Formulae Level 2

How to Guide

Name: _____

Date: _____

Skills Check

Rate how confident you feel about the skills tested in this section:

Skill	Not a clue!	I know a little	I feel okay with this	I feel quite confident	I feel very confident
Work with formulae with different layouts					
Understand what formulae are					
Substitute values into formulae					
Apply BIDMAS					
Use common formulae					
Rearrange formulae					

When you have finished the booklet, use a different colour to mark your confidence levels again.

Formulae

Introduction

People can be intimidated by formulae because it often involves algebra. The idea is really to have one set way of working something out where you can change some of the numbers depending upon what you are doing.

Before doing this booklet make sure you are confident with BIDMAS.

Layout of Formulae

There is no multiplication sign in algebra.

Example

12(5-2) = 12 x (5-2)

6a means 6 x a

3b − 8 = 3 x b − 8

"When things touch they times"

Letters are used to represent values that can change. The use of letters just simplifies something that could look very long written out in full.

Example

A driver is paid £20 per hour and gets £50 per day for expenses.

Here is a formula you could use to work out his pay:
20 x number of hours + 50 x number of days

You could write this more simply as: 20 x h + 50 x d

Or using our rule about not using the x symbol: 20h + 50d

Question

In one week, he works 35 hours over 4 days.
What would his pay be?

Answer

20 x 35 + 50 x 4
do the multiplications first.
700 + 200 = 900
The driver earns £900

Try it Out

Question 1

The next week the driver works 27 hours over 5 days. How much does he earn?

Understanding Formulae

You should always be aware of the units a formula uses. There will generally be a type of key with the question and you need to make sure all the units match i.e. pounds/pence/ grams/kg/metres/cm

Example

A gas bill is £15.23 per month plus 8p per unit used. If 540 units are used what would the total cost be that month in pounds?

Answer

Convert the pence into pounds 8p = £0.08

(540 x 0.08) + 15.23

43.2 + 15.23 = **£58.43**

Try it Out

Question 2

a) Sharleen and Anna have a water meter. Their bill tells them they have to pay a chargeable volume of water in m^3 plus a fixed standing water charge. The standing water charge is £12.55. The chargeable volume of water is 60m^3 at 108.06p. What is the total bill?

b) An engineer uses this formula to calculate acceleration.

$$acceleration = \frac{change\ in\ volocity}{time}$$

Always check your units

Acceleration is measured in m/s^2, change in velocity is measured in m/s and time in seconds.

An object has a change in velocity of 35m/s and takes 3.5 minutes to complete its journey. What is its acceleration?

c) The formula to find area is $A = lw$ where l is length and w is width. What is the area of a room with dimension of 6.5m and 240cm?

Substituting Values

Most formulae work by substituting numbers for values.

Method

1) Match the numbers and letters

2) Check the units match the information in the question

3) Substitute the numbers for the relevant letters

4) Carry out the calculation following the rules of BIDMAS and remembering that the × symbol is not used in algebra.

Example

The formula for mass is $m = \dfrac{f}{a}$

m = mass in kg, f = force in Newtons (N), a = acceleration in m/s^2

A force of 60N is applied to an object accelerating at 12 m/s^2. What is its mass?

Answer

Identify the parts we know: f = 60N and a = 12 m/s^2

Check the units fit the question ✓

Put the values into the formula $m = \dfrac{f}{a} \rightarrow m = \dfrac{60}{12} = 5$

Mass is 5kg

Try it Out

Question 3

a) Ohm's Law states that $V = IR$

R = resistance (Ohms, Ω), V = voltage difference between the two ends of a resistor (Volts, V), I = the current flowing through a resistor (Amperes, A)

What is the voltage if the resistance is 4Ω and the current is 12A?

b) A blog writer uses the following formula to work out how much to charge her clients

$$T = F + 0.05W$$

She charges 5p per word and has a fixed cost of £20. T is the total cost she charges. A client wants a 400 word blog. How much would she charge?

c) A company allows employees to claim travel expenses per mile using the following formula where T is the total cost in pounds.

$$T = 0.45m$$

An employee travels a total of 270 miles in one month. How much would they claim for travel in pounds?

d) Brad reads the instructions for cooking a chicken. The formula given is

$$T = 25\left(\frac{m}{500}\right) + 15$$

Where T is the total cooking time in minutes and m is the mass in grams. How long would a chicken of 2.4kg take to cook? NOTE: *beware of units.*

Common Formulae

Here are some of the formulae you may need to be familiar with. π is the symbol for pi. It's a fixed number that goes on infinitely so that's why we use the symbol to represent it. In some questions you can use 3.1 or 3.14 instead of pi or when you don't have the π button on your calculator.

Area of a circle $$A = \pi r^2$$	**Volume of a cylinder** $$V = \pi r^2 h$$	**Area of a triangle** $$A = \frac{bh}{2}$$	Density $$density = \frac{mass}{volume}$$
Circumference of a circle $$C = \pi d$$	Temperature Conversion $$C = \frac{5}{9}(F\text{-}32)$$	OR $$A = \frac{1}{2}bh$$	**Speed** $$speed = \frac{distance}{time}$$

You should learn the formulae in **bold** as they may not be given on the exam paper.

Try it Out

Question 4 – use the formulae above to answer these questions.

a) Convert a temperature of 88°F to Celsius.

b) What is the area of a triangle with base 15cm and height of 12cm?

c) What is the volume of a cylinder with a radius of 3cm and height of 20cm?

d) What is the area of a circle with radius 5cm?

e) How fast is a car travelling if it covers 80 miles in 1.5 hours?

Rearranging Formulae

Sometimes the bit you are asked to find in a formula is not the part after the equals sign. This means you rearrange the formula to find the part you want. There are a few techniques you can use. Here is one technique:

You always want to have the letter you are interested in on its own on one side of the formula. To do that you move everything else to the opposite side.

Process

Replace any letters with numbers you are given in the question

Do any calculations that are possible as you go along

Move letters and numbers using reverse BIDMAS

When letters and numbers go to the opposite side the operation changes

> ➢ Add becomes subtract and subtract becomes add
> ➢ Multiply becomes divide and divide becomes multiply

Example

The volume of a cylinder is 550cm³ and it has a radius of 6cm. What is its height? $V = \pi r^2 h$

We know V is 550 and r is 6 so that gives $550 = \pi 6^2 h$

We can work out that $6^2 = 36$ so $550 = \pi 36 h$

We want to get h on its own so $\pi \ and \ 36$ need to move to the other side. Remember 'when things touch they times' so the right side is $\pi \times 36 \times h$

When we move $\pi \ and \ 36$ they will do the opposite of times which is divide

$$\frac{550}{\pi \times 36} = h$$

We can now work out h by putting the part on the left into a calculator

h = 4.86cm to 2 d.p.

Try it Out

Question 5 - Use the list of common formulae to answer these questions

a) The circumference of a circle is 220cm. What is its diameter?

b) What is the height of triangle whose base is 4cm and the area is 12cm²?

c) A car travels at 60mph for 3 hours. How far did it travel?

d) The density of air is 1.3 kg/m³. Calculate the mass of a balloon which holds 0.025 m³ of air.

Example	ANSWER
The area of a circle is 80cm². What is its radius? $A = \pi r^2$	$80 = \pi r^2$ We want to leave r on its own so we move π to the left. It is connected to r by multiplication, so we move it by dividing $\frac{80}{\pi} = r^2$ We want just r not r^2 so we need to do the opposite of squaring $\sqrt{\frac{80}{\pi}}$ = r you can now put this in your calculator to give r = 5.05cm

Try it Out

Question 6 - Use the list of common formulae to answer these questions.

a) The volume of a cylinder is 825cm². It is 12cm tall. What is its radius?

b) What's the radius of a circle with an area of 450cm²?

For some formula it is extremely important to follow BIDMAS backwards to avoid making a mistake.

Example

Convert a temperature of 28°C into Fahrenheit.

$$C = \frac{5}{9}(F\text{-}32)$$

ANSWER

We fill in any numbers we know. $C = \frac{5}{9}(F\text{-}32) \rightarrow 28 = \frac{5}{9}(F\text{-}32)$

Following reverse BIDMAS, we leave the bracket until last. We move the $\frac{5}{9}$ to the left first so that we can get F on its own.

We need to do the opposite operation. On the right, the formula divides by 9 and multiplies by 5 (because the fraction is touching the bracket). When we move them to the left, the 9 will multiply and the 5 will divide

$\frac{9 \times 28}{5}$ = (F-32) and we can calculate 9 x 28 $\rightarrow$ $\frac{252}{5}$ = (F-32)

WE can do the calculation on the left $\frac{252}{5}$ = 50.4

Now we can look inside the bracket and move the 32 away from the F. As it is subtracted on the right, it will do the opposite operation when it moves to the left, which is addition

$50.4 + 32 = F$ finish it on the calculator $\rightarrow$ F = 82.4°F
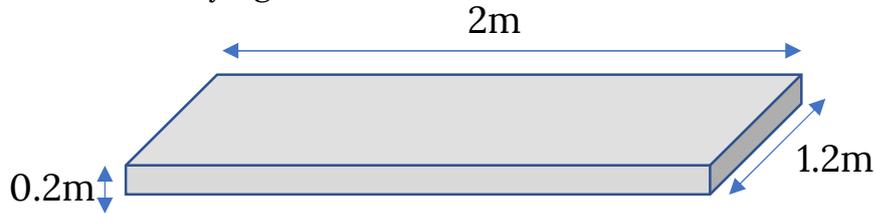
Try it Out

Question 7

a) Convert a temperature of 42°C into Fahrenheit.

b) Convert a temperature of 15°C into Fahrenheit.

Mixed Questions

a) A builder is laying a concrete slab.

2m

0.2m

1.2m

Density

$$density = \frac{mass}{volume}$$

The density of concrete is 2,400 kg per m³. What mass of concrete does the builder need for the slab?

b) The surface area of a sphere is calculated using the formula

$A = 4\pi r^2$. What is the surface area of a sphere with a radius of 5cm?

c) Julie travels often for business. Her company have given her this formula to calculate her expenses. She can claim mileage allowance and daily expenses. She is given £10 per day she is travelling.

In one month, Julie travels 825 miles. She was travelling for 6 days in total. How much can she claim in expenses?

$T = 0.45M + 10D$

M = number of miles

D = number of days

T = total cost in £

d) A tennis ball has a radius of 3.4cm. What is its volume?

Volume of a sphere

$$V = \frac{4}{3}\pi r^3$$

e) A recipe states that a cake should be cooked at 350˚F. Abid works out this is approximately 150˚C. Is he correct?

f) How fast is a lorry travelling if it covers 90 miles in 1 hour 30 minutes?

g) Council tax is going to rise by 4.5% next year. This year, the cost of a house in band D is £622.31. Which of the four calculations below would find the cost for next year?

1) $622.31 \times \frac{4.5}{100}$

2) $622.31 + \frac{4.5}{100}$

3) $622.31 \times 622.31 \times \frac{4.5}{100}$

4) $622.31 + 622.31 \times \frac{4.5}{100}$

h) A taxi firm charges 50p per mile plus a fixed charge of £2.00. How much would a journey of 18 miles cost?

i) To convert between cm and inches you use the formula $I = \frac{C}{2.54}$ with C being centimetres and I being inches.

    1) What would 25cm be in inches?

    2) What would 5 inches be in centimetres?