STUDY FORMULA BOOKLET

Edexcel IAL Maths Unit P2 (WMA12): pure mathematics 2

The booklet gives the sequence formulae, binomial expansion, change of base and trapezium rule. Learn first the circle equation, the laws of logarithms, the factor and remainder theorems, tan = sin/cos and $\sin^2 + \cos^2 = 1$.

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

Built by CuratedPrep from 21 past question papers for Unit P2 in our question bank, October 2019 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.

Algebra and functions

None of these is printed in the booklet, so all of them are Learn it. P2 assumes the P1 specification and its formulae.

Quadratic formula

Roots of $ax^2 + bx + c = 0$. The schemes accept factorising, the formula or completing the square, and many questions say calculator technology is not acceptable, so show the substitution. Used in: Jun 2025 Q8(ii), cos θ from a quadratic that does not factorise; Oct 2022 Q5(b); Oct 2025 (A) Q5(ii), quadratic in log_5 y.

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

LEARN IT

Completing the square

Do it for x and for y to read the centre and radius from an expanded circle equation, or to show a quadratic is always positive. Used in: Jan 2026 Q5(a), centre and radius of C1; Jan 2026 Q6(ii), a quadratic that is never zero; Jun 2024 Q7(a).

$$x^2 + bx + c = \left(x + \frac{b}{2}\right)^2 + c - \frac{b^2}{4}$$

LEARN IT

Discriminant

For a line and a circle, substitute the line into the circle to get a quadratic first: a tangent gives $b^2 - 4ac = 0$. Used in: Jan 2026 Q6(ii), no stationary points; Oct 2025 Q4(b)(ii), only one real solution; Jun 2022 Q10(b), a line tangent to a circle.

$$b^2 - 4ac > 0 \text{ (two real roots)}, \quad b^2 - 4ac = 0 \text{ (one repeated root)}, \quad b^2 - 4ac < 0 \text{ (no real roots)}$$

LEARN IT

Factor theorem

Substitute x = -b/a for the factor (ax + b) and write the = 0 before you reach a printed answer. Used in: Jan 2026 (A) Q4(a), (x - 2) a factor; Jan 2025 Q5(a), (3x - 4) a factor; Oct 2025 Q4(b)(i), (x + 4) a factor.

$$\mathrm{f}(a) = 0 \Rightarrow (x - a) \text{ is a factor}; \quad (ax + b) \text{ is a factor if } \mathrm{f}\left(-\tfrac{b}{a}\right) = 0$$

LEARN IT

Remainder theorem

For a divisor (ax - b), substitute x = b/a. Two remainders give two equations in a and b to solve together. Used in: Jan 2026 (A) Q4(b), remainder -36 on dividing by (x + 1); Jun 2025 Q4(b), remainder 7 on dividing by (2x - 1); Jan 2026 Q3(i), remainder on dividing by (x - 5).

$$\mathrm{f}(x) \div (x - a) \text{ leaves remainder } \mathrm{f}(a); \quad \mathrm{f}(x) \div (ax - b) \text{ leaves remainder } \mathrm{f}\left(\tfrac{b}{a}\right)$$

LEARN IT

Division of a polynomial

Q(x) is the quotient and R the remainder, a constant when you divide by a linear factor. If f(x) is already written in this form, R can be read off. Used in: Jun 2025 (A) Q3(a), remainder on dividing by (x - k); Jun 2024 Q4(a); Oct 2025 Q4(a), quotient and remainder on dividing by (x - 2).

$$f(x) = (x - a)\,Q(x) + R$$

LEARN IT

Laws of indices

Use them to split 3^{2}x+1) into 3 × 3^{2}x), or 6^{1}-x) into 6 / 6^x, before you solve. Used in: Jun 2025 Q6(ii), curves 6 × 3^x and 3^{2}x+1) meeting at P; Jan 2020 Q9(b), 6^{1}-x) = 3 × 4^x.

$$a^m \times a^n = a^{m+n}, \quad a^m \div a^n = a^{m-n}, \quad (a^m)^n = a^{mn}$$

LEARN IT

Coordinate geometry in the (x, y) plane

The circle is the new topic in P2. Every row here is Learn it, including the P1 line formulae that the circle questions rely on.

Equation of a circle

Centre (a, b) and radius r. The radius squared on the right is easy to mis-copy as the radius. Used in: Jan 2026 (A) Q6(c), equation of C from its centre and a point on it; Jun 2025 Q2(a), circle from the ends of a diameter; Oct 2025 Q6(a), circle from the ends of a diameter.

$$(x - a)^2 + (y - b)^2 = r^2$$

LEARN IT

Circle in expanded form

Or complete the square for x and for y. The radius squared must be positive, which gives a range for a constant such as k. Used in: Jan 2026 Q5(a); Oct 2025 (A) Q6(a), centre of C.

$$x^2 + y^2 + 2fx + 2gy + c = 0 \Rightarrow \text{centre } (-f, -g),\ r^2 = f^2 + g^2 - c$$

LEARN IT

Midpoint of a line segment

The centre of a circle is the midpoint of any diameter. Used in: Jan 2026 (A) Q6(a), midpoint M of XY; Jan 2025 Q6(a), midpoint M of the chord AB; Jun 2025 Q2(a), centre from the ends of a diameter.

$$\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$$

LEARN IT

Distance between two points

The radius of a circle is the distance from its centre to a point on it. Leave an exact radius as a surd. Used in: Jan 2026 (A) Q6(c), radius of C; Jun 2023 Q3(a)(i), radius from centre (2, 5) and P(8, -3); Jun 2024 Q7(b), distance between two centres.

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2}$$

LEARN IT

Gradient and equation of a line

Rearrange to the form the question asks for, either y = mx + c or ax + by + c = 0 with integer a, b and c. Used in: Jan 2026 (A) Q6(a), the line ZM in the form ax + by + d = 0; Jan 2025 Q6(a), the line through M and P as y = mx + c; Jun 2023 Q3(b).

$$m = \frac{y_2 - y_1}{x_2 - x_1}, \qquad y - y_1 = m(x - x_1)$$

LEARN IT

Perpendicular lines

A tangent is perpendicular to the radius at the point of contact, so its gradient is the negative reciprocal of the radius gradient, and a normal has the radius gradient. Used in: Jan 2026 (A) Q6(a), ZM perpendicular to XY; Jan 2023 Q6(c), normal to C at P; Jan 2022 Q6(a), showing angle PQR = 90 degrees.

$$m_1 m_2 = -1$$

LEARN IT

Two circles touching

d is the distance between the centres. If d is greater than r_1 + r_2 the circles neither touch nor meet. Used in: Jan 2026 Q5(b), circles C1 and C2 touch; Oct 2025 Q6(b), C2 centred on the origin touching C1; Jun 2024 Q7(b), proving two circles neither touch nor intersect.

$$d = r_1 + r_2 \text{ (touch externally)}, \qquad d = |r_1 - r_2| \text{ (touch internally)}$$

LEARN IT

Sequences and series

The booklet prints the arithmetic and geometric formulae and the binomial expansion for positive whole n. The sum formulae are Given, but the spec says to know their proofs.

nth term of an arithmetic sequence

Use it for a term, or for the number of terms when the last term is known. Used in: Jan 2026 (A) Q1(b), the 8th term half the 7th; Jan 2025 Q1(a), number of terms in an arithmetic series; Oct 2025 Q1(a), the 18th term of 78 + 75 + 72 +.

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

GIVEN

Sum of n terms of an arithmetic series

Use the first form when you know the last term l. It also sums 1 + 2 + ... + n, where a = 1 and d = 1. Used in: Jan 2026 (A) Q1(a), sum of the first 9 terms is 54; Oct 2025 Q1(b), sum of the first 100 terms; Oct 2022 Q3(b), a sum that contains the integers 1, 2, 3, and so on.

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

GIVEN

nth term of a geometric sequence

Used to find r from two given terms by dividing, for example u_6 / u_3 = r^3. Used in: Jan 2026 Q9(c), mass mined in year 10 with a fixed percentage fall; Jun 2025 (A) Q2(a), third term 64 and sixth term -8; Oct 2025 (A) Q9(i), the maximum speed in second gear.

$$u_n = ar^{n-1}$$

GIVEN

Sum of n terms of a geometric series

Used when the number of terms is known, or to find the smallest n for which a sum is greater than a given value. Used in: Oct 2025 Q8(ii), total volume over 40 years with an 8% fall each year; Jan 2025 Q4, sum of the first three terms is 70.2; Oct 2022 Q8(b), S_10 to one decimal place.

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

GIVEN

Sum to infinity

Only valid when |r| < 1, so reject any root of an equation for r that does not satisfy this. Used in: Jun 2025 Q7(i)(a), 10 + 8 + 6.4 + ...; Jan 2025 Q4(a), common ratio from the sum to infinity 75; Jun 2025 (A) Q2(b).

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

GIVEN

Percentage change as a common ratio

A fixed percentage change each period makes the values a geometric sequence, so 8% less each year gives r = 0.92. Used in: Oct 2025 Q8(ii), 8% less each year; Jun 2024 Q10(a), an increase of 3% each year; Jan 2020 Q5(a), finding p% from two values.

$$r = 1 + \frac{p}{100} \text{ (rise of } p\%), \qquad r = 1 - \frac{p}{100} \text{ (fall of } p\%)$$

LEARN IT

Binomial expansion, positive integer n

The general term is (n r) a^(n-r) b^r. Expand in ascending powers of x and keep the sign and the bracket round a negative b. Used in: Jan 2026 Q1(a), the first four terms of (3 + kx) expanded; Jun 2025 Q1(a), the first four terms of (1 - 4x) expanded; Jan 2020 Q2(b), the term independent of x.

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

GIVEN

Binomial coefficient

Use n C r for each coefficient, with n C 1 = n and n C 2 = n(n - 1)/2 in the unknown-n questions. Used in: Jan 2026 (A) Q10(a), 1 + 36x + 567x^2 + ... to find k and n; Oct 2025 Q2, p, q and r from the first four terms; Jun 2025 (A) Q7(a).

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

GIVEN

Exponentials and logarithms

Every one of the 22 papers has a logarithm question. The three laws are on the specification's list of formulae you must know, and the booklet prints only the change of base.

Addition and subtraction laws of logarithms

Combine to a single logarithm on each side, then remove the logs. The base must be the same throughout. Used in: Jan 2026 Q7(ii), log_3 equation with 2 log_3(4 - y); Jan 2026 (A) Q9, log_4 a - log_4 b = 3; Oct 2025 (A) Q5(i).

$$\log_a x + \log_a y = \log_a(xy), \qquad \log_a x - \log_a y = \log_a \frac{x}{y}$$

LEARN IT

Power law of logarithms

Use it to bring down an exponent, as in 8^{2x-5} = 20, or to turn 2 log_3(4 - y) into one logarithm. Used in: Jan 2026 Q7(i), exact solution in the form a + b log_2 5; Jan 2026 Q7(ii); Jun 2025 Q6(i).

$$k\log_a x = \log_a x^k$$

LEARN IT

Logarithm of the base

So any number can be written as a logarithm, for example 3 = log_3 27 or 4 = log_2 16, to combine it with other logarithms. Used in: Oct 2025 (A) Q5(i), the 1 in log_a 27 - 1; Jun 2024 Q3(ii), the value of a logarithm of a power of the base; Jun 2025 Q6(i), 3 written as log_2 8.

$$\log_a a = 1, \qquad \log_a a^n = n$$

LEARN IT

Definition of a logarithm

Use it to remove the logarithm once you have a single log equal to a number, for example log_a 2 = 10 gives a^{10} = 2. Used in: Jun 2025 (A) Q4(a), log_3 of (x + 1)/x equal to 4; Oct 2022 Q4(a), finding a from w = 10 when t = 3; Jan 2026 (A) Q9.

$$y = \log_a x \iff a^y = x$$

LEARN IT

Change of base: solving a^x = b

Solving a^x = b gives x = log b / log a, which is log_a b, so you can find a decimal answer with any base. The schemes accept taking logs of both sides or writing x = log_a b. Used in: Oct 2023 Q5(i), an index equation to 3 decimal places; Oct 2025 Q3(a), the x value at which 3 × 2^(-x) = 300 000; Jan 2021 Q3(i), x in the form log_7 a.

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

GIVEN

Trigonometry

Both identities are on the specification's list of formulae you must know. In P2 they turn an equation with tan into a quadratic in sin or cos.

tan in terms of sin and cos

Replace tan, multiply through by cos θ, then use the next identity. An equation a sin(x) = b cos(x) becomes tan(x) = b/a. Used in: Jan 2026 Q8(ii), 2 tan x sin x + 3 = 0; Jun 2025 Q8(ii), 5 sin θ tan θ = cos θ + 4; Oct 2022 Q5(a).

$$\tan\theta \equiv \frac{\sin\theta}{\cos\theta}$$

LEARN IT

Pythagorean identity

Use $\sin^2$ = 1 - $\cos^2$ to leave a quadratic in cos θ, or $\cos^2$ = 1 - $\sin^2$ to leave one in sin θ. Used in: Jan 2026 Q8(ii); Jun 2025 (A) Q6(i), exact sin θ and tan θ from cos θ = 1/3; Jan 2026 (A) Q8(b), exact cos θ from sin θ = 1/3.

$$\sin^2\theta + \cos^2\theta \equiv 1$$

LEARN IT

Differentiation

P2 asks for algebraic differentiation of powers of x, then uses the result for stationary points and for areas or optimisation.

Derivative of a power

Multiply by any coefficient and differentiate term by term; a constant gives 0. Write roots and 1/x^n as powers of x first. Used in: Jan 2026 Q10(a), the x coordinate of a stationary point; Jun 2025 Q9(b), the minimum surface area; Jan 2026 Q6(ii), the gradient of a cubic.

$$\frac{d}{dx}\left(x^n\right) = nx^{n-1}$$

LEARN IT

Integration and the trapezium rule

Integral of a power

Add 1 to the power and divide by the new power. Put in the limits only after integrating, and subtract the lower value from the upper. Used in: Jan 2026 Q10(b), areas R1 and R2 equal; Jun 2025 Q3, area between a curve and a chord.

$$\int x^n\,dx = \frac{x^{n+1}}{n+1} + c, \quad n \neq -1$$

LEARN IT

Area under a curve

On the specification's list of formulae you must know. If the curve is below the x-axis the integral is negative, so take the positive value for an area. Used in: Jan 2026 Q10(b); Jun 2024 (R) Q10(b), area under a curve and above the x-axis; Oct 2025 (A) Q8(a).

$$\text{area} = \int_a^b y\,dx \quad (y \geq 0)$$

LEARN IT

Area between a curve and a line

Or take the area under the curve and subtract or add the area of a trapezium or triangle under the line. Used in: Jan 2023 Q9(c), regions bounded by a curve and a line; Jun 2025 Q3, region bounded by a curve and the chord PQ.

$$\text{area} = \int_a^b \left(y_{\text{upper}} - y_{\text{lower}}\right) dx$$

LEARN IT

Trapezium rule

h is the strip width and there is one more y value than there are strips. Used in: Jan 2026 Q2(a), area of R with all the y values in a table; Jun 2025 Q5(a), an estimate of an integral; Jan 2026 (A) Q3(a), area of R to 3 decimal places.

$$\int_a^b y\,dx \approx \tfrac{1}{2}h\{(y_0 + y_n) + 2(y_1 + y_2 + \cdots + y_{n-1})\}, \quad h = \frac{b-a}{n}$$

GIVEN

Areas, volumes and optimisation

Optimisation questions build a formula for area or volume first. These shape formulae are not in the booklet.

Volume of a cuboid or prism

Use the given volume to write one dimension in terms of the other. Used in: Jun 2025 Q9(a), a container with triangular ends; Jan 2025 Q3(a), an open cuboid holding 120 m^3; Jan 2023 Q2(a), a brick of volume 972 cm^3.

$$V = (\text{area of cross-section}) \times \text{length}, \qquad V = lwh$$

LEARN IT

Surface area of a cuboid

For an open top, leave out the missing face. Substitute the height from the volume formula so S has one variable. Used in: Jun 2021 Q9(a), a square-based open box; Jan 2023 Q2(a), surface area of the brick; Jan 2025 Q3(a), area of sheet metal.

$$S = 2(lw + lh + wh)$$

LEARN IT

Area of a triangle

Use it for the triangular ends of a prism and for the triangle formed by a tangent and the axes. Used in: Jun 2025 Q9(a), the area of the two congruent triangles; Jan 2021 Q9(c), exact area of triangle OPT; Jun 2021 Q6(b), exact area of triangle RST.

$$A = \tfrac{1}{2} \times \text{base} \times \text{height}$$

LEARN IT

Area and circumference of a circle

A semicircle has half of each, plus its diameter for the perimeter of the joined shape. Used in: Jan 2026 (A) Q7(a), the area and perimeter of a rectangle joined to a semicircle.

$$A = \pi r^2, \qquad C = 2\pi r$$

LEARN IT

Arc length

θ must be in radians. Add only the outer edges for a joined shape. Used in: Oct 2025 (A) Q10(a), perimeter of a stage made from a rectangle and two sectors.

$$s = r\theta$$

LEARN IT

Area of a sector

θ must be in radians. Used in: Oct 2025 (A) Q10(a), the area of the stage equals 30 m^2.

$$A = \tfrac{1}{2}r^2\theta$$

LEARN IT

Also learn these

Proof by exhaustion and algebraic proof

Write whole numbers algebraically: 2n even, 2n + 1 odd, n and n + 1 consecutive, 3p + 1 and 3p + 2 for numbers that are not multiples of 3, then expand and show a factor. Used in: Jan 2026 Q6(i); Jun 2025 Q10; Oct 2022 Q1.

Disproof by counter example

One example that breaks the statement is enough, and it must be fully checked. Used in: Jan 2025 Q8(i), a statement about irrational numbers.

Proof of the sum formulae

The specification says the proof of the sum formula should be known, and questions ask for it. Write out S_n and the reversed sum for an arithmetic series, and S_n and r times S_n for a geometric series. Used in: Oct 2025 Q8(i), geometric; Jun 2024 (R) Q8(i)(a), arithmetic; Jan 2020 Q8(i).

Common ratio and common difference

Three consecutive terms of a geometric sequence satisfy u_2/u_1 = u_3/u_2, and of an arithmetic sequence u_2 - u_1 = u_3 - u_2, which gives an equation for the unknown. Used in: Jan 2026 (A) Q8(a); Jun 2024 (R) Q8(ii)(a); Oct 2023 Q10(i)(b).

Sequences from a recurrence relation

Substitute term by term using u_(n+1) = f(u_n). A sequence is periodic of order k if u_(n+k) = u_n, so find the cycle and use the remainder when n is divided by k. Used in: Jun 2025 (A) Q5; Jan 2026 (A) Q2; Oct 2023 Q2.

Sigma notation

The sum of u_r from r = 1 to n means add the terms in order. Split the sum into parts you can do, such as an arithmetic series plus a geometric series. Used in: Oct 2022 Q3(b); Oct 2021 Q2(b); Jan 2020 Q8(ii)(b).

Convergence of a geometric series

A sum to infinity exists only if |r| < 1, so when solving for r reject any root outside -1 < r < 1 and say why. Used in: Jun 2022 Q6(b); Oct 2021 Q7(ii)(c); Jun 2024 (R) Q8(ii)(b).

Inequalities for r^n with logarithms

To find the smallest n for which a geometric term or sum passes a value, take logs of both sides, use the power law, and reverse the inequality when you divide by a negative log. Used in: Jun 2025 Q7(i)(b); Jan 2023 Q7(c); Jun 2023 Q6(c).

Binomial coefficients in products and approximations

For the coefficient of x^2 in a product such as $(5 + kx)(1 - 4x)^7$, multiply the matching terms and add them. To estimate a number such as 2.0125, substitute a small x into the expansion. Used in: Jun 2025 Q1(b); Jun 2021 Q4(b); Jan 2021 Q4(b).

Exponential graphs

y = a^x with a > 1 passes through (0, 1), is always above the x-axis, rises more steeply as x increases, and has the x-axis as an asymptote; y = k a^x passes through (0, k). Used in: Jan 2020 Q9(a); Jun 2021 Q2; Oct 2025 Q3.

Solving trigonometric equations in an interval

Find the principal value from the calculator, then use the symmetry of the graph to find every solution in the range, working in the unit the question gives. For tan, add 180 degrees (pi radians) each time. Used in: Jan 2026 Q8(i); Jun 2025 Q8(i); Oct 2025 (A) Q7(i).

Exact values and answers in terms of pi

Know sin, cos and tan of 30, 45 and 60 degrees (pi/6, pi/4 and pi/3) when a question asks for an exact answer or an answer of the form k pi. Used in: Jan 2026 Q8(ii), answers in the form k pi; Jun 2025 Q8(i); Oct 2025 Q5(i), exact and non-exact solutions.

Hidden quadratics

Spot a quadratic in cos θ, sin θ or log_5 y, substitute, solve, then return to the original variable and discard any root that is out of range. Used in: Oct 2025 (A) Q5(ii); Jan 2026 Q8(ii); Jun 2025 Q8(ii).

Angle in a semicircle and chords

The angle in a semicircle is a right angle, so if AB is a diameter and C is on the circle then AC is perpendicular to BC; the perpendicular from the centre to a chord bisects the chord. Used in: Jun 2022 Q3(ii); Jan 2020 Q6(c), a chord of length 4; Jan 2025 Q6(a).

Stationary points and their nature

At a stationary point dy/dx = 0. Then d^2y/dx^2 greater than 0 means a minimum and less than 0 a maximum; give the sign and the value you substituted. Used in: Jan 2026 (A) Q7(c); Jun 2025 Q9(c); Jan 2025 Q3(c).

Increasing and decreasing functions

A function is increasing where dy/dx is greater than 0 and decreasing where it is less than 0, so solve the inequality, often after factorising the derivative. Used in: Oct 2025 Q4(c); Oct 2023 Q9(a); Oct 2021 Q8(b).

Improving the trapezium estimate

Use more strips, which means a smaller strip width h; say whether the estimate is over or under by looking at which way the curve bends. Used in: Jan 2026 Q2(b); Jun 2025 (A) Q4(c); Oct 2023 Q6(c).

Using a trapezium result for a related integral

A constant multiple comes outside the integral, and a constant added to the function adds that constant times the width of the interval, so k times f(x) plus c integrates to k times the estimate plus c(b - a). Used in: Jan 2026 Q2(c); Jun 2025 Q5(b); Jan 2026 (A) Q3(b).

Using the booklet in the exam

- Learn the circle equation, the three laws of logarithms, tan = sin/cos and $\sin^2 + \cos^2 = 1$, and the factor and remainder theorems; none is in the booklet.
- Many questions say calculator technology is not acceptable. Show the substitution into the quadratic formula, the algebra for factor theorem and the integration, with the limits written in.
- For a geometric series check |r| < 1 before you use the sum to infinity, and write a^(n-1) with n - 1 when you find a term.
- When solving a log equation, combine to one log on each side first, then remove the logs; always check each root against the original equation.
- For optimisation, write the quantity as a function of one variable, set the derivative to 0, then test the second derivative; the booklet does not print any area or volume formulae.

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