Exponentials & Logarithms

SL 1.5–1.6, AHL 1.7–1.8

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FORMULAS YOU MUST KNOW

$$\log_a x = y \;\Leftrightarrow\; a^y = x \qquad (a > 0,\ a \neq 1,\ x > 0).$$

$a^m \cdot a^n = a^{m+n}$

$\dfrac{a^m}{a^n} = a^{m-n}$

$(a^m)^n = a^{mn}$

$(ab)^n = a^n b^n$

$a^0 = 1$

$a^{-n} = \dfrac{1}{a^n}$

$a^{1/n} = \sqrt[n]{a}$

$a^{m/n} = (\sqrt[n]{a})^m$

$\log_2 8 = 3$

$\log_5 \frac{1}{25} = -2$

$\ln e^3 = 3$

EXAM TRAPS TO AVOID

- $2^3 \cdot 3^3 \neq 6^6$ (correct: $(2 \cdot 3)^3 = 6^3$). $(a^m)^n \neq a^{m+n}$ (correct: a^{mn}). $\sqrt{a^2 + b^2} \neq a + b$ (no shortcut!).
- These are NOT log laws — students invent them under exam pressure: $\log(M+N) \neq \log M + \log N$; $(\log M)^2 \neq 2\log M$; $\dfrac{\log M}{\log N} \neq \log\left(\dfrac{M}{N}\right)$; $\log(kM) \neq k \log M$. There is no simplification rule for $\log(M+N)$.
- You must expand $4 \cdot 3^{x+1} = 12 \cdot 3^x$ before substituting $u = 3^x$. Substituting first gives $4 \cdot 3u$, which is dimensionally wrong.