STUDY FORMULA BOOKLET

Edexcel IAL Maths Unit FP1 (WFM01): further pure mathematics 1

The booklet prints the sums of squares and cubes, Newton-Raphson, the rotation and reflection matrices and a conics table. Learn first the sum of integers, sum and product of roots, linear interpolation, the 2 by 2 inverse and the tangent gradients.

GIVEN printed in the formula booklet LEARN IT not in the booklet: learn it

Built by CuratedPrep from 13 past question papers for Unit FP1 in our question bank, January 2021 to January 2026. Given means it is in the Mathematical Formulae and Statistical Tables booklet (Issue 2, 2021) handed out in every unit exam. Learn it means a past question needed it and the exam did not print it.

Complex numbers

Modulus of a complex number

The distance of the point from the origin on the Argand diagram. Used in: Jan 2023 Q3(c), the modulus of the complex roots; Jan 2022 Q2(b)(i); Jan 2021 Q6(a), using the modulus 5 to find λ.

$$|z| = \sqrt{x^2 + y^2}, \quad z = x + iy$$

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Modulus of a product

The specification says knowledge of arg(z1 z2) = arg z1 + arg z2 is not required, but this result is. Used in: Jun 2025 Q5(a), |z1 z2| = 15 with |z2| = 5.

$$|z_1 z_2| = |z_1|\,|z_2|$$

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Argument of a complex number

Sketch z first and pick the quadrant, because the calculator value of arctan(y/x) can be out by pi. Give radians to the accuracy asked. Used in: Jun 2024 Q4(c), to 3 significant figures; Jun 2023 Q6(d), to 4 significant figures; Jan 2021 Q6(b).

$$\arg z = \theta, \quad \tan\theta = \frac{y}{x}, \quad -\pi < \theta \leqslant \pi$$

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Dividing complex numbers

Multiply the top and the bottom by the conjugate of the denominator, because (c + di)(c - di) = $c^2 + d^2$ is real. Show the multiplier when the question forbids calculator technology. Used in: Jan 2026 Q7(a), z in the form a + bi with k; Jan 2024 Q9(a); Jun 2023 Q6(b).

$$\frac{a + bi}{c + di} = \frac{(a + bi)(c - di)}{c^2 + d^2}$$

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Quadratic formula

Roots of ax^2 + bx + c = 0. When b^2 - 4ac is negative the roots are the conjugate pair p + qi and p - qi. The specification says P1 and P2 knowledge is assumed, so this is not in the FP1 booklet: show a, b and c substituted, or complete the square, when calculator solutions are not acceptable. Used in: Jan 2026 (A) Q2(a), the last quadratic factor of a quartic; Jan 2023 Q3(b); Jun 2023 Q2(b).

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

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Roots of quadratic equations

The specification lists the sum and product of the roots as formulae to know. None of these rows is in the booklet.

Sum and product of roots

For $ax^2 + bx + c = 0$ with roots alpha and beta. Write both down first, then use them without solving the equation. Used in: Jan 2026 Q6(a); Jun 2025 Q6(a), alpha beta from $3x^2 + kx - 5 = 0$; Jan 2025 Q3(a).

$$\alpha + \beta = -\frac{b}{a}, \quad \alpha\beta = \frac{c}{a}$$

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Sum of the squares of the roots

Rearranged from $(\text{alpha} + \text{beta})^2$. It feeds into $\text{alpha}^2 + 1$ products and into the sums of new roots. Used in: Jan 2026 (A) Q5(a)(ii); Jan 2025 Q3(b); Jun 2023 Q5(a), the value of $(\text{alpha}^2 + 1)(\text{beta}^2 + 1)$.

$$\alpha^2 + \beta^2 = (\alpha + \beta)^2 - 2\alpha\beta$$

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Sum of the cubes of the roots

The specification lists this identity in the unit content. One question printed it and asked for a proof by expanding $(\text{alpha} + \text{beta})^3$, so you should also be able to prove it. Used in: Jan 2026 (A) Q5(a)(iii); Oct 2021 Q3(b)(ii); Jan 2021 Q4(a).

$$\alpha^3 + \beta^3 = (\alpha + \beta)^3 - 3\alpha\beta(\alpha + \beta)$$

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Quadratic with given roots

Work out the new sum and the new product from alpha + beta and alpha beta, then multiply through to get integer coefficients when the question asks for p, q and r. A conjugate pair a + bi and a - bi gives $x^2 - 2ax + a^2 + b^2 = 0$. Used in: Jan 2026 (A) Q5(b)(ii); Jun 2025 Q6(d); Jan 2025 Q3(c).

$$x^2 - (\text{sum of roots})\,x + (\text{product of roots}) = 0$$

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Numerical solution of equations

Linear interpolation

For a root between a and b where f changes sign. It is the same as similar triangles, (x - a)/(b - x) = |f(a)|/|f(b)|, so either form earns the method mark. The formula is not in the booklet. Used in: Jun 2025 Q3(ii)(b); Jan 2025 Q2(d); Jan 2024 Q6(i)(b).

$$x \approx \frac{a\,f(b) - b\,f(a)}{f(b) - f(a)}$$

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Newton-Raphson iteration

x0 is the first approximation, so differentiate f(x) before you substitute. Questions say once or twice, and a trig function needs radians. Used in: Jan 2026 Q1(b)(ii); Jan 2026 (A) Q7(c); Jan 2025 Q2(c).

$$x_{n+1} = x_n - \frac{f(x_n)}{f'(x_n)}$$

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Parabola and rectangular hyperbola

The conics table below gives the standard and parametric forms, the focus and the directrix.

Gradient of the tangent to a parabola

Differentiate implicitly, or write y = 2 sqrt(a) sqrt(x); the specification says parametric differentiation is not required. Used in: Jan 2026 (A) Q8(a); Jan 2025 Q9(a); Oct 2021 Q8(a).

$$y^2 = 4ax: \quad \frac{dy}{dx} = \frac{2a}{y} = \frac{1}{t} \text{ at } (at^2,\ 2at)$$

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Gradient of the tangent to a rectangular hyperbola Write y = c^2/x and differentiate. Used in: Jan 2026 Q9(a); Jan 2025 Q6(a); Jun 2023 Q3(a).	$xy = c^2 : \quad \frac{dy}{dx} = -\frac{c^2}{x^2} = -\frac{1}{t^2}$ at $\left(ct, \frac{c}{t}\right)$	LEARN IT
Equation of a straight line Use it for a tangent, a normal, a line through the focus, or a line through two points. Used in: Jan 2026 Q9(b); Jan 2026 Q4(a), the line through the focus with gradient 8; Jan 2025 Q9(a).	$y - y_1 = m(x - x_1)$	LEARN IT
Perpendicular gradients The gradient of a normal is minus the reciprocal of the tangent gradient, and a perpendicular bisector uses the same rule. Used in: Jun 2025 Q4(a); Jan 2025 Q9(b), perpendicular bisectors; Jan 2026 Q9(b).	$m_1 m_2 = -1$	LEARN IT
Gradient of a line through two points Subtract in the same order on the top and the bottom. Used in: Jun 2024 Q9(c), the line through Q and the focus; Jun 2023 Q8(b), showing that a chord passes through the focus.	$m = \frac{y_2 - y_1}{x_2 - x_1}$	LEARN IT
Focus and directrix property For a point P on a parabola with focus S. With the directrix x = -a, the distance from P(x, y) is x + a. Used in: Jun 2025 Q9, a point 5 units from the focus; Jan 2023 Q8(a), showing PS; Jan 2022 Q3(b).	$PS = \text{distance from } P \text{ to the directrix}$	LEARN IT
Distance between two points Pythagoras' theorem on the differences in x and in y. Leave exact answers as simplified surds. Used in: Jan 2026 Q9(d), the exact length PQ; Jun 2024 Q9(c); Jan 2022 Q3(b), the perimeter of triangle OPS.	$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$	LEARN IT
Midpoint of a line segment Add the coordinates, then halve. Used in: Jan 2026 (A) Q3(b); Jan 2026 Q4(b), then the distance to the directrix; Jan 2025 Q9(b).	$\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$	LEARN IT
Area of a triangle On a coordinate diagram take the base along an axis or between two intercepts, with the third point giving the height. Used in: Jan 2026 Q9(c); Jan 2026 (A) Q8(c); Jun 2025 Q4(c).	$A = \frac{1}{2} \times \text{base} \times \text{height}$	LEARN IT

FP1 Conics

Parabola and rectangular hyperbola. Foci and directrices of the rectangular hyperbola are not required in FP1.

	Parabola	Rectangular hyperbola
Standard form	$y^2 = 4ax$	$xy = c^2$
Parametric form	$(at^2, 2at)$	$\left(ct, \frac{c}{t}\right)$
Foci	$(a, 0)$	Not required
Directrices	$x = -a$	Not required

Matrix algebra

Determinant of a 2 by 2 matrix

The matrix is singular when the determinant is 0 and non-singular otherwise. Used in: Jan 2026 (A) Q9(a); Jan 2025 Q1(a); Jun 2024 Q1(i)(a), the value of k for a singular matrix.

$$\det \begin{pmatrix} a & b \\ c & d \end{pmatrix} = ad - bc$$

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Discriminant and non-singular matrices

When the determinant is a quadratic in k with b^2 - 4ac < 0 it is never 0, so the matrix is non-singular for all real k. Completing the square also works. Used in: Jan 2025 Q1(b); Jan 2024 Q1(a).

$$b^2 - 4ac < 0 \Rightarrow \text{no real roots}$$

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Inverse of a 2 by 2 matrix

Swap a and d, change the signs of b and c, and divide by the determinant. Used in: Jan 2026 (A) Q6(a); Jan 2025 Q1(c); Jun 2024 Q1(i)(b).

$$\mathbf{A}^{-1} = \frac{1}{ad - bc} \begin{pmatrix} d & -b \\ -c & a \end{pmatrix}$$

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Solving a matrix equation

Multiply on the same side of both sides, because matrix multiplication is not commutative. Used in: Jan 2026 (A) Q6(b); Jun 2023 Q4(ii).

$$\mathbf{XA} = \mathbf{B} \Rightarrow \mathbf{X} = \mathbf{BA}^{-1}, \quad \mathbf{AX} = \mathbf{B} \Rightarrow \mathbf{X} = \mathbf{A}^{-1}\mathbf{B}$$

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Transformations using matrices

Anticlockwise rotation through angle θ about O

Anticlockwise through θ about the origin; use -θ for clockwise. Questions ask for exact entries, for example at 210 degrees or 240 degrees. Used in: Jan 2024 Q4(b); Jan 2023 Q7(i)(b), a rotation through 240 degrees then an enlargement; Oct 2021 Q7(i)(a).

$$\begin{pmatrix} \cos\theta & -\sin\theta \\ \sin\theta & \cos\theta \end{pmatrix}$$

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Reflection in the line y = (tan θ)x

Reflection in y = (tan θ)x. The x-axis is θ = 0, the y-axis is θ = 90 degrees and y = -x is θ = 135 degrees. Used in: Jun 2025 Q2(c), reflection in y = -x; Jun 2024 Q1(ii)(b), reflection in the y-axis; Jun 2021 Q3(c), reflection in the x-axis.

$$\begin{pmatrix} \cos 2\theta & \sin 2\theta \\ \sin 2\theta & -\cos 2\theta \end{pmatrix}$$

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Stretch and enlargement matrices

k is the scale factor. A stretch parallel to the x-axis changes only x coordinates. Used in: Jan 2026 Q5(b), an enlargement with centre (0, 0); Jan 2025 Q7(i)(b); Jun 2022 Q7(d).

$$\begin{pmatrix} k & 0 \\ 0 & 1 \end{pmatrix} \text{ (stretch } \parallel x\text{)}, \quad \begin{pmatrix} 1 & 0 \\ 0 & k \end{pmatrix} \text{ (stretch } \parallel y\text{)},$$
$$\begin{pmatrix} k & 0 \\ 0 & k \end{pmatrix} \text{ (enlargement, centre } O\text{)}$$

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Area scale factor

Ignore the sign of the determinant. For a power M^n the scale factor is (det M)^n, so you do not need to work out the power. Used in: Jan 2026 (A) Q9(c), area under B = A to a power; Jan 2024 Q4(d); Jun 2022 Q7(f).

$$\text{area of image} = |\det \mathbf{M}| \times \text{area of object}$$

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Series

Sum of the first n integers

The specification says this is a formula you are expected to know and that it will not appear in the booklet. Used in: Jan 2026 (A) Q1; Jun 2022 Q8(a); Oct 2021 Q5(a).

$$\sum_{r=1}^{n} r = \tfrac{1}{2}n(n+1)$$

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Sum of squares

Combine with the sum of the integers, then take n(n + 1) out as a common factor instead of expanding to a quartic. Used in: Jan 2026 (A) Q1; Jan 2026 Q8(a); Jun 2024 Q7(a).

$$\sum_{r=1}^{n} r^2 = \tfrac{1}{6}n(n+1)(2n+1)$$

GIVEN

Sum of cubes

Needed when the term in r is a cubic, for example r(r + 5)(r + 1). Used in: Jan 2025 Q5(a); Jan 2024 Q8(a); Jun 2023 Q1.

$$\sum_{r=1}^{n} r^3 = \tfrac{1}{4}n^2(n+1)^2$$

GIVEN

Sum between two limits

Use the formula from the earlier part with n = b, then subtract the same formula with n = a - 1. Used in: Jan 2026 Q8(b); Jan 2025 Q5(b); Jun 2022 Q8(b).

$$\sum_{r=a}^{b} f(r) = \sum_{r=1}^{b} f(r) - \sum_{r=1}^{a-1} f(r)$$

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Also learn these

Conjugate roots

If a polynomial with real coefficients has the root a + bi, then a - bi is also a root; the pair gives the real quadratic factor x^2 - 2ax + a^2 + b^2. Used in: Jan 2026 (A) Q2(a); Jan 2025 Q4(a); Oct 2021 Q4(a).

Using a known root

If f(a) = 0 then (x - a) is a factor: substitute the root to find an unknown constant, or divide to find the remaining quadratic factor. Used in: Jan 2023 Q3(a); Jan 2021 Q2(b); Jan 2025 Q4(b).

Equating real and imaginary parts

If a + bi = c + di then a = c and b = d, and a number that is real has imaginary part 0. Used in: Jan 2026 (A) Q4; Jun 2025 Q5(b).

Plotting on an Argand diagram

Plot x + iy at the point (x, y); a conjugate pair is a reflection in the real axis. Used in: Jan 2026 (A) Q2(b); Jun 2025 Q5(c); Jan 2025 Q4(c).

Showing a root in an interval

Evaluate f at both ends and state that f is continuous and changes sign, so there is a root. Used in: Jun 2023 Q7(a); Oct 2021 Q2(a); Jan 2025 Q2(a).

Interval bisection

Evaluate f at the midpoint, keep the half where the sign changes and repeat; show the values you calculate. Used in: Jan 2026 (A) Q7(a); Jun 2025 Q3(i); Jun 2023 Q7(b).

Line meeting a conic

Substitute the parametric coordinates, (at^2, 2at) or (ct, c/t), or x and y from the equation of the line, to reach a quadratic and solve it. Used in: Jan 2026 (A) Q3(a); Jan 2026 Q4(a); Jan 2021 Q8(c).

Combining transformations

The transformation A followed by B is the matrix BA, because the matrix nearest the vector acts first. Used in: Jan 2025 Q7(i)(c); Jan 2024 Q4(c); Jun 2022 Q7(e).

Describing a transformation

Name the type and give all its details: for a rotation the angle, direction and centre, for a stretch the scale factor and the axis it is parallel to, for an enlargement the scale factor and centre. Used in: Jan 2026 Q5(a); Jun 2025 Q2(a); Jun 2022 Q7(b).

Proof by induction

Show the result is true for n = 1, assume it is true for n = k, show it is then true for n = k + 1, and finish with a sentence of conclusion. For divisibility, write f(k + 1) - f(k) or f(k + 1) - m f(k) as a multiple of the divisor. Used in: Jan 2026 Q10, a sequence; Jun 2024 Q6(a), a matrix power; Jun 2023 Q9, divisibility.

Using the booklet in the exam

- Learn the sum of the first n integers, the sum and product of roots, linear interpolation and the 2 by 2 inverse: the booklet prints none of them.
- For a tangent or normal, differentiate first because the question says use calculus, then use y - y1 = m(x - x1). The answer is usually printed, so show an intermediate line before it.
- In a summation question take n(n + 1) out as a common factor and do not expand to a quartic. In the hence part, subtract the sum up to a - 1 from the sum up to b.
- Write the Newton-Raphson formula before you substitute, and keep the calculator in radians when f contains a trig function. Give interpolation and Newton-Raphson answers to the number of decimal places asked.

- Where the question says calculator technology is not acceptable, show the quadratic formula, completing the square or factorising for any quadratic, including complex roots.

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