SIXTH FORM BRIDGING WORK

Get Ready for *Physics*

Getting organised: Make sure you have set up a Learning Folder (see Sixth Form file check for content). The PLCs (Personal Learning Checklists) should be at the front.

Subject mind-set and BIG picture thinking…

Physicists focus their thinking on developing insight into what **the observable world is made of** and **how its constituents behave,** trying their hardest to achieve a **deep understanding.**

Physicists seek the **most fundamental** explanations and have utility and currency **across many domains.** They are **not** satisfied with **superficial** explanations.

This involves the **systematic criticism** of every idea and result. They have to bear **a wide range of knowledge** to make sure each analysis is **consistent** with what is already known.

Please complete the following tasks ahead of starting the Sixth Form:

Work to complete

Firefly section "A' level Physics" "GET READY FOR A' LEVEL". There is a transition guide which practices important skills.

Recommended text books

Any A' level text book for AQA. We will be referring to the CGP one during the course, this can be purchased through the school.

Recommended websites you should be familiar with

https://www.physicsandmathstutor.com/ This site has revision notes and most past papers.
https://www.youtube.com/channel/UCZzatyx-xC-Dl_VVUVHYDYw This is the youtube channel of "A' Level physics online".

Related magazines

Physics World • Scientific American • New Scientist

Recommended books & revision guides (Download the exam board recommended reading list)

• A short History of Nearly Everything - Bill Bryson • Why don't penguins' feet freeze? – NewScientist • The Grand Design – Stephen Hawkin and Leonard Mlodinow • Newton – Peter Ackroyd • The Quantum Universe: Everything that can happen does happen – Brian Cox and Jeff Forshaw

Possible places to visit

London Science museum.

A level Physics Year 11-year 12 Transition *Summer workbook*

Background maths and problem solving skills

This work is designed to help prepare you for A-level physics. It covers some of the basic skills that will be used throughout the course. Many of these extend and develop ideas you will have come across at GCSE in science and maths. You will need to use a combination of **careful reading, research, logic** and **persistence**. You should expect to find some parts difficult, but if you persevere you will often find you can do them!

YOU MAY USE A CALCULATOR THROUGHOUT

Name: ……………………………………….

Please complete as much of this booklet as possible, including the self-assessment below, then hand in during the first week of teaching in September.

Confidence:
A = all parts correct and understood
C = some parts correct and mostly understood
E = few parts correct or poorly understood

	Self Assessment		
	Mark	**Confidence (A-E)**	**ISSUES / COMMENTS**
1. Expectations – read and remember!	- - -		
2. Unit Prefixes – complete table + questions	……………/25		
3. (a) SI system of units – complete table (b) Derived units – complete table	……………/11		
4. Maths-powers of ten and standard form – complete calculations	……………/18		
5. Significant figures – read + complete calculations			
6. Rearranging equations	……………/10		
7. Showing your working – read			
8. Bringing it all together – How many of these challenging questions did you crack?	……………/10		
9. Revise and Extend: Energy and Power	…………./30		
10. Revise and Extend: Speed and Acceleration	…………./30		

FEEDBACK:

Tips on completing this bridging work

- Please write all of your answers clearly in **blue** or **black ink**.
- In calculations show all steps in your working clearly and underline the final answer.
- Where answers or a mark scheme is given mark and correct your work in **purple pen**.

1. Expectations

Attendance

1. Attend every lesson
2. Arrive on time
3. Ensure any assignments due are <u>complete</u> and <u>presentable</u> – no excuses

Equipment

4. Bring the following equipment every lesson:
    a. An A4 clip file
    b. pre-punched A4 paper for your notes
    c. plastic wallets for handouts
    d. pen, pencil, ruler (30cm is best), protractor, compasses
    e. Scientific calculator

Private study & Assignments

5. Plan to spend roughly an equal time studying physics outside class as inside.
6. Some of this time will be for assignments ('homework'), the rest for reading around the subject, practicing questions, writing up practicals and improving your notes.
7. Record homework and deadlines clearly.
8. Expect homework at the end of every session – if you are not sure what it is <u>ask</u>.
9. Make a note of anything you get stuck on or do not understand.
10. Don't always work alone - working with a physics partner can be very effective (not one person copying another, but arguing and thinking a problem out together)

In Class

11. **Be proactive**: ask for help if there is anything you don't understand, don't let an idea remain vague ask, think and question until it becomes clear – it will!
12. **Interact**: put your hand up & ask questions as much as possible – don't leave it to others.
13. **Be efficient**: don't waste time chatting or being off task – you will drag yourself and others down if you do.
14. **Listen**: pick up on <u>all</u> the tips and advice then put them into practise, don't ignore them.

2. Unit Prefixes

Prefixes are written in front of units to indicate multiplication or division by multiples factors of 1000. So mega means x1,000,000. (One exception is 'centi', as in cm, which means divide by 100)

YOU MUST LEARN THE PREFIXES BY HEART AND BECOME ADEPT AT WORKING WITH THEM.

1. Complete the following table. (You will need to research some of the missing units).

Symbol		**Multiplier**	**Which means…**
	terra		
		$\times 10^9$	
M			× 1,000,000
k			× 1000
(None)	- - -	- - -	× 1
m			
	micro		/ 1,000,000
n			
		$\times 10^{-12}$	
f			

2. Expand each of these quantities to write out the answer in full (i.e. without the prefixes)
   a. 900 mV =
   b. 12 MJ =
   c. 1.67 mm =
   d. 3.456 kg =
   e. 700 nm =
   f. 0.72 pA =
3. Write each of the following using an appropriate prefix:
   g. 0.005 A =
   h. 30000 s =
   i. 5×10^5 m =
   j. 1001 m =
   k. 0.006 V =
   l. 2,100,000 N =
4. Convert each of the following to the indicated units:
   a. 34 nm = ... mm
   b. 0.012 s = ... µs
   c. 4.5 MJ = ... kJ

3. UNITS (a) The SI system of units

- **Look up the following terms and write a few sentences about each:**

Physical Quantities	
SI Units	
Base Units	
Derived Units	

- **In physics all units can be derived from six base units. Research how the base units are defined.**

Base Quantity	**Base Unit**	**Definition** (Note: you do not need to learn these definitions)
Length	metre (m)	
Mass	kilogram (kg)	
Time	second (s)	
Temperature	kelvin (K)	
Current	ampere (A)	

3. UNITS (b) Derived units

In physics all non-base quantities are called **derived quantities** and are defined by equations.
E.g. (a) Define speed. (b) Define charge.

(a) speed = distance / time **(b) charge = current × time.**

The units of these new quantities are **derived units** and are established from these same equations. So,

(b) The unit of speed = unit of distance / unit of time = m / s = $\underline{m \cdot s^{-1}}$ (**‘**metres per second’)*

(c) The unit of charge = the unit of current × the unit of time = $\underline{A \cdot s}$ (**‘**amp second’)

*NOTE: At A level we write divided units, such as ‘metres <u>per second</u>’ as ms^{-1} **not** m/s.

In the SI system, many of these derived units get their own name. For example, the SI unit of charge is the coulomb (C). So we can say that one coulomb is equal to one amp second.

or **C = A s**

Any SI unit can be expressed in terms of base units. To find the base units work though the defining equations one by one, unit you end up with the base units. For example, what are the base units of a Joule? This requires two steps:

- Energy (Work) = Force × distance moved, So one joule = one newton metre (**J = N·m**)
- Force is defined from F = m a, so one newton = one kilogram metre per second squared (or **N = kg·m·s^{-2}**)
- Therefore, a joule = **N m** = (**kg·m·s^{-2}) m = $\underline{kg \cdot m^2 \cdot s^{-2}}$**

1. Complete the table below.
Try working these out rather than looking them up. You can use the earlier answers to help with the harder ones.

Derived quantity	**Defining equation**	**Standard SI unit (if applicable)**	**Equivalent base units**
speed	S = d / t	n/a	$m \cdot s^{-1}$
momentum	p = m v	n/a	$kg \cdot m \cdot s^{-1}$
acceleration	a = (v - u) / t	n/a	
Force	F = m a	newton (N)	
Power	power = work/time P = W/t		
frequency	frequency = 1/time period f = 1 / T		s^{-1}
Charge	charge = current × time Q = I t	coulomb (C)	A·s
potential difference	voltage = work/charge V = W/Q		
resistance	R = V / I		
specific heat capacity	SHC = Energy / (mass × temperature change) c = Q / (m × q)		

4. MATHS – Powers of 10 and standard form (aka scientific notation)

You need to be able to use your calculator to work in standard form or use power of ten notation to replace unit suffixes.

[Tip: you should use the [x10^x] button on your calculator for entering powers of ten.]

1. Rewrite these numbers in standard form, removing any unit prefixes:

a) 3141 ……………………….

b) .00055 ……………………….

c) 2.0002 ……………………….

d) 120000 *(2sf)* ……………………….

e) 120000 *(6sf)* ……………………….

f) 843×10^4 ……………………….

g) 1.5 μm ……………………….

h) 12.0×10^{-2} nm ……………………….

i) 999 MJ ……………………….

j) 245 mg ……………………….

k) 16 pF ……………………….

l) 97.237 GN ……………………….

All of the equations we use in Physics require variables to be converted to standard SI units. This means any prefixes must first be removed. For example to calculate resistance in ohms (W) you divide the p.d. in volts (V) by the current in amps (A), If current = 8.0 mA (milliamps) and the voltage was 12 kV (kilovolts) the correct calculation would be:

$$R = V/I = 12 \times 10^3 / 8.0 \times 10^{-3} = 1.5 \times 10^6 \text{ W}$$

Try the above on your calculator before you continue.

2. Calculate the following showing your working, giving the answers in appropriate units. (This means removing suffixes, except for grams which need to be converted to kg)

a) Area (m^2) = 120 mm × 250 mm

b) Area (m^2) = 2.4 m × 60 cm

c) Density (kg·m^{-3}) = 48 g ⁄ 12 cm^3

d) Charge in coulombs, Q=I t
= 3.0 × kA × 20 ms

e) Speed squared, $v^2 = (16 \text{ m·s}^{-1})^2$

f) Force, F = m a = 923000g × 9.8 m·s^{-2}

5. Rules for Significant figures (sig fig or sf)

Read from the left and start counting sig figs when you encounter the first non-zero digit

1. All non zero numbers are *significant* (meaning they count as sig figs)
   - 613 has three sig figs
   - 123456 has six sig figs
2. Zeros located between non-zero digits are *significant* (they count)
   - 5004 has four sig figs
   - 602 has three sig figs
   - 6000000000000002 has 16 sig figs!
3. Trailing zeros (those at the end) are *significant* only if the number contains a decimal point; otherwise they are insignificant (they **don't** count)
   - 5.640 has four sig figs
   - 120000. has six sig figs
   - 120000 has two sig figs – unless you're given additional information in the problem
4. Zeros to left of the first nonzero digit are *insignificant* (they **don't** count); they are only placeholders!
   - 0.000456 has three sig figs
   - 0.052 has two sig figs
   - 0.0000000000000000000000000000000000052 also has two sig figs!

Rules for calculations

When you perform a calculation the answer should be given to the same number of significant figures as the weakest piece of data that was used in the calculation. For example if a piece of card is 11.3 cm long and 2.4 cm wide then the area = 27.12 cm^2 (on the calculator), but should be written as **27 cm^2** (i.e. 2 sig fig) because the width (2.4) was only given to 2 sig fig.

C. Practice Questions

1. State the number of sig figs in each of the following numbers:

(a) 0.0000055 g ………………   (c) 1.6402 g ………………   (b) 3.40×10^3 mL ………………

2. Compare the following numbers:

370 000   v 3.70×10^6 (standard form)

Explain the advantage of giving an answer in standard form

………

………

4. Complete each of the following calculations using your calculator, giving your answer in standard form with the correct number of significant figures, with your answer in the units indicated.

(a) $\rho = m / V = 0.542$ g / 0.027 cm^3 = ……………………………………….$g \cdot cm^{-3}$

(b) $E = m c^2 = 231.5 \times 10^{-3} \times (3.00 \times 10^8)^2$ = ……………………………………….J

(c) Mean time = (23 + 20 + 21 + 22 + 25) / 5 = …………………………………….s

(d) Height difference = 2.32m – 2.07m = ………………………………m

5. Complete the following calculations using a calculator, showing your working and giving an answer in standard form to the correct number of significant figures, in appropriate units:

a) $\dfrac{2.3 \times 6.5}{3.7 \times (9.1)^2}$

b) $(314)^3 / (9.9^2)$

c) $(12 \times 45\text{g}) / 12\ \text{cm}^3$

d) $1.2 \times 10^{-6} \times 1.5 \times 10^{-4}$

e) $(16\ \text{m}\cdot\text{s}^{-1})^2$

f) $923\text{Kg} \times 9.8\ \text{m}\cdot\text{s}^{-2}$

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6. REARRANGING EQUATIONS

Rearrange these equations to express them in the terms that follow:

1. $v = x / t$ **a.** $x = ?$ **b.** $t = ?$

2. $F = m\, a$ **a.** $m = ?$ **b.** $a = ?$

3. $a = (v - u) / t$ **a.** $t = ?$ **b.** $v = ?$ **c.** $u = ?$

4. $v^2 = u^2 + 2as$ **a.** $v = ?$ **b.** $a = ?$ **c.** $u = ?$

5. $s = ut + \frac{1}{2} a t^2$ **a.** $u = ?$ **b.** $a = ?$ **c.** $t = ?$

6. $\dfrac{1}{R_{tot}} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ **a.** $R_{tot} = ?$ **a.** $R_1 = ?$

7. Showing your working clearly

When answering physics questions you need to lay out your working clearly showing all the steps, working left to right and top to bottom. Your final answer should be found to the bottom right of your working and should be underlined. Below is an example for you to base your own answer style on.

<u>Ch6, Q4</u>
A white snooker ball with a kinetic energy of 15J collides with a red ball. On impact the white ball stops, transferring all of its KE to the red ball. The mass of the red ball is 120 g. What would be the velocity of the red ball immediately following the collision?

STEPS: Equation being used à rearrange à values inserted
à calculated answer à units à sig fig

$$KE = \frac{1}{2}mv^2 \quad \backslash \quad \frac{2KE}{m} = v^2 \quad \backslash \quad v = \sqrt{\frac{2\times 15J}{0.12\text{kg}}}$$

$$= 15.8\text{ ms}^{-1} \quad \underline{= 16\text{ ms}^{-1}(2sf)}$$

EIGHT STEPS TO IMPROVE THE QUALITY OF YOUR WORKING

- ☐ Show all steps
- ☐ Work left to right and top to bottom
- ☐ Rearrange equations before substituting values
- ☐ If a calculation is two step, underline the answer to the first step before proceeding as this may get marks
- ☐ Your writing should be small and neat. Don't scrawl.
- ☐ You should be able to easily check over your working to find mistakes
- ☐ Plan to use the available answer space wisely
- ☐ Try to leave space for correcting mistakes if you go wrong

8. Bringing it all together

Brain-gym for the physics-muscle in your head (It hurts to start with, but gets easier with practise)

These problems will challenge you to work with powers and units, rearrange equations and use your calculator carefully. Helpful formulae for volume and surface area are given on the last page, as are the answers.

Lay out your working clearly, work step by step, and <u>check your answers</u>. If you get one wrong, go back and try again. Do not be disheartened if they seem difficult to start with, persevere and seek help – you <u>will</u> improve. Importantly, have fun!

1. How many mm^2 are there in

   (a) $1cm^2$? ....

   (b) $1\ m^2$? ....

   (c) $1\ km^2$? ....

2. How many cm^3 are there in

   (a) $1mm^3$? ....

   (b) $1\ m^3$? ....

3. A piece of A4 paper is 210 × 297 mm. All measurements are to the nearest mm. Calculate its area in (a) mm^2, (b) cm^2, (c) m^2. Give answers to the correct number of significant figures.

....

....

a) Area = ... mm^2

b) Area = ...cm^2

c) Area = ... m^2

4. A plastic toy is supplied in a cubic box, 4.0 cm each side. How many of them pack into a carton 80 × 52 × 70 cm? (Students often get the wrong answer and can't see why. Visualise the actual problem don't just rely on maths!)

5. A copper atom has a diameter of 217 pm (pico-meters). How many of them would fit inside $1mm^3$ of copper to 3 sig. fig? (Tip: for simplicity, treat them as cubes of side 217 pm)

6. Water has a density of 1.0 g cm^{-3}. Express this in (a) kg cm^{-3}, (b) kg m^{-3}, (c) kg mm^{-3}

....

....

a) Density = ... kg cm^{-3}

b) Density = ... c kg m^{-3}

c) Density = ...kg mm^{-3}

7. A regular block of metal has sides 12.2 × 3.7 × 0.95 cm, and a mass of 107g.
Find its density in Kg m^{-3} to a suitable number of significant figures.

8. A measuring cylinder is filled with 1.00 litres of water. The column of water inside forms a regular cylinder 32.0 cm high. What is (a) the area of the surface of the water (in mm^2)? (b) the internal diameter of the cylinder (in mm)?
(TIP: Visualise the problem clearly. Draw a diagram if it helps. Use the equation or the volume of a cylinder)

9. The diameter of the sun is 1.4×10^6 km. Its average density is 1.4 g cm^{-3}. What is its mass in kg?
(TIP: The trick here is to convert the units carefully before you start)

10. The total energy arriving in the Earth's upper atmosphere from the sun is 174×10^{15} Watts. Given that the Earth's diameter is 12.8×10^3 km, what is the average intensity of this radiation in W m^{-2}?
(TIP: Think about the units carefully. What does W m^{-2} mean?)

Answers:

1. a) 10^2 (100)
   b) 10^6 (1,000,000)
   c) 10^{12}
2. a) 10^{-3} (1/1000)
   b) 10^6 (1,000,000)
3. a) 6.237×10^4 mm^2 (62,370 mm^2)
   b) 6.237×10^2 cm^2 (623.7 cm^2)
   c) 6.237×10^{-2} m^2 (0.06237 m^2)
4. 4420
5. 9.79×10^{19}
6. a) 1×10^{-3} kg cm^{-3}
   b) 1×10^6 kg m^{-3}
   c) 1×10^{-6} kg mm^{-3}
7. 2.50×10^3 kg m^{-3}
8. a) 3125 mm^2
   b) 63.1 mm
9. 2.0×10^{30} kg
10. 338 W m^{-3}

GEOMETRICAL EQUATIONS

arc length	$= r\theta$
circumference of circle	$= 2\pi r$
area of circle	$= \pi r^2$
surface area of cylinder	$= 2\pi rh$
volume of cylinder	$= \pi r^2 h$
area of sphere	$= 4\pi r^2$
volume of sphere	$= \dfrac{4}{3}\pi r^3$

KS4 Revision & Extension

9. Energy and Power

Look up definitions for each of the following quantities and write down the equations and any notes you think are helpful

Work

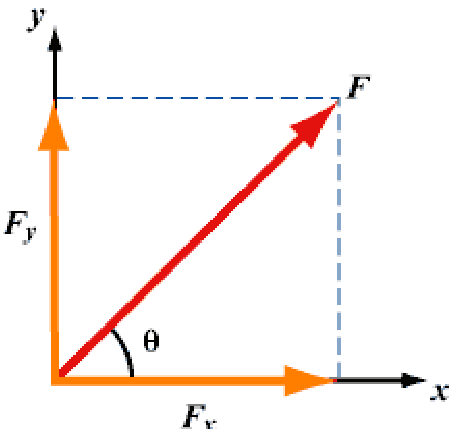
Kinetic Energy

Gravitational Energy

Elastic Potential Energy

Efficiency

Power (including electrical power)



Work

Resolving vectors

In A level Physics you will need to work with vectors that act at odd angles. Often the easiest way to deal with this is to convert the diagonal vector into horizontal and vertical components.

For example, in the case of a force F acting at an angle Ɵ, can be treated as two forces acting horizontally (F_x) and vertically (F_y). These can be calculated with trigonometry:

$$F_y = F \sin(\Theta) \quad \textit{and} \quad F_x = F \cos(\Theta)$$

You may need to use this in the following questions

What is the definition of work?

....

....(2)

In the following calculations take g = 9.8 N kg^{-1}

1) Calculate the work done in each of the following situations, stating the final form of the transferred energy.

i) A box is pushed 3m along the floor by a horizontal force of 500N

....

....

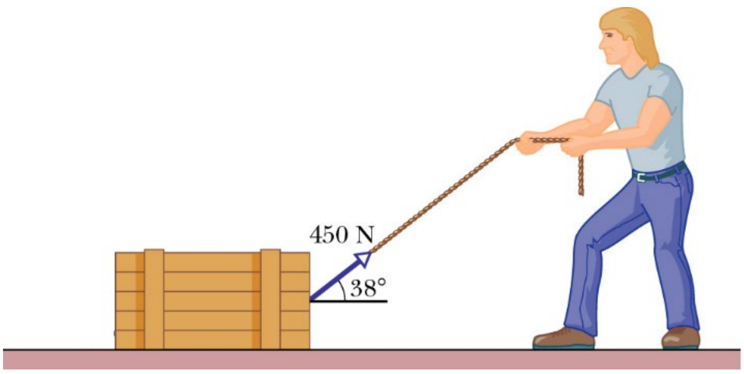
Work = ... J Energy is transferred into...(2)

ii) An electric lift raises 540 kg load through a height of 18.3 metres

....

....

Work = ... J Energy is transferred into...(3)



iii) A man uses a rope to pull a box along a floor, as shown above. He drags the box 3.0 km.

....

....

....

Work done = ... J Energy is transferred into... (4)

iv) A student adds three 100g slotted masses to a spring of spring constant, k = 6.0 Nm^{-1}. It extends by 14.0 cm.

....

....

....

Work done = ... J Energy is transferred into... (4)

Power

What is the definition of power?

....

....(1)

2) Which of the following are units of power? (circle all of the correct units)

joule second   watt   joule second $^{-1}$ newton metre second^{-1} amp volt

(2)

Explain why power is equal to force × velocity

....

....

....(2)

Explain why power is equal to current × potential difference

....

....

....(2)

3) In two minutes a rocket gained 370 MJ of kinetic energy and 1300 MJ of gravitational potential energy.

i) Find the useful power produced by the rocket engines.

....

.... Power = ……………………. W (2)

ii) In the following 30 seconds the rocket travels at a steady speed of 320 ms^{-1}. Assuming the power of the engines to be constant, calculate the thrust force produced by the engines.

....

.... Force = ……………………. N (2)

4) A 12V electric motor is used to lift a 50g mass through 1.0m. The overall efficiency of this system is 10%. Whilst in operation it draws a current of 0.25A.

i) Find the useful power output of the electric motor.

....

.... Power = ……………………. W (2)

ii) How long does it take the motor to raise the mass 1.0m?

....

.... Time = ……………………… s (2)

SPEED QUESTIONS

1. A bullet travels 300m in 2.60 seconds what is its velocity in (a) $m\ s^{-1}$ (b) $km\ h^{-1}$?

   ....

   ....

   ....

2. An alpha particle covers 2.0 cm travelling at 5% the speed of light (speed of light=$3.0\ x10^{8}\ m\ s^{-1}$). How long does it take to cover this distance?

   ....

   ....

   ....

3. A cyclist is racing on a circular track at an average speed of $8.35\ m\ s^{-1}$. She completes three laps in 2 minutes 24.36 seconds. What is the radius of the track?

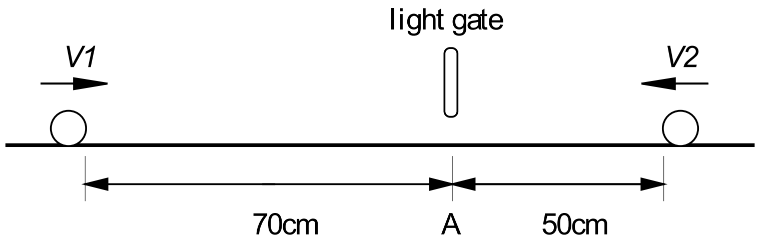
   ....

   ....

   ....

   ....

4. Two pool balls are moving towards each other as in the diagram below. At position A is a light gate.



If $V1$= $0.60\ m\ s^{-1}$ and $V2$ = $0.20\ m\ s^{-1}$ then (a) which ball passes through the light gate first and (b) at what time and (c) at what position do they collide and (d) at what time?

....

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....

5. A light-year is the distance light travels in one year. Calculate this distance in metres to 3 significant figures, given that the speed of light is $3.00 \times 10^{8}\ m\ s^{-1}$.

   ....

   ....

   ....

   ....

   ....

ACCELERATION QUESTIONS

6. A horse is cantering at 3.1 m s^{-1} and breaks into a gallop reaching a speed of 5.6 m s-1 in 3.5 seconds. Calculate its acceleration.

   ....

   ....

7. A car travelling at 16.0 m s^{-1}, brakes for 3.20 s, decelerating at a rate of 3.125 m s^{-2}. What is its final speed?

   ....

   ....

   ....

8. An Olympic diver strikes the water at a speed of 7.2 m s^{-1}, and comes to rest in 1.2 seconds. What is his acceleration?

   ....

   ....

9. A falling ball strikes a floor with a velocity of 4.2 m s^{-1} and rebounds with a velocity of -3.8 m s^{-1}. It is in contact with the floor for 0.12 seconds. What was its acceleration?

   ....

   ....

   ....

10. A Porsche is quoted as having a *"0-60 time of 4.2 seconds"*. This means it accelerates from zero to 60 miles per hour in 4.2 seconds. Given that 1 mile = 1.55 km, calculate its acceleration in ms^{-2}

    ....

    ....

    ....

    ....

11. At the University of Errors Science Tower, a brick is observed falling past the window of the physics laboratory. A quick thinking physics student records its speed as 4.59 m s^{-1}. A moment later it passes the ground floor windows of the engineering faculty and an alert engineer records its speed as 12.91 m s^{-1}.

    (a) Assuming acceleration due to gravity to be 9.81 m s^{-1} and assuming air resistance to be negligible, how long was the 'moment' between these observations?

    ....

    ....

    ....

    (b) By considering its average speed calculate the height between the Physics and the Engineering labs.

    ....

    ....

    ....

PREPARATION FOR YEAR 12

A L PHYSICS

Objectives:

- *To give you the skills needed for the successful study of Physics at A level.*
- *To help you to identify areas in which you might need help.*

There are several areas in which students struggle at A level:

- Use of symbols;
- Use of SI units;
- Use of a calculator;
- Use of formulae.

These notes and activities are to help you to become confident with these basic skills, which will help the start of your Physics studies to be more productive and enjoyable.

Using Symbols

An equation is a mathematical model that sums up how a system behaves. For example, we know that, if we have a current flowing through a wire and double the voltage, the current will double as well. We know that the quantities of current and voltage are related by the simple rule: $V = IR$

In physics problems we are given certain quantities and use them to find an unknown quantity with an equation.

Symbols

At GCSE you were often given equations in words: $distance = speed \times time$

At A level you will be provided with a data sheet in your examinations. The data sheet will provide you with equations that are given in symbols. The symbols all mean something; they are abbreviations. The symbols used in exams and most textbooks are those agreed by the Association of Science Education.

Some symbols are easy; *V* stands for voltage. Some are not so easy. *I* for current comes from the French *intensité du courant*, since it was a French physicist who first worked on it. In print you will always find these symbols written in *italics*.

1. What are the meanings for these symbols?
a
v
F
t
Q

You will come across symbols written in Greek letters. The normal (Latin) alphabet has 26 characters. No symbols, with accents are used such as ä (a – umlaut) or ê (e – circumflex). The Greek alphabet adds another 24.

The Greek Alphabet is this:

Greek	*Name*	*Greek*	*Name*
α	alpha	ν	nu
β	beta	π	pi
γ	gamma	ρ	rho
δ (Δ)	delta	σ (Σ)	sigma
ε	epsilon	τ	tau
η	eta	ϕ (Φ)	phi
θ	theta	χ	chi
λ (Λ)	lambda	ψ (Ψ)	psi
μ	mu	ω (Ω)	omega

We often use Greek letters to represent:

- Particles – many particles are given Greek letters, e.g. π meson.
- Physics equations, e.g. $c = f\lambda$

2. The wave equation is $= f\lambda$. What do the symbols refer to?
c
f
λ

The most common uses of Greek letters are:

- α – as in alpha particle;
- β – as in beta particle;
- γ – as in gamma ray;
- Δ – change in (Δt is time interval);
- θ – angle;
- π – 3.1415...;
- Σ – sum of.

When you use an equation, you will need to know exactly what each term means. But don't worry; the terms will be explained when the formula is introduced to you.

Units

Physics formulae use SI (Système International) units based on seven base units.

Many physics formulae will give you the right answer ONLY if you put the quantities in SI units. This means that you have to convert. You will often find units that are prefixed, for example kilometre. The table below shows you the commonest prefixes and what they mean:

Prefix	*Symbol*	*Meaning*	*Example*
pico	p	$\times 10^{-12}$	1 pF
nano	n	$\times 10^{-9}$	1 nF
micro	µ	$\times 10^{-6}$	1 µg
milli	m	$\times 10^{-3}$	1 mm
centi	c	$\times 10^{-2}$	1 cm
kilo	k	$\times 10^{3}$	1 km
Mega	M	$\times 10^{6}$	1 MΩ
Giga	G	$\times 10^{9}$	1 GWh

When converting, it is perfectly acceptable to write the number and the conversion factor. For example:

$$250 \text{ nm} = 250 \times 10^{-9} \text{ m} = 2.5 \times 10^{-7} \text{ m}$$

3. Convert the following quantities to SI units:	
15 cm	
3 km	
35 mV	
220 nF	

When you write out your answer, you must always put the correct unit at the end. The number 2500 on its own is meaningless; 2500 J gives it a meaning.

Failure to put units in loses one mark in the exam, which is 2 %. Repeated across a paper, it can mean the difference of two grades.

Converting areas and volumes causes many problems.

Area:

$$1m^2 \neq 100cm^2$$

$$1m^2 = 100cm \times 100cm = 10,000cm^2 = 10^4cm^2$$

Volume:

$$1m^3 = 100cm \times 100cm \times 100cm = 1000,000cm^3 = 10^6cm^3$$

4. Convert the following:	
$1\ m^2 =$	mm^2
$45\ 000\ mm^2 =$	m^2
$6\ 000\ 000\ cm^3 =$	m^3

Standard Form

Standard form consists of a number between 1 and 10 multiplied by a power of 10. For big numbers and very small numbers standard form is very useful.

You should have found that very small numbers entered into a calculator are read as 0, unless they are entered as standard form. The following number is shown in standard form:

$$\mathbf{3.28 \times 10^5}$$

$$= 3.28 \times 100\ 000 = 328\ 000$$

Look at this number:

$$4\ 505\ 000\ 000\ 000\ 000\ 000$$

Start counting from here to get the power of 10.

We find that there are 18 digits after the first digit, so we can write the number in standard form as:

$$4.505 \times 10^{18}$$

For fractions, we count how far back the first digit is from the decimal point:

$$0.00000342$$

In this case it is six places from the decimal point, so it is:

$$3.42 \times 10^{-6}$$

A negative power of ten (negative index) means that the number is a fraction, i.e. between 0 and 1.

5. Convert these numbers to standard form:
86
381
45300
1 500 000 000
0.03
0.00045
0.0000000782

There is no hard and fast rule as to when to use standard form in an answer. Basically if your calculator presents an answer in standard form, then use it. Generally use standard form for:

- numbers greater than 100 000
- numbers less than 0.001

When doing a conversion from one unit to another, for example from millimetres to metres, consider it perfectly acceptable to write:

$$15 \text{ mm} = 15 \times 10^{-3} \text{ m}$$

Using a Calculator

A scientific calculator is an essential tool in Physics, just as a chisel is to a cabinet-maker. All physics exams assume you have a calculator, and you should always bring a calculator to every lesson. They are not expensive, so there is no excuse for not having one.

The calculator should be able to handle:

- standard form;
- trigonometrical functions;
- angles in degrees and radians;
- natural logarithms and logarithms to the base 10.

Most scientific calculators have this and much more.

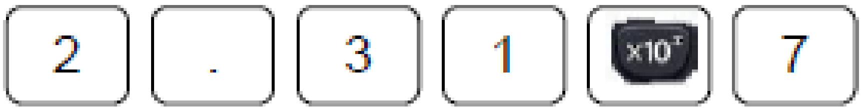
There are no hard and fast rules as to what calculator you should buy:

- Get one that you are happy with.
- Make sure it is accurate; we have known some calculators to get an answer plain wrong!
- Avoid machines that need a hefty instruction manual.
- For the exam, there are certain types of calculator that are NOT allowed, for example those with QWERTY keypads. Make sure that your calculator is an allowable type.

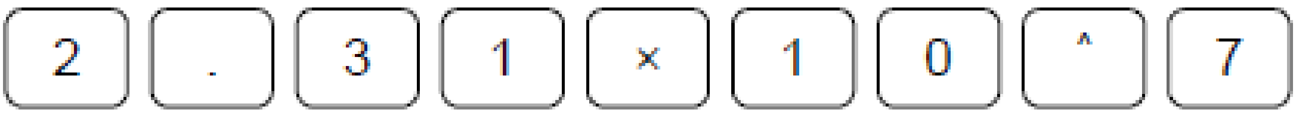
We are assuming that you know the basic functions of your calculator, but we need to draw your attention to a couple of points on the next page.

Correct method for calculations involving standard form:

Suppose we have a number like 2.31×10^7. You key it in like this:



Do NOT key it in like this:



This method can cause issues, due to the order that the calculator completes the calculation. It could ultimately make you lose marks, so get used to using the x10ˣ key.

Too Many Significant Figures

Consider this calculation: $$V_{rms} = \frac{13.6}{\sqrt{2}}$$

Your calculator will give the answer as V_{rms} = 9.6166526 V

There is no reason at all in A-level Physics to write any answer to any more than 4 significant figures. Four significant figures is claiming accuracy to about one part in 10000. Blindly writing your calculator answer is claiming that you can be accurate to one part in 100 million, which is absurd.

The examination mark schemes give answers that are either 2, 3 or 4 significant figures. So our answer above could be written as:

V_{rms} = 9.617 V (4 s.f.)

V_{rms} = 9.62 V (3 s.f.)

V_{rms} = 9.6 V (2 s.f.)

Do any rounding up or down at the end of a calculation. If you do any rounding up or down in the middle, you could end up with rounding errors.

6. Use your calculator to do the following calculations. Write your answers to three significant figures.	
	ANSWER
(a) $\frac{3.4\times10^{-8}\times6.0\times10^{28}}{235}$	
(b) $\frac{27.3^2-24.8^2}{\sqrt{38}}$	
(c) 1.4509^3	
(d) $sin\ 56.4^0$	
(e) Reciprocal of 2.34×10^5	
(f) $45sin10^0$	

Some other tips on use of calculators:

- On most calculators the number is keyed in before the function (sin, cos, log)
- Take one step at a time and write intermediate results.
- It is easy to make a mistake such as pressing the × key rather than the ÷ key. It is a good idea to do the calculation again as a check.
- As you get more experienced, you will get a feel for what is a reasonable answer. 1000 N is a reasonable force that a car would use to accelerate; 2×10^{-10} N is most certainly not.

Transposition of Formulae (Rearranging)

The transposition (or rearrangement) of formulae is a skill that is essential for successful study of Physics. A wrong transposition of a formula will lead to a physics error in the exam and you will lose all the marks available in that part of the question. (However, if you use your incorrect answer correctly in subsequent parts, your error will be carried forward and you will gain the credit.)

Some students find rearrangement very difficult and it hampers their progress and enjoyment of the subject. They try to get round it by learning all the variants of a formula, which is a waste of brain power.

It is far better to get into the habit of rearranging formulae from the start. The best thing to do is to practise.

Key Points:

- What you do on one side you have to do on the other side. It applies whether you are working with numbers, symbols, or both.
- Don't try to do too many stages at once.

Transposing Simple Formulae

Simple formulae are those that consist of three quantities, taking the form $A = BC$. A typical example is $V = IR$

Suppose we are using the equation $V = IR$ and wanted to know *I*.

We want to get rid of the R on the RHS so that I is left on its own. So we divide both sides by *R* which gives us:

$$\frac{V}{R} = \frac{IR}{R}$$

The *R*s on the RHS cancel out because *R*/*R* = 1. So we are left with:

$$\frac{V}{R} = I$$

It does not matter which way the equation ends up, as long as it is rearranged properly.

7. Rearrange these equations:		
Equation	***Subject***	***Answer***
$V = IR$	*R*	
$p = mv$	*v*	
$\rho = \frac{m}{V}$	*m*	
$Q = CV$	*C*	

Formulae with Four Terms

8. Rearrange these equations:		
Equation	***Subject***	***Answer***
$pV = nRT$	*V*	
$E_p = mg\Delta h$	*Δh* (*Δh* is a single term)	
$V = \frac{-Gm}{r}$	*G*	
$\lambda = \frac{ws}{D}$	*D*	

Equations with + or -

If there are terms that are added or subtracted, we need to progress like this:

$$E_k = hf - \Phi$$

We want to find *h*.

To get rid of the □ term we need to add it to both sides of the equation:

$$E_k + \Phi = hf - \Phi + \Phi$$

$$E_k + \Phi = hf$$

Now we can get rid of the *f* on the RHS by dividing the whole equation by *f*:

$$\frac{(E_k + \Phi)}{f} = \frac{hf}{f}$$

Which gives us our final result of:

$$h = \frac{(E_k + \Phi)}{f}$$

9. Rearrange these equations:		
Equation	***Subject***	***Answer***
$v = u + at$	*t*	
$E = V + Ir$	*r*	

Now Mark your work. Ensure that it is ticked and that you have written up your corrections.

ANSWERS

1. What are the meanings for these symbols?
a *acceleration*
v *velocity*
F force
t *time*
Q *amount of charge*

2. The wave equation is $= f\lambda$. What do the symbols refer to?
c speed
f frequency
λ wavelength

3. Convert the following quantities to SI units:	
15 cm	*0.15 m*
3 km	*3000 m*
35 mV	*0.035 V*
220 nF	2.2×10^{-7} *F*

4. Convert the following:
1 m^2 = *1000 000* mm^2
45 000 mm^2 = *0.045* m^2
6 000 000 cm^3 = *6* m^3

5. Convert these numbers to standard form:
86 = 8.6×10^1
381 = 3.81×10^2
45300 = 4.53×10^4
1 500 000 000 = 1.5×10^9

$0.03 = 3.0 \times 10^{-2}$
$0.00045 = 4.5 \times 10^{-4}$
$0.0000000782 = 7.82 \times 10^{-8}$

6. Use your calculator to do the following calculations. Write your answers to no more than three significant figures.	
(a) $\frac{3.4\times10^{-8}\times6.0\times10^{28}}{235}$	8.68×10^{18}
(b) $\frac{27.3^2-24.8^2}{\sqrt{38}}$	21.1
(c) 1.4509^3	3.05
(d) $\sin 56.4^0$	0.833
(e) Reciprocal of 2.34×10^5	4.27×10^{-6}
(f) $45\sin 10^0$	7.81

7. Rearrange these equations:		
$V = IR$	R	$R = \frac{V}{I}$
$p = mv$	v	$v = \frac{p}{m}$
$\rho = \frac{m}{V}$	m	$m = \rho V$
$Q = CV$	C	$C = \frac{Q}{V}$

8. Rearrange these equations:		
$pV = nRT$	V	$V = \frac{nRT}{p}$
$E_p = mg\Delta h$	Δh (Δh is a single term)	$\Delta h = \frac{E_p}{mg}$
$V = \frac{-Gm}{r}$	G	$G = -\frac{Vr}{m}$
$\lambda = \frac{ws}{D}$	D	$D = \frac{ws}{\lambda}$

9. Rearrange these equations:		
$v = u + at$	t	$t = \frac{v-u}{a}$
$E = V + Ir$	r	$r = \frac{E-V}{I}$

Transition guide: Physics

We have created this student support resource to help you make the transition from GCSE to AS or A-level Physics.

Contents

You're studying AS or A-level Physics, congratulations!

Studying physics after your GCSEs really develops your practical and mathematical skills. If you enjoy experimenting in the lab, you'll love it.

At first, you may find the jump in demand from GCSE a little daunting, but if you follow the tips and advice in this guide, you'll soon adapt.

We recommend you keep this somewhere safe, as you may like to refer to the information inside throughout your studies.

Why study A-level Physics?

Physicists explore the fundamental nature of almost everything we know of. They study everything from the fundamental particles that build matter, to the galaxies that make up the universe itself. Join them to enter a world deep beneath the surface of normal human experience.

Even if you don't decide to work in physics, studying it still develops useful and transferable skills for other careers. You'll develop research, problem solving and analytical skills, alongside teamwork and communication. Universities and business regard all of these very highly.

Possible degree options

According to bestcourse4me.com the top seven degree courses taken by students who have A-level Physics are:

- mathematics
- physics
- mechanical engineering
- computer science
- civil engineering
- economics
- business.

For more details, go to bestcourse4me.com or UCAS.

Which career appeals to you?

Studying Physics at A-level or degree level opens up all sorts of career opportunities.

- Geophysicist/field seismologist
- Healthcare scientist, medical physics
- Higher education lecturer or secondary school teacher
- Radiation protection practitioner
- Research scientist (physical sciences)
- Scientific laboratory technician
- Meteorologist
- Structural or Acoustic engineer
- Product/process development scientist
- Systems developer
- Technical author.

You can also move into engineering, astrophysics, chemical physics, nanotechnology, renewable energy and more. With physics, the opportunities are endless.

Specification at a glance

AS and A-level

1 Measurements and their errors

2 Particles and radiation

3 Waves

4 Mechanics and materials

5 Electricity

A-level only

6 Further mechanics and thermal physics

7 Fields and their consequences

8 Nuclear physics

9 Optional topics. You will study one of these: Astrophysics, Medical physics, Engineering physics, Turning points in physics or Electronics.

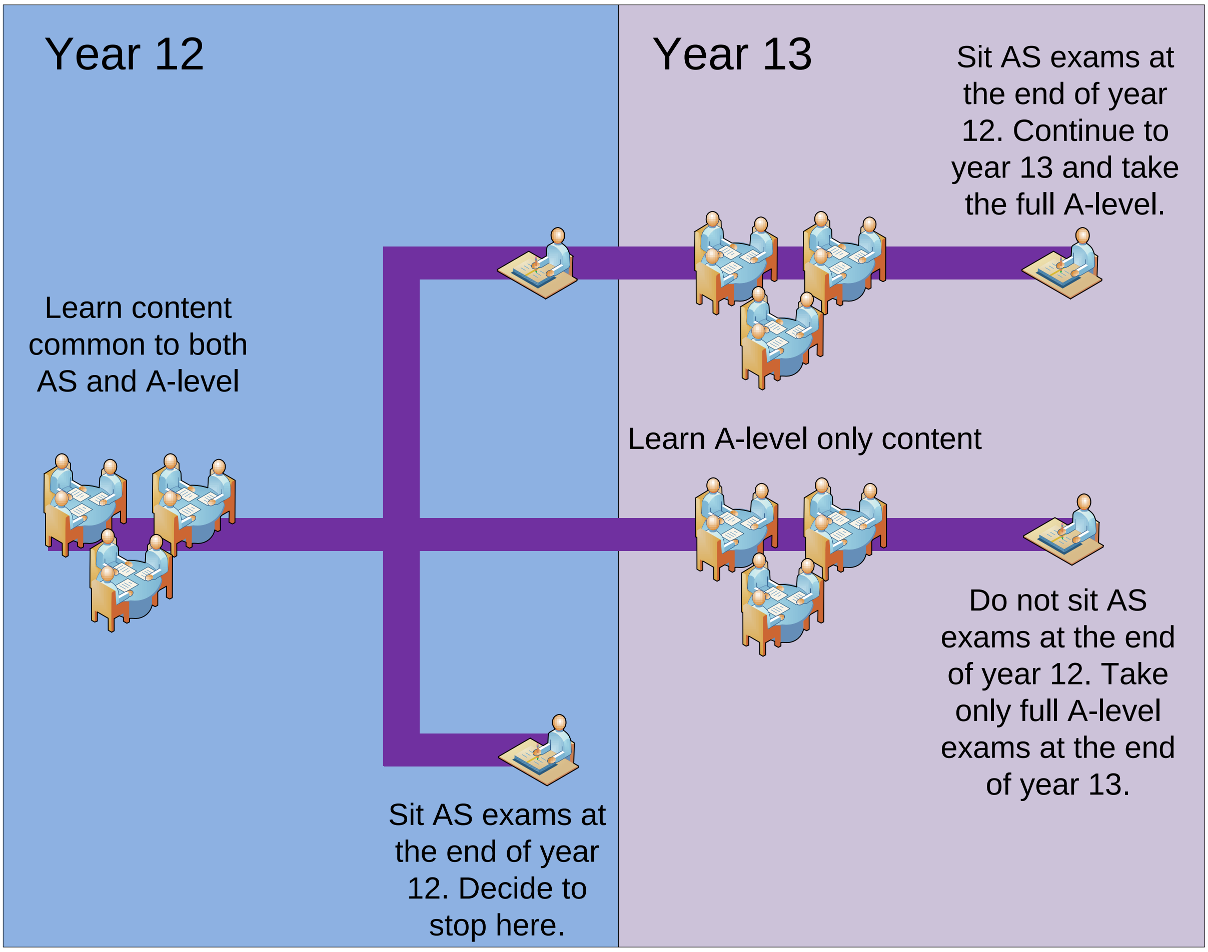
Should you study AS or A-level?

AS and A-level are separate qualifications.

An AS lasts one year. Your exam results don't count towards an A-level, but they're still valuable and AS points are accepted by higher education institutions.

Despite being separate from an A-level, AS course content is the same as the first year of A-level. If you want to switch from an AS to an A-level, you can. Your teacher will help you decide whether it's the right move for you.

All exams for the AS take place at the end of the one-year course. Exams for the A-level take place at the end of the two-year course.



The assessment for the AS consists of two exams

Paper 1	+	Paper 2
What's assessed Sections 1 – 5		What's assessed Sections 1 – 5
Assessed • written exam: 1 hour 30 minutes • 70 marks • 50% of AS		Assessed • written exam: 1 hour 30 minutes • 70 marks • 50% of AS
Questions 70 marks of short and long answer questions split by topic.		Questions Section A: 20 marks of short and long answer questions on practical skills and data analysis. Section B: 20 marks of short and long answer questions from across all areas of AS content. Section C: 30 multiple choice questions

The assessment for the A-level consists of three exams

Paper 1	Paper 2	Paper 3
What's assessed Sections 1 – 5 and 6.1 (Periodic motion)	What's assessed Sections 6.2 (Thermal Physics), 7 and 8 Assumed knowledge from sections 1 to 6.1	What's assessed Section A: Compulsory section: Practical skills and data analysis Section B: Optional topic
Assessed • written exam: 2 hours • 85 marks • 34% of A-level	Assessed • written exam: 2 hours • 85 marks • 34% of A-level	Assessed • written exam: 2 hours • 80 marks • 32% of A-level
Questions 60 marks of short and long answer questions and 25 multiple choice questions on content.	Questions 60 marks of short and long answer questions and 25 multiple choice questions on content.	Questions 45 marks of short and long answer questions on practical experiments and data analysis. 35 marks of short and long answer questions on optional topic.

Resources to help

Our website is a great place to start.

Our Physics webpages are aimed at teachers, but you may find them useful too. Information includes:

- The specification – this explains exactly what you need to learn for your exams.
- Practice exam papers
- Lists of command words and subject specific vocabulary – so you understand the words to use in exams
- Practical handbooks explain the practical work you need to know
- Past papers from the old specification. Some questions won't be relevant to the new AS and A-level, so please check with your teacher.
- Maths skills support.

Institute of Physics (IOP)

The IOP do everything from research like that taking place at CERN to lobbying MPs. You'll find lots of handy resources on their website at iop.org/tailored/students/

The student room

Join the A-level Physics forums and share thoughts and ideas with other students if you're stuck with your homework. Just be very careful not to share any details about your assessments, there are serious consequences if you're caught cheating. Visit thestudentroom.co.uk

Textbooks

Our approved textbooks are published by Collins, Hodder and Oxford University Press. Textbooks from other publishers will also be suitable, but you'll need to double check that the content and formula symbols they use match our specification.

Revision guides

These are great if you want a quick overview of the course when you're revising for your exams. Remember to use other tools as well, as these aren't detailed enough on their own.

YouTube

YouTube has thousands of Physics videos. Just be careful to look at who produced the video and why because some videos distort the facts. Check the author, date and comments – these help indicate whether the clip is reliable. If in doubt, ask your teacher.

Magazines

Focus, New Scientist or Philip Allan updates can help you put the physics you're learning in context.

Useful information and activities

Greek letters

Greek letters are used often in science. They can be used as symbols for numbers (such as π = 3.14…), as prefixes for units to make them smaller (eg $\mu\mathrm{m}$ = 0.000 000 001 m) or as symbols for particular quantities (such as λ which is used for wavelength).

The Greek alphabet is shown below.

Α	α	alpha
Β	β	beta
Γ	γ	gamma
Δ	δ	delta
Ε	ε	epsilon
Ζ	ζ	zeta
Η	η	eta
Θ	θ	theta
Ι	ι	iota
Κ	κ	kappa
Λ	λ	lambda
Μ	μ	mu

Ν	ν	nu
Ξ	ξ	ksi
Ο	ο	omicron
Π	π	pi
Ρ	ρ	rho
Σ	ς or σ	sigma
Τ	τ	tau
Υ	υ	upsilon
Φ	φ	phi
Χ	χ	chi
Ψ	ψ	psi
Ω	ω	omega

Activity 1

List all of the uses of Greek letters that you have encountered in your GCSE Science and Maths studies.

SI units

Every measurement must have a size (eg 2.7) and a unit (eg metres or °C). Sometimes, there are different units available for the same type of measurement. For example ounces, pounds, kilograms and tonnes are all used as units for mass.

To reduce confusion, and to help with conversion between different units, there is a standard system of units called the SI units which are used for most scientific purposes.

These units have all been defined by experiment so that the size of, say, a metre in the UK is the same as a metre in China.

The seven SI base units are:

Physical quantity	Usual quantity symbol	Unit	Abbreviation
mass	m	kilogram	kg
length	l or x	metre	m
time	t	second	s
electric current	I	ampere	A
temperature	T	kelvin	K
amount of substance	N	mole	mol
luminous intensity	(not used at A-level)	candela	cd

All other units can be derived from the SI base units. For example, area is measured in square metres (written as m^2) and speed is measured in metres per second (written as ms^{-1}).

Some derived units have their own unit names and abbreviations, often when the combination of SI units becomes complicated. Some common derived units are:

Physical quantity	Usual quantity symbol	Unit	Abbreviation	SI unit
Force	F	newton	N	$kg\ m\ s^{-2}$
Energy	E or W	joule	J	$kg\ m^2\ s^{-2}$
Frequency	f	hertz	Hz	s^{-1}

It is not always appropriate to use a full unit. For example, measuring the width of a hair or the distance from Manchester to London in metres would cause the numbers to be difficult to work with.

Prefixes are used to multiply each of the units. You will be familiar with centi (meaning 1/100), kilo (1000) and milli (1/1000) from centimetres, kilometres and millimetres.

There is a wide range of prefixes. The majority of quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, a distance of 33 000 m would be quoted as 33 km. The most common prefixes you will encounter are:

Prefix	Symbol	Multiplication factor		
Tera	T	10^{12}	1 000 000 000 000	
Giga	G	10^{9}	1 000 000 000	
Mega	M	10^{6}	1 000 000	
kilo	k	10^{3}	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	μ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000
femto	f	10^{-15}	0.000 000 000 000 001	1/1 000 000 000 000 000

Activity 2

Which SI unit and prefix would you use for the following quantities?

1. The length of a finger
2. The temperature of boiling water
3. The time between two heart beats
4. The width of an atom
5. The mass of iron in a bowl of cereal
6. The current in a simple circuit using a 1.5 V battery and bulb

Sometimes, there are units that are used that are not combinations of SI units and prefixes.

These are often multiples of units that are helpful to use. For example, a light year is a distance of 9.46×10^{12} km.

Activity 3

Re-write the following in SI units.

1. 1 minute

2. 1 hour

3. 1 tonne

Activity 4

Re-write the following quantities:

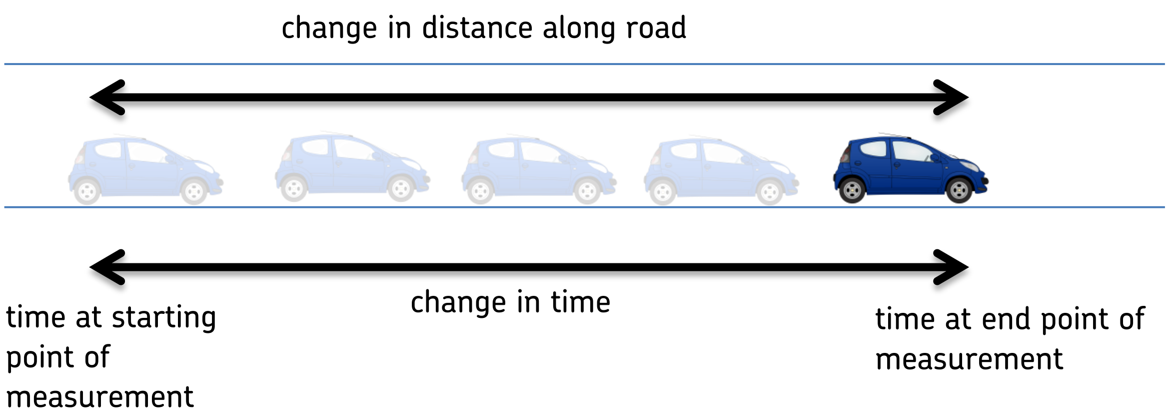
1. 1502 metres in kilometres
2. 0.000 45 grams in micrograms
3. 0.000 45 metres in millimetres
4. 1055 kilometres in metres
5. 180 megaseconds in seconds
6. 2500 centimetres in millimetres

The delta symbol Δ

The delta symbol is used to mean “change in”. For example, at GCSE, you would have learned the formula:

$speed = \dfrac{distance}{time}$ which can be written as $s = \dfrac{d}{t}$

What you often measure is the change in the distance of the car from a particular point, and the change in time from the beginning of your measurement to the end of it.



Because of the fact that the distance and the speed are changing, you use the delta symbol to emphasise this. The A-level version of the above formula becomes:

$velocity = \dfrac{displacement}{time}$ which can be written as $v = \dfrac{\Delta s}{\Delta t}$

Note: the delta symbol is a property of the quantity it is with, so you treat “Δs” as one thing when rearranging, and you cannot cancel the delta symbols in the equation above.

Activity 5

Research exercise

1. Find out the difference between:

   speed and velocity

   distance and displacement

2. Look at the A-level Physics formula sheet on the AQA website (it's under "assess" on the Physics A-level page). Which equations look similar to ones you've encountered at GCSE, but include the delta symbol?

Important vocabulary for practical work

There are many words used in practical work. You will have come across most of these words in your GCSE studies. It is important that you are using the right definition for each word. The activity on the next page tests your understanding of terms used in practical work.

Activity 6

Join the boxes to link the word to its definition.

Accurate	A statement suggesting what may happen in the future.
Data	An experiment that gives the same results when a different person carries it out, or a different set of equipment or technique is used.
Precise	A measurement that is close to the true value.
Prediction	An experiment that gives the same results when the same experimenter uses the same method and equipment.
Range	Physical, chemical or biological quantities or characteristics.
Repeatable	A variable that is kept constant during an experiment.
Reproducible	A variable that is measured as the outcome of an experiment.
Resolution	This is the smallest change in the quantity being measured (input) of a measuring instrument that gives a perceptible change in the reading.
Uncertainty	The interval within the true value can be expected to lie.
Variable	The spread of data, showing the maximum and minimum values of the data.
Control variable	Measurements where repeated measurements show very little spread.
Dependent variable	Information, in any form, that has been collected.

Maths help

Physics uses the language of mathematics to make sense of the world. It is important that you are able to use maths. The following exercises will help you to practise some of the maths you have covered during your GCSE studies to help with your A-level course.

Activity 7: Standard form

1. Write in standard form

   (a) 379.4

   (b) 0.0712

2. Write as ordinary numbers (use the data sheet on the last page of this booklet):

   (a) The speed of light

   (b) The charge on an electron

3. Write one quarter of a million in standard form.

4. Write these constants in ascending order (ignoring units):

   permeability of free space; the Avogadro constant; proton rest mass;

   acceleration due to gravity; mass of the Sun.

5. Work out the value of the following.

   Give your answer in standard form.

   The mass of an electron/the mass of the Earth (use the data sheet).

6. Solve $(2.4 \times 10^{7})x = 1.44 \times 10^{9}$

   Give your answer in standard form.

Activity 8: Decimal places, significant figures and rounding

1. How many rockets would be needed to deliver 30 tonnes of material to a space station, if every rocket could hold 7 tonnes?

2. A power station has an output of 3.5 MW. The coal used had a potential output of 9.8 MW.

   Work out the efficiency of the power station.

   Give your answer as a percentage to one decimal place.

3. A radioactive source produces 17 804 beta particles in 1 hour.

   Calculate the mean number of beta particles produced in 1 minute.

   Give your answer to one significant figure.

Activity 9: Fractions, ratios and percentages

1. The ratio of turns of wire on a transformer is 350 : 7000 (input : output)

   What fraction of the turns are on the input side?

2. A bag of electrical components contains resistors, capacitors and diodes.

   $\frac{2}{5}$ of the components are resistors.

   The ratio of capacitors to diodes in a bag is 1 : 5. There are 100 components in total.

   How many components are diodes?

3. The number of coins in two piles are in the ratio 5 : 3. The coins in the first pile are all 50p coins. The coins in the second pile are all £1 coins.

   Which pile has the most money?

4. A rectangle measures 3.2 cm by 6.8 cm. It is cut into four equal sized smaller rectangles.

   Work out the area of a small rectangle.

5. Small cubes of edge length 1 cm are put into a box. The box is a cuboid of length 5 cm, width 4 cm and height 2 cm.

   How many cubes are in the box if it is half full?

6. In a circuit there are 600 resistors and 50 capacitors. 1.5% of the resistors are faulty. 2% of the capacitors are faulty.

   How many faulty components are there altogether?

7. How far would you have to drill in order to drill down 2% of the radius of the Earth?

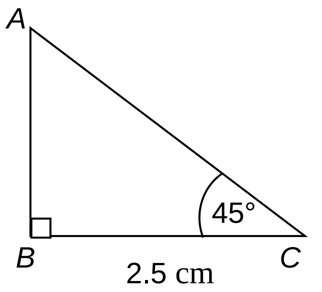
8. Power station A was online 94% of the 7500 days it worked for.

   Power station B was online $\frac{8}{9}$ of the 9720 days it worked for.

   Which power station was offline for longer?

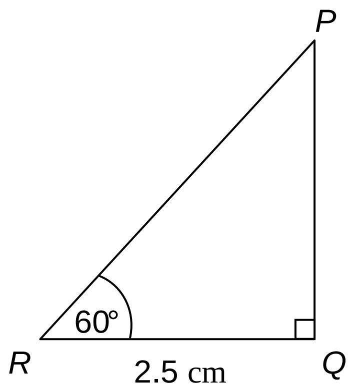
Activity 10: Use sine, cosine and tangent

1 (a) Work out the length of *AB*.



(Not drawn accurately)

(b) Work out the length of *PR*.



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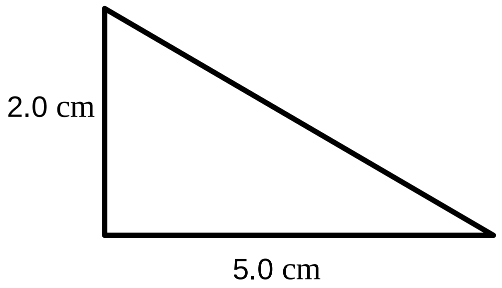
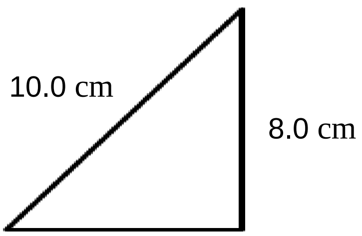
Activity 11: Pythagoras's theorem

Work out the lengths of the unlabelled sides.





Activity 12: Arithmetic means

1. The mean weight of 9 people is 79 kg

   A 10th person is such that the mean weight increases by 1 kg

   How heavy is the 10th person?

2. A pendulum completes 12 swings in 150 s.

   Work out the mean swing time.

Activity 13: Rearranging formulas

1. Rearrange $y = 2x + 3$ to make x the subject.

2. Rearrange $C = 2\pi r$ to make r the subject.

3. Rearrange $E = \frac{1}{2} mv^2$ to make v the subject.

4. Rearrange $s = ut + \frac{1}{2} at^2$ to make u the subject.

5. Rearrange $s = ut + \frac{1}{2} at^2$ to make a the subject.

6. Rearrange $\omega = \frac{v}{r}$ to make r the subject.

7. Rearrange $T = 2\pi \sqrt{\frac{v}{r}}$ to make r the subject.

8. Rearrange $v = \omega\sqrt{A^2 - x^2}$ to make x the subject.

Note: in science, subscripts are often used to label quantities. So in the following two examples, there are two masses, m_1 and m_2. The 1 and 2 are part of the quantity and should be kept with the m.

9. Rearrange $F = \frac{Gm_1 m_2}{r^2}$ to make m_2 the subject.

10. Rearrange $F = \frac{Gm_1 m_2}{r^2}$ to make r the subject.

Activity 14: Graphs

1. The cost of hiring a piece of equipment is given by the formula $C = 8d + 10$, where d is the number of days for which the equipment is hired and C (£) is the total cost of hire.

   Add a line to the graph to show this equation $C = 8d + 10$

2. For the above graph, what was the deposit required for hiring the equipment?

3. Another shop hires out equipment where the cost of hire is given by the formula $C = 5d + 24$

   Josh says that the first supplier is always cheaper if you want to hire equipment.

   Add this formula to the graph.

   Is he correct? Give reasons for your answer.

Activity 14: Graphs (continued)

4. The cost of hiring a laser is worked out as follows:

   Fixed charge = £28

   Cost per day = £12

   Draw a graph to work out the cost of hiring the laser for 6 days.

5. Another firm hires out a laser machine for £22 fixed charge, plus the cost of the first 2 days at £20 per day, then £8 for each additional day.

   Draw a graph on the same axes as the one above to show the cost of hiring the laser for 6 days.

   Which firm would you use to hire the laser machine for 5 or more days?

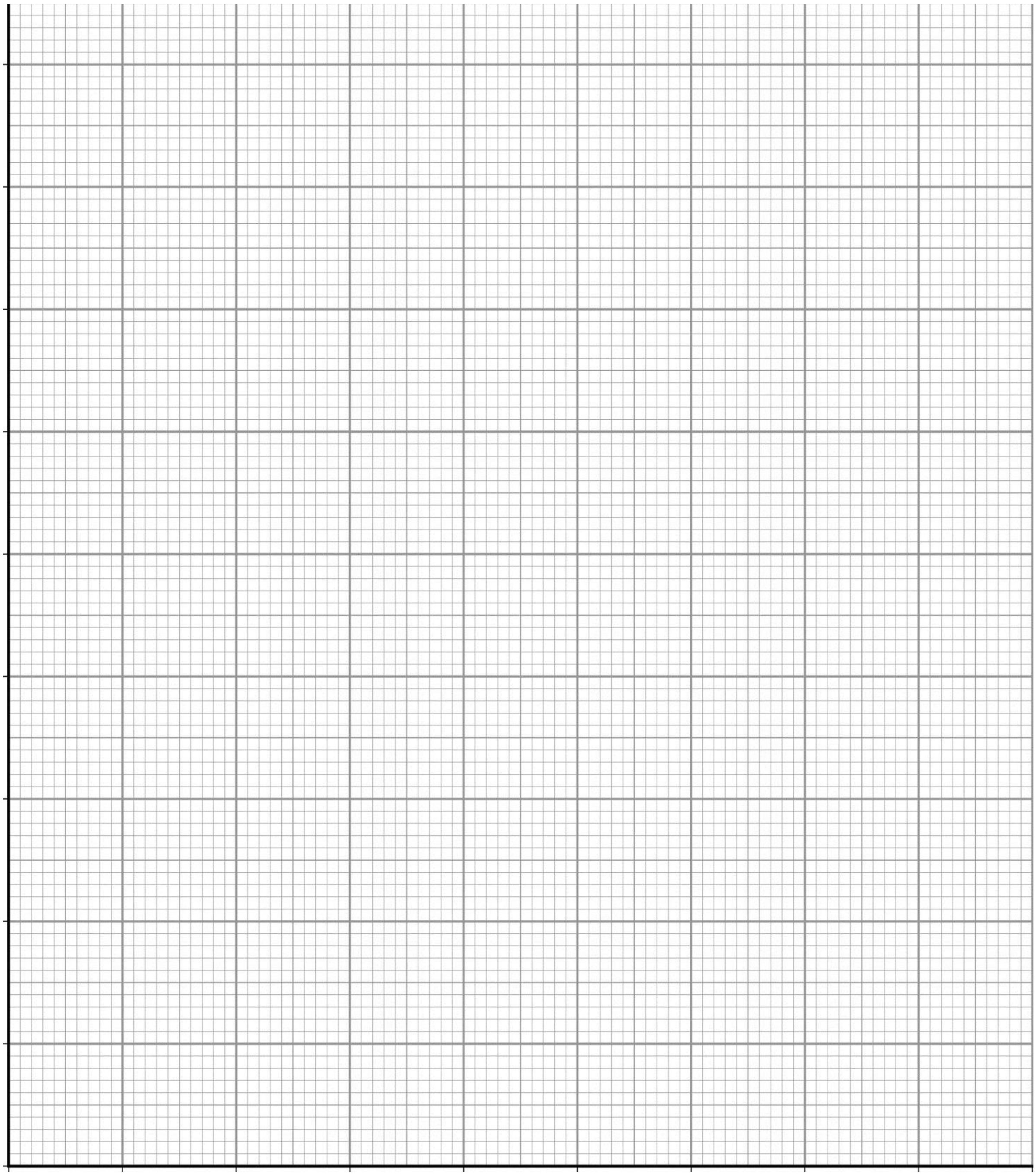
   Give reasons for your answer.

Activity 14: Graphs (continued)

6. Draw graphs of the following functions from x = –3 to x = +3

   Choose axes that allow all values of all graphs to be shown.

   $y = x^2$, $y = x^3$ and $y =\sqrt{(x)}$ for positive numbers only .



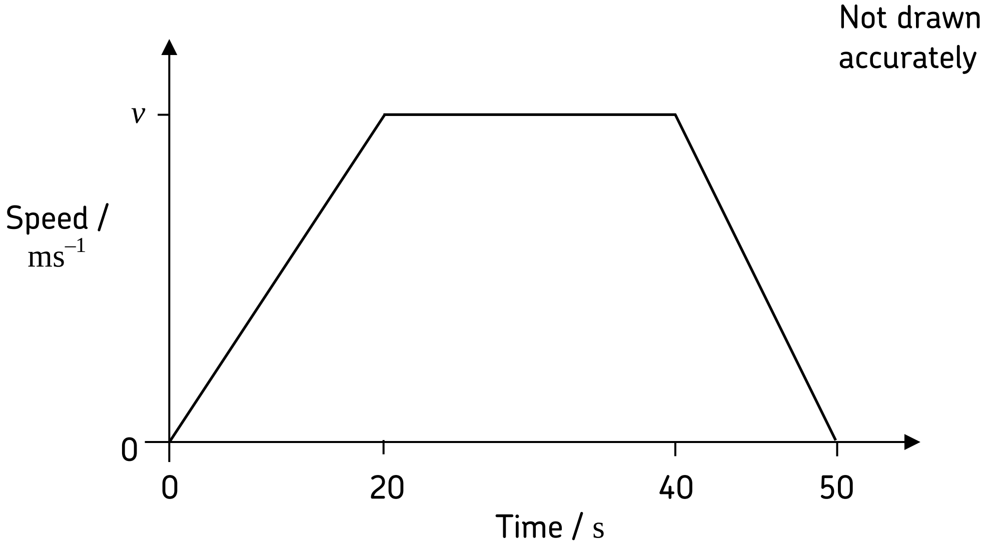
Activity 15: Gradients and areas

1. The graph shows the speed of a car between two sets of traffic lights.

   It achieves a maximum speed of v metres per second.

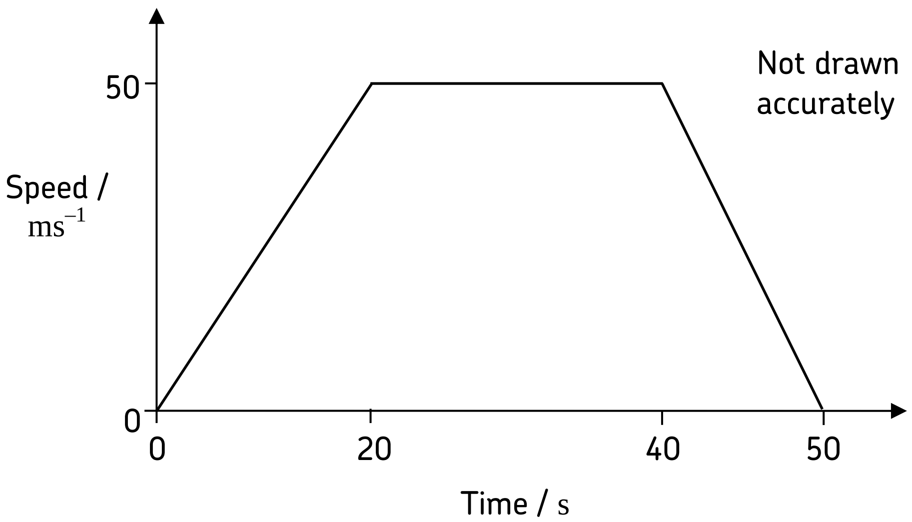
   It travels for 50 seconds.

   The distance between the traffic lights is 625 metres.



   Calculate the value of v

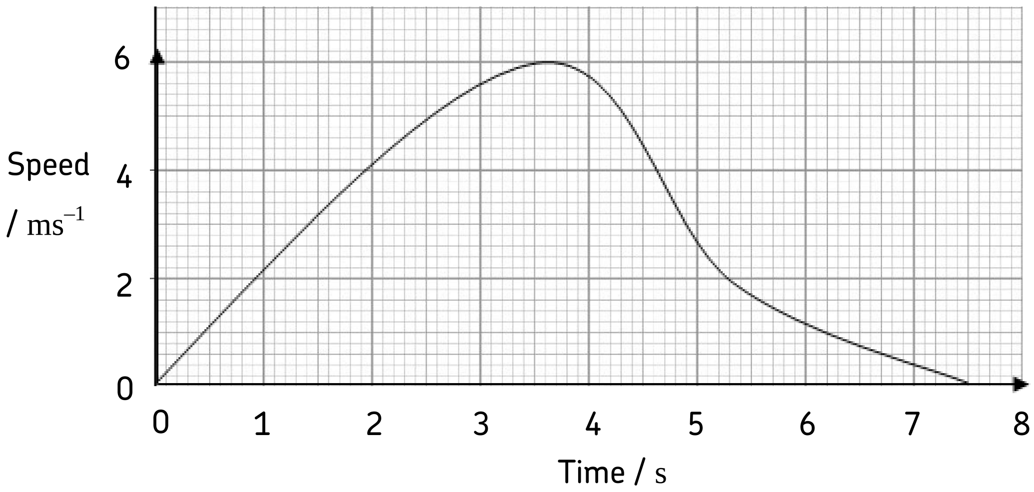
2. The graph shows the speed of a train between two stations.



   Calculate the distance between the stations.

Activity 16: Non-linear graphs

3 The graph shows the speed-time graph of a car.



Use the graph to work out:

a. The maximum speed of the car.

b. The total distance travelled.

c. The average speed for the journey.

d. The deceleration of the car after 8 seconds.

There are a number of activities throughout this resource. The answers to some of the activities are available on our secure website, e-AQA. Your teacher will be able to provide you with these answers.

Data Sheet

Quantity	Symbol	Value	Units
speed of light in vacuo	c	3.00×10^{8}	$\mathrm{m\ s^{-1}}$
permeability of free space	μ_0	$4\pi \times 10^{-7}$	$\mathrm{H\ m^{-1}}$
permittivity of free space	ε_0	8.85×10^{-12}	$\mathrm{F\ m^{-1}}$
magnitude of the charge of electron	e	1.60×10^{-19}	C
the Planck constant	h	6.63×10^{-34}	J s
gravitational constant	G	6.67×10^{-11}	$\mathrm{N\ m^{2}\ kg^{-2}}$
the Avogadro constant	N_{A}	6.02×10^{23}	$\mathrm{mol^{-1}}$
electron rest mass	m_{e}	9.11×10^{-31}	kg
proton rest mass	m_{p}	$1.67(3) \times 10^{-27}$	kg
neutron rest mass	m_{n}	$1.67(5) \times 10^{-27}$	kg
gravitational field strength	g	9.81	$\mathrm{N\ kg^{-1}}$
acceleration due to gravity	g	9.81	$\mathrm{m\ s^{-2}}$
atomic mass unit	u	1.661×10^{-27}	kg
mass of the Sun		1.99×10^{30}	kg
mean radius of the Sun		6.96×10^{8}	m
mass of the Earth		5.98×10^{24}	kg
mean radius of the Earth		6.37×10^{6}	m