

No formula sheet is supplied, but this exam is less about formulae than about the behaviour of four function families and the ability to say what a change to a parameter does. This booklet lists what must be recalled, and – since most of the credit sits there – how to phrase the behaviour claims the rubric is looking for.

Polynomial and rational functions

End behaviour – Determined by the leading term alone. Even degree with a positive leading coefficient rises at both ends; odd degree with a positive coefficient falls left and rises right.

Multiplicity – An odd multiplicity crosses the x -axis; an even multiplicity touches and turns back. Stating this is a standard scored justification.

Rates of change – Average rate of change over $[a, b]$ is $\frac{f(b)-f(a)}{b-a}$. A function is concave up where the average rates of change are increasing – the exam phrases it exactly this way.

Asymptotes – A vertical asymptote comes from a zero of the denominator that does not cancel; a cancelling factor gives a HOLE instead. Horizontal behaviour comes from comparing the degrees, and equal degrees give the ratio of leading coefficients.

Exponential and logarithmic functions

The defining property – An exponential function changes by a constant FACTOR over equal intervals; a linear function changes by a constant amount. Identifying which from a table is a recurring first question.

General form – $f(x) = ab^x$, with a the initial value and b the growth factor. A growth rate of 7 per cent means $b = 1.07$; a decay of 7 per cent means $b = 0.93$.

Logarithm laws – $\log(xy) = \log x + \log y$; $\log(x/y) = \log x - \log y$; $\log x^n = n \log x$; change of base $\log_b x = \frac{\ln x}{\ln b}$.

Inverse relationship – $b^{\log_b x} = x$ and $\log_b(b^x) = x$. Solving an exponential equation means taking a logarithm of both sides; solving a logarithmic one means exponentiating – and then checking for extraneous solutions, since the domain excludes non-positive arguments.

Semi-log plots – Exponential data plotted with a logarithmic vertical axis becomes a straight line, and the slope of that line is $\log b$. This appears every year.

Trigonometric and polar functions

The unit circle – Sine is the y -coordinate, cosine the x -coordinate. The exact values at multiples of $\pi/6$ and $\pi/4$ must be known without a calculator.

Sinusoidal form – $f(x) = a \sin(b(x - h)) + k$: amplitude $|a|$, period $2\pi/|b|$, horizontal shift h , midline $y = k$. Reading these four off a graph, and building the equation back from them, is the core skill.

Identities to recall – $\sin^2 \theta + \cos^2 \theta = 1$; $\tan \theta = \sin \theta / \cos \theta$; the double-angle forms $\sin 2\theta = 2 \sin \theta \cos \theta$ and $\cos 2\theta = \cos^2 \theta - \sin^2 \theta$.

Inverse trigonometric ranges – Arcsine returns values in $[-\pi/2, \pi/2]$ and arccosine in

$[0, \pi]$. A calculator gives one solution; the question usually wants all of them in an interval, so use the symmetry of the circle.

Polar – $x = r \cos \theta$, $y = r \sin \theta$, $r^2 = x^2 + y^2$. Describe a polar graph by whether r is increasing or decreasing as θ increases, and note that a negative r plots opposite the angle.

Transformations and composition

Order of operations – In $af(b(x-h)) + k$, the inside operations act on x and run opposite to intuition: b compresses horizontally by a factor $1/b$, and h shifts right. The outside operations act on y and behave as expected.

Inverse functions – Swap x and y and solve. The domain of the inverse is the range of the original, and a function needs to be one-to-one before an inverse exists – say so when asked to justify.

Composition – The domain of $f(g(x))$ excludes any x outside the domain of g , and any x whose $g(x)$ falls outside the domain of f . The second condition is the one that is forgotten.

Phrasing that earns the point

Describe behaviour with both a direction and a rate: “as x increases, f increases at a decreasing rate”. A bare “it goes up” does not score.

When constructing a model from a description, define your variables including their units and state the domain over which the model is reasonable. Both are scored, separately from the equation.

Justify a choice of model by the property in the data: constant differences mean linear, constant ratios mean exponential, a repeating pattern with a fixed period means sinusoidal.