

Direct Proportion Equations (Non-Linear)

Starter

1. **(Review of last lesson)** You are given that f is directly proportional to g . When $f = 27$, $g = 378$. What is the value of f when $g = 203$?

Notes

From last lesson y is directly proportional to $x \Rightarrow y \propto x \Rightarrow y = kx$.

This is a linear relationship because x is raised to the power of 1 i.e. $x = x^1$.

y could also be directly proportional to other powers of x – these are **non-linear relationships**.

y is proportional to...	Relationship	Equation
... x	$y \propto x$	$y = kx$
...the square of x	$y \propto x^2$	$y = kx^2$
...the cube of x	$y \propto x^3$	$y = kx^3$
the cube root of x	$y \propto \sqrt[3]{x}$	$y = k\sqrt[3]{x}$

The method to solve the problems is the same as before.

Success criteria – finding the proportion equation

- Write an expression with the proportion symbol, \propto .
- Replace the proportion symbol by “ $= k$ ”, where k is the **constant of proportionality**.
- Use the given values to find the value of k .
- Replace k in the equation from step 2 by the value found in step 3.

E.g. 1 A quantity A is directly proportional to the square of B . When $A = 36$, $B = 3$.

- Find the constant of proportionality.
- Find A when $B = 5$.
- Find B when A is 196.

Working:

(a) $A \propto B^2 \Rightarrow A = kB^2$
 $A = 36, B = 3 \Rightarrow 36 = k \times 3^2$
 $k = 4$

(b) ...

E.g. 2 Given that $V \propto r^3$, copy and complete the table.

r		2		1.5
V	1.6	32	256	

Hint: Calculate the constant of proportionality so that you have a formula. Substitute numbers into the formula to find the missing values.

E.g. 3 In an experiment, Julie made measurements of w and p .

w	2	5	7
p	1.6	25	68.6

Which of these laws fits the results: $p \propto w$, $p \propto w^2$ or $p \propto w^3$?

Hint: Calculate the constant of proportionality for all three relationships using one piece of data (e.g. $w = 5$ and $p = 25$ since they are both whole numbers) so that you have a formula for each.

Then substitute the other sets of data points into the formula to see if they give the correct values.

Working: **Assume** $p \propto w$ so $p = kw$
Using $w = 5$ and $p = 25$: $25 = k \times 5$ so $k = 5$
 So $p = 5w$
When $w = 2$: $p = 5w = 5 \times 2 = 10 \neq 1.6$
 So $p \propto w$ is not the relationship

Now do the same for $p \propto w^2$ and $p \propto w^3$

Video: [Direct proportion](#)

[Solutions to Starter and E.g.s](#)

Exercise

9-1 class textbook: p145 E5.2 Qu 2-10
 A*-G class textbook: p135 E5.3 Qu 1-10
 9-1 homework book: p51 E5.2 Qu 1-7
 A*-G homework book: p38 E5.3 Qu 1-7

Summary

y could be directly proportional to other powers of x — these are **non-linear relationships**.

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1. Write an expression with the proportion symbol, \propto .
2. Replace the proportion symbol by “ = k ”, where k is the **constant of proportionality**.
3. Use the given values to find the value of k .
4. Replace k in the equation from step 2 by the value found in step 3.

Homework book answers (only available during a lockdown)