap B)}{P(B)}$

Expected value: $E(X) = \sum x\,P(X = x)$

★ Valid distribution; fair game: $\sum P(X = x) = 1$; $E(\text{gain}) = 0$

★ Binomial $X \sim B(n, p)$: $P(X = r) = \binom{n}{r}p^r(1-p)^{n-r}$

Binomial mean, variance: $E(X) = np$, $\mathrm{Var}(X) = np(1-p)$

★ Normal: about 68%, 95%, 99.7% of values lie within 1, 2, 3 s.d. of μ

χ^2 statistic: $\chi^2_{\text{calc}} = \sum \frac{(f_o - f_e)^2}{f_e}$

★ Expected frequency (independence): $f_e = \frac{\text{row total} \times \text{column total}}{\text{grand total}}$

★ Degrees of freedom: independence: $(r-1)(c-1)$; goodness of fit: classes $-\ 1$

★ Test decision: reject H_0 if p-value < significance level (or $\chi^2_{\text{calc}} >$ critical value)

★ t-test (GDC): compares two population means; $H_0: \mu_1 = \mu_2$

5 Calculus

Derivative of x^n: $f(x) = x^n \Rightarrow f'(x) = nx^{n-1}$

★ Constant multiples, sums: $f(x) = ax^n + bx^m \Rightarrow f'(x) = anx^{n-1} + bmx^{m-1}$

★ Gradient of tangent at $x = a$: $f'(a)$; tangent $y - f(a) = f'(a)(x - a)$

★ Gradient of normal: $-\frac{1}{f'(a)}$

★ Increasing / decreasing: $f'(x) > 0$; $f'(x) < 0$

★ Stationary points; optimisation: $f'(x) = 0$; check the sign of f' either side

Integral of x^n, $n \ne -1$: $\int x^n\,dx = \frac{x^{n+1}}{n+1} + C$

Area, $y \ge 0$: $A = \int_a^b y\,dx$

Trapezoidal rule, $h = \frac{b-a}{n}$: $\int_a^b y\,dx \approx \frac{1}{2}h\left[(y_0 + y_n) + 2(y_1 + \cdots + y_{n-1})\right]$

★ Boundary condition: find C by substituting a known point into $\int f'(x)\,dx$

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