EDEXCEL IGCSE MATHS (4MA1) — TUTORIALS & WORKED EXAMPLES

Edexcel IGCSE (4MA1) Higher Extension — Tutorials & Examples

(Higher Tier · Grades 6–9 Extension)

Standalone IGCSE Extension Notes, Visual Diagrams & Step-by-Step Model Examples

- **1-Page Syllabus Cross-Reference Guide** (which UK GCSE topics to skip)
- **All 7 Extra IGCSE Topics** with Formula Cards & Visual Diagrams
- **Step-by-Step Worked Examples** tailored to PEARSON EDEXCEL IGCSE (4MA1)
- **Designed to Pair Seamlessly** with the BreakingDownMaths Grades 4–9 Booklets

Student Name: _____

School / Class: _____

Target Grade: _____

SCAN FOR INTERACTIVE IGCSE PRACTICE & WORKED SOLUTIONS

BreakingDownMaths.com

Select "Edexcel IGCSE (4MA1)" on the Home Page

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CROSS-REF CHECKLIST — SYLLABUS BRIDGE

Edexcel IGCSE (4MA1) Cross-Reference Guide

Roughly 90% of Pearson Edexcel International GCSE Mathematics A (4MA1) is identical to UK GCSE (9–1) and is covered in our main Grades 1–9 Booklets. Use this slim Higher Extension Booklet alongside Grades 4–9 to master all 7 extra 4MA1 Higher topics — and skip the 8 UK-GCSE-only topics below.

1. UK-GCSE-ONLY TOPICS TO SKIP IN THE MAIN GRADES 3–9 BOOKLETS

Topic in Main Booklet	Booklet	IGCSE Guidance
3D Solids, Plans & Elevations	**Grade 3**	Keep 3D faces/edges/vertices & nets; skip front/side/plan elevations
Frequency Trees	**Grade 3**	UK GCSE only — not examined on Edexcel 4MA1
Product Rule for Counting	**Grade 6**	UK GCSE only — not examined on Edexcel 4MA1
Box Plots	**Grade 6**	Skip box plots (keep Cumulative Frequency & IQR!)
Stratified Sampling	**Grade 6**	UK GCSE only — not examined on Edexcel 4MA1
Capture-Recapture	**Grade 6**	UK GCSE only — not examined on Edexcel 4MA1
Iteration	**Grade 8**	Fixed-point iteration $x_{n+1} = g(x_n)$ is not on 4MA1
Equation of a Circle	**Grade 9**	$x^2 + y^2 = r^2$ tangent equations are not on 4MA1

2. YOUR 7 EXTRA IGCSE TOPICS MASTERED IN THIS BOOKLET

IGCSE Extension Topic	Syllabus Area	Notes	Practice
1. Formal Set-Builder & Subset Notation	Probability	☐	☐
2. Arithmetic Sequences & Series	Algebra	☐	☐
3. Functions: Domain & Range	Algebra	☐	☐
4. Intersecting Chords, Secants & Tangents	Geometry and Measures	☐	☐
5. Magnitude (Modulus) of a Vector	Geometry and Measures	☐	☐
6. Differentiation & Turning Points	Algebra	☐	☐
7. Negative Powers & Calculus Kinematics	Ratio, Proportion and Rates of Change	☐	☐

3. BONUS 4MA1 EXAM-FORMAT & TIME-SAVING TIPS

- **100% Calculator Exam (Papers 1H & 2H):** Both 4MA1 papers allow a scientific calculator — no need to memorise exact trig values ($\sin 30°, \cos 45°, \tan 60°$) or drill long non-calculator arithmetic.
- **Sequences & Speed–Time Graphs:** Skip quadratic nth term ($an^2 + bn + c$), geometric progressions, and curved velocity–time trapezia — 4MA1 tests **Arithmetic Series (u_n, S_n)** (Topic 2) and **Calculus Kinematics** (Topic 7) instead.
- **Graphical Equations ($f(x) = mx + c$):** To solve e.g. $x^2 - 5x - 1 = 0$ from a plotted curve $y = x^2 - 4x + 1$, rearrange to $x^2 - 4x + 1 = x + 2$ and draw the straight line $y = x + 2$.

PROBABILITY — SET THEORY

Formal Set-Builder & Subset Notation

1 Elements, Cardinality $n(A)$ & Empty Sets

CORE CONCEPT & METHOD

IGCSE formal set language uses compact symbols:

- $x \in A$ / $x \notin A$: *x is an element of A / is not an element of A.*
- $n(A)$: The **number of elements** in set A (its cardinality).
- $\varnothing$ **(or** $\{\}$**):** The **empty set** containing zero elements, so $n(\varnothing) = 0$.
- **Inclusion–Exclusion:** $n(A \cup B) = n(A) + n(B) - n(A \cap B)$.

MODEL WORKED EXAMPLE

EXAMPLE 1.1

Given $n(\mathscr{E}) = 30$, $n(A) = 14$, $n(B) = 11$ and $n(A \cap B) = 4$, find $n(A \cup B)$ and $n((A \cup B)')$.

STEP-BY-STEP SOLUTION:

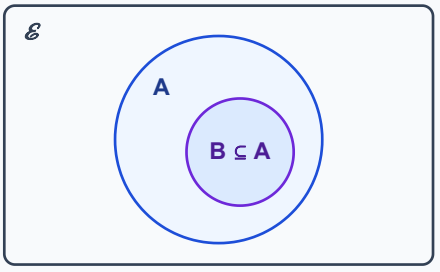
$n(A \cup B) = 14 + 11 - 4 = 21.$
$n((A \cup B)') = 30 - 21 = 9.$

$$21; \quad 9$$

2 Subsets ($\subseteq$) & Combined Operations

CORE CONCEPT & METHOD

$B \subseteq A$ means B **is a subset of** A: every element of B also belongs to A.



- When $B \subseteq A$, we automatically have $A \cap B = B$ and $A \cup B = A$.
- A finite set with k elements has exactly 2^k subsets (including $\varnothing$ and the set itself).

MODEL WORKED EXAMPLE

EXAMPLE 2.1

Given $\mathscr{E} = \{1, 2, 3, 4, 5, 6, 7, 8\}$, $A = \{2, 4, 6, 8\}$ and $B = \{1, 2, 3, 4\}$, list $A' \cap B$.

STEP-BY-STEP SOLUTION:

$A' = \{1, 3, 5, 7\}$. Intersecting with $B = \{1, 2, 3, 4\}$ gives $\{1, 3\}$.

$$\{1, 3\}$$

3 Set-Builder Notation & Algebraic Venn Diagrams

CORE CONCEPT & METHOD

Set-builder notation $\{x : \text{rule}\}$ reads as *"the set of all x such that..."*. Always check the universal set $\mathscr{E}$ (e.g. integers $\mathbb{Z}$ vs positive integers $\mathbb{Z}^+$) before listing elements!

In algebraic Venn diagrams, write an expression for **each separate region** (especially subtracting the overlap x from the outer parts!) and equate the sum of all regions to $n(\mathscr{E})$.

MODEL WORKED EXAMPLE

EXAMPLE 3.1

Let $\mathscr{E} = \{\text{integers}\}$, $A = \{x : 2x + 1 \geq 5\}$ and $B = \{x : x < 6\}$. List $A \cap B$.

STEP-BY-STEP SOLUTION:

$2x + 1 \geq 5 \implies x \geq 2$. Combining $x \geq 2$ and $x < 6$ for integers gives $\{2, 3, 4, 5\}$.

$$\{2, 3, 4, 5\}$$

ALGEBRA — EQUATIONS & SEQUENCES

Arithmetic Sequences & Series

1 Arithmetic Progressions (u_n)

CORE CONCEPT & METHOD

An **arithmetic sequence** (or progression) has a constant **common difference** d from one term to the next. If the first term is a, the nth term u_n is:

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

For example, the 10th term is $a + 9d$ and the 25th term is $a + 24d$.

MODEL WORKED EXAMPLE

EXAMPLE 1.1

In an arithmetic sequence, the 4th term is 17 and the 10th term is 41. Find the 20th term.

STEP-BY-STEP SOLUTION:

1. Write two equations: $a + 3d = 17$ and $a + 9d = 41$.
2. Subtract: $6d = 24 \implies d = 4$, so $a = 17 - 3(4) = 5$.
3. Find $u_{20} = 5 + 19(4) = 81$.

$$81$$

2 Sum of an Arithmetic Series (S_n)

CORE CONCEPT & METHOD

When the terms of an arithmetic sequence are added together, we get an **arithmetic series**. The sum S_n of the first n terms is:

$$S_n = \frac{n}{2}\left[2a + (n-1)d\right] \quad \text{or} \quad S_n = \frac{n}{2}(a + l)$$

Use the second version whenever you know the first term a and the last term l!

MODEL WORKED EXAMPLE

EXAMPLE 2.1

Find the sum of the first 30 terms of the arithmetic series $5 + 9 + 13 + 17 + \ldots$

STEP-BY-STEP SOLUTION:

Here $a = 5$, $d = 4$ and $n = 30$.

$$S_{30} = \frac{30}{2}\left[2(5) + (30-1)(4)\right] = 15 \times (10 + 116) = 15 \times 126 = 1890.$$

$$1890$$

3 Simultaneous & Quadratic Series Problems

CORE CONCEPT & METHOD

Higher Grade 8–9 exam problems test three powerful techniques:

- **Finding n given S_n:** Substitute a, d and S_n to form a quadratic equation in n, then choose the positive integer root!
- **Using S_n formulas:** Because $S_n = u_1 + u_2 + \cdots + u_{n-1} + u_n$, the $n\text{th}$ term is always $u_n = S_n - S_{n-1}$ (and $a = S_1$).
- **Sum of multiples:** Identify the first multiple a and last multiple l in the interval, find $n = \dfrac{l-a}{d} + 1$, then use $\dfrac{n}{2}(a+l)$.

MODEL WORKED EXAMPLE

EXAMPLE 3.1

The sum of the first n terms of a series is $S_n = 3n^2 + 4n$. Work out the 6th term.

STEP-BY-STEP SOLUTION:

Use $u_6 = S_6 - S_5$:

$S_6 = 3(6)^2 + 4(6) = 108 + 24 = 132$

$S_5 = 3(5)^2 + 4(5) = 75 + 20 = 95$

$u_6 = 132 - 95 = 37.$

$$37$$

ALGEBRA — EXPRESSIONS & FORMULAE

Functions: Domain & Range

1 Excluded Values & Natural Domains

CORE CONCEPT & METHOD

The **domain** of a function is the set of allowed **input (x)** values. Two rules restrict real domains:

- **Never divide by zero:** In $f(x) = \dfrac{a}{g(x)}$, solve $g(x) = 0$ to find the **excluded** value(s) of x.
- **No negative square roots:** In $f(x) = \sqrt{g(x)}$, require $g(x) \geq 0$.

MODEL WORKED EXAMPLE

EXAMPLE 1.1

State the value of x that must be excluded from any domain of $f(x) = \dfrac{5}{2x - 8}$, and find the largest possible domain of $g(x) = \sqrt{x - 3}$.

STEP-BY-STEP SOLUTION:

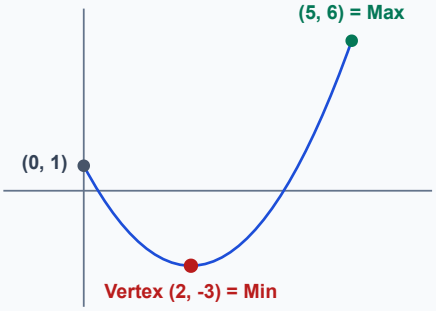
For $f(x)$: set $2x - 8 = 0 \implies x = 4$ must be excluded.
For $g(x)$: require $x - 3 \geq 0 \implies x \geq 3$.

$$x = 4; \quad x \geq 3$$

2 Finding the Range of a Function

CORE CONCEPT & METHOD

The **range** of f is the set of all possible **output values** $f(x)$ produced by the domain.



Quadratic Turning-Point Trap: On $f(x) = (x - 2)^2 - 3$ for $0 \leq x \leq 5$, do *not* only test $x = 0$ and $x = 5$! Because the vertex $x = 2$ lies inside $[0, 5]$, the minimum output is $f(2) = -3$, giving $-3 \leq f(x) \leq 6$.

MODEL WORKED EXAMPLE

EXAMPLE 2.1

Find the range of $f(x) = (x - 3)^2 + 4$ for all real x.

STEP-BY-STEP SOLUTION:

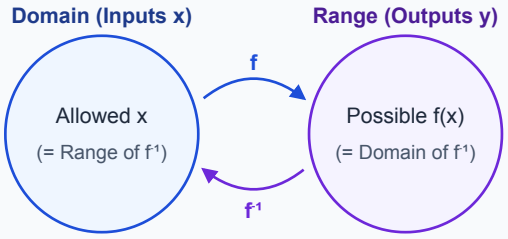
Because $(x - 3)^2 \geq 0$ for all real x, adding 4 gives $(x - 3)^2 + 4 \geq 4$.

$$f(x) \geq 4$$

3 Domain & Range of Inverse Functions

CORE CONCEPT & METHOD

Because an inverse function f^{-1} swaps inputs and outputs:



$$\text{Domain of } f^{-1} = \text{Range of } f \qquad \text{and} \qquad \text{Range of } f^{-1} = \text{Domain of } f$$

MODEL WORKED EXAMPLE

EXAMPLE 3.1

The function $f(x) = (x-2)^2 + 5$ is defined for $x \geq 2$. State the domain and range of $f^{-1}(x)$.

STEP-BY-STEP SOLUTION:

1. For $x \geq 2$, the range of f is $f(x) \geq 5$, so the **domain of** f^{-1} is $x \geq 5$.
2. The domain of f is $x \geq 2$, so the **range of** f^{-1} is $f^{-1}(x) \geq 2$.

$$\text{Domain: } x \geq 5, \quad \text{Range: } f^{-1}(x) \geq 2$$

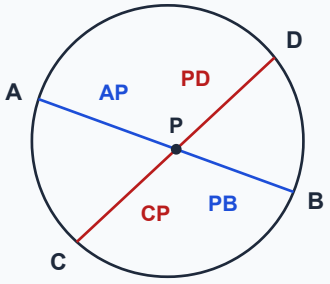
GEOMETRY AND MEASURES — CIRCLES

Intersecting Chords, Secants & Tangents

1 Internal Intersecting Chords

CORE CONCEPT & METHOD

When two chords AB and CD intersect at a point P **inside** a circle, the products of their segments are equal:



$$AP \times PB = CP \times PD$$

MODEL WORKED EXAMPLE

EXAMPLE 1.1

Chords AB and CD intersect inside a circle at P. Given $AP = 6$ cm, $PB = x$ cm, $CP = 4$ cm and $PD = 12$ cm, find x.

STEP-BY-STEP SOLUTION:

Apply $AP \times PB = CP \times PD$:

$6 \times x = 4 \times 12$

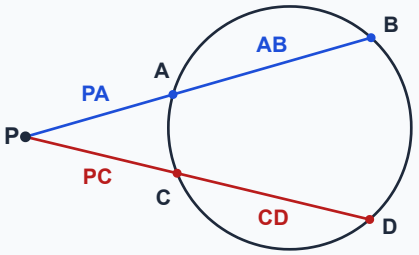
$6x = 48 \implies x = 8$

$$x = 8$$

2 External Intersecting Secants

CORE CONCEPT & METHOD

When two secants PAB and PCD meet at an **external** point P, multiply the **outside part** by the **whole secant length**:



> **Exam Trap Alert:** $PA \times PB = PC \times PD$, where $PB = PA + AB$ and $PD = PC + CD$.
> *Never multiply $PA \times AB$! Always use Outside $\times$ Whole.*

MODEL WORKED EXAMPLE

EXAMPLE 2.1

From an external point P, secants PAB and PCD satisfy $PA = 5$ cm, $AB = 7$ cm, and $PC = 4$ cm. Find CD.

STEP-BY-STEP SOLUTION:

1. Whole length $PB = 5 + 7 = 12$ cm, and whole length $PD = 4 + CD$.
2. Use $PA \times PB = PC \times PD$:

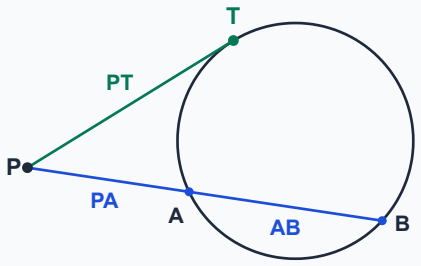
$$5 \times 12 = 4(4 + CD) \implies 60 = 4(4 + CD) \implies 15 = 4 + CD \implies CD = 11 \text{ cm}.$$

$$11 \text{ cm}$$

3 Tangent–Secant Theorem

CORE CONCEPT & METHOD

When a tangent PT and a secant PAB are drawn from the same external point P, the square of the tangent equals **outside** $\times$ **whole**:



$$PT^2 = PA \times PB \quad (\text{where } PB = PA + AB)$$

MODEL WORKED EXAMPLE

EXAMPLE 3.1

PT is a tangent and PAB is a secant. Given $PA = 4$ cm and $AB = 5$ cm, find PT.

STEP-BY-STEP SOLUTION:

1. Find the whole secant length: $PB = 4 + 5 = 9$ cm.
2. Apply $PT^2 = PA \times PB$:

$PT^2 = 4 \times 9 = 36 \implies PT = 6$ cm.

$$6 \text{ cm}$$

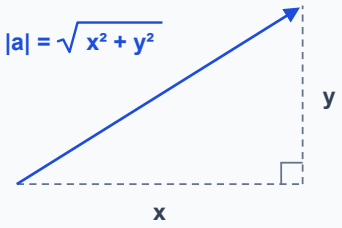
GEOMETRY AND MEASURES — TRANSFORMATIONS & VECTORS

Magnitude (Modulus) of a Vector

1 Modulus of a Column Vector

CORE CONCEPT & METHOD

The **magnitude** (or **modulus**) of a vector $\mathbf{a} = \begin{pmatrix} x \\ y \end{pmatrix}$, written $|\mathbf{a}|$, is its length found by Pythagoras' theorem:



$$|\mathbf{a}| = \sqrt{x^2 + y^2}$$

MODEL WORKED EXAMPLE

EXAMPLE 1.1

Given $\mathbf{a} = \begin{pmatrix} -6 \\ 8 \end{pmatrix}$, work out $|\mathbf{a}|$.

STEP-BY-STEP SOLUTION:

$|\mathbf{a}| = \sqrt{(-6)^2 + 8^2} = \sqrt{36 + 64} = \sqrt{100} = 10.$

$$10$$

2 Combined & Displacement Vectors $|\overrightarrow{AB}|$

CORE CONCEPT & METHOD

Crucial Rule: $|\mathbf{a} + \mathbf{b}|$ is *not* equal to $|\mathbf{a}| + |\mathbf{b}|$!

- Always combine the vectors into a **single column vector first**, then apply $\sqrt{x^2 + y^2}$.
- For two points $A(x_1, y_1)$ and $B(x_2, y_2)$, first find $\overrightarrow{AB} = \begin{pmatrix} x_2 - x_1 \\ y_2 - y_1 \end{pmatrix}$, then find $|\overrightarrow{AB}|$.

MODEL WORKED EXAMPLE

EXAMPLE 2.1

A is $(-1, 4)$ and B is $(4, -8)$. Work out $|\overrightarrow{AB}|$.

STEP-BY-STEP SOLUTION:

1. $\overrightarrow{AB} = \begin{pmatrix} 4 - (-1) \\ -8 - 4 \end{pmatrix} = \begin{pmatrix} 5 \\ -12 \end{pmatrix}$.
2. $|\overrightarrow{AB}| = \sqrt{5^2 + (-12)^2} = \sqrt{25 + 144} = 13.$

$$13$$

3 Missing Components & Parallel Vectors

CORE CONCEPT & METHOD

When you are given the magnitude $|\mathbf{v}| = m$ and asked to find an unknown k, square both sides ($x^2 + y^2 = m^2$) so the square root disappears!

Remember: unless k is restricted (e.g. $k > 0$), taking a square root gives **two solutions ($\pm$)**. To scale a vector $\mathbf{p}$ to a new length L, multiply $\mathbf{p}$ by $\dfrac{L}{|\mathbf{p}|}$.

MODEL WORKED EXAMPLE

EXAMPLE 3.1

Vector $\mathbf{v} = \begin{pmatrix} k \\ -8 \end{pmatrix}$ has $|\mathbf{v}| = 10$ with $k < 0$. Find k.

STEP-BY-STEP SOLUTION:

$k^2 + (-8)^2 = 10^2 \implies k^2 + 64 = 100 \implies k^2 = 36 \implies k = \pm 6.$

Since $k < 0$, $k = -6$.

$$k = -6$$

ALGEBRA — CALCULUS & DIFFERENTIATION

Differentiation & Turning Points

1 Differentiating Polynomials

CORE CONCEPT & METHOD

Differentiation finds the **gradient function** $\frac{dy}{dx}$ (or $f'(x)$) of a curve at any point.

> **The Power Rule:** If $y = ax^n$, then $\frac{dy}{dx} = anx^{n-1}$
> *"Multiply by the power, then subtract 1 from the power."*

- **Linear terms (kx):** Differentiate to k (since $x^1 \to 1x^0 = 1$).
- **Constants (c):** Differentiate to 0 (a horizontal line $y = c$ has gradient 0).
- **Brackets or fractions:** Always **expand brackets** or **divide through** so y is written as separate powers of x before differentiating!

MODEL WORKED EXAMPLES

EXAMPLE 1.1

Given that $y = 4x^3 - 7x^2 + 9x - 12$, find $\frac{dy}{dx}$.

STEP-BY-STEP SOLUTION:

Differentiate each term separately:
$4x^3 \to 4 \times 3x^{3-1} = 12x^2$
$-7x^2 \to -7 \times 2x^{2-1} = -14x$
$+9x \to +9$ and $-12 \to 0$.

$$12x^2 - 14x + 9$$

EXAMPLE 1.2

Find $\frac{dy}{dx}$ when $y = x(2x - 5)^2$.

STEP-BY-STEP SOLUTION:

1. Expand the brackets first:
$y = x(4x^2 - 20x + 25) = 4x^3 - 20x^2 + 25x$

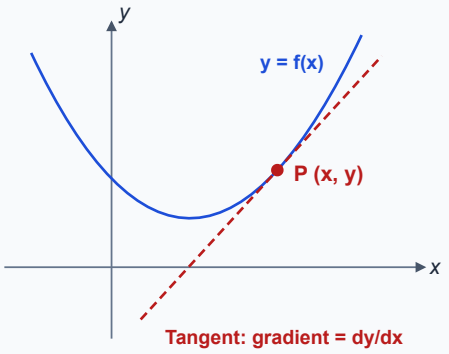
2. Apply the power rule to each term:
$\frac{dy}{dx} = 12x^2 - 40x + 25$

$$12x^2 - 40x + 25$$

2 Gradients & Equations of Tangents

CORE CONCEPT & METHOD

The derivative $\frac{dy}{dx}$ gives the **exact gradient of the tangent** to the curve at any x-coordinate.



- **Gradient at $x = a$:** Find $\frac{dy}{dx}$, then substitute $x = a$.
- **Where is the gradient equal to m?** Solve the equation $\frac{dy}{dx} = m$ for x.
- **Equation of the tangent at (x_1, y_1):** Find $m = \frac{dy}{dx}$ at x_1, then substitute m and (x_1, y_1) into $y = mx + c$.

MODEL WORKED EXAMPLE

EXAMPLE 2.1

Find the equation of the tangent to the curve $y = x^2 - 3x + 5$ at the point $(4, 9)$.

STEP-BY-STEP SOLUTION:

1. Differentiate to find the gradient function:

$$\frac{dy}{dx} = 2x - 3$$

2. Substitute $x = 4$ to get the tangent gradient:

$m = 2(4) - 3 = 5$

3. Substitute $m = 5$ and $(4, 9)$ into $y = mx + c$:

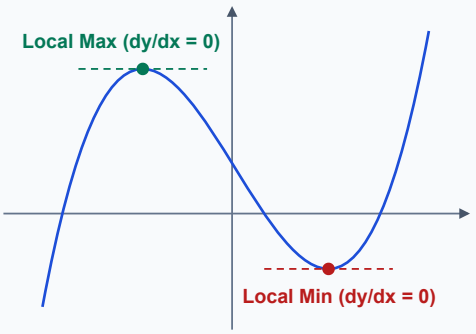
$9 = 5(4) + c \implies c = -11$

$$y = 5x - 11$$

3 Stationary Points & Optimisation

CORE CONCEPT & METHOD

At a **stationary point** (turning point), the tangent is completely horizontal, so $\frac{dy}{dx} = 0$.

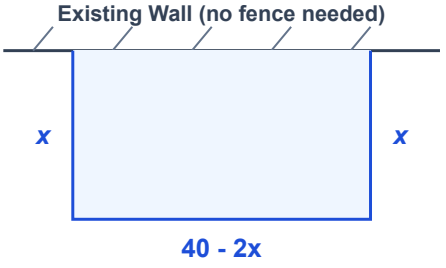


- **Step 1:** Solve $\frac{dy}{dx} = 0$ to find the x-coordinate(s).
- **Step 2:** Substitute x back into the original equation $y = f(x)$ to find y.
- **Max vs Min on a positive cubic ($+ax^3$):** The curve rises first then falls then rises (↗↘↗), so the **smaller** x is the local maximum and the **larger** x is the local minimum!

MODEL WORKED EXAMPLE

EXAMPLE 3.1

A farmer uses 40 m of fencing for three sides of a rectangular enclosure against a wall, giving area $A = 40x - 2x^2$ m^2.



Find the maximum possible area.

STEP-BY-STEP SOLUTION:

1. At maximum area, $\frac{dA}{dx} = 0$:

$$\frac{dA}{dx} = 40 - 4x = 0 \implies x = 10 \text{ m}$$

2. Substitute $x = 10$ into A:

$$A_{\max} = 40(10) - 2(10)^2 = 400 - 200 = 200 \text{ m}^2$$

$$200 \text{ m}^2$$

RATIO, PROPORTION AND RATES OF CHANGE — RATES OF CHANGE

Negative Powers & Calculus Kinematics

1 Differentiating Negative Powers

CORE CONCEPT & METHOD

In Edexcel IGCSE (4MA1), you also differentiate fractions with x in the denominator by rewriting them as **negative powers** first: $\frac{a}{x^n} = ax^{-n}$.

> **Watch the negative sign when subtracting 1 from the power!**
> $x^{-1} \to -1x^{-2} = -\frac{1}{x^2}$ • $x^{-2} \to -2x^{-3} = -\frac{2}{x^3}$

3D Solid Optimisation: When a cuboid or cylinder of fixed volume has surface area $S = ax^2 + \frac{k}{x}$, rewrite as $ax^2 + kx^{-1}$ and solve $\frac{dS}{dx} = 0$ to find the minimum surface area.

MODEL WORKED EXAMPLE

EXAMPLE 1.1

Given that $y = 2x^2 + \frac{12}{x}$, find the gradient of the curve where $x = 2$.

STEP-BY-STEP SOLUTION:

1. Rewrite using negative indices: $y = 2x^2 + 12x^{-1}$
2. Differentiate: $\frac{dy}{dx} = 4x - 12x^{-2} = 4x - \frac{12}{x^2}$
3. Substitute $x = 2$: $\frac{dy}{dx} = 4(2) - \frac{12}{2^2} = 8 - 3 = 5$

$$5$$

2 Displacement, Velocity & Acceleration

CORE CONCEPT & METHOD

When a particle moves along a straight line with displacement s at time t, calculus links **displacement (s)**, **velocity (v)**, and **acceleration (a)**:

- **Velocity:** $v = \dfrac{ds}{dt}$ (differentiate displacement once with respect to t).
- **Acceleration:** $a = \dfrac{dv}{dt}$ (differentiate velocity with respect to t).

MODEL WORKED EXAMPLE

EXAMPLE 2.1

A particle has displacement $s = 2t^3 - 5t^2 + 8t$ metres after t seconds. Find its velocity and acceleration when $t = 3$.

STEP-BY-STEP SOLUTION:

1. Velocity: $v = \dfrac{ds}{dt} = 6t^2 - 10t + 8$. At $t = 3$: $v = 6(9) - 30 + 8 = 32$ m/s.

2. Acceleration: $a = \dfrac{dv}{dt} = 12t - 10$. At $t = 3$: $a = 12(3) - 10 = 26$ m/s^2.

$$v = 32 \text{ m/s},\ a = 26 \text{ m/s}^2$$

3 Instantaneous Rest & Max Displacement

CORE CONCEPT & METHOD

Key kinematics phrases in exam questions translate directly into equations:

- **"Instantaneously at rest"** or **"changes direction"** or **"maximum height/displacement"** $\implies$ set $v = 0$!
- **"Returns to O"** $\implies$ set $s = 0$.
- **"Constant/maximum velocity"** $\implies$ set $a = 0$.

MODEL WORKED EXAMPLE

EXAMPLE 3.1

A particle moves with displacement $s = t^3 - 6t^2 + 9t$ metres ($t \geq 0$). Find its displacement from O when it first comes to rest.

STEP-BY-STEP SOLUTION:

1. Set $v = \dfrac{ds}{dt} = 0$:
$3t^2 - 12t + 9 = 0 \implies 3(t-1)(t-3) = 0 \implies t = 1$ s or $t = 3$ s.

2. It **first** comes to rest at $t = 1$ s. Substitute $t = 1$ into s:
$s = (1)^3 - 6(1)^2 + 9(1) = 4$ m.

$$4 \text{ m}$$