Name	Date started	Target end date

WJEC GCSE Mathematics and Numeracy (Double Award) — Question Pack

Forming and using equations for direct and inverse proportion: $y \propto x$, $y \propto x^2$, $y \propto \frac{1}{x}$, and related variations. Find

REVISE
.wales

3.05 — Direct & inverse proportion equations

Spec 2.2.10 — Unit 3 (calculator allowed)

Forming and using equations for direct and inverse proportion: $y \propto x$, $y \propto x^2$, $y \propto \frac{1}{x}$, and related variations. Find the constant of proportionality from a given pair of values, then use the equation to predict other values. Sourced from legacy WJEC GCSE Mathematics & Mathematics-Numeracy Higher calculator-allowed papers, organised for revision under the 2025 spec.

2025 SPECIFICATION

Estimated time for entire question pack: ~1 hours 30 minutes

*Derived from the GCSE Higher pace of **~1.5 min/mark** (60 marks across 15 questions).*

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **focused single-topic practice pack**, not a single mock paper. Questions are organised against the 2025 specification. Questions are ordered chronologically by sitting, with custom-written and SAM questions at the end.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working — method marks are awarded for clear setup.

A calculator is allowed on every question in this pack (Unit 3 is the calculator-allowed paper).

Direct & inverse proportion equations — what the new spec asks

WJEC GCSE Mathematics (first teaching 2025) · Unit 3: calculator-allowed.

Forming the equation 2.2.10

- Translate the wording into $y = kx^n$ or $y = \frac{k}{x^n}$.
- Identify the power n from phrases like ‘square of’ or ‘square root of’.
- Use $\propto$ to write the proportion, then introduce k.

Finding the constant 2.2.10

- Substitute the given pair (x, y) into the equation.
- Solve for k — keep exact values.
- Re-state the complete formula before moving on.

Applying the formula 2.2.10

- Substitute any new x to predict y (or vice versa).
- Use a calculator in Unit 3 — round only at the final step.
- Watch units: km vs. m, hours vs. minutes.

Tables & mixed parts 2.2.10

- Many questions follow up with a table to complete using the formula.
- Check at least one entry against the original data as a sanity check.
- Inverse-proportion tables often have decimals — quote answers to the requested d.p.

Crib sheet »

Direct & inverse proportion equations in one page

Quick-reference notes — revisit before each question. Don't use during the questions.

Direct proportion

$y \propto x \Rightarrow y = kx$.

$y \propto x^2 \Rightarrow y = kx^2$.

$y \propto \sqrt{x} \Rightarrow y = k\sqrt{x}$.

Doubling x changes y in a predictable way set by the power.

Inverse proportion

$y \propto \frac{1}{x} \Rightarrow y = \frac{k}{x}$.

$y \propto \frac{1}{x^2} \Rightarrow y = \frac{k}{x^2}$.

As x grows, y shrinks — useful for physics-flavoured questions (resistance, intensity, etc.).

Finding k

Substitute the given (x, y) pair into the proportion equation.

Solve for k.

Worked: $y = kx^2$, given $y = 18$ when $x = 3$. Then $18 = 9k \Rightarrow k = 2$.

Using the equation

Once you have k, write the explicit formula (e.g. $y = 2x^2$).

Substitute any new x to predict y, or rearrange to find x from y.

Calculator-allowed: keep k exact (fraction or surd) until the last step.

Worked example (direct)

$y \propto x^3$, and $y = 40$ when $x = 2$.

$40 = k \cdot 8 \Rightarrow k = 5$.

So $y = 5x^3$. When $x = 4$: $y = 5 \cdot 64 = 320$.

Worked example (inverse)

$y \propto \frac{1}{x}$, and $y = 12$ when $x = 5$.

$k = xy = 60$, so $y = \frac{60}{x}$.

When $x = 8$: $y = 7.5$.

Reading the wording

'Varies as' or 'is proportional to' ⇒ direct.

'Varies inversely as' or 'inversely proportional to' ⇒ inverse.

Check the power — 'proportional to the square of', 'cube of', 'square root of'.

Common traps

• Mixing up $y = kx$ and $y = \frac{k}{x}$ — always quote the proportion statement first.

• Forgetting the power (e.g. writing $y = kx$ when it's really $y = kx^2$).

• Solving for k but never writing the full formula.

• Rounding k too early and propagating error to later parts.

Examiner only

11. Given that y is inversely proportional to x, and that $y = 4$ when $x = 3$,

(a) find an expression for y in terms of x, [3]

(b) use the expression you found in *(a)* to complete the following table. [2]

x	3	0·25	
y	4		$\frac{1}{5}$

Examiner only

13. Given that y is inversely proportional to x^3 and that $y = 120$ when $x = 2$,

(a) find an expression for y in terms of x, [3]

(b) use the expression you found in part *(a)* to complete the following table. [2]

x	2	10	
y	120		15

Examiner only

11. Given that y is directly proportional to $\sqrt{x}$ and that $y = 30$ when $x = 36$,

(a) find an expression for y in terms of x, [3]

(b) use the expression you found in part *(a)* to complete the following table. [2]

x	36	49	
y	30		40

Examiner only

11. During a chemistry experiment, it was found that a particle **lost** $\frac{3}{4}$ of its mass every second.

The initial mass of the particle was 160 mg.

(a) Calculate the mass of the particle after 4 seconds.
Circle your answer. [1]

2·5 mg 0·15625 mg 40 mg 0·625 mg 0·875 mg

(b) Write down a formula for the mass m, in milligrams, of the particle after t seconds. [3]

Examiner only

12. Catrin is measuring the force between a pair of magnets in a physics laboratory. It is known that the force, F, between the magnets is inversely proportional to the square of the distance, d, between them.

Catrin measures the force to be 4 newtons when the distance between the magnets is 10 m.

What is the distance between the magnets when the force is 100 newtons? [5]

Examiner only

11. The illuminance of light, I, from a lamp depends on the distance, d, from the lamp.
The unit used to measure the illuminance of light is the lux.

It is known that I is inversely proportional to the square of d.

Carys has a desk lamp in her room.
For her lamp, Carys measures the illuminance, I, to be 5 lux when the distance, d, is 2 m.

What is the illuminance of light from this lamp at a distance of 0·5 m? [4]

Examiner only

10. A farmer knows that the time, t, taken by goats to eat all the grass in a particular field is inversely proportional to the number of goats, g, in the field.

When there are 25 goats in the field, the time taken to eat all the grass is 36 days.

You may assume that all the goats eat grass at the same rate.

(a) Find a formula for the time, t, in terms of the number of goats, g. [3]

(b) Hence, find the time taken for all of the grass to be eaten when there are 20 goats in the field. [1]

(c) The farmer needs the grass to last for at least 40 days.
What is the greatest number of goats that should be allowed in the field? [2]

Examiner only

10. *(a)* (i) You are given that y is **inversely** proportional to $\sqrt{x}$.
$y = 65$ when $x = 51{\cdot}84$.
Find an expression for y in terms of x. [3]

(ii) Use the expression you found in part (i) to complete the following table. [2]

x	51·84	15·21	
y	65		78

(b) It is known that c is **directly** proportional to the square of d.
What happens to c if d is doubled?
Circle the correct statement below. [1]

c is divided by 2	c is multiplied by 2	c is divided by 4	c is multiplied by 4	c is squared

Examiner only

11. The wavelength of a sound wave, W metres, is **inversely proportional** to its frequency, f hertz (Hz).

Richard is measuring the wavelengths of different sound waves.
The wavelength is 0·5 m when the frequency is 1200 Hz.

What is the frequency when the wavelength is 10 m? [4]

Examiner only

11. (a) Given that y is **directly** proportional to x^3 and that $y = 108$ when $x = 3$,

(i) find an expression for y in terms of x. [3]

(ii) Use the expression you found in part (i) to complete the following table. [2]

x	3	5	
y	108		4000

(b) It is known that e is **inversely** proportional to f.
Describe what happens to e when f is doubled. [1]

Examiner only

11. (a) Given that y is inversely proportional to x and that $y = 0{\cdot}2$ when $x = 160$, find an expression for y in terms of x. [3]

(b) Use the expression you found in part (a) to complete the following table. [2]

x	160	128	
y	0·2		0·8

Examiner only

13. y is inversely proportional to the square of x.
$y = 16$ when $x = 5$.

(a) Find an expression for y in terms of x. [3]

(b) Use the expression you found in part (a) to complete the following table. [2]

x	5	0·1	
y	16		100

Examiner only

12. x is proportional to $\sqrt{w}$, and $x = 24$ when $w = 36$.

Also, y is inversely proportional to x, and $y = 8$ when $x = 15$.

Find the value of y when $w = 25$. [6]

Examiner only

11. In a science experiment, Jamil collects the following pairs of data values for two variables, x and y.

x	4	7	8
y	80	245	320

(a) Using the values in the table, show that y is **not** directly proportional to x. [2]

(b) Given that y is directly proportional to x^2, find a formula for y in terms of x. [3]

x			
y			