### Integration (+ constant)

| $\mathbf{f}(x)$ | $\int \mathbf{f}(x)\ \mathbf{d}x$ |
|---|---|
| $\sec^2 kx$ | $\frac{1}{k}\tan kx$ |
| $\tan x$ | $\ln\lvert\sec x\rvert$ |
| $\cot x$ | $\ln\lvert\sin x\rvert$ |

# Pure Mathematics P4

Candidates sitting Pure Mathematics P4 may also require those formulae listed under Pure Mathematics P1, P2 and P3.

### Binomial series

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{1\times 2}x^2 + \ldots + \frac{n(n-1)\ldots(n-r+1)}{1\times 2\times \ldots \times r}x^r + \ldots \qquad (\lvert x\rvert < 1,\ n \in \mathbb{R})$$

### Integration (+ constant)

| $\mathbf{f}(x)$ | $\int \mathbf{f}(x)\ \mathbf{d}x$ |
|---|---|
| $\operatorname{cosec} x$ | $-\ln\lvert\operatorname{cosec} x + \cot x\rvert, \quad \ln\left\lvert\tan\left(\frac{1}{2}x\right)\right\rvert$ |
| $\sec x$ | $\ln\lvert\sec x + \tan x\rvert, \quad \ln\left\lvert\tan\left(\frac{1}{2}x + \frac{1}{4}\pi\right)\right\rvert$ |

$$\int u\frac{\mathrm{d}v}{\mathrm{d}x}\,\mathrm{d}x = uv - \int v\frac{\mathrm{d}u}{\mathrm{d}x}\,\mathrm{d}x$$

# Pure Mathematics P1

## Mensuration

Surface area of sphere $= 4\pi r^2$

Area of curved surface of cone $= \pi r \times$ slant height

## Cosine rule

$a^2 = b^2 + c^2 - 2bc\cos A$

# Pure Mathematics P2

## Arithmetic series

$u_n = a + (n-1)d$

$S_n = \frac{1}{2}n(a+l) = \frac{1}{2}n[2a + (n-1)d]$

## Geometric series

$u_n = ar^{n-1}$

$S_n = \frac{a(1-r^n)}{1-r}$

$S_\infty = \frac{a}{1-r}$ for $|r| < 1$

## Logarithms and exponentials

$\log_a x = \frac{\log_b x}{\log_b a}$

## Binomial series

$$(a+b)^n = a^n + \binom{n}{1}a^{n-1}b + \binom{n}{2}a^{n-2}b^2 + \ldots + \binom{n}{r}a^{n-r}b^r + \ldots + b^n \quad (n \in \mathbb{N})$$

where $\binom{n}{r} = {}^nC_r = \frac{n!}{r!(n-r)!}$

$$(1+x)^n = 1 + nx + \frac{n(n-1)}{1\times 2}x^2 + \ldots + \frac{n(n-1)\ldots(n-r+1)}{1\times 2\times \ldots \times r}x^r + \ldots \quad (|x| < 1, n \in \mathbb{R})$$

## Numerical integration

The trapezium rule: $\int_a^b y \, dx \approx \frac{1}{2}h\{(y_0 + y_n) + 2(y_1 + y_2 + \ldots + y_{n-1})\}$, where $h = \frac{b-a}{n}$

# Pure Mathematics P3

Candidates sitting Pure Mathematics P3 may also require those formulae listed under Pure Mathematics P1 and P2.

## Logarithms and exponentials

$$e^{x \ln a} = a^x$$

## Trigonometric identities

$$\sin(A \pm B) \equiv \sin A \cos B \pm \cos A \sin B$$

$$\cos(A \pm B) \equiv \cos A \cos B \mp \sin A \sin B$$

$$\tan(A \pm B) \equiv \frac{\tan A \pm \tan B}{1 \mp \tan A \tan B} \qquad \left(A \pm B \neq \left(k + \frac{1}{2}\right)\pi\right)$$

$$\sin A + \sin B \equiv 2 \sin \frac{A + B}{2} \cos \frac{A - B}{2}$$

$$\sin A - \sin B \equiv 2 \cos \frac{A + B}{2} \sin \frac{A - B}{2}$$

$$\cos A + \cos B \equiv 2 \cos \frac{A + B}{2} \cos \frac{A - B}{2}$$

$$\cos A - \cos B \equiv -2 \sin \frac{A + B}{2} \sin \frac{A - B}{2}$$

## Differentiation

| $\mathbf{f}(x)$ | $\mathbf{f}'(x)$ |
|---|---|
| $\tan kx$ | $k \sec^2 kx$ |
| $\sec x$ | $\sec x \tan x$ |
| $\cot x$ | $-\operatorname{cosec}^2 x$ |
| $\operatorname{cosec} x$ | $-\operatorname{cosec} x \cot x$ |
| $\frac{\mathrm{f}(x)}{\mathrm{g}(x)}$ | $\frac{\mathrm{f}'(x)\mathrm{g}(x) - \mathrm{f}(x)\mathrm{g}'(x)}{(\mathrm{g}(x))^2}$ |


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