Maths Skills for Scientists

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Maths for GCSE sciences

- **For students:** connecting the skills they have learnt in GCSE maths to GCSE sciences

- **For teachers:** helping raise confidence in their maths skills as applied to GCSE sciences

Maths Required in GCSE sciences

1. Arithmetic and numerical computation (decimals, standard form, ratios, fractions, percentages, estimations)

2. Handling data (sig figs, means, bar charts, histograms, sampling, probability, mode/median scatter diagrams, order of magnitude)

3. Algebra (changing subject of equations, substituting numerical values, solving simple equations)

4. Graphs (linear relationships, plotting data, determining slope and intercept if linear, tangent as rate of change)

5. Geometry and trigonometry (angles, 2D representations of 3D objects, areas, volumes)

	Mathematical skills		Sub	ject	
1	**Arithmetic and numerical computation**				
a	Recognise and use expressions in decimal form	B	C	P	CS
b	Recognise and use expressions in standard form	B	C	P	CS
c	Use ratios, fractions and percentages	B	C	P	CS
d	Make estimates of the results of simple calculations	B	C	P	CS
2	**Handling data**				
a	Use an appropriate number of significant figures	B	C	P	CS
b	Find arithmetic means	B	C	P	CS
c	Construct and interpret frequency tables and diagrams, bar charts and histograms	B	C	P	CS
d	Understand the principles of sampling as applied to scientific data	B			CS
e	Understand simple probability	B			CS
f	Understand the terms mean, mode and median	B		P	CS
g	Use a scatter diagram to identify a correlation between two variables	B		P	CS
h	Make order of magnitude calculations	B	C	P	CS
3	**Algebra**				
a	Understand and use the symbols: =, <, <<, >>, >, ∞, proportional to	B	C	P	CS
b	Change the subject of an equation		C	P	CS
c	Substitute numerical values into algebraic equations using appropriate units for physical dimensions		C	P	CS
d	Solve simple algebraic equations	B		P	CS
4	**Graphs**				
a	Translate information between graphical and numeric form	B	C	P	CS
b	Understand that y=mx+c represents a linear relationship	B	C	P	CS
c	Plot two variables from experimental or other data	B	C	P	CS
d	Determine the slope and intercept of a linear graph	B	C	P	CS
e	Draw and use the slope of a tangent to a curve as a measure of rate of change	C			CS
f	Understand the physical significance of area between a curve and the x-axis and measure it by counting squares as appropriate			P	CS
5	**Geometry and trigonometry**				
a	Use angular measures in degrees			P	CS
b	Visualise and represent 2D and 3D forms including 2D representations of 3D objects		C	P	CS
c	Calculate areas of triangles and rectangles, surface areas and volumes of cubes	B	C	P	CS

Book Resources

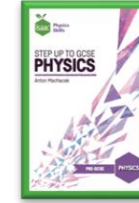- Interactive online books, also available in print
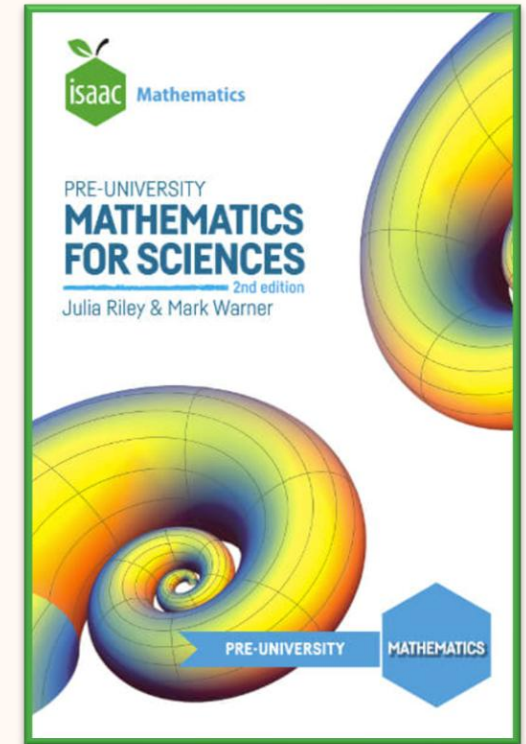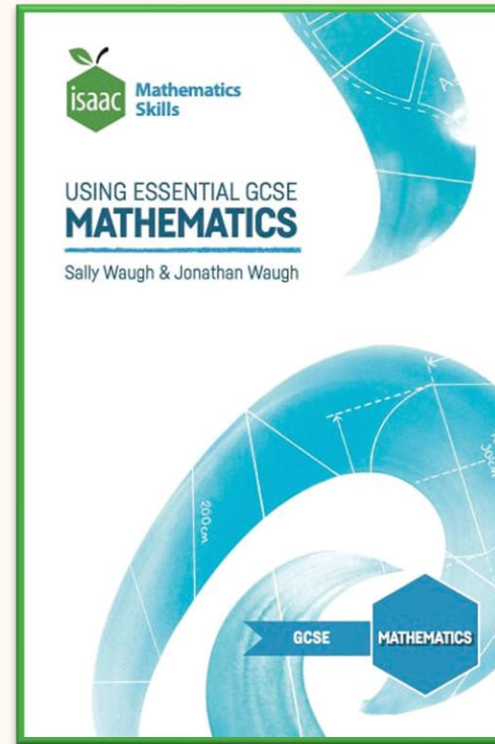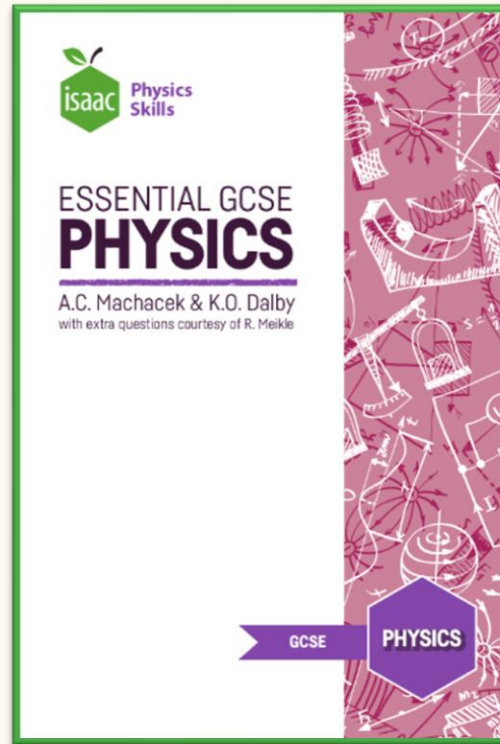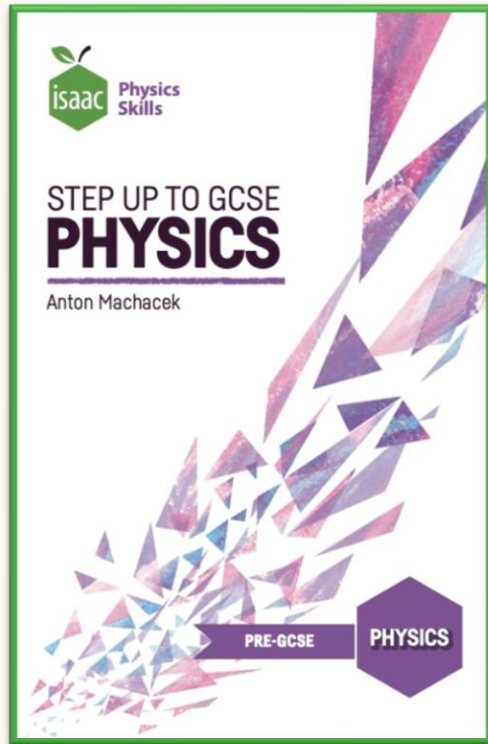
Step Up to GCSE Physics

- An excellent resource for rearranging equations.

Chapter 1, section 5

Essential GCSE Physics
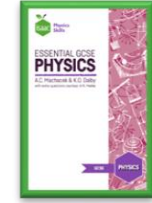
- Resources for essential maths skills for GCSE.

Chapter 1

Using Essential GCSE Mathematics

- Addition online resources for maths and user-of-maths teachers.

Advice for teaching maths topics

Resources for sixth form entry

Resources for GCSE science

Using Essential GCSE Mathematics
By S.A. Waugh & J.N. Waugh

Teacher notes ⌄

Teacher notes

The following resources for teachers accompany this book:

Specification Table - This maps the content of the book to exam boards. Mapping is available for Edexcel, AQA, WJEC, OCR, IGCSE, CCEA and SQA.

Teacher's Manual - Notes by the author to accompany each chapter of the book, including hints for the harder questions. The manual includes suggestions for user-of-maths teachers on approaches to teaching a number of topics with which students often struggle.

Preparation for Sixth Form (pdf) - Suggestions on how to use use the book to revisit key maths topics at the beginning of sixth form, catering for students starting a variety of different courses.

Useful Question for STEM - Tables listing problems within the book that may be useful for teaching STEM subjects.

Maths Skills for GCSE Science - Tables mapping the content of the book to mathematical skills for science requirements.

Pre-University Mathematics for Sciences
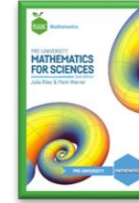
- Questions in the book range from GCSE to University.

- Each question is graded by educational stage (G, A, F) and difficulty (P1-3 or C1-3).

- Geared towards the physical sciences (physics and engineering).

A1.6 a) Rearrange $E_k = \frac{1}{2}mv^2$, which gives the kinetic energy E_k of a body of
G P2   mass m travelling with speed v, to make v the subject of the equation.

b) Rearrange $P = \dfrac{V^2}{R}$, which gives the power P dissipated in a resistance R when the voltage across it is V, to make V the subject.

A1.7 Find the force, in newtons, on a body of mass $3.0\,\text{kg}$ which is accelerating at
G P2 $2.5\,\text{m s}^{-2}$.

A1.8 Rearrange $F = \dfrac{GMm}{r^2}$, the expression for the gravitational force F between
G P2 two masses M and m a distance r apart, to make r the subject.

A1.9 a) In the equation of motion for a body accelerating uniformly at a rate a,
G C3   the distance s travelled in time t is given by $s = ut + \frac{1}{2}at^2$, where u is its
initial speed. Rearrange the equation to find an expression for t, assuming $u = 0$.

b) Rearrange the equation $s = ut + \frac{1}{2}at^2$ again, this time without assuming $u = 0$, to make t the subject.

c) In the equation of motion for a body accelerating uniformly at a rate a, the relationship between the distance travelled s and the initial and final speeds u and v is given by $v^2 = u^2 + 2as$. Rearrange the equation to find an expression for u.

d) Rearrange $v^2 = u^2 + 2as$ again, to make s the subject.

Core Skills Practice

- Tools for practising a specific maths skill.

- Answers / attempts are not tracked. "No risk" practice.

- A new feature on Isaac. Only a few tools available now, but more on the way.

- Currently available:

  - Mental Maths

  - Simultaneous Equations

Mental Maths

- Get started A Level
- Go deeper A Level
- Overall Mental Maths

Simultaneous Equations

- Linear, 2-variable simultaneous equations
- Linear, 3-variable simultaneous equations
- Quadratic, 2-variable simultaneous equations
- Combination of simultaneous equations

Simultaneous Equations Practice

Created by Andrea Chlebikova

Generate new question

$$-4x - 8y = -32$$

$$x + 3y = 12$$

$x :$ $y :$

Check answers

I would like some help

Examples of Appropriate Question Decks

Three question decks:

1. Rearranging equations: 10 questions concentrating on two topics

2. Sample Topics: 10 questions from across the range of skills

3. Trigonometry in Science: 3 questions on sine, cosine and tangent

Question Deck: Rearranging equations

- 10 questions

- Mathematical skills covered:
  - Algebra b) change subject of equatio
  - Algebra c) substitute numerical value into algebraic equations using appropriate units for physical quantities

For example: *Re-arranging and Changing the Subject 7*

25 IPTS: Maths for Sciences - Rearranging Equations

Equation Editor: Text Entry

Linear Equations 1
Pre-Uni Maths for Sciences A1.1
Maths | Algebra | Manipulation
GCSE Practice 1
A Level Practice 1

Linear Equations 2
Pre-Uni Maths for Sciences A1.2
Maths | Algebra | Manipulation
GCSE Practice 1
A Level Practice 1

Formula Triangles 2
Essential GCSE Maths 18.2
Maths | Algebra | Manipulation
GCSE Challenge 1

Formula Triangles 6
Essential GCSE Maths 18.6
Maths | Algebra | Manipulation
GCSE Challenge 2

Quadratic Equations 1
Pre-Uni Maths for Sciences A1.6
Maths | Algebra | Manipulation
GCSE Practice 2
A Level Practice 1

Re-arranging and Changing the Subject 7
Essential GCSE Maths 17.7
Maths | Algebra | Manipulation
GCSE Practice 2
A Level Practice 1

Re-arranging and Changing the Subject 7

The surface area A of a sphere is given by $A = 4\pi r^2$, where r is the radius.

Part A
Re-arrange the formula ⌄

Re-arrange the formula to make r the subject.

> Type your formula here   ?

The following symbols may be useful: A, pi, r

> or click here to drag and drop your answer

Check my answer

Part B
Find r ⌄

If $A = 4\,\text{cm}^2$ find r to 2 decimal places, stating the units.

Value   Units

> [   ]   [⌄]

ⓘ What can I type in this box?

Check my answer

Question Deck: Sample Topics

- **5 pairs of questions:** for one topic from each of the 5 sets of skills

- **Each pair:** a purely mathematical example followed by a physical example using the same mathematical technique

For example: *Rounding, accuracy and bounds 1*, followed by *Rounding, accuracy and bounds 9*

25 IPTS: Maths Skills for Sciences - Sample Topics

Equation Editor: Text Entry

Percentages 8
Essential GCSE Maths 6.8
Maths | Number | Rational Numbers
GCSE Practice 1

Percentages 19
Essential GCSE Maths 6.19
Maths | Number | Rational Numbers
GCSE Challenge 2

Rounding, Accuracy and Bounds 1
Essential GCSE Maths 8.1
Maths | Number | Arithmetic
GCSE Practice 1
A Level Practice 1

Rounding, Accuracy and Bounds 7
Essential GCSE Maths 8.7
Maths | Number | Arithmetic
GCSE Challenge 2
A Level Practice 1

BIDMAS and Substituting Into Formulae 9
Essential GCSE Maths 3.9
Maths | Number | Arithmetic
GCSE Challenge 1
A Level Practice 1

BIDMAS and Substituting Into Formulae 12
Essential GCSE Maths 3.12
Maths | Number | Arithmetic
GCSE Challenge 1
A Level Practice 1

Rounding, Accuracy and Bounds 1 & 9

isaac

Round the following to the stated accuracy.

Part A
Round 81.63 ⌄

Round 81.63 to 2 sf.

Value

[   ]

ⓘ What can I type in this box?

[Check my answer]

Need some help?

[Hint 1 ›]

⚑

Part B
Round 0.0027356 ›

Part C
Round 0.49999 ›

Two students try the following question: "Calculate the volume of a sphere of diameter $2.30\,\text{cm}$ using the formula $V = \frac{4}{3}\pi r^3$. Give your answer correct to 2 significant figures."

Part A
What value does student A get? ⌄

Student A sees that this is a 2 significant figures question and rounds the value of the radius before using the formula. He then also rounds the answer he gets from the formula. What value does he get for the volume?

Value   Unit

[   ]   (cm^3)

ⓘ What can I type in this box?

[Check my answer]

Need some help?

[Hint 1 ›]

⚑

Part B
What value does student B get? ›
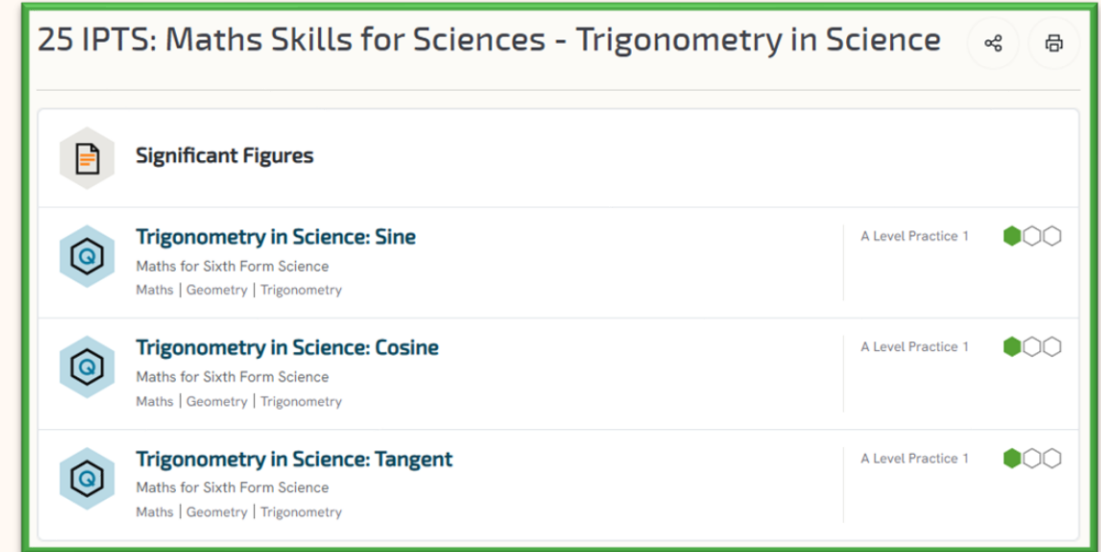
Part C
Which student is correct? ›

Part D
What is the percentage error? ›

Trigonometry in Science

- 3 questions

- Each question considers one of 3 trig functions: sine, cosine and tangent; it includes the definition, 2 straightforward applications of the definition and a relevant physical example

For example: *Trigonometry in Science: Sine*

25 IPTS: Maths Skills for Sciences - Trigonometry in Science

Significant Figures

Trigonometry in Science: Sine
Maths for Sixth Form Science
Maths | Geometry | Trigonometry
A Level Practice 1

Trigonometry in Science: Cosine
Maths for Sixth Form Science
Maths | Geometry | Trigonometry
A Level Practice 1

Trigonometry in Science: Tangent
Maths for Sixth Form Science
Maths | Geometry | Trigonometry
A Level Practice 1

Trigonometry in Science - Sine

Trigonometry is a useful tool for calculating quantities in science in situations where right-angled triangles can be drawn.

This question is about $\sin \theta$. For a right-angled triangle,

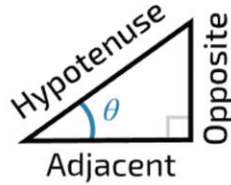$$\sin \theta = \frac{\text{Opposite}}{\text{Hypotenuse}}$$

Figure 1: Side labelling for trigonometry
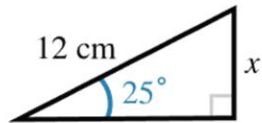
Part A
Find side length x ∨

Figure 2: A right-angled triangle with a side of length x.

Use trigonometry to find the value of x.

Part B
Find side length L ❯

Part C
Find the component $W_{\parallel}$ ∨

A car is stationary on a hill which has a slope of $5.0°$ to the horizontal. The weight of the car, $12\,000\,\text{N}$, acts vertically downwards.
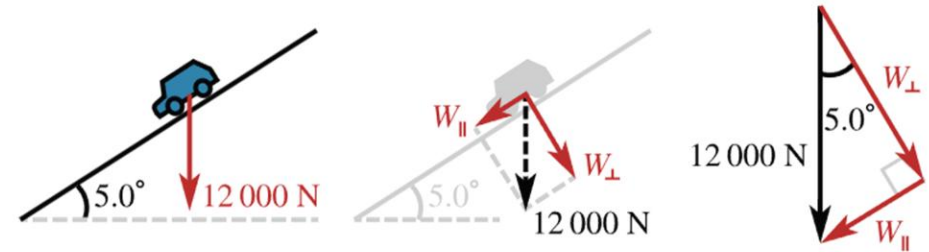
Figure 4: Illustrating how the weight of a car on a slope can be split into components parallel to the slope $W_{\parallel}$ and perpendicular to the slope $W_{\perp}$.

The weight of the car can be thought of as having a component parallel to the slope, $W_{\parallel}$, plus a component perpendicular to (at right-angles to) the slope, $W_{\perp}$. Use trigonometry to find the size of the component parallel to the slope, $W_{\parallel}$.
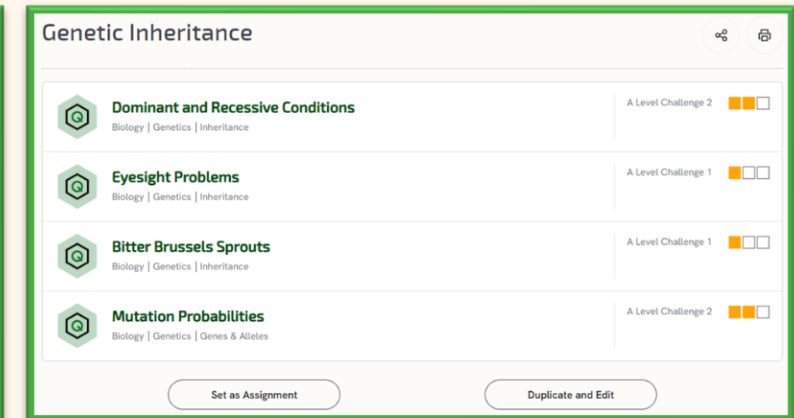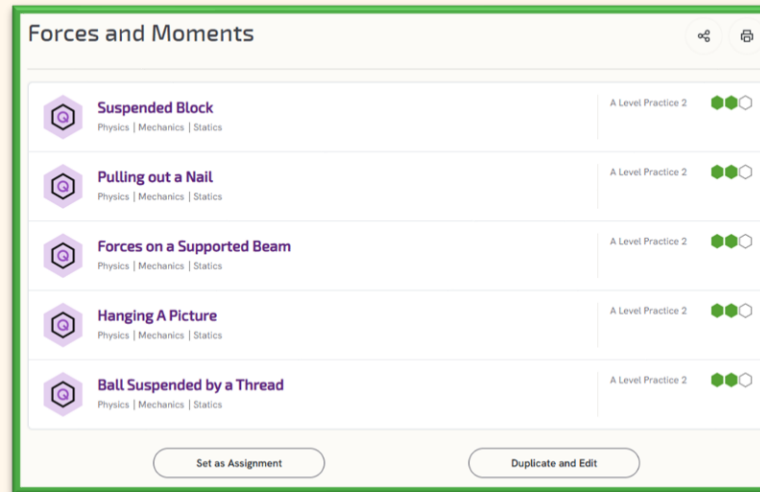
Integrating Maths and Science

- You can embed maths and science questions into a deck
- Help reinforce connections between subjects and consolidate skills

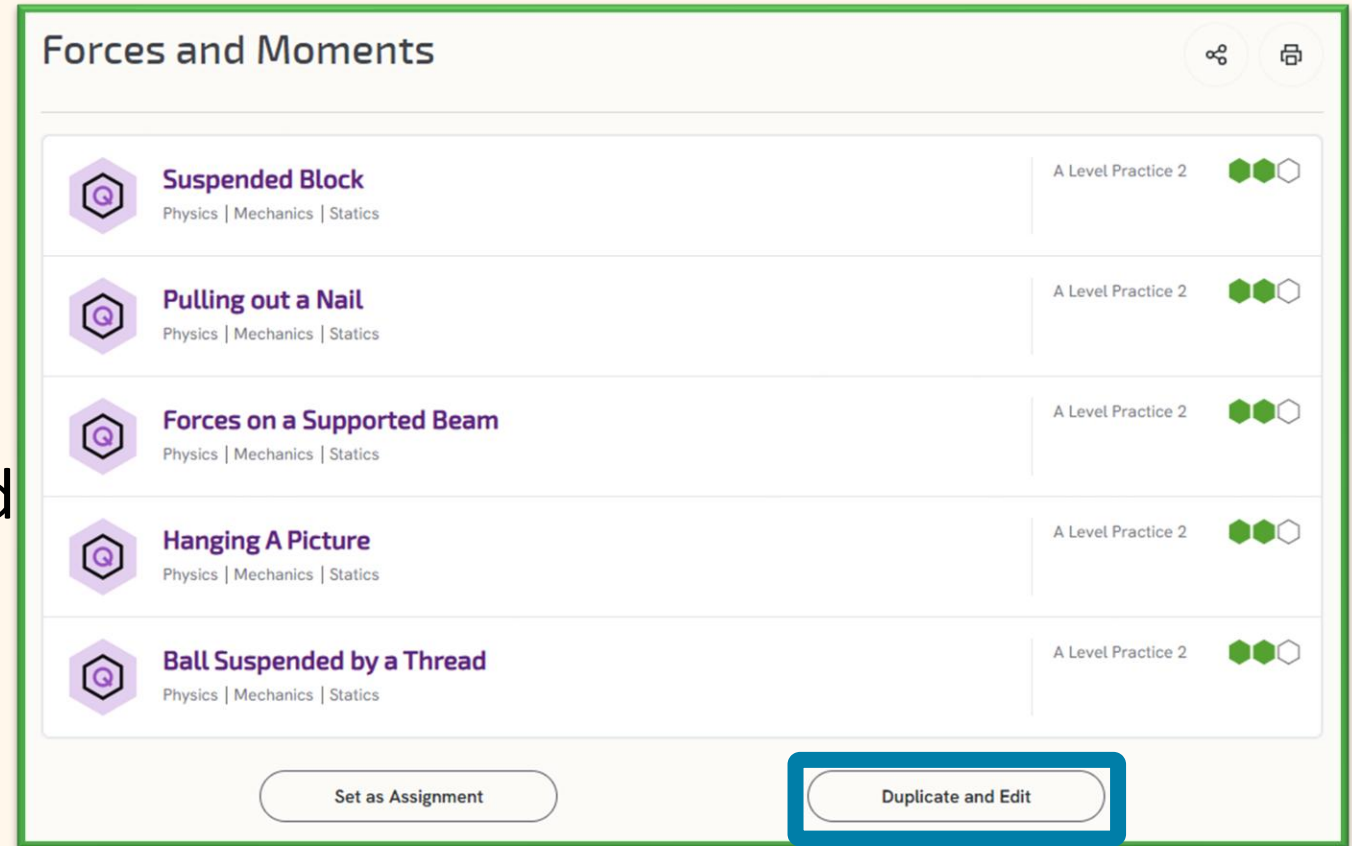**Example Decks**

- Forces and Moments
- Genetic Inheritance

Integrating Maths and Science

Forces and Moments

- Questions on resolving forces, moments and equilibrium

- Could add trigonometry questions to reinforce required skills

- Use Duplicate and Edit to edit

Editing a Deck

- Edit title or questions

- Search by text, book, stage, topic, or difficulty

- Reorder or remove questions

- Can undo or redo changes

- Click to save the deck

Integrating Maths and Science

Genetic Inheritance

- Questions on genetics, inheritance, mutations

- Could add probability questions to reinforce required skills
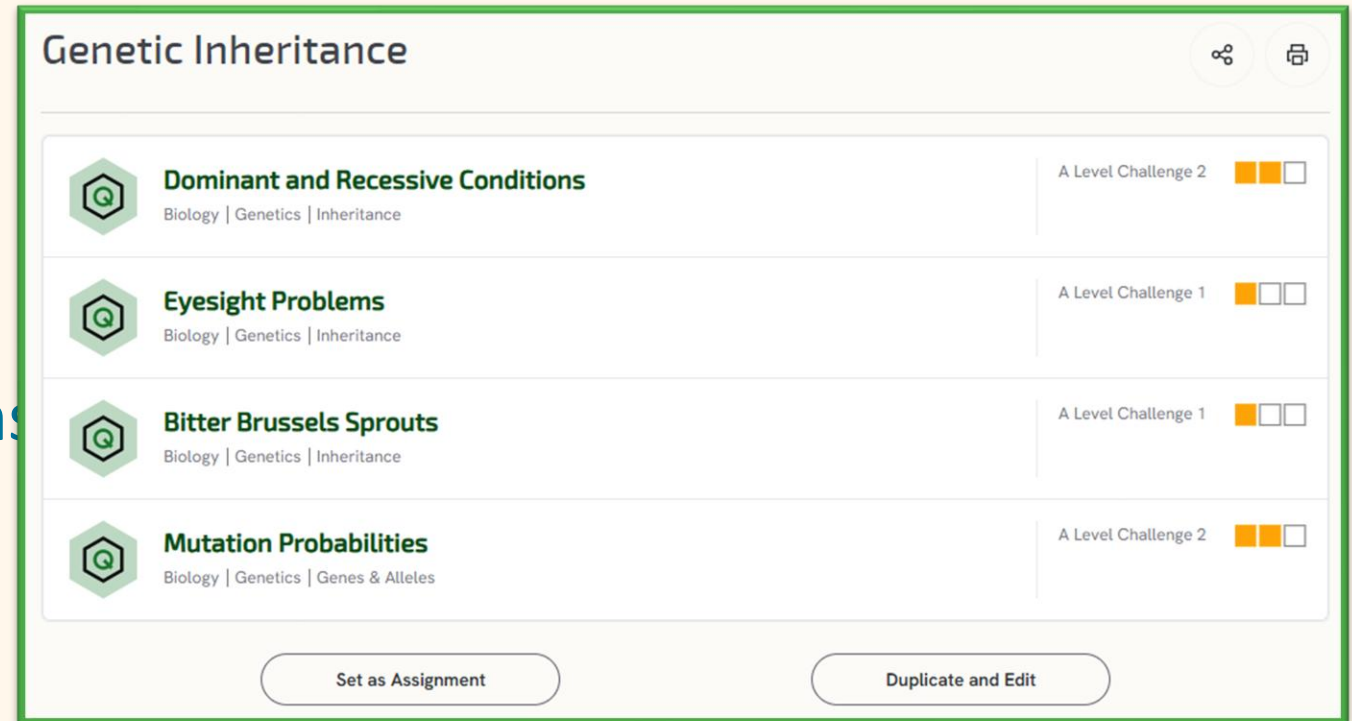
Have a go!

Step up to GCSE Book isaacscience.org/books/step_up_phys

GCSE Physics Book isaacscience.org/books/phys_book_gcse

GCSE Maths Book isaacscience.org/books/maths_book_gcse

Pre-Uni Maths Book isaacscience.org/books/pre_uni_maths_2e

Core Skills Practice isaacscience.org/maths/a_level/tools

Rearranging Equations isaacscience.org/question_decks#ipts25_sat_3a_re_eqn

Sample Topics isaacscience.org/question_decks#ipts25_sat_3a_topics

Trigonometry in Science isaacscience.org/question_decks#ipts25_sat_trig