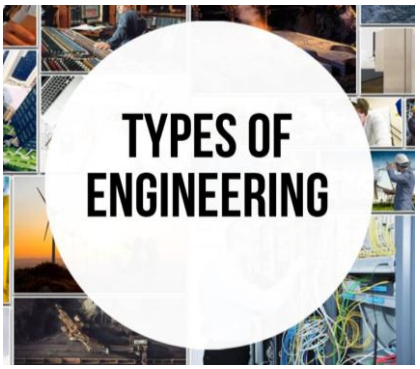
Engineering AAQ
Bridging Task

Contents:

What is Engineering? What will you study?

What is Engineering? Engineering is about solving real-world problems. Engineers use a combination of **mathematics, science and practical thinking** to design, build and improve the world around us. From transport systems and medical devices to energy generation and modern technology, engineering plays a role in almost every part of everyday life.

There are many different types of engineers, including:



- Mechanical engineers (machines and structures)
- Electrical engineers (circuits and systems)
- Design engineers (products and CAD modelling)
- Materials engineers (selecting and testing materials)

At its core, engineering is about **thinking logically, solving problems and making decisions based on evidence**.

What will you study?

The course is split into 5 main areas: **mechanical & electrical engineering**(understanding how systems and components work), **materials science**(selecting and evaluating materials for engineering applications), **CAD** - computer aided design creating and developing 2D and 3D designs), **programmable electronics** (working with modern electronic systems) and **coursework projects** (applying your knowledge to solve real engineering problems).

What is the course like?

In the first year, you will complete **two externally assessed exams**:

- **Unit 1 – Engineering Principles**
  - 90 marks
  - 2 hours 15 minutes
  - Strong focus on **mathematics and physics in engineering contexts**
- **Unit 2 – Engineering Applications**
  - 70 marks
  - 2 hours
  - Focus on **engineering sectors, materials, processes and modern technologies**

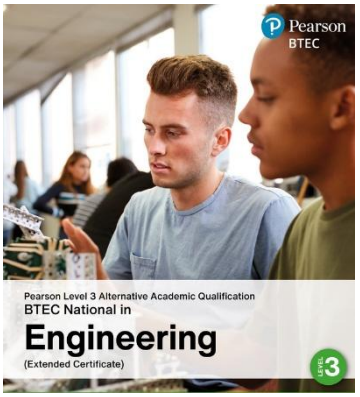
You will be expected to:

- Use a formula book confidently, rearrange and solve equations
- Apply mathematics to real engineering situations
- Explain engineering concepts clearly
- Make decisions about materials and manufacturing processes

This course is designed to:

- Develop your ability to **think like an engineer**
- Build your confidence in solving **unfamiliar problems**
- Help you understand how engineering works in **real-world applications**
- Prepare you for **coursework, design tasks and projects in Year 2**

What will this course lead to?



At the end of two years, you will achieve a:

Cambridge Advanced National Extended Certificate in Engineering

This qualification is equivalent in size to an A Level and is highly valued by:

- Universities
- Employers
- Apprenticeship providers

Progression opportunities

This course can lead to a range of pathways, including:

- University engineering degrees *(particularly when combined with A Level Maths)*
- Foundation degrees in engineering
- Higher and degree apprenticeships

It provides a strong foundation for careers in a wide range of engineering sectors.

How do we support you at CCSW?

We understand that this course can be challenging, particularly due to the **mathematical and technical content**.

At CCSW, we support you by:

- Revisiting key GCSE maths and physics concepts where needed
- Providing structured lesson materials and clear worked examples
- Giving regular feedback to help you improve
- Supporting you with coursework, organisation and deadlines
- Helping you develop strong study habits and independent learning skills

Our aim

Our aim is to help you become:

- A confident problem solver
- An independent learner
- A successful engineering student

1. Engineering Essentials – Measurements, SI Units & Prefixes

Why is this important?

Engineers use measurements and units every day to:

- design products
- carry out calculations
- communicate information clearly

Using the **correct units and values** is essential. Small mistakes in units can lead to major engineering failures.

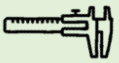
SI Units

In engineering and science, we use **standard units** called **SI units** *(Système International)*.

These are used all over the world to ensure consistency.

Task 1.1 – Complete the Table

Fill in the missing information below:

Quantity	Standard SI Unit?	Measuring Instrument Used To Measure Quantity?	
time	second	timer or stopwatch	
length		In the range mm → m? 	Smaller than a mm? 
mass	kg	(hint: begins with the letter 'b'!) 	
current			Circuit Symbol? 
voltage			Circuit Symbol? 
resistance			

SI Prefixes

Engineers often work with **very large or very small numbers**.
Instead of writing lots of zeros, we use **prefixes**.
For example:

- 1,000 metres = **1 kilometre (km)**
- 0.001 metres = **1 millimetre (mm)**

Prefix Name	Symbol	Meaning
pico	**p**	**x 10^{-12}**
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}**

Task 2: Use the information on the table to make 8 double-sided flashcards.

Write the prefix name and symbol on the front, and the ×10^{value} on the back. Use the cards to test yourself on the prefixes until you've memorized them – you'll be tested on them in September.

Task 1.3 – Application
Convert the following:

1. **2500 mm = _____ m**
2. **3.2 km = _____ m**
3. **0.5 A = _____ mA**

Why this matters
You will need these skills in:

- Unit 1 exam (Engineering Principles)
- All calculations involving formulas
- Engineering problem solving

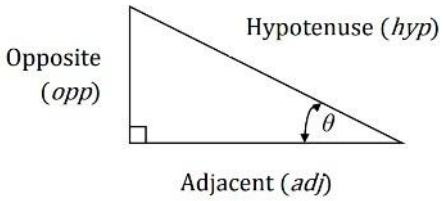
If you are not confident with these, make sure you practise before September.

2. Mechanical Engineering Basics - Geometry

In GCSE Maths you've already learned about **Pythagoras' Theorem** ($a^2 + b^2 = c^2$) and **Trigonometry** (soh cah toa). You will be given an Engineering formula booklet with the following information:

Trigonometry

Trigonometric Ratios



$$\sin\theta = \frac{opp}{hyp}$$

$$\cos\theta = \frac{adj}{hyp}$$

$$\tan\theta = \frac{opp}{adj}$$

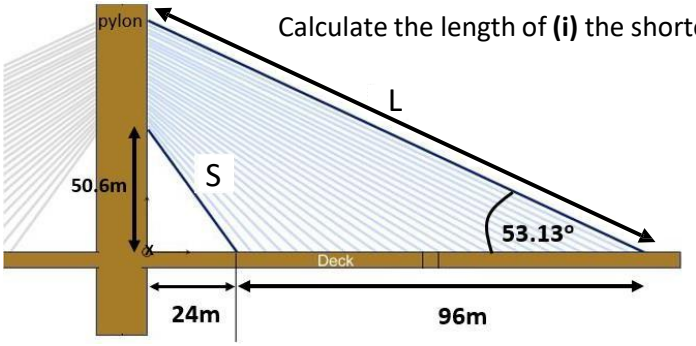
Pythagoras' rule: $hyp^2 = opp^2 + adj^2$

USE A SCIENTIFIC CALCULATOR TO HELP YOU SOLVE THE FOLLOWING QUESTIONS.

YOU MUST SHOW YOUR FULL WORKING.

Question 1 A diagram of a suspension bridge is shown. Cables of different lengths connect the vertical pylon with the deck of the bridge.

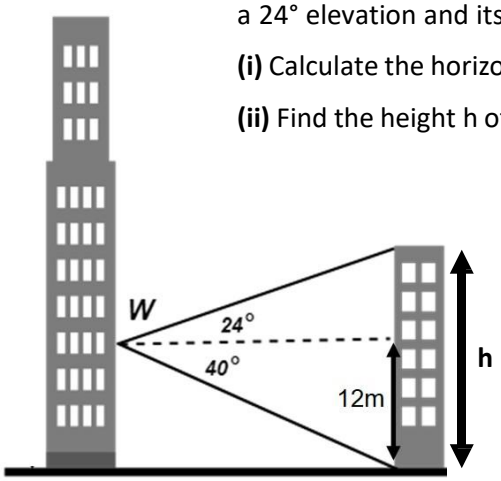
Calculate the length of **(i)** the shortest cable, S **(ii)** the longest cable, L.



Question 2 An Engineer at a window 12m above ground observes the top of another building at a 24° elevation and its base at a 40° depression.

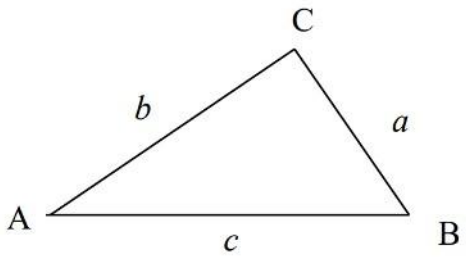
(i) Calculate the horizontal distance between the 2 buildings (the length of the dotted line in the diagram)

(ii) Find the height h of the second building.



Unlike Pythagoras and basic trigonometry, the Sine and Cosine rules apply to any triangle, not just right-angled ones. You will be given the following information in the Engineering formula book. The **uppercase letters represent angles**. The **lowercase letters represent sides**.

Sine and Cosine rules



Sine rule: $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

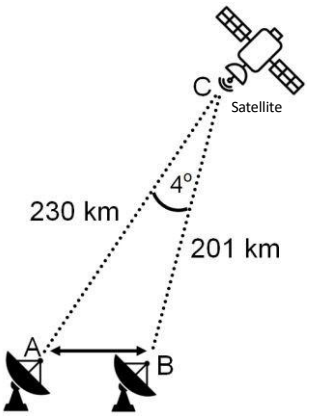
Cosine rule: $a^2 = b^2 + c^2 - 2bc\cos A$

$b^2 = a^2 + c^2 - 2ac\cos B$

$c^2 = b^2 + a^2 - 2ab\cos C$

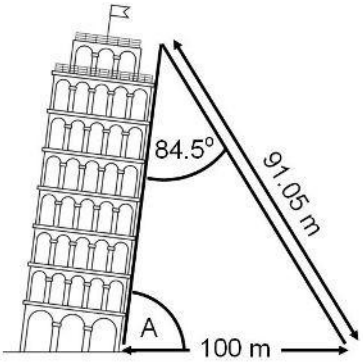
Question 3

Use the **cosine rule** to calculate the horizontal distance between the satellite dishes A and B.



Question 4

Use the **sine rule** to calculate the angle A.



The Leaning Tower of Pisa, Italy

3.Mechanical Engineering Basics - Kinematics

In GCSE Physics you learned that: $$\text{speed} = \frac{\text{distance}}{\text{time}}$$

In Engineering we will also use: $$\text{velocity} = \frac{\text{change in displacement}}{\text{change in time}}$$

where velocity is defined as the "rate of change of displacement"

Speed and velocity are both measured in *meters per second*. At GCSE you'll have written this as m/s. Beyond GCSE we'll start to use the notation **m/s** to represent ***meters per second***. See if you can get used to this new way of writing units in the following questions.

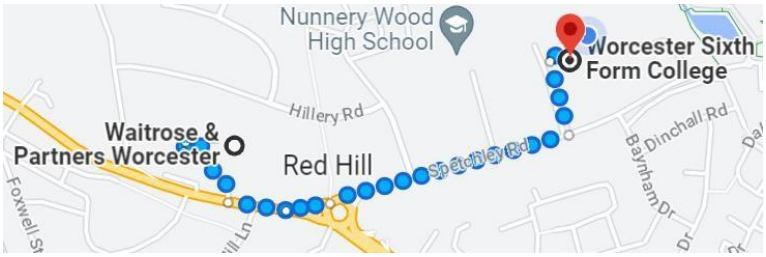
Task 3: Write the above equations, worded definition and unit on flash cards. On the reverse of each card write a question, e.g. "what is the definition of velocity?" so you can use the flash cards to test yourself and memorise these before your first lesson with us in September.

Question 5 A skydiver falls at terminal (constant) velocity for 30 seconds. During this time they travel 1950 metres.

Calculate the velocity of the skydiver . Give a suitable unit with your answer.

Question 6 The Boston Dynamics Spot robot can run 8 km in 90 minutes. Calculate Spot's velocity. Give your answer in metres per second (ms^{-1})

Question 7 It takes 11 minutes to walk at a velocity of 1.5 ms^{-1} from Waitrose to Worcester Sixth Form College. Calculate the distance in **(i)** metres **(ii)** kilometres



Acceleration is calculated using: $\text{acceleration} = \frac{\text{change in velocity}}{\text{change in time}}$

where acceleration is defined as the "rate of change of velocity"

The SI unit for **acceleration** is ***metres per second squared***. In Engineering we'll use the notation **ms^{-2}** (instead of m/s^2).

Task 4: Add the above equation, definition and unit to your growing pile of flash cards. Make these cards double sided with a question on the back so you can easily memorise them before September.

Question 8

A Lamborghini Aventador takes 2.8 seconds to accelerate from rest to a velocity of 28 ms^{-1}.

Calculate the acceleration.

Give the correct SI unit with your answer.

Question 9

Upon launch, a space rocket has an acceleration of 4.5 ms^{-2}

(iii) Calculate its velocity 4 seconds after launch

(iv) How long would it take for the rocket to reach a velocity of 36 ms^{-1} ?

Question 10

Fighter pilots can withstand accelerations of 9g for up to two seconds (where g = 9.81 ms^{-2})

Calculate the change in velocity that the pilot would experience in this time.

4.Electrical Engineering Fundamentals - Circuit Symbols

Why is this important?

Electrical principles are used in many areas of engineering, including:

- electronics
- control systems
- modern technologies

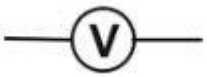
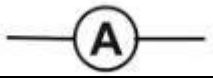
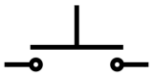
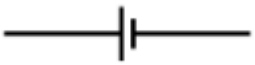
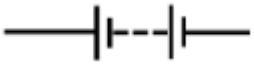
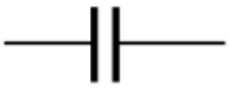
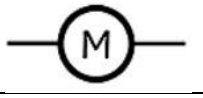
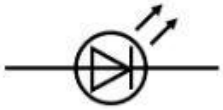
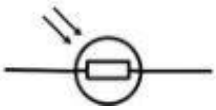
You will need to understand **basic circuits and current flow** for both the course and the **Unit 1 exam**.

Circuit Symbols

Engineers use standard symbols to represent components in circuits.

Electrical Engineering requires you to be familiar with a range of circuit symbols. Many of these you will have encountered before at GCSE, others will be brand new to you.

Task 4: Research the following circuit symbols and complete the table:

Circuit Symbol	Name of Component?	Circuit Symbol	Name of Component?
			
			
			
			
			
			
			
			
			

Electrical Current

In GCSE Physics you used the following equation:

Electric current is the **flow of charge**.

The equation is:

$$Q = It$$

Where:

- Q= charge (coulombs)
- I= current (amps)
- t= time (seconds)

You are expected to:

- recognise basic circuit symbols
- use simple equations correctly
- include units in your answers
- explain concepts clearly

Why this matters?

These skills are needed for:

- **Unit 1 calculations (electricity topics)**
- Understanding circuits in real engineering systems
- Further study in electronics and programmable systems

Question 11

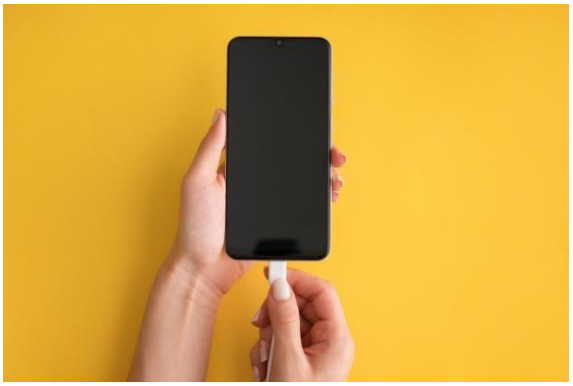
An electric car charger can deliver a current of 300A to fast charge a battery in 30 minutes

Calculate the number of coulombs of charge transferred to the battery.

Question 12

It takes 2 hours to fully charge a phone using a USB charger. During this time 7200 coulombs of charge are transferred.

Calculate the current through the cable.



Question 13

Across the previous pages you have come across some familiar equations, but also some worded definitions for certain quantities. Match up each term with its correct definition.

Velocity	**Rate of flow of charge**
Acceleration	**Rate of change of velocity**
Current	**Rate of change of displacement**

5. Engineering Applications Introduction – Sectors, Materials and Processes

Why is this important?
Engineering is not just about calculations — it is about applying knowledge to real-world situations.
Engineers must:

- understand different industries
- select appropriate materials
- choose how products are manufactured

This is a key part of the **Unit 2 exam (Engineering Applications).**

Engineering Sectors
Different types of engineers work in different industries (sectors).

Task 5.1 – Engineering Sectors
Match each product to the correct engineering sector:

Product	Engineering Sector
Wind turbine	
Hip replacement	
Industrial robot	
Road bridge	

Materials in Engineering
Engineers must choose materials based on their properties.
For example:

- strength
- weight
- durability

Task 5.2 – Materials Selection
A safety helmet must be:

- lightweight
- strong
- impact resistant

Question:
Name **one suitable material** and explain why it is suitable.
(2–3 sentences)

Manufacturing Processes
Once a material is chosen, engineers must decide how to make the product.

Task 5.3 – Manufacturing Process
Name **one process** that could be used to manufacture the helmet. Explain briefly how the process works.
(2–3 sentences)

Thinking Like an Engineer

Task 5.4 – Short Explanation
Why is it important for engineers to:

- choose the correct material?
- choose the correct manufacturing process?

(3–4 sentences)

Engineering Notice
In this section, you are expected to:

- apply knowledge to real situations
- explain your answers clearly
- justify your choices

End of Tasks

6. Solutions – Check your Calculations!

Question 1

(i) Using Pythagoras' Theorem

$$s = \sqrt{50.6^2 + 24^2}$$

$$s = 56 \text{ m}$$

(ii) Using trigonometry (cosine)

$$\cos\ \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\cos\ 53.15^\circ = \frac{120}{L}$$

$$L = \frac{120}{\cos 53.15^\circ}$$

$$L = 200 \text{ m}$$

Question 2

(i) Bottom triangle

$$\tan\ \theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$\tan\ 40^\circ = \frac{12}{\text{adjacent}}$$

$$\text{adjacent} = \frac{12}{\tan 40^\circ}$$

$$\text{adjacent} = 14.3 \text{ m}$$

(ii) Top triangle

$$\tan\ \theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$\tan\ 24^\circ = \frac{\text{opposite}}{14.3}$$

$$\text{opposite} = 14.3 \times \tan\ 24^\circ$$

Question 3

Using Cosine Rule

$$c^2 = a^2 + b^2 - 2ab\cos\ C$$

$$c^2 = 201^2 + 230^2 - 2(201)(230)\cos\ 4^\circ$$

$$c^2 = 1066.2$$

$$c = \sqrt{1066.2} = 32.7 \text{ km (3 s.f.)}$$

Additional calculation:

$$h = 12 + 6.37 = 18.4 \text{ m (3 s.f.)}$$

Question 4

Using Sine Rule

$$\frac{\sin A}{a} = \frac{\sin B}{b}$$

$$\frac{\sin A}{91.05} = \frac{\sin 84.5^\circ}{100}$$

$$\sin A = 0.906$$

$$A = \sin^{-1}(0.906)$$

$$A = 65^\circ$$

Question 5

$$\text{velocity} = \frac{\text{change in displacement}}{\text{time}}$$

$$= \frac{1950}{30} = 65 \text{ m/s}$$

Question 6

$$\text{velocity} = 1.48 \text{ m/s}$$

Note: Distance must be in metres and time in seconds before using equations.

Question 7

(i)

$$\text{distance} = \text{speed} \times \text{time}$$

$$= 1.5 \times (11 \times 60) = 990 \text{ m}$$

(ii)

$$990 \text{ m} = 0.99 \text{ km}$$

Question 8

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time}}$$

$$= \frac{28}{2.8} = 10 \text{ m/s}^2$$

Question 9

(i)

$$v = at$$

$$= 4.5 \times 4 = 18 \text{ m/s}$$

(ii)

$$t = \frac{v}{a}$$

$$= \frac{36}{4.5} = 8 \text{ s}$$

Question 10

$$\text{change in velocity} = at$$

$$= (9 \times 9.81) \times 2$$

$$= 176.58 \text{ m/s}$$

Question 11

$$Q = It$$

$$= 300 \times (30 \times 60)$$

$$= 540{,}000 \text{ C}$$

Question 12

$$I = \frac{\Delta Q}{\Delta t}$$

$$= \frac{7200}{2 \times 60 \times 60}$$

$$= 1 \text{ A}$$

Question 13

- **Velocity = rate of change of displacement**
- **Acceleration = rate of change of velocity**
- **Current = rate of flow of charge**

7. Getting Ready for September – Tick List

Use this checklist to make sure you are fully prepared for the course.

- Complete Questions 1 – 13 ☐
- Use the solutions (page 14) to mark and correct your answers ☐
- Create double-sided flash cards for:
  - (i) the **8 prefixes** on page 5 ☐
  - (ii) **equations** for **v**, **a**, **Q** & **I** ☐
  - (iii) **definitions** for **v**, **a** & **I** ☐
  - (iv) SI units for **v**, **a**, **Q** & **I** ☐
- Use your flashcards to **revise and memorise** key information ☐
- Be prepared for a **test in September** ☐
- Acquire a Scientific Calculator (Casio recommended – pre-2023 ClassWiz models are ideal) ☐

8. Extra Information and Preparation for the Course

What to expect

- You will have **4 Engineering lessons per week**
- There is a **high level of mathematical content**
- You should expect **3–4 hours of homework per week**

Assessment

- The **May exams** are externally assessed
- They will count towards your **final course grade**

Course materials

- You **do not need to purchase a textbook (optional)**
- You will be provided with **presentations for each unit**, including:
  - lesson content
  - notes
  - practice questions

Organisation

- You will need a folder to stay organised
  (ring binder, document wallet, or similar)
- Keep all worksheets and notes in a safe and structured way.

Calculator guidance

- A **scientific calculator is essential**
- Casio calculators are recommended
- Pre-2023 models (non-circular buttons) are preferred for engineering use.

These older models are great!

Final reminder

This course is designed to help you grow your skills and confidence in engineering.
You won't be expected to know everything straight away — we'll support you as you learn.