



# GCSE Physics

## A Step by Step Guide to Maths Questions

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### INSTRUCTIONS, EXAMPLES & GRID SHEET

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## Tips from Experienced Teachers

A formula is just a quick mathematical way to describe a relationship between variables. If you can use words to describe the relationship, it will be much easier to see how the formula works. There's a story behind each one, and the human brain is really good at remembering stories. A formula is an equation involving measurable quantities.

The diagram shows the formula  $Q = It$  with three arrows pointing to the variables: a teal arrow from the word "charge" to  $Q$ , a purple arrow from the word "time" to  $t$ , and an orange arrow from the word "current" to  $I$ . Below the formula, the words "charge", "current", and "time" are highlighted in teal, orange, and purple respectively, and are separated by an equals sign and a multiplication sign to form the sentence "charge = current x time".

Understanding a formula and remembering it are different things, just like remembering a spelling and using a word correctly are different. You learn hundreds, even thousands of new words every year - memorising a few formulas is easy.

The symbols used aren't random. They mean something, usually because of the history behind the science. (We use  $I$  for current because the French scientist who described it used the phrase *intensité du courant*, shortened to  $I$ .) You might find them easier to remember if you know the reason. Symbols are usually printed in italic font.

You can make your life much easier if you memorise the quantity, the symbol, the unit, abbreviation and measuring device as linked ideas. Eg Force  $F$  is measured in newtons (N), and the device is called a newtonmeter

Learning a process that you follow every time reduces the chance of mistakes and so helps you get more marks. You can use the same process to solve every single mathematical problem in physics. It might seem silly to go through every step for easy problems, but it means you will be confident when the maths gets tricky.

## Answering Maths Questions

Below we'll walk you through the steps you should take when answering a mathematical question, with an example shown for reference at each stage. **On the last page we've included a blank grid so that you can practise the steps with your own questions.**

This process might seem like a lot of hassle when the question is simple, but checklists are a really good idea. They're used by airline pilots and heart surgeons so that everyone does things the same way and nothing gets forgotten.



These steps can be used for every single mathematical question in a science classroom, and everyone goes through them - even your teachers! The difference is that with practice, for an easy question you might do some of the steps in your head rather than on paper. It's like tying your shoes...

The reason you can do it quickly now is that you learned each step and practised.



A variable is something that can be measured or calculated. It has a symbol, usually printed in italics, and a unit [with its own abbreviation].



## For example

Acceleration is the rate of change of velocity, or how much the velocity changes per second of time. The symbol is  $a$  and it is measured in metres per second squared, or  $m/s^2$ .

In any question, you will be given *values* for some of the variables, which are numbers with a unit. It's important to include the unit, because we can write the same amount in different ways, e.g. 30 cm and 0.3 m mean the same thing.

Below, we show you a real example of how to use the steps. At the end of the booklet there is a blank grid which you can use to solve other mathematical questions. Good luck!

## Example question

A model car travels 900 cm at 2 m/s.  
How long does it take?

The kinetic energy of the model car is 5 J when it is travelling at 2 m/s.  
What is the mass?

Step	Details	Question part 1	Question part 2
1. Read	Read the whole question. This includes looking at any diagram or table of data. It's often helpful to underline the numbers or label them with the variable.	A model car travels <u>900 cm</u> at <u>2 m/s</u> . How long does it take?	The kinetic energy of the model car is <u>5 J</u> when it is travelling at <u>2 m/s</u> . What is the mass?
2. Write what's there	Write out the numbers that matter. For each one, write the variable and then the value, followed by the unit.	$s = 900 \text{ cm}$ $v = 2 \text{ m/s}$	$E = 5 \text{ J}$ $v = 2 \text{ m/s}$
3. Write what you need	What is the question asking for? Write down the symbol for the variable.	$t = ?$	$m = ?$
4. Formula?	Which relationship do you need? The list of variables you wrote down in steps 2 and 3 will help you make the right choice. You might remember it, or you might need to check the equation sheet.	$v = s / t$ velocity = distance / time	$E = \frac{1}{2} mv^2$ (The kinetic energy could be written as $E$ , $E_k$ or sometimes KE. If in doubt, use words.)



5. Convert?	<i>If needed</i> , convert the values to standard units. Everything that is going into the equation needs to be in standard unit. E.g. if you have a value in kilometres, you need to multiply by 1000 to get it in metres.	$s = 900 \text{ cm} = 9 \text{ m}$ $v = 2 \text{ m/s}$	$E = 5 \text{ J}$ $v = 2 \text{ m/s}$
6. Rearrange?	<i>If needed</i> , rearrange the equation. In maths, this is often called changing the subject of the equation. There are several ways to do this and you should use the one you are best at. The most common mistake is to be careless with square functions.	$v = s / t$ $v t = (s / t) t$ $v t = s$ $v t / v = s / v$ $t = s / v$  You might also have memorised the triangle mnemonic for this.	$E = \frac{1}{2} m v^2$ $2 E = m v^2$ $m = [2 E] / v^2$  Like several others in GCSE Physics, this formula is hard to rearrange with the triangle method.
7. Substitute	Refer back to what you wrote down and substitute in the values.	$t = s / v$ $= 9 \text{ m} / 2 \text{ m/s}$	$m = [2 E] / v^2$ $= [2 \times 5 \text{ J}] / [2 \text{ m/s}]^2$
8. Calculate	Calculate the value you need – this is where you use your calculator. You might find there are numbers you can cancel first to make it easier.	$t = 9 / 2$ $= 4.5$	$m = [2 \times 5] / 2^2$ $= 10 / 4$ $= 2.5$
9. Unit and Check	Add the unit to your answer (words or an abbreviation) and do a common sense check. Before you move on, does what you've written make sense?	$t = 4.5 \text{ seconds}$  This seems reasonable. If the calculation gave 450 seconds (more than 7 minutes) then this check would be a chance to realise something had gone wrong.	$m = 2.5 \text{ kg}$  This seems reasonable for a <i>model</i> car.

## Step by Step Grid for Answering Maths Questions, see the Step by Step Guide for how to use it

Step	Write here. Check hints column only <i>if needed</i>	Hints
1. Read		This includes looking at any diagram or table of data. It's often helpful to underline the numbers or label them with the variable.
2. Write what's there		For each one, write the variable and then the value, followed by the unit.
3. Write what you need		What is the question asking for? Write down the symbol for the variable.
4. Formula?		The list of variables you wrote down in steps 2 and 3 will help you make the right choice. You might remember it, or you might need to check the formula sheet.
5. Convert?		Everything that is going into the formula needs to be in standard units. So if you've got a value in kilometres, you need to multiply by 1000 to get it in metres.
6. Rearrange?		In maths, this is often called "changing the subject of the equation." There are several ways to do this and you should use the one you are best at.
7. Substitute		Refer back to what you wrote down and write in each value.
8. Calculate		This is where you use your calculator. You might find there are numbers you can cancel first to make it easier.
9. Unit and check		Write the answer with the right unit (words or abbreviation). Before you move on, does it make sense?



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