**College Taster Pack**
Engineering


enquiries@abingdon-witney.ac.uk
**www.abingdon-witney.ac.uk**

# Welcome to Engineering

Engineering is all around us, from the food we eat, the clothes we wear, the way we travel and how we spend our time. We live in an engineered world. We do not expect you to have any prior knowledge of engineering, some of you may have completed a L2 engineering qualification or design & technology. To be an engineer you must have an inquisitive mind, enjoy problem solving, ability to think outside the box and to have a fascination for making things.

Depending on your entry requirements you will either study the L2 BTEC First Extended Certificate in Engineering, or the L3 BTEC National in Engineering. The L3 qualification is a two-year course, the first year you will complete the Foundation Diploma and in your second year this will be topped up to the Extended Diploma in Engineering. Links to these specifications are given at the back of this pack. Both the level 2 and the level 3 courses are designed to give you an understanding of the engineered world and introduce you to mechanical, manufacturing, electrical and electronic engineering.

Covid-19 and lockdown has meant that it is quite some time since you were in school. These activities are aimed at getting you back into the way of learning. Some of you will find it easy, others of you will find it more of a challenge. Do not worry if you cannot complete it all. I look forward to seeing your Mars Landing videos and posters when you come to college in September for your introduction.

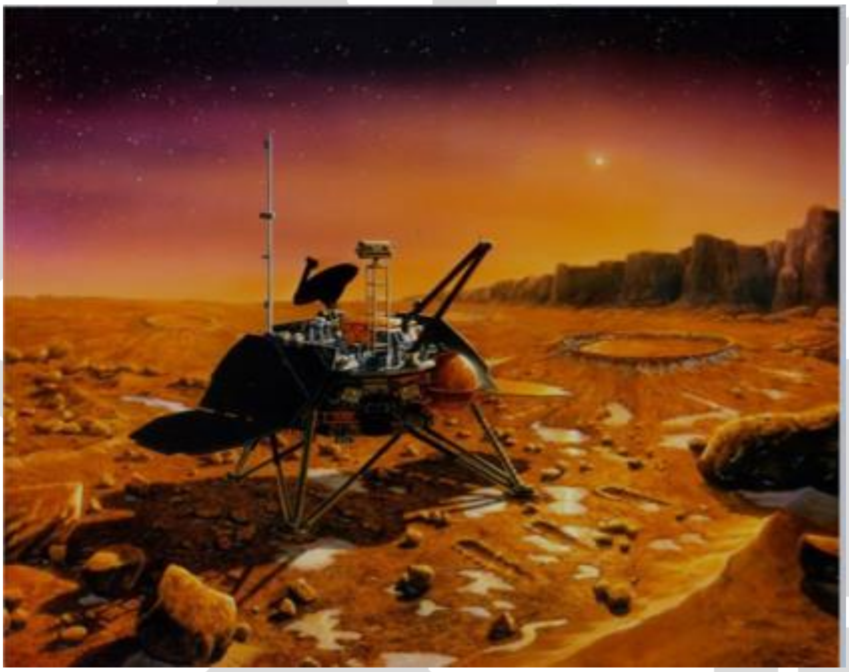
Thank you for your interest in Engineering at Abingdon & Witney College.

Fiona Dallas
Curriculum Manager, Engineering & Science

# College Taster Activities

## Challenge 1:

1. Try to complete the questions and then follow the instructions to design and build your own Mars Lander! Try and video the result so that you can share it with us during our induction period.



MARS LANDER VIDEO CLIP ‘7 minutes of terror’

https://www.youtube.com/watch?v=Ki_Af_o9Q9s

CALCULATIONS - USEFUL DATA & EQUATIONS

- mass of ping-pong ball = 10g
- height dropped = 3m
- acceleration due to gravity on Earth = $9.81Nkg^{-1}$
- acceleration due to gravity on Mars = 38% of the value on Earth
- air density on Earth = $1.2kgm^{-3}$
- air density on Mars = 0.6% of the value on Earth
- $KE = 0.5mv^2$
- GPE = mgh
- Air resistance = 0.5 x air density x drag coefficient x area x $v^2$

CALCULATE THE FOLLOWING:

1. The velocity of the ping-pong ball just before landing
    a. On Earth
    b. On Mars
    - What assumption have you made?

2. The ratio of the air resistance on Mars to the air resistance on Earth at the maximum velocity (Hint: which properties of the ping-pong ball are the same in both places?).

DESIGNING YOUR OWN MARS LANDER

1. Consider the most important design considerations for your Mars lander:

- Air resistance
- Shock absorption
- Stability
- Payload

2. Sketch a drawing of your design and write a paragraph below that explains why you have designed the Mars Lander like this.

BUILDING YOUR MARS LANDER

Find the following materials to build your Mars Lander:

- 5 x straws
- 1 x sheet A4 paper
- Sticky tape
- 1 x Plastic beaker
- 1 astronaut (ping pong ball or Lego figure)

TESTING YOUR MARS LANDER

1. The Mars lander must land an astronaut safely on Mars. You will need to test this. Put your astronaut in the beaker and see if it stays in the beaker on landing
   • Round 1: drop from shoulder height
   • Round 2: drop with your arm as high as it will reach
   • Round 3: drop when standing on a chair (be safe!)

DID YOUR ASTRONAUT SURVIVE?

2. Video your Mars lander as it falls and bring this with you to induction.

ADAPTABILITY OF ENGINEERING COMPANIES

Covid-19 and the astounding quantities of resources and medical equipment required to treat those who have contracted the virus has meant that many engineering companies have had to rapidly change the products they normally produce. Investigate one major engineering company that has changed its production line to meet the demands of Covid-19. Create a poster showing the products they normally make and explain how they have responded to Covid-19. We would also like to share these during induction and see how many different companies have taken up the challenge to help resource the NHS.

**Challenge 2:**

MATHS QUESTIONS

You may wonder why we have included maths questions in an introduction to engineering; engineering relies on mathematics; you could say that it is the language of engineering. If you are not a competent mathematician, you will struggle with engineering. We also know that it is very easy to forget the maths you have learned for your GCSE, so the activities are designed to get you back into thinking about maths. The skills we expect you to have at the start of the course include:

- Standard form
- Significant figures
- Re-arranging equations
- Drawing and interpreting graphs
- Using a calculator
- SI units and prefixes.

STANDARD FORM

You may recall that standard form (or scientific notation) is a convenient method for writing numbers that are very large or very small.
The format for standard form is:
One digit from one to nine; a decimal point; one or more digits; times ten to the power of something. e.g.68725 = $6.8725 \times 10^4$
The power of ten is positive for a large number and negative for small decimals.

1. Which of these is not written in standard form? Rewrite the incorrect answers in standard form.
   a. $35.44 \times 10^{-3}$
   b. 4.52 x 104
   c. $1.2 \times 10^{-55}$
   d. $0.0599 \times 10^{-4}$
   e. $0.34 \times 10^4$
   f. $3 \times 10^4$

2. Calculate the following sums which are written in standard form, give your answer in standard form.
   a. $3.45 \times 10^{-5} + 9.5 \times 10^{-6}$
   b. $(2.31 \times 10^5 \times 3.98 \times 10^{-3}) + 1.35$

SIGNIFICANT FIGURES

Significant means the most important numbers. These are usually the largest ones.
To find significant figures we use the same skills as when we round off decimals. Significant figures can be decimal numbers or whole numbers:

2.5 correct to 2 significant figures is 2.5
2.5 correct to 1 significant figure is 3
1.38 to 3 sig. figs is 1.38
1.38 to 2 sig. figs is 1.4
1.38 to 1 sig. fig is 1

Each time you are rounding off, leave the number of figures it asks for. The numbers can be decimals or whole numbers. 0's are counted as significant figures if they are in the middle of a number. 0's are NOT counted as significant figures if you need them for place value (the value of the number would change if you took them out).

1. How many significant figures does each of these numbers have? (Remember to count the 0's in the middle of a number, but not those at the end):
   a. 2.01
   b. 7000
   c. 0.015
   d. 6700
   e. 30.7
   f. 40
   g. 3050
   h. 67900
2. Now write these numbers to 1 significant figure:
   a. 1.754
   b. 7.36
   c. 946.2
   d. 0.0758
   e. 0.9999
3. Now write these numbers to two significant figures:
   a. 1.754
   b. 7.236
   c. 946.2
   d. 0.0758
   e. 0.9999

CALCULATOR PRACTICE

1. Calculate the following using your calculator:
   a. $2.3 \times 10^{5} \times 4.1 \times 10^{-3}$
   b. $(6.8 \times 10^{-7}) + (3.9 \times 10^{-8})$
   c. $(6.3 \times 10^{-5} \times 9.1 \times 10^{-7}$
   d. $(1.2 \times 10^{7}) - (9.8 \times 10^{6})$
   e. $(5.6 \times 10^{3}) + (7.8 \times 10^{4})$
2. Calculate the following using your calculator:
   a. $\sqrt{1.6 \times 10^{-2} \times 3.1}$
   b. $\sqrt{2.5 \times 10^{7} + 3.1 \times 10^{6}}$
   c. $\sqrt{4.6 \times 10^{-7} \times 8.6 \times 10^{4}}$
   d. $\sqrt{6 \times 10^{-3} \pi}$
   e. $\sqrt{8 \times 10^{-76} \times 1012}$

REARRANGING EQUATIONS

To succeed in engineering, you will need to be able to rearrange equations. Practice rearranging the following equations to change the subject of the equation.

1. $V=IR$, find:
   a. $I=$
   b. $R=$
2. $F=ma$, find:
   a. $m=$
   b. $a=$
3. $P= IR^2$, find:
   a. $I=$
   b. $R=$
4. $R_T = R_1 + R_2 + R_3$, find:
   a. $R_1=$
   b. $R_2=$
   c. $R_3=$
5. $v^2 = u^2 + 2as$, find:
   a. $u=$
   b. $a=$
   c. $s=$

UNITS

There are seven SI units which are used internationally in engineering.

| Base quantity | Name | Symbol |
|---|---|---|
| length | metre | m |
| mass | kilogram | kg |
| time | second | s |
| Electric current | ampere | A |
| Thermodynamic temperature | kelvin | K |
| Amount of substance | mole | mol |
| Luminous intensity | candela | cd |

From these seven SI units there are further derived SI units. Complete the table below.

| Derived quantity | Name & Symbol | Expression in terms of other SI Units |
|---|---|---|
| Force | | - |
| | hertz (Hz) | - |
| Pressure, stress | pascal (Pa) | |
| Energy, work, quantity of heat | | Nm |
| Power | | J/s or $Js^{-1}$ |
| | coulomb (C) | - |
| Electric potential difference | | W/A |

Notice that there are many units named after scientists. The full names of the units are written in small letters. The symbol of these units always starts with a CAPITAL letter.

Example: The frequency is 300 hertz (small letters) or 300 Hz (capital H, small z).
Where the units are not named after a scientist, the full names and symbols are in small letters.
Example: The distance is 1200 metres (all small letters) or 1200 m (all small letters).

The kilogram is the only base SI unit to have a prefix as part of its name. For multiples and submultiples, the appropriate prefix is placed in front of the word gram.
There are 20 prefixes used to form decimal multiples and submultiples of SI Units, complete this table.

| Factor | Name | Symbol | Factor | Name | Symbol |
|---|---|---|---|---|---|
| $10^{24}$ | | Y | $10^{-1}$ | | d |
| $10^{21}$ | | Z | $10^{-2}$ | | c |
| $10^{18}$ | | E | $10^{-3}$ | | m |
| $10^{15}$ | | P | $10^{-6}$ | | µ |
| $10^{12}$ | | T | $10^{-9}$ | | n |
| $10^{9}$ | | G | $10^{-12}$ | | p |
| $10^{6}$ | | M | $10^{-15}$ | | f |
| $10^{3}$ | | k | $10^{-18}$ | | a |
| $10^{2}$ | | h | $10^{-21}$ | | z |
| $10^{1}$ | | da | $10^{-24}$ | | y |

WEBSITES TO VISIT

https://qualifications.pearson.com/en/qualifications/btec-nationals/engineering-2016.html#%2Ftab-3

https://qualifications.pearson.com/en/qualifications/btec-firsts/engineering-2010-qcf.html#%2Ftab-2