

6 Useful formulae



Technique sheet

Problem-based learning resources

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How can I use formulae in practical situations?

You can work out many unknown quantities using mathematical formulae. For example, when you apply a force (F) to an object it accelerates. The greater the force the greater the acceleration (a). But the mass (m) of the object also affects the relationship. A massive object needs a larger force to produce the same acceleration. This is shown by the formula: $F = ma$. To work out the force that was applied to a object of mass 850kg accelerating at 2.5m/s^2

$$F = m \times a$$

$$F = 850 \times 2.5$$

$$= 2125\text{N.}$$

What do all the letters mean when using a formula?

When using formulae there are two different sets of letters: variables and units.

So, $F=ma$ has three variables. F is the force that is being applied, m is the mass of the object that the

force is being applied to and a is the acceleration of that object.

These variables are quantities and so they must be measured in specific units. Force F is measured in Newtons, which is abbreviated to N. Mass m is measured in kilograms (kg) and acceleration a is measured in metres per second per second or metres per second squared (m/s^2) It is sometimes written as ms^{-2} or msec^{-2} .

Whenever you show your answer, it is important to show the units for your answer. The outcome of the calculation will only be in Newtons if the acceleration was measured in m/s^2 and the mass was measured in kg. So, if you took measurements in different units e.g. you measured the mass in pounds and ounces or grammes, then you must convert to kg before you can use the formula.

What happens if I need to work out one of the other variables in the formula?

To do this you will need to use some algebra. There are two ways to go which depend on what you prefer. Either you can rearrange the formula before starting the calculation, or you can substitute the

numbers you know and then rearrange. The BIC rule is this: do the same thing to both sides of the equation to make the changes you need. 1. Rearrange before you start:

Start with the standard formula
 $F = ma$

Divide both sides of the equation by m
 $F/m = ma/m$

Cancel out (m divided by m)
 $F/m = a$

Rearrange the formula
 $a = F/m$

This is a more convenient version when you are looking for a!

Using the original numbers to check
 $a = 2125/850$
 $= 2.5m/s^2$

What happens with different types of formulae?

In Ohms Law, $V = IR$, V is potential difference in Volts (V), I is current in Amps (A) and R is resistance in ohms (Ω). Notice that the letters in the formula do not match up with the variables and for one of them it matches with the units.

The pressure formula $P = m/V$ where m is mass (kg) and V is volume (m^3). Notice that this one is shown as a division, so to change it to show m you can multiply both sides by V to give $PV = m$

Some formulae have more variables, like the one for starting and finishing velocity, acceleration and time.

Start with the basic formula.	$v = u + at$
Take away u from both sides	$v - u = at$
Divide by a and re-arrange to give	$t = (v - u) / a$

Start again with the basic formula	$v = u + at$
Take away u from both sides again	$v - u = at$
This time divide by t and re-arrange to give	$a = (v - u) / t$

Some formulae have more variables	$v = u + at$
Take away at from both sides	$v - at = u$
Now just re-arrange to give	$u = v - at$

How hard can it get?

Formulae can get longer or have more complicated expressions like square roots and lots of brackets but the basic rules are the same:

- What you do to one side of the equals you must do to the other (e.g. dividing by t)
- Equations can be re-arranged to make them more convenient so $a = b + c + d$ is exactly the same as $b + c + d = a$
- Once you have the formula in the most convenient form, substitute in the values and do the calculation.



Check yourself

You should be able to answer these questions easily after reading this sheet.

1. Why are units important when using scientific formulae?
2. What are three ways to write acceleration metres per second per second?
3. What is the first rule when re-arranging formulae?



Taking it further

These activities will deepen your understanding of this topic.

There are much more sophisticated formulae used in more advanced applications.

It is a good idea to become familiar with the graphs of different relationships, so you get a feel for how things change.

In the production process, liquid chocolate cools, it becomes solid and then the solid chocolate cools further.

