ELITE IGCSE MATHEMATICS
EXPERIENCE NOTES

Mechanics 1 Strategy Booklet

Complete strategy booklet collected from the individual topic notes, with hard-variant coverage preserved.

Mechanics 1 Strategy Booklet · WME01 · Complete

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Dr Eslam Ahmed · Cairo University Faculty of Engineering

Booklet Map

This complete booklet collects all Mechanics 1 individual strategy notes into one printable file. The individual topic PDFs remain available separately.

COURSE EVIDENCE Topics: 10. Topic-note pages: 110. The combined PDF also includes this cover and map.

ELITE IGCSE MATHEMATICS
EXPERIENCE NOTES

Quantities, Units & Modelling

Mechanics begins by naming the quantity, unit, and model before doing any algebra.

QUANTITIES, UNITS & MODELLING · M1 · 01

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The Map

This strategy booklet was mined from the local Mechanics 1 topic problem/answer PDFs, Dr Eslam's source notes, and the WME01 website answer bank. Mechanics questions become reliable when the diagram, sign convention, and equation family are chosen first.

01 UNIT: Unit Discipline
TRIGGER *units, modelling, dimensions*

02 MODEL: Modelling Words
TRIGGER *particle, light string, smooth plane*

03 WEIGH: Mass And Weight
TRIGGER *mass, weight, g*

04 ROUND: Accuracy Control
TRIGGER *show that, 3 significant figures*

BANK EVIDENCE Local pages: 29 problem, 46 answer, 15 notes. Website primary entries: 0. Website linked entries: 42.

01 UNIT: Unit Discipline

TRIGGER *units, modelling, dimensions*

BECOMES Convert and carry units before substituting.

FIRST LINE TO WRITE

$$\text{quantity} = \text{number} \times \text{unit}$$

SIMPLEST STRATEGY

1. **U**nderline the quantity.
2. **N**ame the unit.
3. **I**nsert conversions.
4. **T**est the final unit.

WORKED MODEL

$72\ \mathrm{km\,h^{-1}} = 20\ \mathrm{m\,s^{-1}}$.

HARD VARIANTS

1. Convert before using SUVAT or $F = ma$.
2. For compound units, convert every component of the unit.
3. Check if the question fixes $g = 9.8$ or allows exact g.

BOTTOM LINE

Units are part of the answer, not decoration.

Practice Page: UNIT

QUESTION TYPE Units and conversions

Convert 54 $\mathrm{km\,h^{-1}}$ into $\mathrm{m\,s^{-1}}$.

COMMON TRAP Mixing metres with kilometres or hours with seconds.

02 MODEL: Modelling Words

TRIGGER *particle, light string, smooth plane*

BECOMES Translate each modelling word into a mathematical permission.

FIRST LINE TO WRITE

$$\text{smooth} \Rightarrow F = 0$$

SIMPLEST STRATEGY

1. **M**ark the modelling word.
2. **O**utput its meaning.
3. **D**raw what remains.
4. **E**xclude ignored effects.
5. **L**ink to the equation.

WORKED MODEL

> Light string means the tension is the same throughout that string.

HARD VARIANTS

1. Smooth means no friction, not no normal reaction.
2. Light means no weight for that string or rod only.
3. Inextensible means connected particles have the same acceleration magnitude.

BOTTOM LINE

A modelling word is an instruction for the diagram.

Practice Page: MODEL

QUESTION TYPE Model assumptions

State the modelling assumption that lets air resistance be ignored.

COMMON TRAP Using a force that the model says is absent.

03 WEIGH: Mass And Weight

TRIGGER *mass, weight, g*

BECOMES Convert mass into weight only when a force is needed.

FIRST LINE TO WRITE

$$W = mg$$

SIMPLEST STRATEGY

1. **W**rite $W = mg$.
2. **E**nter mass in kg.
3. **I**nsert g.
4. **G**ive force in newtons.
5. **H**old exact g if requested.

WORKED MODEL

> A 5 kg particle has weight $5g$ N, or 49 N if $g = 9.8$.

HARD VARIANTS

1. Use mg in moments and dynamics, not just m.
2. If answers use g, do not replace it unless asked.
3. For grams, convert to kg before multiplying by g.

BOTTOM LINE

Mass is measured in kg; weight is a force.

Practice Page: WEIGH

QUESTION TYPE Mass/weight

Find the weight of a 3.2 kg particle.

COMMON TRAP Writing kilograms as a force.

04 ROUND: Accuracy Control

TRIGGER *show that, 3 significant figures*

BECOMES Keep exact working, round only the final statement.

FIRST LINE TO WRITE

> exact first, rounded last

SIMPLEST STRATEGY

1. **R**etain exact fractions or radicals.
2. **O**nly round at the end.
3. **U**se the requested accuracy.
4. **N**ame units.
5. **D**o a reasonableness check.

WORKED MODEL

> $\sqrt{52} = 7.211\ldots$, so 7.21 to 3 s.f.

HARD VARIANTS

1. For show-that answers, keep enough figures to support the printed value.
2. Bearings need three digits.
3. Do not mix exact g and decimal g in the same final line.

BOTTOM LINE

Rounding early moves the answer.

Practice Page: ROUND

QUESTION TYPE Accuracy

Give $37.5g$ N to 2 significant figures using $g = 9.8$.

COMMON TRAP Rounding inside the equation and losing the mark.

Quick Recognition Table

WHEN YOU SEE	FIRST LINE TO WRITE
units, modelling, dimensions	quantity $=$ number $\times$ unit
particle, light string, smooth plane	smooth $\Rightarrow F = 0$
mass, weight, g	$W = mg$
show that, 3 significant figures	exact first, rounded last

Hard Variant Checklist

STRATEGY	CHECK BEFORE FINAL ANSWER
UNIT: Unit Discipline	Convert before using SUVAT or $F = ma$.
	For compound units, convert every component of the unit.
	Check if the question fixes $g = 9.8$ or allows exact g.
MODEL: Modelling Words	Smooth means no friction, not no normal reaction.
	Light means no weight for that string or rod only.
	Inextensible means connected particles have the same acceleration magnitude.
WEIGH: Mass And Weight	Use mg in moments and dynamics, not just m.
	If answers use g, do not replace it unless asked.
	For grams, convert to kg before multiplying by g.
ROUND: Accuracy Control	For show-that answers, keep enough figures to support the printed value.
	Bearings need three digits.
	Do not mix exact g and decimal g in the same final line.

ELITE IGCSE MATHEMATICS
EXPERIENCE NOTES

Working with Vectors

Vector questions become simple after choosing components and keeping direction signs visible.

Working with Vectors · M1 · 02

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The Map

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01 COMP: Component Form

TRIGGER *bearing, magnitude, vector components*

02 RESULT: Resultant And Bearing

TRIGGER *resultant force, magnitude, bearing*

03 PATH: Position Path

TRIGGER *position vector, velocity vector*

04 CLOSE: Closest Distance

TRIGGER *minimum distance, nearest approach*

BANK EVIDENCE Local pages: 23 problem, 46 answer, 162 notes. Website primary entries: 27. Website linked entries: 42.

01 COMP: Component Form

TRIGGER *bearing, magnitude, vector components*

BECOMES Resolve the vector into i and j components.

FIRST LINE TO WRITE

$$\mathbf{v} = (v_E)\mathbf{i} + (v_N)\mathbf{j}$$

SIMPLEST STRATEGY

1. **C**hoose east/north axes.
2. **O**btain the reference angle.
3. **M**ultiply by sine/cosine.
4. **P**lace signs by quadrant.

WORKED MODEL

> A speed 40 on bearing 150° is $20\mathbf{i} - 20\sqrt{3}\mathbf{j}$.

HARD VARIANTS

1. East component uses sine of the bearing; north uses cosine.
2. Check signs from the quadrant, not from memory.
3. For angles from the i-axis, the sine/cosine roles change.

BOTTOM LINE

Bearings are measured clockwise from north.

Working with Vectors · M1 · 02

Practice Page: COMP

QUESTION TYPE Components

Write a vector of magnitude 8 on bearing 120°.

COMMON TRAP Swapping sine and cosine for bearings.

02 RESULT: Resultant And Bearing

TRIGGER *resultant force, magnitude, bearing*

BECOMES Add components, then find magnitude and direction.

FIRST LINE TO WRITE

$$\mathbf{R} = \sum \mathbf{F}, \quad |\mathbf{R}| = \sqrt{x^2 + y^2}$$

SIMPLEST STRATEGY

1. **R**esolve every vector.
2. **E**nter signs.
3. **S**um components.
4. **U**se Pythagoras.
5. **L**ocate quadrant.
6. **T**urn angle into bearing.

WORKED MODEL

$\mathbf{R} = -4\sqrt{3}\mathbf{i} - 14\mathbf{j}$ points south-west.

HARD VARIANTS

1. Bearings must be written as three digits.
2. If the vector is west/south, add the reference angle to 180° or 360° correctly.
3. Use exact components until the final angle.

BOTTOM LINE

A bearing answer must match the quadrant.

Practice Page: RESULT

QUESTION TYPE Resultants

Find the magnitude and bearing of $-6\mathbf{i} + 8\mathbf{j}$.

COMMON TRAP Giving the acute angle but not the bearing.

03 PATH: Position Path

TRIGGER *position vector, velocity vector*

BECOMES Build position as start plus velocity times time.

FIRST LINE TO WRITE

$$\mathbf{r} = \mathbf{r}_0 + t\mathbf{v}$$

SIMPLEST STRATEGY

1. **P**lace the initial vector.
2. **A**dd velocity times time.
3. **T**idy i and j components.
4. **H**andle units of time.

WORKED MODEL

$\mathbf{r} = (60 - 20t)\mathbf{i}$ for motion west from $60\mathbf{i}$.

HARD VARIANTS

1. Use the time unit matching the velocity unit.
2. Meeting means both components are equal at the same time.
3. Due north/south/east/west means one component is fixed.

BOTTOM LINE

Position vector is a moving address.

Practice Page: PATH

QUESTION TYPE Position vectors

A boat starts at $3\mathbf{i} + 2\mathbf{j}$ and moves with velocity $-\mathbf{i} + 4\mathbf{j}$.

COMMON TRAP Forgetting to convert minutes to hours or seconds.

04 CLOSE: Closest Distance

TRIGGER *minimum distance, nearest approach*

BECOMES Minimise distance squared.

FIRST LINE TO WRITE

$$d^2 = x(t)^2 + y(t)^2$$

SIMPLEST STRATEGY

1. **C**reate separation vector.
2. **L**ength squared.
3. **O**pen the quadratic.
4. **S**quare complete or use vertex.
5. **E**valuate distance.

WORKED MODEL

$(t-4)^2 + (5-t)^2 = 2(t-4.5)^2 + 0.5.$

HARD VARIANTS

1. Keep $d^2 \geq 0$; the minimum distance is not the minimum squared value unless square-rooted.
2. Reject a minimum time outside the allowed time interval.
3. For two particles, use one separation vector, not two separate distances.

BOTTOM LINE

Minimise d^2, then square-root at the end.

Practice Page: CLOSE

QUESTION TYPE Nearest approach

Find the closest distance from $(t-1)\mathbf{i} + (2t+3)\mathbf{j}$ to O.

COMMON TRAP Minimising a component instead of the distance.

Quick Recognition Table

WHEN YOU SEE	FIRST LINE TO WRITE
bearing, magnitude, vector components	$\mathbf{v} = (v_E)\mathbf{i} + (v_N)\mathbf{j}$
resultant force, magnitude, bearing	$\mathbf{R} = \sum \mathbf{F}, \quad \lvert\mathbf{R}\rvert = \sqrt{x^2 + y^2}$
position vector, velocity vector	$\mathbf{r} = \mathbf{r}_0 + t\mathbf{v}$
minimum distance, nearest approach	$d^2 = x(t)^2 + y(t)^2$

Hard Variant Checklist

STRATEGY	CHECK BEFORE FINAL ANSWER
COMP: Component Form	East component uses sine of the bearing; north uses cosine. Check signs from the quadrant, not from memory. For angles from the i-axis, the sine/cosine roles change.
RESULT: Resultant And Bearing	Bearings must be written as three digits. If the vector is west/south, add the reference angle to 180° or 360° correctly. Use exact components until the final angle.
PATH: Position Path	Use the time unit matching the velocity unit. Meeting means both components are equal at the same time. Due north/south/east/west means one component is fixed.
CLOSE: Closest Distance	Keep $d^2 \geq 0$; the minimum distance is not the minimum squared value unless square-rooted. Reject a minimum time outside the allowed time interval. For two particles, use one separation vector, not two separate distances.

ELITE IGCSE MATHEMATICS
EXPERIENCE NOTES

Kinematics Graphs

Graph questions ask for gradients, areas, and clean piecewise stories.

Kinematics Graphs · M1 · 03

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The Map

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01 GRAD: Gradient Means Acceleration

TRIGGER *velocity-time graph gradient*

02 AREA: Area Means Displacement

TRIGGER *area under velocity-time graph*

03 PIECE: Piecewise Motion

TRIGGER *multi-stage graph*

04 SKETCH: Sketch From Words

TRIGGER *draw velocity-time graph*

BANK EVIDENCE Local pages: 59 problem, 86 answer, 17 notes. Website primary entries: 12. Website linked entries: 17.

01 GRAD: Gradient Means Acceleration

TRIGGER *velocity-time graph gradient*

BECOMES Acceleration is the gradient of the velocity-time graph.

FIRST LINE TO WRITE

$$a = \frac{\Delta v}{\Delta t}$$

SIMPLEST STRATEGY

1. **G**et two points.
2. **R**ise is velocity change.
3. **A**cross is time change.
4. **D**ivide with sign.

WORKED MODEL

> A fall from 12 to 4 in 2 s gives $a = -4\ \mathrm{m\,s^{-2}}$.

HARD VARIANTS

1. Curved graphs need tangent gradients.
2. Use signs: below the time axis means negative velocity.
3. Acceleration changes on each different line segment.

BOTTOM LINE

Downward graph slope means negative acceleration.

Practice Page: GRAD

QUESTION TYPE Graph gradient

Find the acceleration from a line joining $(0, 8)$ to $(4, 20)$.

COMMON TRAP Using distance over time from a velocity-time graph.

02 AREA: Area Means Displacement

TRIGGER *area under velocity-time graph*

BECOMES Displacement is signed area under the velocity-time graph.

FIRST LINE TO WRITE

$$s = \text{area under } v\text{-}t$$

SIMPLEST STRATEGY

1. **A**dd simple shapes.
2. **R**ecord sign above or below axis.
3. **E**valuate each area.
4. **A**ggregate displacement.

WORKED MODEL

> A triangle of base 6, height 10 has area 30.

HARD VARIANTS

1. For total distance, add absolute areas.
2. If the graph crosses the axis, split the area at the crossing.
3. Use trapeziums for sloping segments with two non-zero velocities.

BOTTOM LINE

Area gives displacement, not always distance.

Practice Page: AREA

QUESTION TYPE Graph area

Find the displacement from a triangle under a v-t graph.

COMMON TRAP Calling signed displacement total distance.

03 PIECE: Piecewise Motion

TRIGGER *multi-stage graph*

BECOMES Treat each graph segment as its own motion stage.

FIRST LINE TO WRITE

$$\text{stage 1} + \text{stage 2} + \cdots$$

SIMPLEST STRATEGY

1. **P**artition at corners.
2. **I**dentify each shape.
3. **E**valuate gradients/areas.
4. **C**ombine carefully.
5. **E**xplain the motion in words.

WORKED MODEL

Constant velocity is a horizontal line; constant acceleration is a straight sloping line.

HARD VARIANTS

1. Rest is $v = 0$, not necessarily $s = 0$.
2. Negative velocity means motion in the opposite direction.
3. Average speed needs total distance divided by total time.

BOTTOM LINE

Every corner starts a new rule.

Practice Page: PIECE

QUESTION TYPE Piecewise graphs

Describe the motion shown by a three-stage velocity-time graph.

COMMON TRAP Using one acceleration for the whole graph.

04 SKETCH: Sketch From Words

TRIGGER *draw velocity-time graph*

BECOMES Convert each phrase into a graph feature.

FIRST LINE TO WRITE

> accelerates uniformly ⇒ straight sloping line

SIMPLEST STRATEGY

1. **S**tart at the given velocity.
2. **K**eep axes labelled.
3. **E**ncode each phrase.
4. **T**ime-scale the segments.
5. **C**heck areas if distance is given.
6. **H**old units.

WORKED MODEL

> Uniform deceleration to rest is a straight line ending on the time axis.

HARD VARIANTS

1. If distance is given, area must match it.
2. If acceleration is greater, slope must be steeper.
3. Graph labels can earn marks even when scale is not perfect.

BOTTOM LINE

The shape tells the motion.

Practice Page: SKETCH

QUESTION TYPE Graph sketching

Sketch a v-t graph for acceleration, constant speed, then rest.

COMMON TRAP Drawing a curve for uniform acceleration.

Quick Recognition Table

WHEN YOU SEE	FIRST LINE TO WRITE
velocity-time graph gradient	$a = \dfrac{\Delta v}{\Delta t}$
area under velocity-time graph	$s =$ area under v-t
multi-stage graph	stage $1 +$ stage $2 + \cdots$
draw velocity-time graph	accelerates uniformly $\Rightarrow$ straight sloping line

Hard Variant Checklist

STRATEGY	CHECK BEFORE FINAL ANSWER
GRAD: Gradient Means Acceleration	Curved graphs need tangent gradients. Use signs: below the time axis means negative velocity. Acceleration changes on each different line segment.
AREA: Area Means Displacement	For total distance, add absolute areas. If the graph crosses the axis, split the area at the crossing. Use trapeziums for sloping segments with two non-zero velocities.
PIECE: Piecewise Motion	Rest is $v = 0$, not necessarily $s = 0$. Negative velocity means motion in the opposite direction. Average speed needs total distance divided by total time.
SKETCH: Sketch From Words	If distance is given, area must match it. If acceleration is greater, slope must be steeper. Graph labels can earn marks even when scale is not perfect.

ELITE IGCSE MATHEMATICS
EXPERIENCE NOTES

Constant Acceleration in 1D

One-dimensional motion is a sign convention plus the right SUVAT equation.

Constant Acceleration in 1D · M1 · 04

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Constant Acceleration 1D · 04

The Map

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01 SUVAT: Choose The Missing Letter
TRIGGER *constant acceleration, u, v, a, s, t*

02 SIGN: Sign Convention
TRIGGER *opposite directions, deceleration*

03 MEET: Meeting Motions
TRIGGER *two particles meet, overtake*

04 VERT: Vertical Gravity
TRIGGER *thrown up, falling, maximum height*

BANK EVIDENCE Local pages: 22 problem, 41 answer, 12 notes. Website primary entries: 16. Website linked entries: 66.

01 SUVAT: Choose The Missing Letter

TRIGGER *constant acceleration,* u, v, a, s, t

BECOMES List knowns and choose the equation missing the unwanted letter.

FIRST LINE TO WRITE

$$u,\ v,\ a,\ s,\ t$$

SIMPLEST STRATEGY

1. **S**elect positive direction.
2. **U**nderline known quantities.
3. **V**acant letter is avoided.
4. **A**pply the matching equation.
5. **T**idy units.

WORKED MODEL

> If u, a, t are known and s is needed, use $s = ut + \frac{1}{2}at^2$.

HARD VARIANTS

1. Only use SUVAT when acceleration is constant.
2. If direction changes, split the motion at $v = 0$.
3. Convert units before writing the equation.

BOTTOM LINE

SUVAT is a selection problem first.

Practice Page: SUVAT

QUESTION TYPE SUVAT

A particle starts from rest and accelerates at 3 m s^{-2} for 5 s.

COMMON TRAP Choosing an equation before listing knowns.

02 SIGN: Sign Convention

TRIGGER *opposite directions, deceleration*

BECOMES Choose one positive direction and make all quantities obey it.

FIRST LINE TO WRITE

> up/right/forward is positive

SIMPLEST STRATEGY

1. **S**et the positive direction.
2. **I**nsert signs for u, v, a, s.
3. **G**uard against word signs.
4. **N**ote final direction.

WORKED MODEL

> If upward is positive, gravity gives $a = -g$.

HARD VARIANTS

1. Displacement can be negative even when distance is positive.
2. Final velocity sign tells direction.
3. Do not change sign convention halfway through a part.

BOTTOM LINE

A negative answer usually means opposite to your chosen direction.

Practice Page: SIGN

QUESTION TYPE Signs

A particle is projected upwards with speed 12 $\mathrm{m\,s^{-1}}$.

COMMON TRAP Treating deceleration as automatically negative without direction.

03 MEET: Meeting Motions

TRIGGER *two particles meet, overtake*

BECOMES Write each position from the same origin and set them equal.

FIRST LINE TO WRITE

$$s_A = s_B$$

SIMPLEST STRATEGY

1. **M**odel both positions.
2. **E**qualise positions.
3. **E**xtract valid time.
4. **T**ranslate time into the asked result.

WORKED MODEL

> $s_A = 2t$, $s_B = 20 - t^2$, so meeting means $2t = 20 - t^2$.

HARD VARIANTS

1. Use a common origin and sign convention.
2. Reject negative times.
3. If they start at different times, adjust the time variable.

BOTTOM LINE

Meeting is same place at same time.

Practice Page: MEET

QUESTION TYPE Two-body motion

Two particles move on a line; find when one catches the other.

COMMON TRAP Equating speeds instead of positions.

04 VERT: Vertical Gravity

TRIGGER *thrown up, falling, maximum height*

BECOMES Use $a = -g$ if upward is positive and split at the top if needed.

FIRST LINE TO WRITE

$$v = 0 \quad \text{at greatest height}$$

SIMPLEST STRATEGY

1. **V**ertical positive direction.
2. **E**nter $a = -g$.
3. **R**ecognise top has $v = 0$.
4. **T**ime/height from SUVAT.

WORKED MODEL

> At greatest height, $v = 0$, so $0 = u^2 - 2gh$.

HARD VARIANTS

1. Total flight may need two stages if launch and landing heights differ.
2. Use $g = 9.8$ only if numerical answers are wanted.
3. Velocity can be negative on the way down.

BOTTOM LINE

The top of the flight has zero velocity, not zero acceleration.

Practice Page: VERT

QUESTION TYPE Vertical motion

Find the greatest height of a particle projected upwards at 14 $\mathrm{m\,s^{-1}}$.

COMMON TRAP Setting $a = 0$ at the top.

Quick Recognition Table

WHEN YOU SEE	FIRST LINE TO WRITE
constant acceleration, u, v, a, s, t	$u,\ v,\ a,\ s,\ t$
opposite directions, deceleration	up/right/forward is positive
two particles meet, overtake	$s_A = s_B$
thrown up, falling, maximum height	$v = 0$ at greatest height

Hard Variant Checklist

STRATEGY	CHECK BEFORE FINAL ANSWER
SUVAT: Choose The Missing Letter	Only use SUVAT when acceleration is constant. If direction changes, split the motion at $v = 0$. Convert units before writing the equation.
SIGN: Sign Convention	Displacement can be negative even when distance is positive. Final velocity sign tells direction. Do not change sign convention halfway through a part.
MEET: Meeting Motions	Use a common origin and sign convention. Reject negative times. If they start at different times, adjust the time variable.
VERT: Vertical Gravity	Total flight may need two stages if launch and landing heights differ. Use $g = 9.8$ only if numerical answers are wanted. Velocity can be negative on the way down.

ELITE IGCSE MATHEMATICS
EXPERIENCE NOTES

Constant Acceleration in 2D

Two-dimensional motion is two one-dimensional motions sharing the same time.

Constant Acceleration in 2D · M1 · 05

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01 SPLIT: Split Axes

TRIGGER *2D constant acceleration*

02 PROJ: Projectile Equation

TRIGGER *projectile, trajectory*

03 TIME: Flight Time

TRIGGER *hits ground, returns to level*

04 REL: Relative Position

TRIGGER *two moving particles in 2D*

BANK EVIDENCE Local pages: 19 problem, 39 answer, 4 notes. Website primary entries: 1. Website linked entries: 22.

01 SPLIT: Split Axes

TRIGGER *2D constant acceleration*

BECOMES Resolve into independent i and j equations.

FIRST LINE TO WRITE

$$\mathbf{r} = \mathbf{r}_0 + \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$$

SIMPLEST STRATEGY

1. **S**eparate i and j.
2. **P**lace the same t in both.
3. **L**ist known components.
4. **I**nsert acceleration.
5. **T**ie answers back together.

WORKED MODEL

$\mathbf{r} = (2 + 3t)\mathbf{i} + (5 - 4.9t^2)\mathbf{j}$.

HARD VARIANTS

1. Horizontal acceleration is zero in projectile motion unless stated.
2. Use vector components for velocity too.
3. Keep units consistent in both axes.

BOTTOM LINE

The same time connects both axes.

Practice Page: SPLIT

QUESTION TYPE Vector kinematics

Write the position vector for a particle with $\mathbf{u} = 3\mathbf{i} + 4\mathbf{j}$ under gravity.

COMMON TRAP Using different times in each component.

02 PROJ: Projectile Equation

TRIGGER *projectile, trajectory*

BECOMES Use horizontal motion to express t, then substitute into vertical motion.

FIRST LINE TO WRITE

$$x = u_x t, \quad y = u_y t - \frac{1}{2} g t^2$$

SIMPLEST STRATEGY

1. **P**ick horizontal equation.
2. **R**earrange for t.
3. **O**utput vertical equation.
4. **J**oin them by substitution.

WORKED MODEL

> If $x = ut$, then $t = x/u$ and $y = u_y(x/u) - \frac{1}{2}g(x/u)^2$.

HARD VARIANTS

1. If launch point is not origin, include initial x, y.
2. Horizontal velocity stays constant only when no horizontal acceleration.
3. Domain matters: the path equation may extend beyond the physical flight.

BOTTOM LINE

Trajectory comes from eliminating time.

Practice Page: PROJ

QUESTION TYPE Projectile path

Find the equation of the path of a projectile.

COMMON TRAP Trying to use one SUVAT equation for both axes.

03 TIME: Flight Time

TRIGGER *hits ground, returns to level*

BECOMES Use the vertical displacement condition to find time.

FIRST LINE TO WRITE

$$y(t) = 0 \quad \text{or given height}$$

SIMPLEST STRATEGY

1. **T**ake the vertical equation.
2. **I**nsert final height.
3. **M**ake a quadratic if needed.
4. **E**xclude the wrong root.

WORKED MODEL

> Returning to launch level gives $t = 0$ or $t = \frac{2u_y}{g}$.

HARD VARIANTS

1. If landing height differs, solve the full quadratic.
2. Check that a root lies after launch.
3. Use the time in horizontal motion to get range.

BOTTOM LINE

The useful time is usually the non-zero positive root.

Practice Page: TIME

QUESTION TYPE Time of flight

Find when a projectile returns to its starting height.

COMMON TRAP Keeping $t = 0$ as the impact time.

04 REL: Relative Position

TRIGGER *two moving particles in 2D*

BECOMES Subtract position vectors and minimise or solve components.

FIRST LINE TO WRITE

$$\overrightarrow{AB} = \mathbf{r}_B - \mathbf{r}_A$$

SIMPLEST STRATEGY

1. **R**ead both position vectors.
2. **E**xtract separation.
3. **L**ink condition: meet, distance, due direction.

WORKED MODEL

Due east means the j-component of separation is zero.

HARD VARIANTS

1. Meet means both separation components are zero.
2. Closest distance uses separation squared.
3. Bearings from one object use the relative vector from that object.

BOTTOM LINE

Relative position turns two particles into one vector.

Practice Page: REL

QUESTION TYPE Relative motion

Find when B is due north of A.

COMMON TRAP Using absolute positions when a relative vector is needed.

Quick Recognition Table

WHEN YOU SEE	FIRST LINE TO WRITE
2D constant acceleration	$\mathbf{r} = \mathbf{r}_0 + \mathbf{u}t + \frac{1}{2}\mathbf{a}t^2$
projectile, trajectory	$x = u_x t, \quad y = u_y t - \frac{1}{2}gt^2$
hits ground, returns to level	$y(t) = 0$ or given height
two moving particles in 2D	$\overrightarrow{AB} = \mathbf{r}_B - \mathbf{r}_A$

Hard Variant Checklist

STRATEGY	CHECK BEFORE FINAL ANSWER
SPLIT: Split Axes	Horizontal acceleration is zero in projectile motion unless stated. Use vector components for velocity too. Keep units consistent in both axes.
PROJ: Projectile Equation	If launch point is not origin, include initial x, y. Horizontal velocity stays constant only when no horizontal acceleration. Domain matters: the path equation may extend beyond the physical flight.
TIME: Flight Time	If landing height differs, solve the full quadratic. Check that a root lies after launch. Use the time in horizontal motion to get range.
REL: Relative Position	Meet means both separation components are zero. Closest distance uses separation squared. Bearings from one object use the relative vector from that object.

ELITE IGCSE MATHEMATICS
EXPERIENCE NOTES

Forces

Force questions reward a clean diagram before any equation.

Forces · M1 · 06

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The Map

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01 FBD: Free Body Diagram

TRIGGER *forces on a particle*

02 RESOLVE: Resolve Forces

TRIGGER *force at angle, components*

03 EQUIL: Equilibrium Equations

TRIGGER *particle in equilibrium*

04 FRIC: Friction Limit

TRIGGER *rough plane, limiting friction*

BANK EVIDENCE Local pages: 26 problem, 52 answer, 12 notes. Website primary entries: 15. Website linked entries: 29.

01 FBD: Free Body Diagram

TRIGGER *forces on a particle*

BECOMES Draw only the forces acting on the body being studied.

FIRST LINE TO WRITE

$$\text{weight} = mg, \quad R \perp \text{surface}$$

SIMPLEST STRATEGY

1. **F**ocus on one body.
2. **B**uild all external forces.
3. **D**elete forces on other bodies.

WORKED MODEL

On a rough horizontal plane: mg down, R up, friction along the plane.

HARD VARIANTS

1. Tension pulls away from the particle along the string.
2. Normal reaction is perpendicular to the contact surface.
3. Friction opposes actual or impending motion.

BOTTOM LINE

The diagram chooses the equations.

Practice Page: FBD

QUESTION TYPE Force diagrams

Draw the forces on a particle pulled by a string on a rough plane.

COMMON TRAP Drawing action-reaction forces on the same body.

02 RESOLVE: Resolve Forces

TRIGGER *force at angle, components*

BECOMES Resolve every angled force along chosen axes.

FIRST LINE TO WRITE

$$F_x = F\cos\theta, \quad F_y = F\sin\theta$$

SIMPLEST STRATEGY

1. **R**otate to useful axes.
2. **E**valuate components.
3. **S**ign by direction.
4. **O**rganise parallel/perpendicular equations.
5. **L**abel units.
6. **V**erify with diagram.
7. **E**nd with resultant.

WORKED MODEL

> A 10 N force at 30° above horizontal has horizontal component $10\cos 30°$.

HARD VARIANTS

1. If the angle is to the vertical, swap sine/cosine roles.
2. On slopes, axes parallel/perpendicular to plane are usually best.
3. Keep exact trig until the final result.

BOTTOM LINE

Resolve along the axes you will use.

Practice Page: RESOLVE

QUESTION TYPE Resolving forces

Resolve a force of 12 N at 40° above the horizontal.

COMMON TRAP Using sine/cosine against the wrong angle.

03 EQUIL: Equilibrium Equations

TRIGGER *particle in equilibrium*

BECOMES Set resultant force to zero in each direction.

FIRST LINE TO WRITE

$$\sum F_x = 0, \quad \sum F_y = 0$$

SIMPLEST STRATEGY

1. **E**stablish axes.
2. **Q**uietly resolve.
3. **U**se zero resultant.
4. **I**solate unknowns.
5. **L**abel final forces.

WORKED MODEL

For equilibrium on a horizontal plane, $R = mg$ if no other vertical force acts.

HARD VARIANTS

1. Use simultaneous equations when two unknowns appear.
2. If three forces are in equilibrium, a triangle of forces may help.
3. Do not assume $R = mg$ when angled pulls are present.

BOTTOM LINE

Equilibrium means no resultant force.

Practice Page: EQUIL

QUESTION TYPE Equilibrium

Find the tension in a string holding a particle in equilibrium.

COMMON TRAP Balancing magnitudes that are not in the same direction.

04 FRIC: Friction Limit

TRIGGER *rough plane, limiting friction*

BECOMES Use $F \leq \mu R$, and $F = \mu R$ only at limiting motion.

FIRST LINE TO WRITE

$$F_{\max} = \mu R$$

SIMPLEST STRATEGY

1. **F**ind the normal reaction.
2. **R**ead impending direction.
3. **I**nsert friction opposite it.
4. **C**hoose $F = \mu R$ only if limiting.

WORKED MODEL

At impending upward motion, friction acts down the plane.

HARD VARIANTS

1. For equilibrium, friction can be less than μR.
2. Normal reaction changes when a force has a perpendicular component.
3. Check whether motion is up or down the plane before placing friction.

BOTTOM LINE

Friction has a direction before it has a value.

Practice Page: FRIC

QUESTION TYPE Friction

A particle is on the point of sliding; find the friction force.

COMMON TRAP Using $F = \mu R$ when the particle is not limiting.

Quick Recognition Table

WHEN YOU SEE	FIRST LINE TO WRITE
forces on a particle	weight $= mg$, $R \perp$ surface
force at angle, components	$F_x = F\cos\theta$, $F_y = F\sin\theta$
particle in equilibrium	$\sum F_x = 0$, $\sum F_y = 0$
rough plane, limiting friction	$F_{\max} = \mu R$

Hard Variant Checklist

STRATEGY	CHECK BEFORE FINAL ANSWER
FBD: Free Body Diagram	Tension pulls away from the particle along the string. Normal reaction is perpendicular to the contact surface. Friction opposes actual or impending motion.
RESOLVE: Resolve Forces	If the angle is to the vertical, swap sine/cosine roles. On slopes, axes parallel/perpendicular to plane are usually best. Keep exact trig until the final result.
EQUIL: Equilibrium Equations	Use simultaneous equations when two unknowns appear. If three forces are in equilibrium, a triangle of forces may help. Do not assume $R = mg$ when angled pulls are present.
FRIC: Friction Limit	For equilibrium, friction can be less than μR. Normal reaction changes when a force has a perpendicular component. Check whether motion is up or down the plane before placing friction.

ELITE IGCSE MATHEMATICS
EXPERIENCE NOTES

Newton's Second Law

Dynamics is force-resultant first, then acceleration.

Newton's Second Law · M1 · 07

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The Map

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01 NET: Net Force

TRIGGER *Newton's second law*

02 TENS: Connected Tension

TRIGGER *connected particles, string*

03 SYS: Whole System

TRIGGER *find acceleration of system*

04 COMBO: Motion Plus Dynamics

TRIGGER *force then distance/time*

BANK EVIDENCE Local pages: 49 problem, 78 answer, 25 notes. Website primary entries: 12. Website linked entries: 55.

01 NET: Net Force

TRIGGER *Newton's second law*

BECOMES Resultant force in a direction equals mass times acceleration.

FIRST LINE TO WRITE

$$\sum F = ma$$

SIMPLEST STRATEGY

1. **N**ame the direction.
2. **E**nter signed forces.
3. **T**ie to ma.

WORKED MODEL

> If right is positive, $P - F = ma$.

HARD VARIANTS

1. Use weight mg, not mass, in vertical force sums.
2. Acceleration sign must match the chosen positive direction.
3. If acceleration is zero, this becomes equilibrium.

BOTTOM LINE

Only the resultant force equals ma.

Practice Page: NET

QUESTION TYPE Newton's law

Find acceleration when a 6 kg particle is pulled by 30 N against 6 N resistance.

COMMON TRAP Writing one force equal to *ma*.

02 TENS: Connected Tension

TRIGGER *connected particles, string*

BECOMES Use common acceleration and separate body equations.

FIRST LINE TO WRITE

$$a_A = a_B, \quad \text{same string}$$

SIMPLEST STRATEGY

1. **T**race the string.
2. **E**stablish common acceleration.
3. **N**ame tension.
4. **S**et one equation per body.

WORKED MODEL

For two particles: $P - T = m_1 a$, $T - R = m_2 a$.

HARD VARIANTS

1. Light string gives the same tension throughout that string.
2. Use whole-system equation to find acceleration quickly, then individual equation for tension.
3. Pulley or slope geometry may reverse signs.

BOTTOM LINE

Tension is internal to the system but external to each particle.

Practice Page: TENS

QUESTION TYPE Connected particles

Two connected particles move on a smooth table; find T and a.

COMMON TRAP Using different accelerations for an inextensible string.

03 SYS: Whole System

TRIGGER *find acceleration of system*

BECOMES Add bodies together to cancel internal tensions.

FIRST LINE TO WRITE

$$\text{external resultant} = (m_1 + m_2)a$$

SIMPLEST STRATEGY

1. **S**elect the whole moving system.
2. **Y**ield only external forces.
3. **S**olve for common acceleration.

WORKED MODEL

> If two masses move together, $P - R = (m_1 + m_2)a$.

HARD VARIANTS

1. Only include bodies that share the same acceleration.
2. External resistance and weight components remain.
3. Return to a single-body equation for tension.

BOTTOM LINE

Internal tensions cancel in the whole-system equation.

Practice Page: SYS

QUESTION TYPE System dynamics

Find the acceleration of two connected particles using the whole system.

COMMON TRAP Including tension when treating the whole system.

04 COMBO: Motion Plus Dynamics

TRIGGER *force then distance/time*

BECOMES Find acceleration from forces, then use kinematics.

FIRST LINE TO WRITE

$$\sum F = ma \quad \Rightarrow \quad \text{SUVAT}$$

SIMPLEST STRATEGY

1. **C**alculate acceleration.
2. **O**rganise initial motion data.
3. **M**atch SUVAT equation.
4. **B**ring units together.
5. **O**utput requested time/speed/distance.

WORKED MODEL

$a = 2$, then $v^2 = u^2 + 2as$.

HARD VARIANTS

1. If a force stops acting, split the motion into stages.
2. Friction may change direction after motion reverses.
3. Use the acceleration from the correct stage only.

BOTTOM LINE

Dynamics often supplies the missing SUVAT acceleration.

Practice Page: COMBO

QUESTION TYPE Dynamics plus kinematics

A pulled particle starts from rest; find its speed after moving 10 m.

COMMON TRAP Using force equations after acceleration changes.

Quick Recognition Table

WHEN YOU SEE	FIRST LINE TO WRITE
Newton's second law	$\sum F = ma$
connected particles, string	$a_A = a_B,$ same string
find acceleration of system	external resultant $= (m_1 + m_2)a$
force then distance/time	$\sum F = ma \quad \Rightarrow \quad$ SUVAT

Hard Variant Checklist

STRATEGY	CHECK BEFORE FINAL ANSWER
NET: Net Force	Use weight mg, not mass, in vertical force sums. Acceleration sign must match the chosen positive direction. If acceleration is zero, this becomes equilibrium.
TENS: Connected Tension	Light string gives the same tension throughout that string. Use whole-system equation to find acceleration quickly, then individual equation for tension. Pulley or slope geometry may reverse signs.
SYS: Whole System	Only include bodies that share the same acceleration. External resistance and weight components remain. Return to a single-body equation for tension.
COMBO: Motion Plus Dynamics	If a force stops acting, split the motion into stages. Friction may change direction after motion reverses. Use the acceleration from the correct stage only.

ELITE IGCSE MATHEMATICS
EXPERIENCE NOTES

Resolving Forces Inclined Planes

Slope questions become straight when axes run along and normal to the plane.

RESOLVING FORCES, INCLINED PLANES · M1 · 08

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The Map

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01 AXES: Slope Axes

TRIGGER *inclined plane*

02 NORM: Normal Reaction

TRIGGER *reaction on inclined plane*

03 SLIDE: Sliding Equation

TRIGGER *acceleration on slope*

04 LIMIT: Limiting Friction On Slope

TRIGGER *rough inclined plane, about to move*

BANK EVIDENCE Local pages: 43 problem, 68 answer, 19 notes. Website primary entries: 19. Website linked entries: 29.

01 AXES: Slope Axes

TRIGGER *inclined plane*

BECOMES Resolve parallel and perpendicular to the plane.

FIRST LINE TO WRITE

$$mg \sin\theta \text{ down slope,} \quad mg \cos\theta \text{ into plane}$$

SIMPLEST STRATEGY

1. **A**lign axes with the plane.
2. **X**mark weight components.
3. **E**quation parallel.
4. **S**econd equation perpendicular.

WORKED MODEL

On a 30° slope, the down-slope component is $mg \sin 30^\circ$.

HARD VARIANTS

1. The normal reaction is perpendicular to the plane.
2. If the angle is given to the vertical, redraw the triangle.
3. Keep signs according to up/down slope choice.

BOTTOM LINE

Slope axes remove unnecessary diagonal forces.

Practice Page: AXES

QUESTION TYPE Inclined planes

Resolve the weight of a particle on a 20° inclined plane.

COMMON TRAP Using $mg \cos heta$ down the slope.

02 NORM: Normal Reaction

TRIGGER *reaction on inclined plane*

BECOMES Use perpendicular balance because acceleration perpendicular to the plane is zero.

FIRST LINE TO WRITE

$$\sum F_{\perp} = 0$$

SIMPLEST STRATEGY

1. **N**ame perpendicular axis.
2. **O**ppose into/out of plane components.
3. **R**eaction is unknown.
4. **M**ake equation.

WORKED MODEL

> If no other perpendicular force acts, $R = mg\cos\theta$.

HARD VARIANTS

1. Angled pulls or pushes change R.
2. No perpendicular acceleration does not mean no perpendicular forces.
3. Friction depends on this R, so find it first.

BOTTOM LINE

The normal reaction is found perpendicular to the surface.

Practice Page: NORM

QUESTION TYPE Reaction

Find the normal reaction on a smooth plane inclined at 25°.

COMMON TRAP Assuming $R = mg$ on a slope.

03 SLIDE: Sliding Equation

TRIGGER *acceleration on slope*

BECOMES Resolve along the plane and use $\sum F = ma$.

FIRST LINE TO WRITE

$$\sum F_{\parallel} = ma$$

SIMPLEST STRATEGY

1. **S**elect positive direction.
2. **L**ist along-plane forces.
3. **I**nsert signs.
4. **D**o ma.
5. **E**valuate acceleration.

WORKED MODEL

Down a smooth slope: $mg \sin\theta = ma$, so $a = g \sin\theta$.

HARD VARIANTS

1. Friction acts opposite motion or impending motion.
2. If motion is up the slope, weight component and friction may both act down slope.
3. Use SUVAT after acceleration is found.

BOTTOM LINE

The along-plane equation drives the motion.

Practice Page: SLIDE

QUESTION TYPE Slope acceleration

Find the acceleration down a smooth 15° plane.

COMMON TRAP Including the normal reaction in the parallel equation.

04 LIMIT: Limiting Friction On Slope

TRIGGER *rough inclined plane, about to move*

BECOMES Set friction to μR only at the limiting case.

FIRST LINE TO WRITE

$$F = \mu R$$

SIMPLEST STRATEGY

1. **L**ocate impending motion.
2. **I**nsert friction opposite it.
3. **M**ake $F = \mu R$.
4. **I**nclude weight component.
5. **T**idy inequality/equality.

WORKED MODEL

About to slide down: friction acts up the slope.

HARD VARIANTS

1. For rest, friction may be less than μR.
2. If an applied force acts, it may change both R and the limiting friction.
3. Check whether the question asks greatest or least force.

BOTTOM LINE

Limiting friction is a threshold, not a default.

Practice Page: LIMIT

QUESTION TYPE Limiting friction

A particle is just about to slide down a rough plane; find μ.

COMMON TRAP Putting friction the wrong way.

Quick Recognition Table

WHEN YOU SEE	FIRST LINE TO WRITE
inclined plane	$mg\sin\theta$ down slope, $mg\cos\theta$ into plane
reaction on inclined plane	$\sum F_{\perp} = 0$
acceleration on slope	$\sum F_{\parallel} = ma$
rough inclined plane, about to move	$F = \mu R$

Hard Variant Checklist

STRATEGY	CHECK BEFORE FINAL ANSWER
AXES: Slope Axes	The normal reaction is perpendicular to the plane. If the angle is given to the vertical, redraw the triangle. Keep signs according to up/down slope choice.
NORM: Normal Reaction	Angled pulls or pushes change R. No perpendicular acceleration does not mean no perpendicular forces. Friction depends on this R, so find it first.
SLIDE: Sliding Equation	Friction acts opposite motion or impending motion. If motion is up the slope, weight component and friction may both act down slope. Use SUVAT after acceleration is found.
LIMIT: Limiting Friction On Slope	For rest, friction may be less than μR. If an applied force acts, it may change both R and the limiting friction. Check whether the question asks greatest or least force.

ELITE IGCSE MATHEMATICS
EXPERIENCE NOTES

Momentum, Impulse & Collisions

Momentum questions are bookkeeping: direction, before/after, and impulse.

MOMENTUM, IMPULSE & COLLISIONS · M1 · 09

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The Map

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01 MOM: Conserve Momentum

TRIGGER *collision, before and after*

02 IMP: Impulse Change

TRIGGER *impulse, change in momentum*

03 COLL: Collision Pair

TRIGGER *two particles collide*

04 FORCE: Impulse From Force

TRIGGER *constant force for time, force-time graph*

BANK EVIDENCE Local pages: 29 problem, 51 answer, 9 notes. Website primary entries: 18. Website linked entries: 22.

01 MOM: Conserve Momentum

TRIGGER *collision, before and after*

BECOMES Total momentum before equals total momentum after, in one chosen direction.

FIRST LINE TO WRITE

$$\sum mu = \sum mv$$

SIMPLEST STRATEGY

1. **M**ark positive direction.
2. **O**rder before and after.
3. **M**ultiply mass by velocity.
4. **E**quate totals.
5. **N**egative signs for opposite direction.
6. **T**idy unknown velocity.

WORKED MODEL

$2(5) + 3(-1) = 2v_1 + 3v_2.$

HARD VARIANTS

1. Use velocities, not speeds, inside the equation.
2. External impulse must be absent for conservation.
3. Check if particles coalesce and share one final velocity.

BOTTOM LINE

Momentum conservation is signed.

Practice Page: MOM

QUESTION TYPE Momentum

Two particles collide on a line; find the unknown final speed.

COMMON TRAP Adding speeds without signs.

02 IMP: Impulse Change

TRIGGER *impulse, change in momentum*

BECOMES Impulse equals final momentum minus initial momentum.

FIRST LINE TO WRITE

$$I = m(v - u)$$

SIMPLEST STRATEGY

1. **I**dentify direction.
2. **M**ultiply final velocity.
3. **P**repare initial momentum.
4. **U**se final minus initial.
5. **L**abel N s.
6. **S**tate direction.
7. **E**valuate.

WORKED MODEL

If $u = 4$ and $v = -2$, then $I = m(-2 - 4)$.

HARD VARIANTS

1. The impulse on the other body is equal and opposite.
2. Units are N s or kg m s^{-1}.
3. If a force-time graph is given, impulse is area.

BOTTOM LINE

Impulse is a signed change.

Practice Page: IMP

QUESTION TYPE Impulse

Find the impulse on a 0.5 kg ball changing from 8 to $-3\ \mathrm{m\,s^{-1}}$.

COMMON TRAP Using $u - v$ instead of $v - u$.

03 COLL: Collision Pair

TRIGGER *two particles collide*

BECOMES Use momentum plus any given collision relation.

FIRST LINE TO WRITE

$$\text{momentum equation} + \text{second relation}$$

SIMPLEST STRATEGY

1. **C**hoose direction.
2. **O**rganise before/after table.
3. **L**ink with momentum.
4. **L**ink with given condition.
5. **I**solve simultaneous equations.
6. **D**ecide physical root.
7. **E**nd with speeds/directions.

WORKED MODEL

If they move together, set $v_1 = v_2$ after impact.

HARD VARIANTS

1. For coalescence, both final velocities are equal.
2. If a rebound happens, one velocity changes sign.
3. Check that post-collision directions match the signs you report.

BOTTOM LINE

One equation is rarely enough for two final velocities.

Practice Page: COLL

QUESTION TYPE Collisions

Two particles collide and move together; find their common speed.

COMMON TRAP Forgetting the second condition.

04 FORCE: Impulse From Force

TRIGGER *constant force for time, force-time graph*

BECOMES Use impulse as force times time or area under force-time graph.

FIRST LINE TO WRITE

$$I = Ft \quad \text{or} \quad I = \text{area}$$

SIMPLEST STRATEGY

1. **F**ind the time interval.
2. **O**btain force or graph area.
3. **R**elate to $m(v-u)$.
4. **C**alculate unknown.
5. **E**xpress direction.

WORKED MODEL

> A force 6 N for 0.4 s gives impulse 2.4 N s.

HARD VARIANTS

1. For triangular force graphs, use triangle area.
2. Direction of force controls sign of impulse.
3. Average force is impulse divided by time.

BOTTOM LINE

Impulse is the area under a force-time graph.

Practice Page: FORCE

QUESTION TYPE Force impulse

A constant force acts for 0.2 s; find the speed change.

COMMON TRAP Using acceleration without the time interval.

Quick Recognition Table

WHEN YOU SEE	FIRST LINE TO WRITE
collision, before and after	$\sum mu = \sum mv$
impulse, change in momentum	$I = m(v - u)$
two particles collide	momentum equation + second relation
constant force for time, force-time graph	$I = Ft$ or $I =$ area

Hard Variant Checklist

STRATEGY	CHECK BEFORE FINAL ANSWER
MOM: Conserve Momentum	Use velocities, not speeds, inside the equation. External impulse must be absent for conservation. Check if particles coalesce and share one final velocity.
IMP: Impulse Change	The impulse on the other body is equal and opposite. Units are N s or kg m s^{-1}. If a force-time graph is given, impulse is area.
COLL: Collision Pair	For coalescence, both final velocities are equal. If a rebound happens, one velocity changes sign. Check that post-collision directions match the signs you report.
FORCE: Impulse From Force	For triangular force graphs, use triangle area. Direction of force controls sign of impulse. Average force is impulse divided by time.

ELITE IGCSE MATHEMATICS
EXPERIENCE NOTES

Moments

Moments questions become calm when you choose the pivot that deletes the worst unknown.

Moments · M1 · 10

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The Map

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01 PIVOT: Choose Pivot

TRIGGER *take moments about*

02 REACT: Find Reactions

TRIGGER *supports, reactions*

03 TILT: Tilting Limit

TRIGGER *on point of tilting, just lifts*

04 CENTRE: Centre Of Mass

TRIGGER *uniform rod, midpoint, centre*

BANK EVIDENCE Local pages: 39 problem, 57 answer, 13 notes. Website primary entries: 18. Website linked entries: 18.

01 PIVOT: Choose Pivot

TRIGGER *take moments about*

BECOMES Take moments about a point that removes an unknown reaction or tension.

FIRST LINE TO WRITE

$$\sum M_{\text{clockwise}} = \sum M_{\text{anticlockwise}}$$

SIMPLEST STRATEGY

1. **P**ick the pivot.
2. **I**gnore forces through pivot.
3. **V**alue each perpendicular distance.
4. **O**rient clockwise/anticlockwise.
5. **T**idy equation.

WORKED MODEL

Taking moments about A removes the reaction at A.

HARD VARIANTS

1. Use perpendicular distance to the line of action.
2. Weight of a uniform rod acts at its midpoint.
3. For angled forces, use perpendicular component or perpendicular distance.

BOTTOM LINE

A good pivot deletes one unknown.

Practice Page: PIVOT

QUESTION TYPE Moments

Take moments about A for a uniform rod supported at A and C.

COMMON TRAP Taking moments about a point that leaves every unknown.

02 REACT: Find Reactions

TRIGGER *supports, reactions*

BECOMES Use vertical equilibrium plus a moment equation.

FIRST LINE TO WRITE

$$R_A + R_B = \text{total weight}$$

SIMPLEST STRATEGY

1. **R**ecord upward reactions.
2. **E**quate vertical forces.
3. **A**pply one moment equation.
4. **C**alculate reactions.
5. **T**est by substitution.

WORKED MODEL

> $R_A + R_B = 50g$, then moments gives one reaction.

HARD VARIANTS

1. Use mg for each mass.
2. If a support is at a pivot, its moment about that point is zero.
3. Check reactions are non-negative unless the support loses contact.

BOTTOM LINE

Reactions are forces, so they belong in force balance and moments.

Practice Page: REACT

QUESTION TYPE Reactions

Find the reactions at two supports for a loaded beam.

COMMON TRAP Forgetting the beam’s own weight.

03 TILT: Tilting Limit

TRIGGER *on point of tilting, just lifts*

BECOMES At tilting, the reaction at the lifting support is zero.

FIRST LINE TO WRITE

$$R_{\text{lifting support}} = 0$$

SIMPLEST STRATEGY

1. **T**ell which pivot remains.
2. **I**gnore reaction at pivot in moments.
3. **L**et other support reaction be zero.
4. **T**ake moments about pivot.

WORKED MODEL

> On the point of tilting about C, the reaction at D is zero.

HARD VARIANTS

1. Greatest/least mass decides which end is about to lift.
2. Draw the pivot before writing equations.
3. Use equality at the limiting case, not inequality.

BOTTOM LINE

Tilting means one support has just lost contact.

Practice Page: TILT

QUESTION TYPE Tilting

A beam is about to tilt; find the greatest mass.

COMMON TRAP Taking moments about the support that has lifted.

04 CENTRE: Centre Of Mass

TRIGGER *uniform rod, midpoint, centre*

BECOMES Place the weight at the centre of mass before taking moments.

FIRST LINE TO WRITE

> uniform rod weight at midpoint

SIMPLEST STRATEGY

1. **C**heck if body is uniform.
2. **E**stablish midpoint/centre.
3. **N**ame the weight.
4. **T**ake distance from pivot.
5. **R**euse in moments.
6. **E**nd with units.

WORKED MODEL

> A uniform 6 m rod has weight acting 3 m from either end.

HARD VARIANTS

1. Non-uniform rods may give the centre distance as x.
2. If a particle is attached, its weight acts at its own point, not the rod midpoint.
3. Distances must be from the chosen pivot.

BOTTOM LINE

Uniform means midpoint weight.

Practice Page: CENTRE

QUESTION TYPE Centre of mass

Place the weight of a uniform rod AB of length 5 m.

COMMON TRAP Putting the rod weight at a support.

Quick Recognition Table

WHEN YOU SEE	FIRST LINE TO WRITE
take moments about	$\sum M_{\text{clockwise}} = \sum M_{\text{anticlockwise}}$
supports, reactions	$R_A + R_B =$ total weight
on point of tilting, just lifts	$R_{\text{lifting support}} = 0$
uniform rod, midpoint, centre	uniform rod weight at midpoint

Hard Variant Checklist

STRATEGY	CHECK BEFORE FINAL ANSWER
PIVOT: Choose Pivot	Use perpendicular distance to the line of action. Weight of a uniform rod acts at its midpoint. For angled forces, use perpendicular component or perpendicular distance.
REACT: Find Reactions	Use mg for each mass. If a support is at a pivot, its moment about that point is zero. Check reactions are non-negative unless the support loses contact.
TILT: Tilting Limit	Greatest/least mass decides which end is about to lift. Draw the pivot before writing equations. Use equality at the limiting case, not inequality.
CENTRE: Centre Of Mass	Non-uniform rods may give the centre distance as x. If a particle is attached, its weight acts at its own point, not the rod midpoint. Distances must be from the chosen pivot.