WORCESTER
SIXTH FORM COLLEGE

Progression - Engineering

Contents:

1. Thinking of studying Engineering at Worcester Sixth Form College?

We teach the **OCR Cambridge Technical Engineering** specification.

Here is a brief summary of the units we cover over the first year of the two-year course. If you want to find out more about each of these topics, you can find the full specification on the OCR website (our full two year course is called Extended Certificate and holds A-level equivalence): https://www.ocr.org.uk/qualifications/cambridge-technicals/engineering/units/#level-3

Unit 01 – Mathematics for Engineering

- Triangles
- Basic algebra, rearrangements and fractions
- Factorisation and completing the square
- Simultaneous equations
- Logarithms and exponential relationships
- Coordinate geometry
- Circles, arcs sectors and radians
- Calculus (integration and differentiation – the maths of change)

Unit 02 – Science for Engineering

- Dynamics and kinematics (the physics of forces and motion)
- Torque and moments (turning forces)
- Energy, work and power
- Circuits
- Material physics
- Fluid flow and pressure
- Heat, thermodynamics and gas laws

In Year 1 you will also study **Unit 03 – Principles of Mechanical Engineering**. This unit expands on the physics principles in Unit 02 and includes more advanced topics such as gear systems, levers, frictional forces, centres of mass, beams and structural loading. Year 2 features 2 coursework units and a Unit on Electronic Engineering

2. Tasks to complete before September

In order to prepare for the course, you need to complete the following 3 tasks.

Task 1) Basic Maths Skills Check

1. Expand the brackets $(2x - 4)(-4 + x)$

2. Given $f(x) = x^2 + 5x - 2$ find the value of $f(4)$

3. Solve the simultaneous equations.
$$3x - 4y = 20$$
$$5x + 5y = 10$$

4. Solve each of these equations.

(i) $4x - 3 = 15$
(ii) $\frac{y}{3} + 4 = 9$
(iii) $5m - 8 = 2m + 13$

5. A (0,2), B (7,9) and C (6,10) are three points.

(i) Show that AB and BC are perpendicular.
(ii) Find the length of AC.

6. Given that $cos\theta = \frac{1}{3}$ and θ is acute, find the exact value of $tan\theta$.

Task 2) Symbols, Quantities and Prefixes

In Engineering, unlike GCSE, you need to remember all symbols, units and prefixes. Below is a list of quantities you may have already come across and will be using during your Engineering course.

1. Complete the gaps in the table. You may need to look up some of the symbols.

Quantity	Symbol	Unit
Velocity	v	**m/s or ms^{-1}**
Acceleration		**m/s^2 or ms^{-2}**
Time		**s**
	m	**kg**
Force	F	
Distance	s (yes really!)	**m**
	R	**Ω**
Potential difference	V	
	I	**A**
Energy		
Pressure	P	
Momentum		**$kgms^{-1}$**
Power	P	
Density	ρ	**kgm^{-3}**
Charge	**Q**	**C**
Magnetic Flux		
Inductance		
Capcitance		

2. The units in the table above are called SI units. Do some research and find out what SI stands for. Write a few notes in the space below.

Inevitably, some SI units are too big or too small for certain Engineering applications. The width of this page is about 20 centimeters, it wouldn't necessarily occur to you to describe the width of the page in metres, since a metre is much bigger than the page.

The word 'centi' is called a prefix and it has a mathematical meaning:

20cm = 0.20m so centi must mean x 0.01 or $x10^{-2}$

There are lots of other prexifes, allowing us to use SI units for huge numbers as well as teeny weeny ones.

Prefix	Symbol	Power of ten
nano	n	**x 10^{-9}**
micro	µ	**x 10^{-6}**
milli	m	**x 10^{-3}**
centi	c	**x 10^{-2}**
kilo	k	**x 10^{3}**
mega	M	**x 10^{6}**
giga	**G**	**x 10^{9}**

You need to memorise these prefixes. To help, here's an example of a method you can use:

Step 1) Find a word similar or related to the prefix – the weirder the better!!

Step 2) Visualise your link to the prefix, and find a way to include a visual reminder of the power of ten.

Example: Nano sounds like Nandos. You could visualise the Nando's logo and incorporate the -9 into the design. Alternatively, you could visualise going to Nandos and finding that the little flag in your burger has x10^{-9} written on it – the choice is yours!

3. Come up with visual reminders for each of the prefixes – some of them are trickier than others and it *will* take some time to come up with some really good memorable ones!!

Draw or describe each of the prefixes in the boxes below:

micro, µ	milli, m	centi, c	kilo, k	Mega, M	Giga, G

Converting Between Units

Prefixes are important because they make it nice and easy to convert back and forth between units. To convert from a prefixed unit into an SI unit all you have to do is replace the prefix symbol with the appropriate power of ten.

Example 1: 100 km = 100 x 10^3 m

Example 2: 3mA = 3 x 10^{-3} A

4. Convert the following into SI units:

i) 10 cm

ii) 730 nm

iii) 15 ms (milliseconds)

iv) 1 kN

v) 440 MJ

f) 1000 µF

In the above examples we 'got rid' of the prefix by **multiplying** by the appropriate power of 10. So, to add a prefix to a unit we must have to do the opposite – we **divide**. Let's convert 5000 grams to kilograms as an example:

$$5000 \text{ g} = \frac{5000}{10^3} \text{ kg} = 5 \text{ kg}$$

5. Convert the following into the specified units:

i) 120 g to kg

ii) 10 m to cm

iii) 0.001 A to mA

iv) 0.0005 s to µs

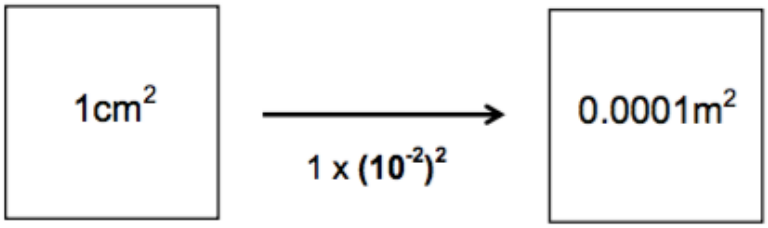
v) 19850 J to MW=J

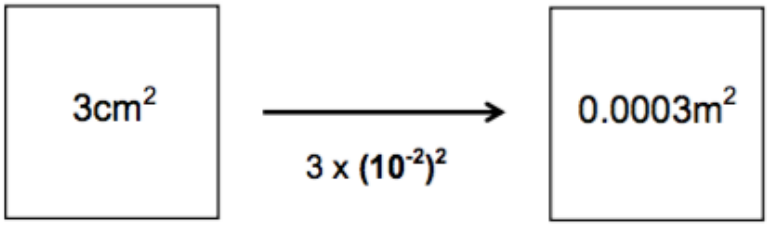
f) 190 000 000 W to GW

Converting Areas

We can use prefixes to convert areas. For starters it's worth debunking some mis-conceptions. $1m^2$ is **not** equivalent to $100cm^2$. Imagine a $1m^2$ area (think about four metre rulers on the floor set out in a square). Now imagine splitting that $1m^2$ into little 1cm x 1cm chunks . There would *already* be 100 of these little chunks just along one edge of the $1m^2$ so the number of square centimetres packed into $1m^2$ must be much *much* greater that 100.

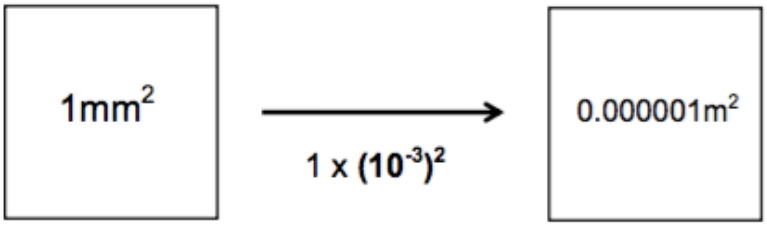
Let's see how we can convert areas using prefixes.

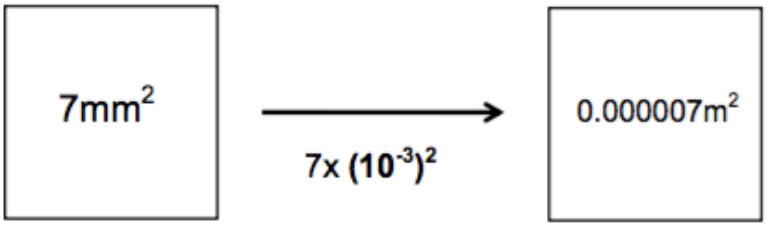




To convert cm^2 to m^2 we multiply by the square of the prefix $(10^{-2})^2$ i.e. 10^{-4}

We can apply the same method to convert *any* area with a prefix.





To convert mm^2 to m^2 we multiply by the square of the prefix $(10^{-3})^2$ i.e. 10^{-6}

6. Convert the following areas into m^2 (answers in standard from are best)

i) 10 cm^2

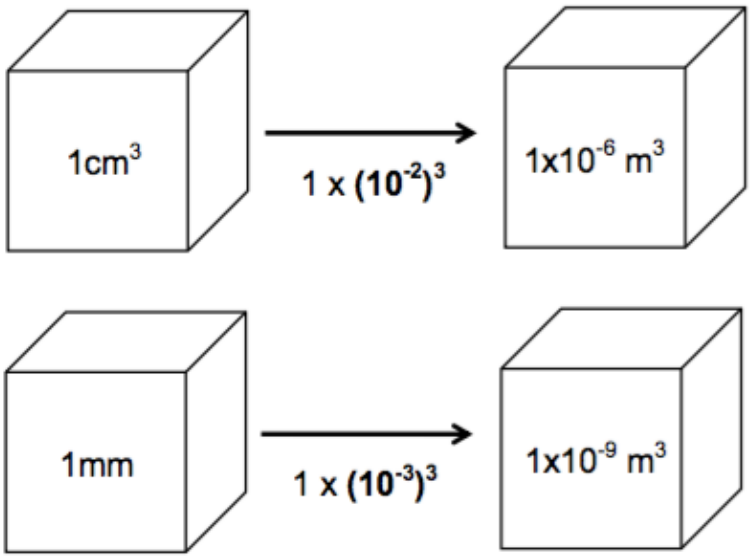
ii) 50 mm^2

iii) 300 cm^2

iv) 4 mm^2

v) 5 km^2

Volumes can be converted in exactly the same way, however because the units are cubed, the prefixes must be cubed rather than squared.



7. Convert the following volumes into m^3

i) 15 cm^3

ii) 12 mm^3

iii) 300 mm^3

iv) 4 cm^3

v) 2 km^3

Task 3) Materials Research Task

The development of materials has been one of the major steps to human progress. We moved from the Stone Age, to the Bronze Age and then the Iron Age It has been suggested that we now live in the polymer age or even the silicon age.

Pick 4 of the following questions to answer:

a) Why do brittle materials fail?
b) Why is glass fibre combined with polyester resin to build boats?
c) How do edge dislocations in metals alter their properties?
d) What is the role of carbon in steel?
e) How is toughened glass made?
f) How is steel tempered and why is it beneficial?
g) What is necking and how does it lead to failure?
h) What are alloys and why are they generally stronger?
i) What is annealing and why is it beneficial?
j) What is quenching and why is it beneficial?

Produce a PowerPoint presentation which includes:

- Information about your chosen topics including pictures and diagrams
- What you find interesting about the topic
- What you would like to learn more about the topic

3. Getting ready for September

- Before September you need to have completed the three tasks in this booklet and have your PowerPoint presentation ready to submit to your teacher.

- You will be provided with class workbooks for each Engineering unit, however **you will also need a folder** to keep yourself organised.

  Many students choose to use ring binders, however alternatively you may find a couple of foolscape or document wallets are useful for keeping worksheets safe – initially one for the Mathematics unit and another for the Science for Engineering unit which will be taught alongside eachother.

- You will need a scientific calculator. **The Casio Classwiz** range offer statistics functions which are highly recommended.

  Don't rush to make a purchase – wait until September if necessary (particularly if you are considering studying A-level Mathematics – they will advise you on the most appropriate models for their course)