

Supported Focus Companion

Pearson Edexcel • International GCSE • Mathematics A

Reviewed native lessons only; qualification gaps remain

exercises.lol

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Numbers and the number system – supported focus

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Supported teaching and tier boundary

4MA1: Numbers and the number system. Version: Issue 2, November 2017; first assessment June 2018; linear Mathematics A.

Foundation teaching and Higher additions are labelled below. This reference packages the existing native-lesson crosswalk. It does not certify unreviewed specification rows or a whole qualification. Original diagnostics are separate and are not reproduced.

■ Exact arithmetic and estimation · Foundation

Prime factors reveal shared structure. Use the smallest common prime powers for the HCF and the largest for the LCM. Estimate before calculating; use brackets to preserve the order of operations.

$$72 = 2^3 \times 3^2, \quad 90 = 2 \times 3^2 \times 5, \quad \text{HCF} = 18$$

$72=2^3 \times 3^2$ and $90=2 \times 3^2 \times 5$. Their HCF is $2 \times 9=18$. Make 18 bags with 4 pencils and 5 pens each. Their LCM is $2^3 \times 3^2 \times 5=360$.

The HCF divides both numbers; the LCM is a multiple of both. They answer different questions. A decimal estimate is not an exact fraction.

For a non-calculator paper, keep fractions exact and show cancellation. For a calculator paper, enter the full expression and compare with your estimate.

■ Exact arithmetic and estimation · Higher

Prime factors reveal shared structure. Use the smallest common prime powers for the HCF and the largest for the LCM. Estimate before calculating; use brackets to preserve the order of operations.

$$a = \prod p_i^{\alpha_i}, \quad b = \prod p_i^{\beta_i}, \quad \text{HCF}(a, b) = \prod p_i^{\min(\alpha_i, \beta_i)}$$

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$$72 = 2^3 \times 3^2$$

$$90 = 2 \times 3^2 \times 5$$

Shared smallest powers: $2 \times 3^2 = 18$

Original native-lesson illustration; labels belong to its worked example.

■ Integer indices and standard form · Foundation

Use integer powers, square and cube roots and standard form with $1 \leq a < 10$. In multiplying powers with the same base, add indices; in division, subtract them.

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

$0.000072 = 7.2 \times 10^{-5}$. Also $2^3 \times 2^4 = 2^7 = 128$. The square root of 81 is 9. Check a standard-form answer by writing it out as a decimal.

Index laws do not turn a sum into a single power: $2^3 + 2^4 = 24$, not 2^7 . Do not round a surd when an exact answer is requested.

This Foundation/Core lesson excludes fractional powers and surd rationalisation. Estimate a result before using a calculator and retain the required precision.

■ Indices, surds and standard form · Higher

For the same positive base, multiplication adds indices and division subtracts them. A negative index means reciprocal; a fractional index represents a root. Standard form has $1 \leq a < 10$.

$$a^m a^n = a^{m+n}, \quad a^{-n} = \frac{1}{a^n}, \quad a^{m/n} = (\sqrt[n]{a})^m$$

$0.000072 = 7.2 \times 10^{-5}$. Also $16^{3/4} = (16^{1/4})^3 = 2^3 = 8$. Simplify $\sqrt{72} = 6\sqrt{2}$, then rationalise $1/\sqrt{2} = \sqrt{2}/2$.

Index laws do not turn a sum into a single power: $2^3 + 2^4 = 24$, not 2^7 . Do not round a surd when an exact answer is requested.

Check powers of ten against the original quantity. Use surds for exact geometry, and round only the final length when the question asks for a decimal.

$$0.000072 = 7.2 \times 10^{-5}$$

7.2 is the coefficient; -5 is the power

The coefficient is between 1 and 10

Original native-lesson illustration; labels belong to its worked example.

■ Percentages, ratio and proportional reasoning · Foundation

A $p\%$ increase has multiplier $1 + p/100$; a decrease has multiplier $1 - p/100$. Reverse a percentage by dividing by the multiplier. In a ratio, first find the total number of parts.

$$P_{\text{new}} = P_{\text{old}} \left(1 + \frac{r}{100} \right)$$

Let the original price be P . The model is sale price $= 0.8P$. Hence $P = 240/0.8 = 300$. A later 20% increase gives $240 \times 1.2 = 288$, so the two changes do not cancel.

A percentage uses a stated base. Subtracting the percentages loses that base. For compound change, multiply the multipliers; do not add the percentages.

Use percentage multipliers and divide a total into ratio parts. This Foundation/Core lesson uses linear proportional contexts, not the advanced regression methods.

■ Percentages, ratio and proportional reasoning · Higher

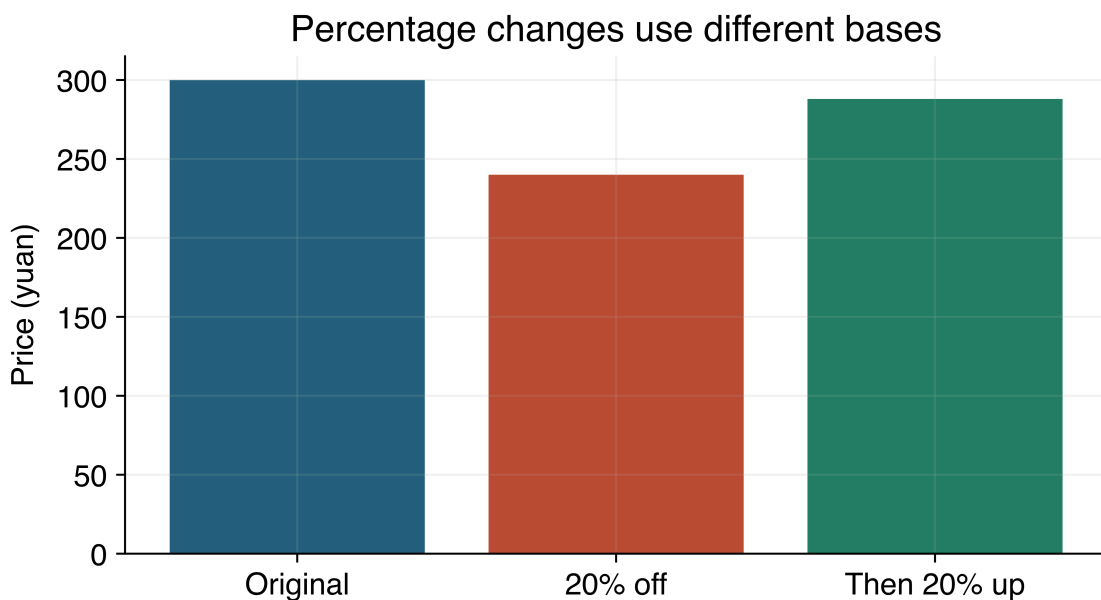
A $p\%$ increase has multiplier $1+p/100$; a decrease has multiplier $1-p/100$. Reverse a percentage by dividing by the multiplier. In a ratio, first find the total number of parts.

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A percentage uses a stated base. Subtracting the percentages loses that base. For compound change, multiply the multipliers; do not add the percentages.

For direct proportion use $y=kx$; for inverse proportion use $y=k/x$. Calculate k from a known pair before using a new value. State what you held constant.



Original native-lesson illustration; labels belong to its worked example.

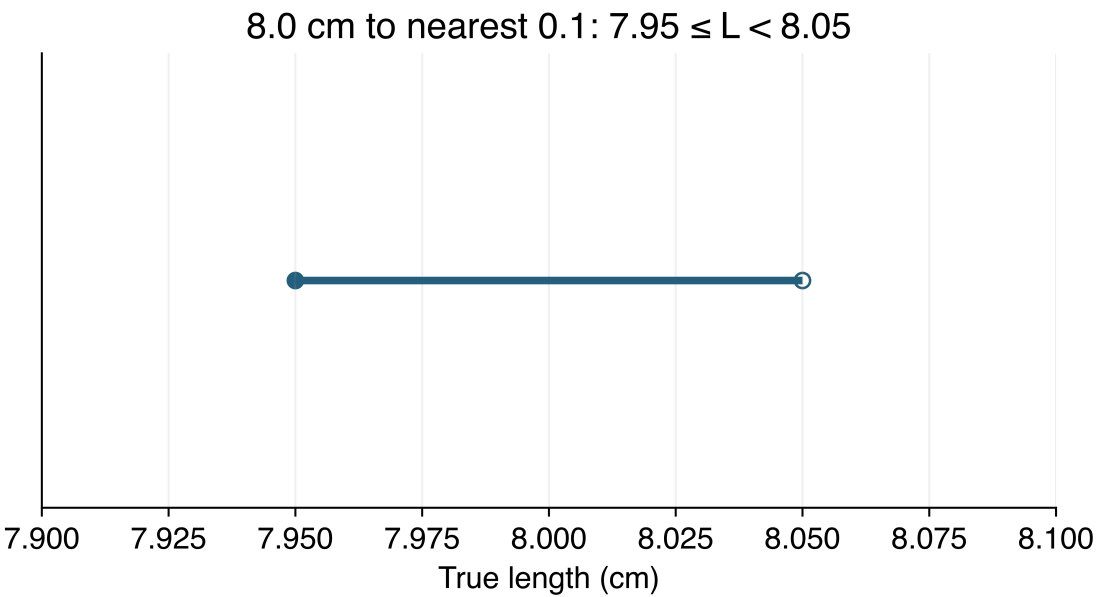
■ Accuracy, bounds and compound measures · Higher

A value rounded to the nearest unit u lies from stated value $-u/2$ up to, but usually not including, stated value $+u/2$. For positive quantities, combine extremes according to the operation.

$$A = LW, \quad v = \frac{d}{t}$$

The lengths satisfy $7.95 \leq L < 8.05$ and $4.95 \leq W < 5.05$. Since $A = LW$, $39.3525 \leq A < 40.6525$. For speed d/t , the largest speed uses the largest distance and smallest positive time.

An upper bound is not automatically achieved. Dividing upper distance by upper time does not give the largest speed. Keep enough digits in intermediate calculations. Distinguish measurement uncertainty from arithmetic rounding. A sensible reported precision cannot be finer than the measurements justify.



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Remaining qualification limits

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Terms

- prime factor** .
- index** .
- multiplier** .
- lower bound** .

Equations, formulae and identities – supported focus

Pearson Edexcel · International GCSE · Mathematics A

Supported teaching and tier boundary

4MA1: Equations, formulae and identities. Version: Issue 2, November 2017; first assessment June 2018; linear Mathematics A.

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■ Equations, identities and rearrangement · Foundation

An equation asks which inputs satisfy an equality; an identity holds for all allowed inputs. Preserve equality by applying the same operation to both sides. State restrictions before dividing by a variable.

$$C_1 = 20 + 3x, \quad C_2 = 44 + x, \quad C_1 = C_2$$

$20+3x=44+x$ gives $2x=24$ and $x=12$. Both plans then cost 56. In $A=\pi r^2$, divide by π and take the positive square root to obtain $r=\sqrt{A/\pi}$, because r is a length.

Cancelling a term is not the same as cancelling a factor. In $(x^2+2x)/x$, factor the numerator and retain $x \neq 0$. Check a rearrangement by substitution.

Define the unknown and set up a linear equation. Check the answer by substitution. Restrict this Foundation/Core lesson to simple expressions and equations.

■ Equations, identities and rearrangement · Higher

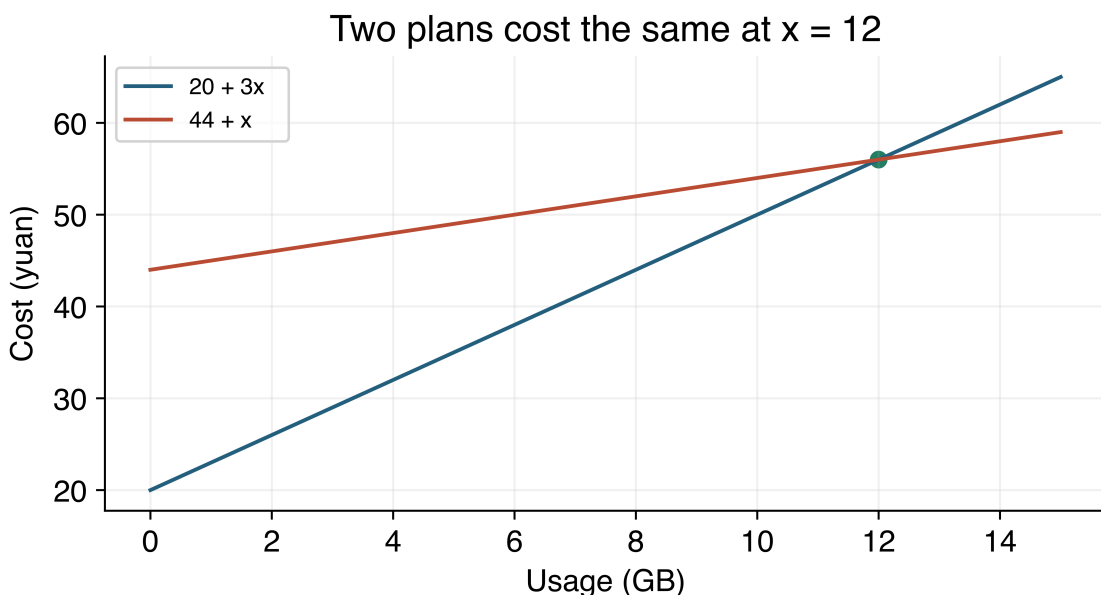
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Cancelling a term is not the same as cancelling a factor. In $(x^2+2x)/x$, factor the numerator and retain $x \neq 0$. Check a rearrangement by substitution.

Set up the equation from units and the meaning of the unknown. A negative or fractional solution may be algebraically correct but impossible for a count.



Original native-lesson illustration; labels belong to its worked example.

■ Factorising and solving simple quadratics · Foundation

Expand brackets and factorise simple quadratics. Solve by setting each factor equal to zero, and use a graph to interpret the roots.

$$(x - 3)(x - 7) = 0$$

$x^2 - 10x + 21 = (x - 3)(x - 7)$. Hence the equation $x^2 - 10x + 21 = 0$ has roots 3 and 7. Check each root by substitution and mark both intercepts on the graph.

Multiplying an inequality by a negative number reverses its direction. A sketch must show which side of each root satisfies the inequality. Geometry may restrict x further. This Foundation/Core lesson uses factorisation and graphical roots; the discriminant, quadratic formula and quadratic inequalities are reserved for the advanced tier.

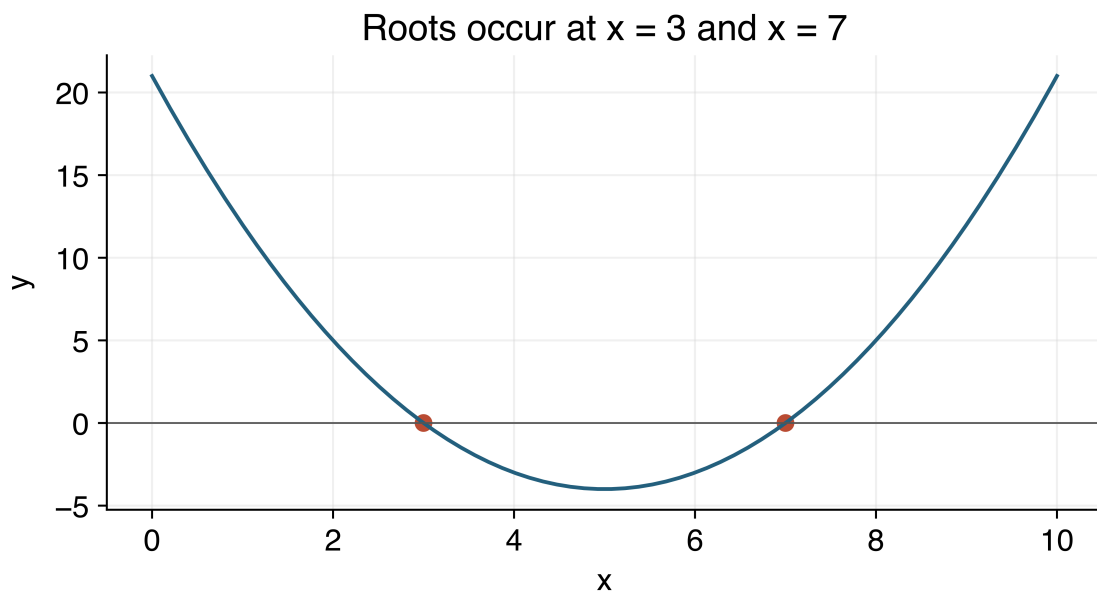
■ Quadratics and inequalities · Higher

Factor where possible; otherwise complete the square or use the quadratic formula. A quadratic inequality needs the sign on intervals, not only the roots. The discriminant identifies repeated or missing real roots.

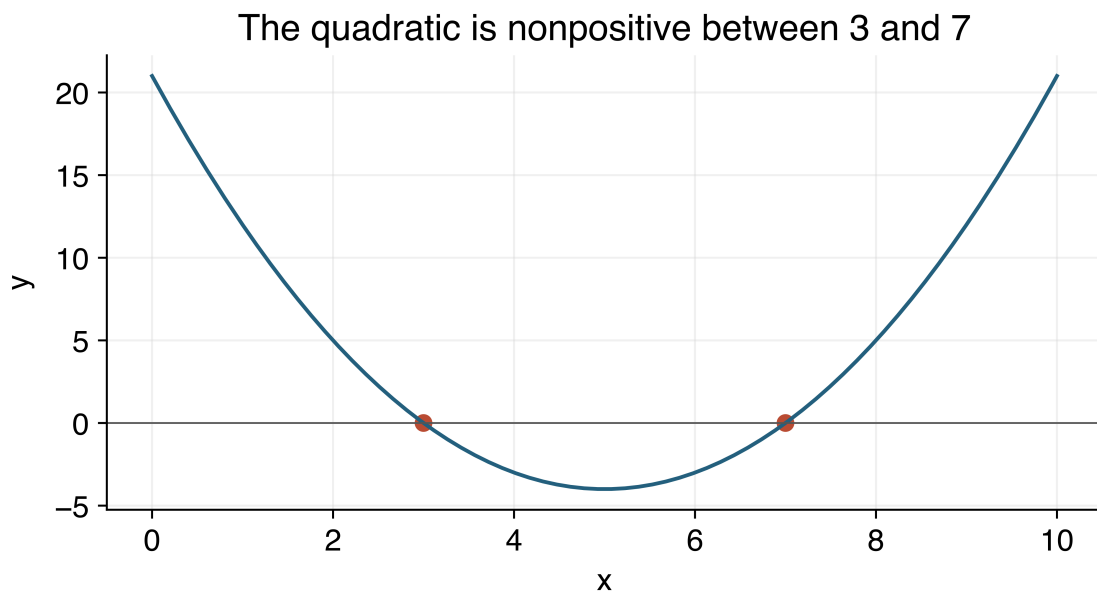
$$ax^2 + bx + c = 0, \quad \Delta = b^2 - 4ac$$

The condition is $x(10 - x) \geq 21$, so $x^2 - 10x + 21 \leq 0$. Factor $(x - 3)(x - 7) \leq 0$. The upward parabola is nonpositive between its roots, giving $3 \leq x \leq 7$. The maximum area is 25 at $x = 5$.

Multiplying an inequality by a negative number reverses its direction. A sketch must show which side of each root satisfies the inequality. Geometry may restrict x further. Use the vertex to interpret an optimum. Check an endpoint and a point between the roots; the algebra and graph should tell the same story.



Original native-lesson illustration; labels belong to its worked example.



Original native-lesson illustration; labels belong to its worked example.

■ Simultaneous equations and feasible regions · Foundation

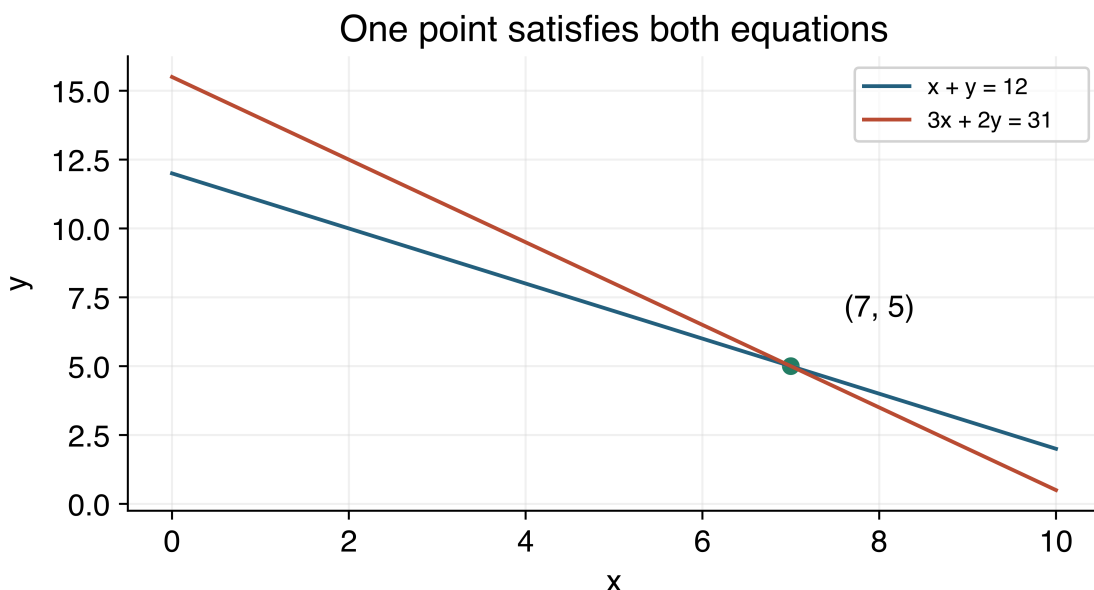
For two linear equations, use elimination or substitution and check both equations. For a line and a quadratic, substitute the linear relation first; then solve the resulting quadratic. For inequalities, shade the region satisfying every condition.

$$x + y = 12, \quad 3x + 2y = 31$$

If $x+y=12$ and $3x+2y=31$, subtract twice the first equation from the second to obtain $x=7$, then $y=5$. For $y=x+1$ and $y=x^2-1$, $x^2-x-2=0$ gives $x=2$ or -1 , with $y=3$ or 0 .

One equation checked is not enough. A line can meet a quadratic twice, so retain both solutions unless the context removes one. Inequality boundaries may be included or excluded according to the sign.

Define the variables and their units. If they count objects, both must be nonnegative integers. For a feasible region, test one point on the required side of each boundary and then take the intersection.



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Terms

identity .

discriminant .

elimination .

Sequences, functions and graphs – supported focus

Pearson Edexcel · International GCSE · Mathematics A

Supported teaching and tier boundary

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■ Arithmetic sequences and nth terms · Foundation

Find a constant difference for an arithmetic sequence. Its n th term is $a+(n-1)d$. A term-to-term rule describes how to reach the next term; a position-to-term rule gives a term directly.

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

For 5,8,11,14,... the common difference is 3. The n th term is $5+3(n-1)=3n+2$. At $n=8$, $u_8=26$. To find the position of 62, solve $3n+2=62$, giving $n=20$.

The first term has index 1, so the exponent is $n-1$. A sequence is a list; a series is a sum. A geometric sequence can alternate in sign and still converge.

Generate several terms and check a proposed n th-term rule. Infinite geometric series and advanced sum formulae are excluded from this Foundation/Core lesson.

■ Arithmetic sequences and finite sums · Higher

For an arithmetic sequence, $u_n=a+(n-1)d$. Pairing the first and last terms gives equal pair sums $a+u_n$. Therefore the first n terms have sum $S_n=n(a+u_n)/2=n[2a+(n-1)d]/2$. A sequence lists terms; a series adds them. State the first index before using a formula.

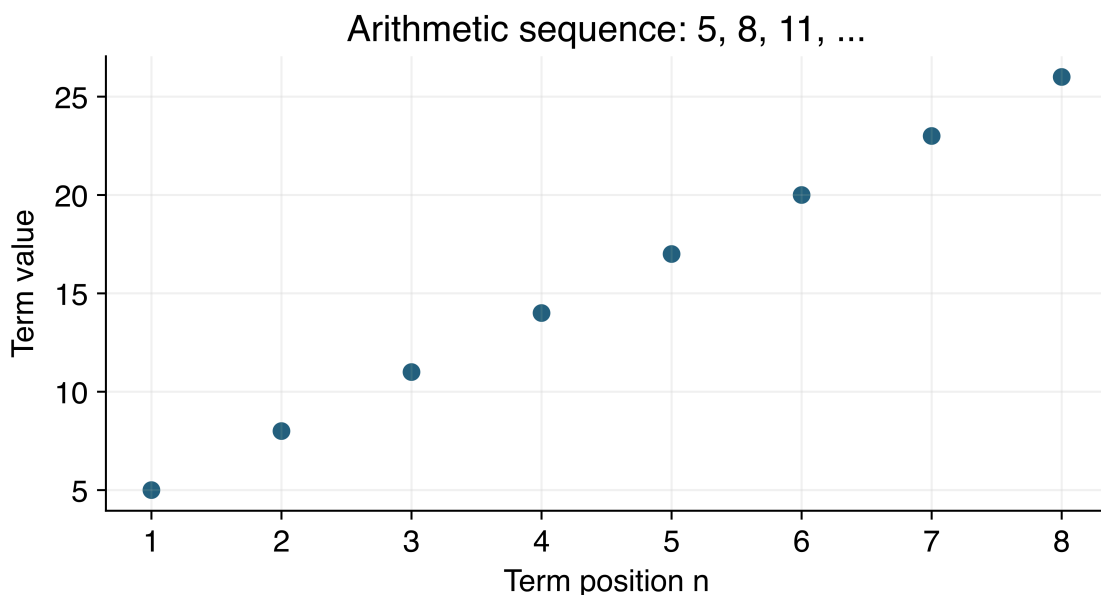
$$u_n = a + (n - 1)d, \quad S_n = \frac{n}{2} [2a + (n - 1)d]$$

For $a=5, d=3, n=8$, $u_8=5+7 \times 3=26$ and $S_8=8(5+26)/2=124$. If the second term is 7 and the fifth is 19, then $3d=19-7=12$, so $d=4$ and $a=7-4=3$. The first four terms 3,7,11,15 sum to 36, also $4(3+15)/2=36$. The sum formula depends on a constant difference.

A term is not a sum. The first term is indexed by 1 in these formulae. An arithmetic sum requires a constant difference; increasing terms alone do not establish this.

4MA1 Higher 3.1 A–C covers common difference, the arithmetic n th term and the sum

of the first n arithmetic terms. Geometric finite/infinite sum formulae are excluded from this supported focus lesson.



Original native-lesson illustration; labels belong to its worked example.

■ Straight lines and gradients · Foundation

Gradient is change in y divided by change in x . A straight line has $y=mx+c$, where c is its y -intercept. Parallel lines have equal gradients.

$$y = mx + c$$

Through (2,5) with gradient 3, substitute to get $5=3 \times 2+c$, so $c=-1$ and $y=3x-1$. Points (1,2) and (4,8) give gradient $(8-2)/(4-1)=2$.

A vertical line has no finite gradient; do not force it into $y=mx+c$. Read the signs of a circle's centre carefully. The radius to a tangent is perpendicular to the tangent.

Plot a straight line using two checked points and label its intercept. Perpendicular-gradient formulae and circle equations are not part of this Foundation/Core lesson.

■ Coordinate geometry and tangents · Higher

A line through (x_1, y_1) with gradient m has $y-y_1=m(x-x_1)$. Parallel lines have equal gradients. Finite perpendicular gradients multiply to -1 . A circle has $(x-a)^2+(y-b)^2=r^2$.

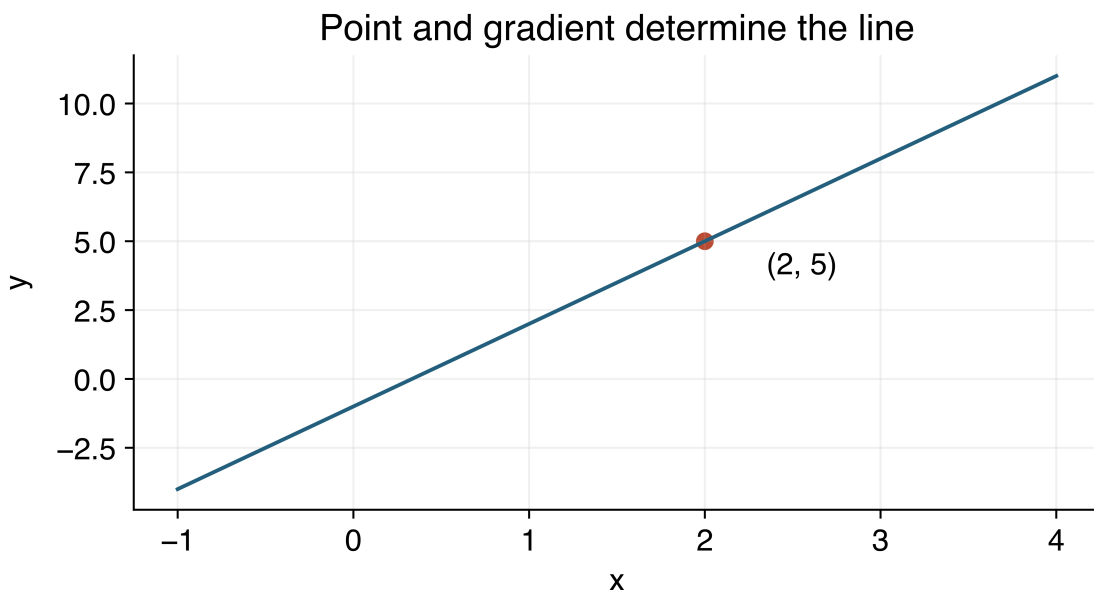
$$y - y_1 = m(x - x_1), \quad (x - a)^2 + (y - b)^2 = r^2$$

Through (2,5) with gradient 3, $y-5=3(x-2)$, so $y=3x-1$. A perpendicular through the

same point has $y-5=-(x-2)/3$. The circle $(x-2)^2+(y+1)^2=25$ has centre $(2,-1)$ and radius 5.

A vertical line has no finite gradient; do not force it into $y=mx+c$. Read the signs of a circle's centre carefully. The radius to a tangent is perpendicular to the tangent.

Before solving a line-circle intersection, predict whether there are zero, one or two intersections. Substitution produces a quadratic whose discriminant checks the prediction.



Original native-lesson illustration; labels belong to its worked example.

■ Domains, inverses and composition · Higher

State the domain and range. For an inverse, first ensure the function is one-to-one on its domain. Composition fg means apply g first, then f ; the intermediate output must be an allowed input to f .

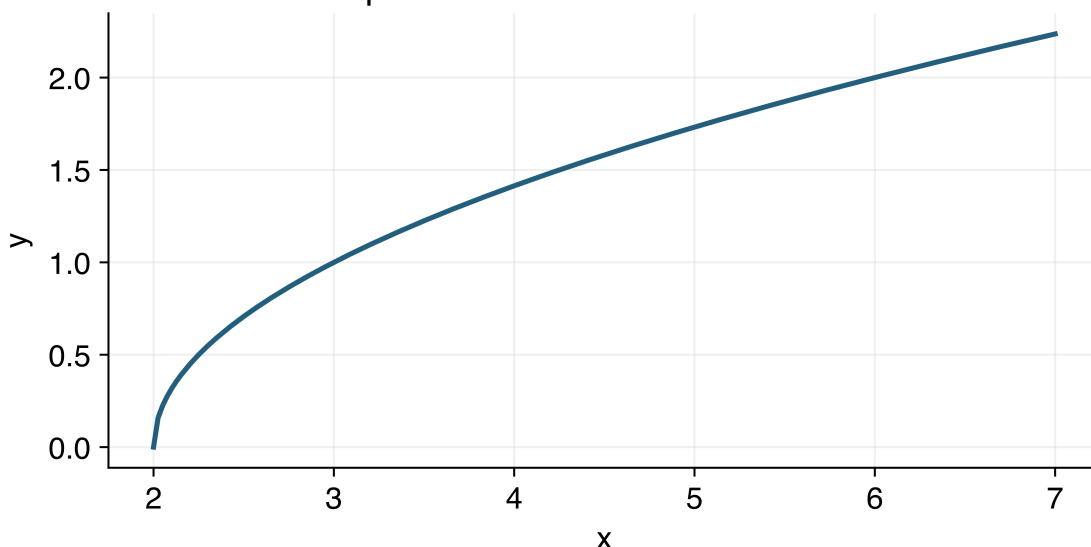
$$f(g(x)) = (f \circ g)(x), \quad f^{-1}(f(x)) = x$$

For $f(x)=\sqrt{x-2}$, $x \geq 2$ and the range is $y \geq 0$. From $y=\sqrt{x-2}$, $x=y^2+2$. Thus f inverse(x)= x^2+2 with $x \geq 0$. For $g(x)=x+3$, $fg(1)=f(4)=\sqrt{2}$.

Squaring can introduce extraneous solutions. Restricting a parabola's domain is essential before claiming an inverse. A horizontal translation inside f has the opposite sign to the graph's movement.

Check $f(f \text{ inverse}(x))=x$ on the inverse domain. Use a sketch to test whether a horizontal line meets the original graph more than once.

Square-root domain starts at $x = 2$



Original native-lesson illustration; labels belong to its worked example.

■ Derivatives and stationary points · Higher

For a polynomial term ax^n with nonnegative integer n , the gradient term is anx^{n-1} . Add the differentiated terms. A stationary point has zero gradient.

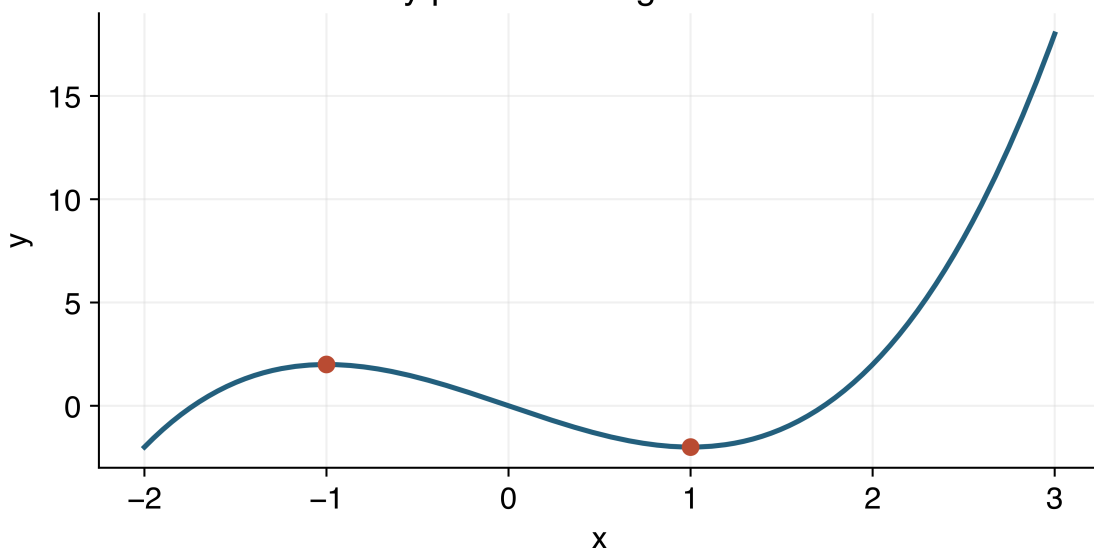
$$\frac{d}{dx}(ax^n) = anx^{n-1}, \quad f'(x) = 0$$

For $y=x^3-3x$, $dy/dx=3x^2-3$. At $x=1$, the gradient is 0 and $y=-2$. The gradient $3x^2-3$ changes from negative to positive at $x=1$, so this is a local minimum. At $x=-1$, $y=2$ and the gradient changes from positive to negative, giving a local maximum. Use gradient signs and the graph shape, within this specification.

A zero derivative does not always mean a maximum or minimum: $y=x^3$ is stationary at 0 but continues increasing. An endpoint can also produce an extreme value on a restricted domain.

This advanced-tier IGCSE lesson is limited to polynomial differentiation, tangent gradients and stationary points. Chain, product, quotient and implicit differentiation are excluded.

Stationary points and signed accumulation



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Terms

common difference .

gradient .

domain .

derivative .

Geometry and trigonometry – supported focus

Pearson Edexcel · International GCSE · Mathematics A

Supported teaching and tier boundary

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■ Angles, lengths and area · Foundation

Use angle facts with a stated reason. Similar shapes have equal corresponding angles and proportional corresponding lengths. Areas of rectangles and triangles come from their dimensions; compound shapes can be split into simpler parts.

$$A_{\text{rectangle}} = LW, \quad A_{\text{triangle}} = \frac{1}{2}bh$$

A rectangle of length 8 cm and width 5 cm has area $A=LW=40 \text{ cm}^2$. A triangle on the same base and height has area $A=bh/2=20 \text{ cm}^2$. For a pentagon, the interior-angle sum is $(5-2) \times 180 = 540^\circ$.

Equal angles alone establish similarity, not equal size. Use corresponding lengths in the same order. Convert linear units before calculating area or volume, or square/cube the conversion factor correctly.

Use a labelled sketch and appropriate units. This Foundation/Core lesson does not test area/volume scale factors or advanced circle-theorem proofs.

■ Angle reasoning, similarity and mensuration · Higher

For similar shapes with length scale factor k , areas scale by k^2 and volumes by k^3 . State angle reasons explicitly. A circle's tangent is perpendicular to the radius at the contact point.

$$\frac{A_2}{A_1} = k^2, \quad \frac{V_2}{V_1} = k^3$$

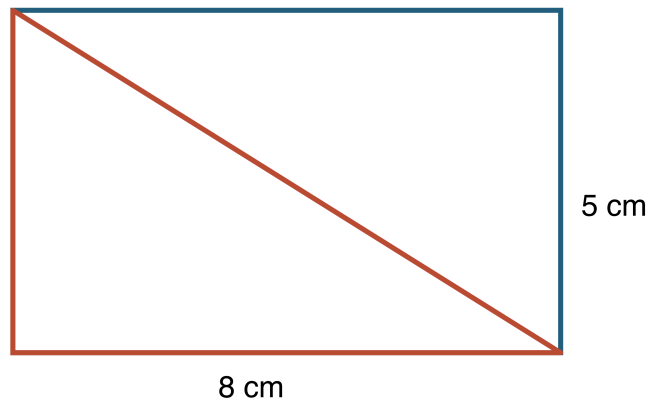
If model-to-real length factor is 3, a model area of 12 cm^2 gives $12 \times 3^2 = 108 \text{ cm}^2$ and a model volume of 8 cm^3 gives $8 \times 3^3 = 216 \text{ cm}^3$. A cylinder with $r=3, h=5$ has volume $\pi r^2 h = 45\pi$.

Equal angles alone establish similarity, not equal size. Use corresponding lengths in the same order. Convert linear units before calculating area or volume, or square/cube the conversion factor correctly.

A geometric proof should name the relevant theorem, identify the equal angle or ratio, and draw the conclusion. A scale drawing is evidence only when the task permits measurement.

Same base and height, half the area

Rectangle: 40 cm^2 ; triangle: 20 cm^2



Original native-lesson illustration; labels belong to its worked example.

A length scale factor is squared for area



Original native-lesson illustration; labels belong to its worked example.

■ Right triangles and non-right triangles · Foundation

Use Pythagoras in a right triangle and use sine, cosine or tangent with the sides labelled relative to the chosen angle.

$$a^2 + b^2 = c^2, \quad \tan \theta = \frac{\text{opposite}}{\text{adjacent}}$$

The ladder length is $c = \sqrt{3^2 + 4^2} = 5$ m. Its angle to the ground satisfies $\tan \theta = 4/3$, so $\theta \approx 53.1^\circ$. A right triangle with legs 6 and 8 has area $6 \times 8 / 2 = 24$.

Label sides relative to the chosen angle. Pythagoras needs a right angle. A calculator angle mode error can produce a plausible but wrong result. Keep unrounded values for later steps.

This Foundation/Core lesson uses right-angled triangles only. Sine and cosine rules for non-right triangles belong to the advanced-tier lesson.

■ Right triangles and non-right triangles · Higher

In a right triangle $a^2 + b^2 = c^2$; $\sin \theta = \text{opposite} / \text{hypotenuse}$, $\cos \theta = \text{adjacent} / \text{hypotenuse}$ and $\tan \theta = \text{opposite} / \text{adjacent}$. For other triangles, use the sine or cosine rule, or $\text{area} = ab \sin C / 2$.

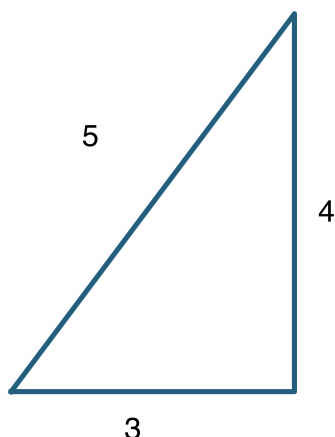
$$a^2 + b^2 = c^2, \quad \tan \theta = \frac{\text{opposite}}{\text{adjacent}}$$

The ladder length is $c = \sqrt{3^2 + 4^2} = 5$ m. Its angle to the ground satisfies $\tan \theta = 4/3$, so $\theta \approx 53.1^\circ$. With two sides 6 and 8 enclosing 60° , $c^2 = 6^2 + 8^2 - 2 \times 6 \times 8 \cos 60^\circ = 52$.

Label sides relative to the chosen angle. Pythagoras needs a right angle. A calculator angle mode error can produce a plausible but wrong result. Keep unrounded values for later steps.

Use a plan or elevation for a three-dimensional problem before applying a triangle rule. Explain why the chosen triangle contains the required length or angle.

Label the known sides before choosing a rule



Original native-lesson illustration; labels belong to its worked example.

■ Circle theorems and reasoned proofs · Higher

The angle at the centre is twice the angle at the circumference on the same arc. Angles in the same segment are equal. Opposite angles of a cyclic quadrilateral sum to 180° . A radius is perpendicular to a tangent at contact.

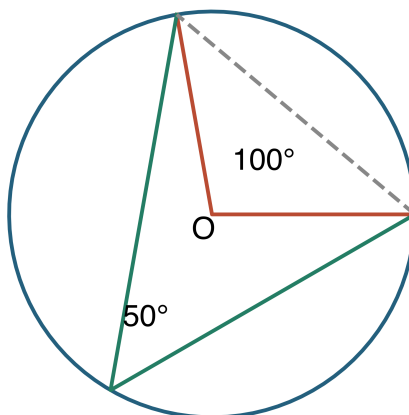
$$\theta_{\text{centre}} = 2\theta_{\text{circumference}}$$

If a central angle is 100° , the corresponding angle at the circumference is 50° . In a cyclic quadrilateral with one angle 112° , its opposite angle is $180-112=68^\circ$. A radius meeting a tangent gives 90° , even if the drawing looks oblique.

Identify the same chord and the correct arc before using a theorem. Two visible right angles do not prove a quadrilateral cyclic without a valid converse argument. A diagram need not be to scale.

Write one reason alongside each angle calculation. For the alternate-segment theorem, name the tangent and chord, then identify the angle in the opposite segment. Use auxiliary radii only when they help the proof.

The centre angle is twice the circumference angle



Original native-lesson illustration; labels belong to its worked example.

■ Constructions, loci and geometric conditions · Foundation

Points equally distant from A and B lie on the perpendicular bisector of AB. Points at fixed distance r from C lie on a circle. Points equally distant from two intersecting lines lie on their angle bisectors.

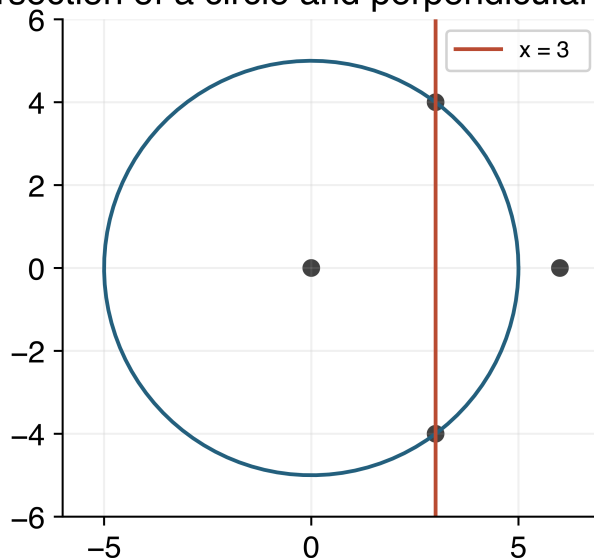
$$x = 3, \quad x^2 + y^2 = 25$$

For $A=(0,0)$ and $B=(6,0)$, the perpendicular bisector is $x=3$. Points also 5 units from A satisfy $x^2+y^2=25$. Substituting $x=3$ gives $y^2=16$, so $(3,4)$ and $(3,-4)$ satisfy both conditions.

The perpendicular bisector concerns distance to two points; the angle bisector concerns distance to two lines. A sketch is not a ruler-and-compass construction: preserve arcs as evidence of the method.

Translate each condition into a locus before finding intersections. For a region closer to A than B, choose the correct side of the perpendicular bisector and show whether a boundary is allowed.

Intersection of a circle and perpendicular bisector



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Terms

scale factor .

hypotenuse .

cyclic quadrilateral .

locus .

Vectors and transformation geometry – supported focus

Pearson Edexcel · International GCSE · Mathematics A

Supported teaching and tier boundary

4MA1: Vectors and transformation geometry. Version: Issue 2, November 2017; first assessment June 2018; linear Mathematics A.

Foundation teaching and Higher additions are labelled below. This reference packages the existing native-lesson crosswalk. It does not certify unreviewed specification rows or a whole qualification. Original diagnostics are separate and are not reproduced.

■ Vectors and transformation geometry · Foundation

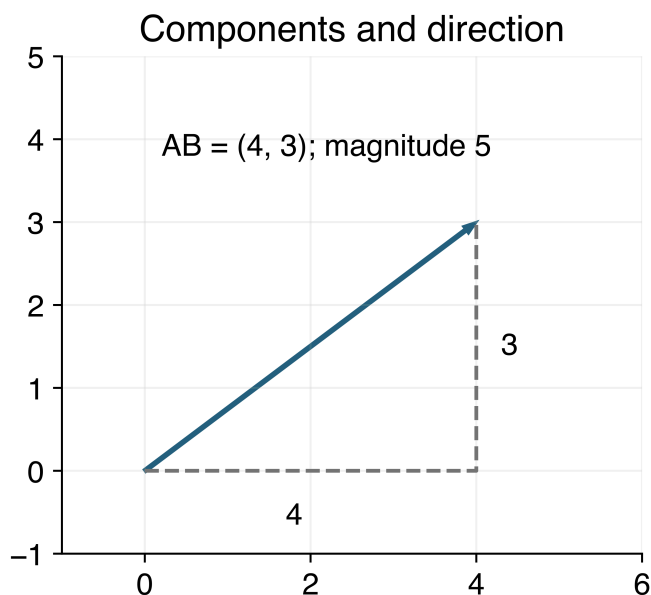
Add corresponding vector components and subtract position vectors to find a displacement. A translation moves every point by the same vector; a scalar multiple changes length and possibly direction.

$$\overrightarrow{AB} = \mathbf{b} - \mathbf{a}, \quad |\mathbf{v}| = \sqrt{v_x^2 + v_y^2}$$

With $\mathbf{a}=(4,1)$ and $\mathbf{b}=(1,3)$, $\mathbf{a}+\mathbf{b}=(5,4)$. From $A=(1,2)$ to $B=(5,5)$, displacement $\overrightarrow{AB}=(4,3)$. Its magnitude is $\sqrt{4^2+3^2}=5$.

The order of subtraction matters: $\overrightarrow{BA}=-\overrightarrow{AB}$. Proving parallelism needs a scalar-multiple relation; a sketch alone is insufficient. Negative enlargement reverses position about its centre.

Draw arrows with direction and identify the starting and ending points. Scalar products, spatial line equations and advanced angle calculations are excluded from this Foundation/Core lesson.



Original native-lesson illustration; labels belong to its worked example.

■ Reflections, rotations and enlargements • Foundation

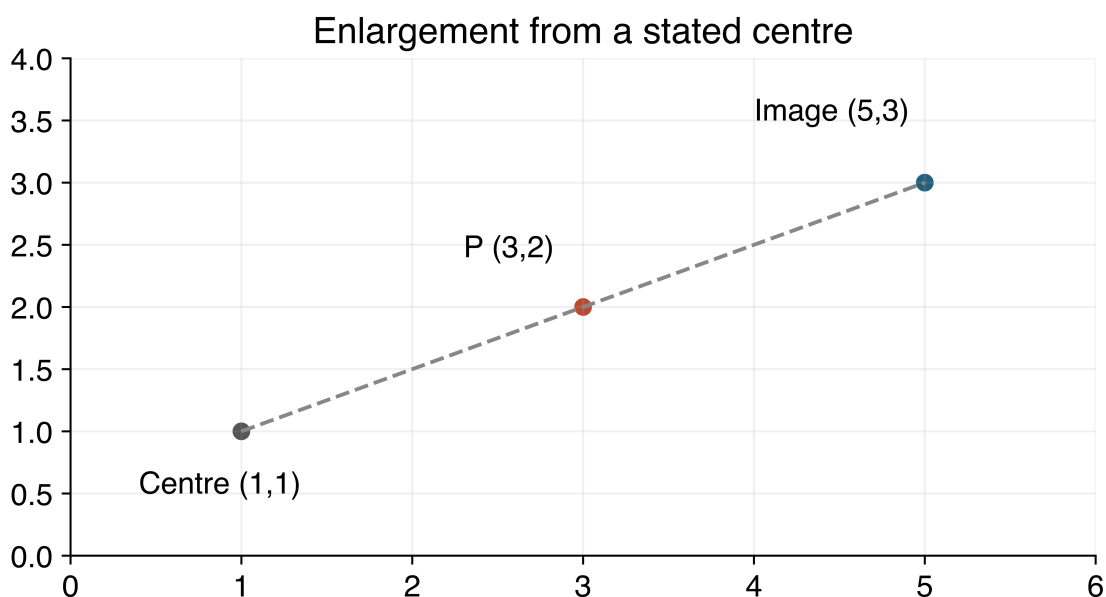
A translation adds a vector. A reflection reverses signed perpendicular distance from a mirror line. A rotation needs a centre, angle and direction. For enlargement from C , use new $P=C+k(P-C)$.

$$\mathbf{p}_{\text{image}} = \mathbf{c} + k(\mathbf{p} - \mathbf{c})$$

For $C=(1,1), P=(3,2), k=2$, $P-C=(2,1)$, so new $P=(1,1)+2(2,1)=(5,3)$. Reflection of $(3,2)$ in the y -axis gives $(-3,2)$. A 90° anticlockwise rotation about the origin gives $(-2,3)$.

A rotation needs its centre and direction, not just an angle. A negative enlargement factor places the image on the opposite side of the centre. A translation does not change orientation or size.

Describe a transformation completely before constructing the image. Check corresponding distances and angles. For combined transformations, apply them in the stated order; they usually do not commute.



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Terms

resultant .

centre of enlargement .

Statistics and probability – supported focus

Pearson Edexcel · International GCSE · Mathematics A

Supported teaching and tier boundary

4MA1: Statistics and probability. Version: Issue 2, November 2017; first assessment June 2018; linear Mathematics A.

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■ Centre, spread and data displays · Foundation

The mean is total divided by count. The median is the central value after sorting. The range is maximum minus minimum. Use frequency tables, bar charts and suitable comparisons.

$$\bar{x} = \frac{\sum x_i}{n}$$

For 2,4,4,6,9, total=25 and count=5, so mean=5. The central value is 4, so median=4. The range is 9-2=7. Explain both a typical value and the spread.

The tallest histogram bar need not contain the most observations. A grouped mean is an estimate. Correlation does not prove causation, and extrapolation extends beyond the observed range.

A bar chart uses separate bars for categories. Unequal-class-width histograms and formal density calculations are outside this Foundation/Core lesson.

■ Data summaries, histograms and interpretation · Higher

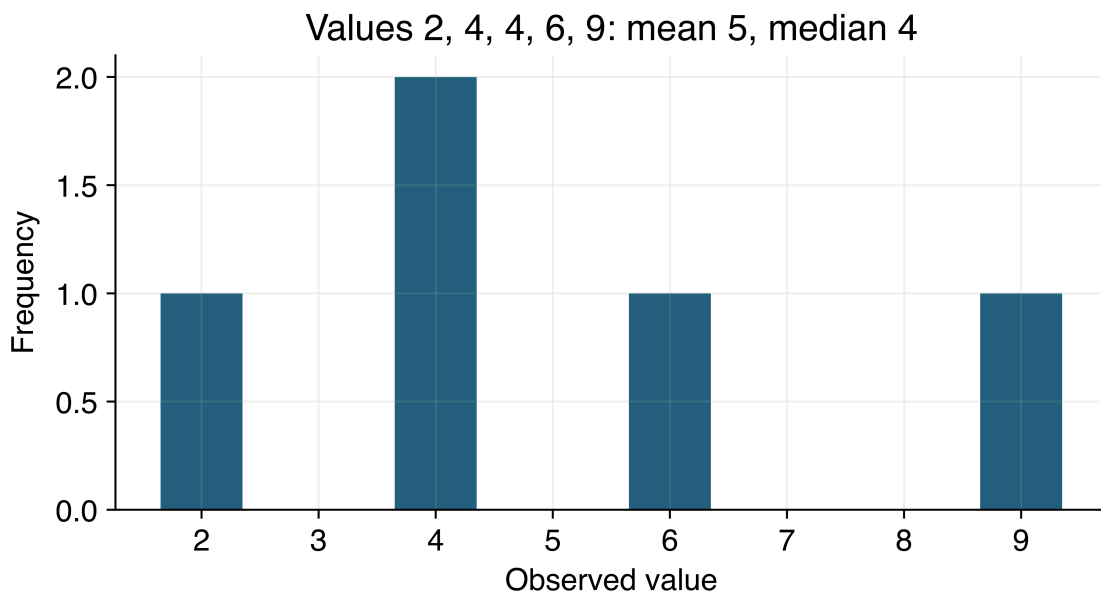
Compare an appropriate average and spread in context. A histogram uses area for frequency, so height=frequency/class width. Grouped estimates assume representative values within intervals.

$$\bar{x} = \frac{\sum x_i}{n}, \quad \text{density} = \frac{\text{frequency}}{\text{class width}}$$

A class from 10 to 20 with frequency 30 has density 30/10=3. A class from 20 to 40 with frequency 20 has density 20/20=1. Its wider bar must not be mistaken for a larger density. For values 2,4,4,6,9, the median is 4 and mean is 5.

The tallest histogram bar need not contain the most observations. A grouped mean is an estimate. Correlation does not prove causation, and extrapolation extends beyond the observed range.

Choose a display that fits the data type. Give both a numerical comparison and what it means for the population; do not infer more precision than the sample supports.



Original native-lesson illustration; labels belong to its worked example.

■ Probability trees and outcomes · Foundation

A probability lies between 0 and 1. Exhaustive, mutually exclusive outcomes have probabilities summing to 1. Multiply successive branch probabilities and add separate routes to an outcome.

$$P(RR) = P(R_1)P(R_2 | R_1)$$

A bag contains 3 red and 2 blue counters. With replacement, $P(\text{two red}) = \frac{3}{5} \times \frac{3}{5} = \frac{9}{25} = 0.36$. Without replacement, the red-red branch is $\frac{3}{5} \times \frac{2}{4} = 0.3$. Label each branch before multiplying.

Mutually exclusive means no overlap; independent means that knowing one event does not change the other's probability. Two disjoint events with positive probability are not independent.

Use a frequency table or a simple tree before calculating. Formal conditional probability formulae are outside this Foundation/Core support lesson.

■ Probability, trees and conditional reasoning · Higher

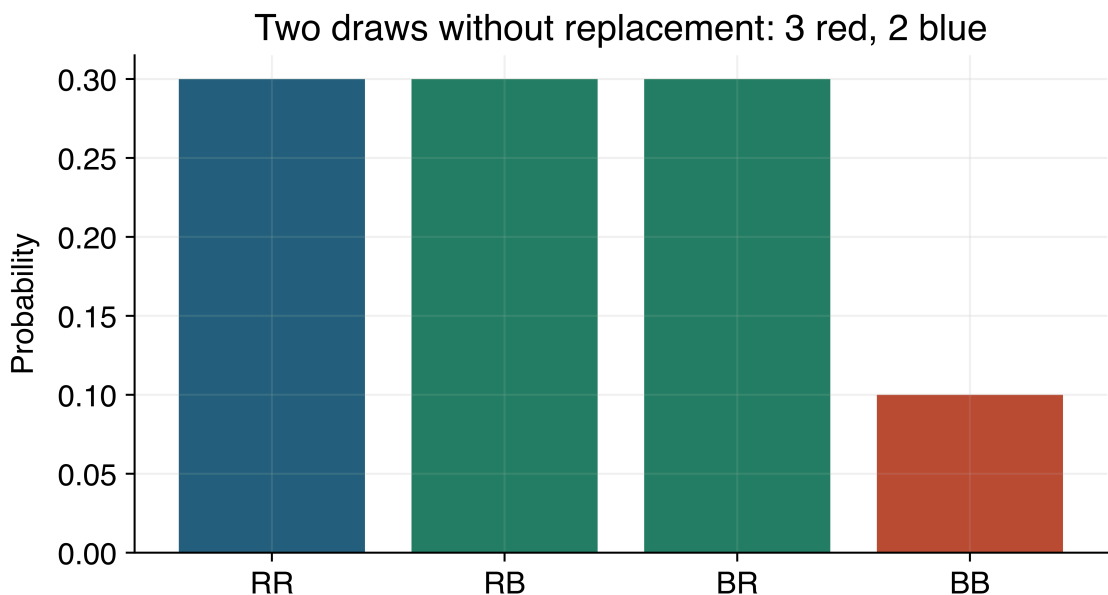
Multiply along a tree branch and add disjoint branches. With replacement, the composition stays fixed. Conditional probability is $P(A \text{ given } B) = P(A \cap B) / P(B)$, for $P(B) > 0$.

$$P(A | B) = \frac{P(A \cap B)}{P(B)}, \quad P(B) > 0$$

Without replacement, $P(\text{two red}) = 3/5 \times 2/4 = 3/10$. $P(\text{one of each}) = 3/5 \times 2/4 + 2/5 \times 3/4 = 3/5$. If $P(A \cap B) = 0.12$ and $P(B) = 0.3$, $P(A \text{ given } B) = 0.4$.

Mutually exclusive means no overlap; independent means that knowing one event does not change the other's probability. Two disjoint events with positive probability are not independent.

A two-way table makes the restricted denominator visible. Before using a product $P(A)P(B)$, justify independence from the context or the supplied information.



Original native-lesson illustration; labels belong to its worked example.

■ Cumulative frequency and box plots · Higher

A cumulative frequency counts observations below successive class boundaries. Read quartiles at one quarter, one half and three quarters of the total frequency. A box plot represents minimum, lower quartile, median, upper quartile and maximum.

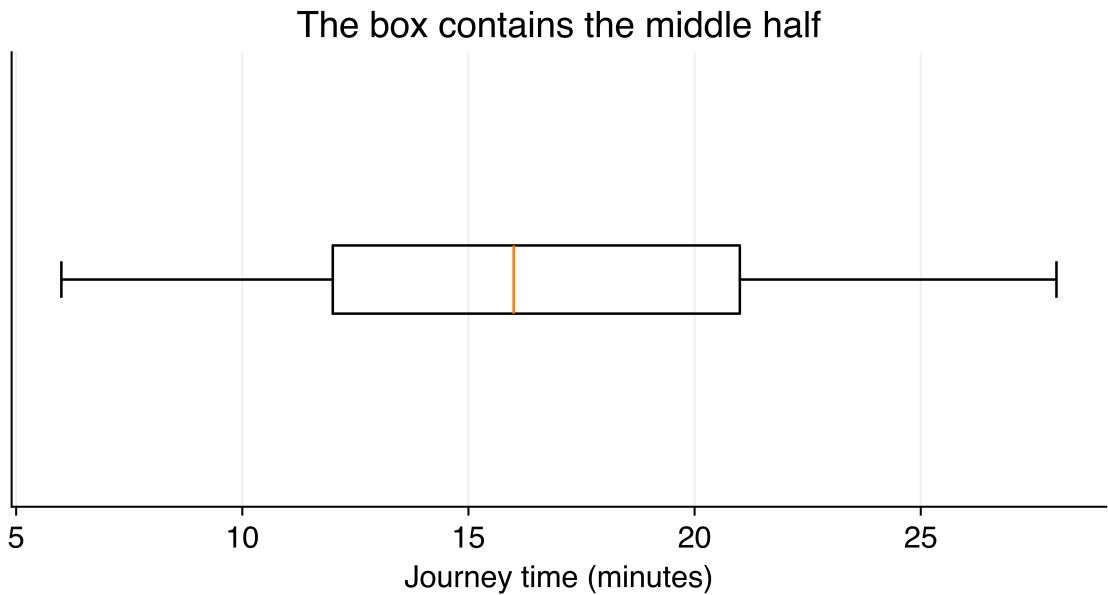
$$\text{IQR} = Q_3 - Q_1$$

For 80 observations, read Q_1 at cumulative frequency 20, median at 40 and Q_3 at 60.

If $Q1=12, Q3=21$, then $IQR=9$. Compare the medians for typical journey time and the IQRs for consistency.

Plot against class boundaries rather than midpoints. Grouped quartiles are estimates. The range is sensitive to extremes; the IQR describes only the middle half.

Explain a comparison in the context of the measured quantity. An outlier rule may use $Q1-1.5IQR$ and $Q3+1.5IQR$; use the rule specified in the task rather than assuming every graph follows it.



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Terms

range .

frequency density .

conditional probability .

interquartile range .