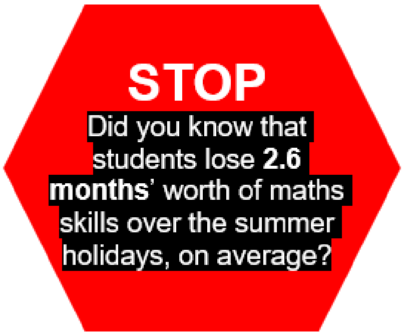
Salvatorian
Sixth Form

Physics

2024-25

Name: ______________________________________

Year 11 pre-A-level Physics work



In preparation for your A-level physics course, there are 4 tasks to compete.

1) Revision of key GCSE topics and will also check your GCSE exam technique and maths skills (including triple content). This will help you prepare for your entry exam & A-level course. Complete the Home Baseline test.

2) Complete the Course preparation booklet.

3) Work through a 'transition guide' prepared by AQA that will help you to understand what the A-level course will involve and will develop some key skills that will be required over the next two years.

4) The last task is a project that will get you started on your A-level studies.

If you have any questions email Ms Schipor a.schipor@salvatorian.harrow.sch.uk

Bring your work with you to your first Physics lesson.

Task 1: GCSE revision, exam technique and maths skills

Work through the GCSE exam questions. You may need to do some revision in order to complete this work. The questions will test your exam technique (e.g. your knowledge of command words) and also your maths skills. When you have completed the questions, mark your work using the mark scheme. Think about any areas of weakness you might have and how you might improve these before you start the A-level course (for example, using BBC Bitesize or Hegarty Maths). This task should take around 3-4 hours, the test should take 1 hour to complete.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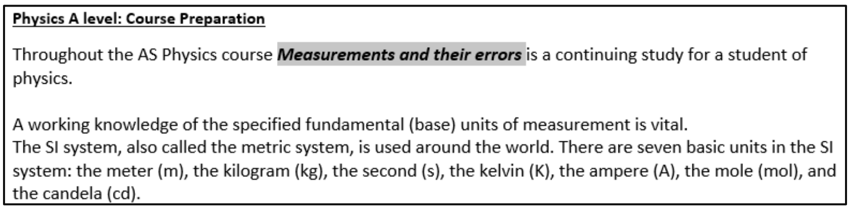
2024-25

Task 2: Complete the activities in the AQA transition guide

This booklet has been designed to help you understand ***Symbols, Measurements and their errors.*** This should take around 1-2 hours.

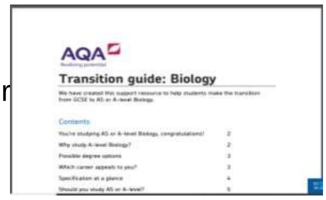

Physics A level: Course Preparation

Throughout the AS Physics course ***Measurements and their errors*** is a continuing study for a student of physics.

A working knowledge of the specified fundamental (base) units of measurement is vital.
The SI system, also called the metric system, is used around the world. There are seven basic units in the SI system: the meter (m), the kilogram (kg), the second (s), the kelvin (K), the ampere (A), the mole (mol), and the candela (cd).

Task 3: Complete the activities in the AQA transition guide

There are 18 activities to complete. This should take around 4-5 hour


AQA

Transition guide: Biology

Task 4: Project

Explore the Physics that interests you!

TED

TED talks are really great, thought-provoking (and free!) presentations on a huge range of topics, often given by the world's leading thinkers. You will create your own 5-minute TED talk on a physics topic that interests you!

Browse https://www.ted.com/talks and using the internet to help you, prepare a TED talk on a part of Physics that fascinates you (big or small). Practice your talk and make a captivating recording. Bring this via a USB to your first Physics lesson.

Please use this source for ideas, sources include; videos, podcasts, magazines and other sites
Main source: https://www.physicstutoronline.co.uk/year-11-to-a-level-physics-transition-work/

Task 1

A-Level Physics Home Baseline Test

DEO DUCE

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2024-25

1 hour

Answer ALL questions in the spaces provided

Section 1: Calculations and conversions *(1 mark per question)*

1. Convert these numbers into normal form.

   a) 5.239×10^3 b) 4.543×10^4 c) 6.665×10^9

   ______________ ______________ ______________

2. Convert these numbers into standard form.

   a) 65345 b) 548454

   ______________ ______________

3. Convert these numbers into normal form.

   a) 8.34×10^{-3} b) 2.541×10^{-8} c) 1.01×10^{-5}

   ______________ ______________ _____________

4. Convert these numbers to standard form.

   a) 0.987 b) 0.0000605

   ______________ ______________

5. Calculate, giving answers in standard form,

   a) $(3.45 \times 10^{-5} + 9.5 \times 10^{-6}) \div 0.004$ ______________

   b) $2.31 \times 10^5 \times 3.98 \times 10^{-3} + 0.005$ ______________

6. It has been 44 years since England won the World Cup, how long is this in seconds?

   ____

7. Convert:

a) 0.023 kms^{-1} into ms^{-1} ______________

b) 33 km hr^{-1} into ms^{-1} ______________

8. Express:

a) 65 mm in m ______________

b) 34 cm in mm ______________

9. What is 5.2 mm^3 in m^3? ______________

10. What is 24cm^2 in m^2? ______________

11. What is 34 m^3 in μm^3? ______________

12. Three waves are produced by a loudspeaker in 0.0001 seconds. How many waves does the loudspeaker produce every second? ______________

13. The speed of ultrasound in water is 1500 m / s. Calculate the wavelength of the 3.0 MHz waves in water. ______________

14. A bus is moving and has 500 000 J of kinetic energy. The brakes are applied and the bus stops in a distance of 25 m. Calculate the force that was needed to stop the bus. ______________

15. How many neutrons are in the nucleus of a $^{206}_{82}Pb$ atom? ____________

16. A car is travelling at a speed of 20 m/s when the driver applies the brakes. The mass of the car and driver is 1600 kg.
(a) Calculate the kinetic energy of the car and driver before the brakes are applied.

____

Kinetic energy =__________________ J (2 marks)

(b) How much work is done by the braking force to stop the car and driver?

Work done =__________________J (1 mark)

17. The resultant force on a body of mass 4.0 kg is 20 N. What is the acceleration of the body? (2 marks) ____

18. A small aircraft accelerated down a runway at 4.0 m/s^2

The aircraft started from rest and reached a speed of 34 m/s just before take-off.

(a) Calculate the distance the aircraft travelled while accelerating.

Give your answer to 2 significant figures.

____

____

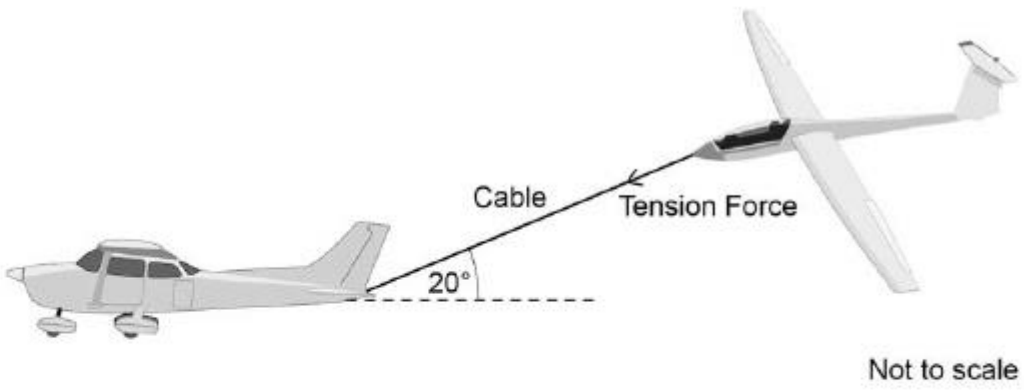
____

____

Distance = ___________________ m **(4)**

(b) **Figure 3** shows the small aircraft being used to tow a glider.

Figure 3



The tension force in the cable can be resolved into a horizontal component and a vertical component.

The tension in the cable is 2000 N

The cable makes an angle of 20° with the horizontal.

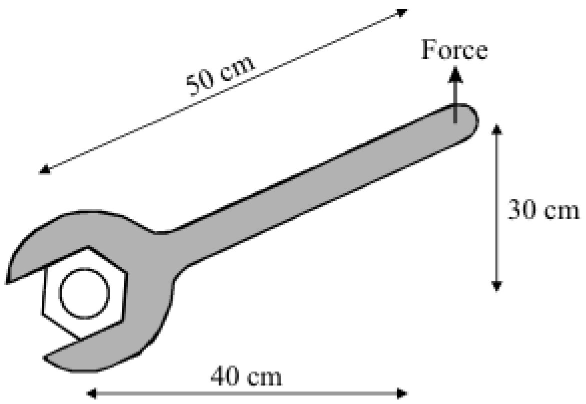
Draw a vector diagram to determine the magnitude of the two components of the tension force in the cable.

Magnitude of the horizontal component = ____________________ N

Magnitude of the vertical component = ____________________ N

(1)

19. The diagram shows a spanner being used to undo a tight nut.



The nut was tightened using a moment of 120 newton metres.

Calculate the force needed to undo the nut. Show clearly how you work out your answer.

____

____

Force = ________________________ N **(Total 2 marks)**

Section 2: Definitions

20. What is the difference between **longitudinal** and **transverse waves**? (2 marks)

21. What is the meaning of **potential difference**? (2 marks)

22. What is the meaning of **power**? (2 marks)

23. What is the meaning of **half life**? (2 marks)

24. How is a **vector quantity** different to a scalar quantity?
Name a vector quantity (2 marks)

Section 3: Worked questions and data interpretation

25. An atom of uranium-238 ($^{238}_{92}U$) decays to form an atom of thorium-234 ($^{234}_{90}Th$). What type of radiation, alpha, beta or gamma, is emitted by uranium-238? *(1 mark)*

26. An atom of iodine-131 decays into an atom of xenon (Xe) by emitting a beta particle.

a) The decay of iodine-131 can be represented by the equation below.

Complete the equation by writing the correct number in each of the **two** boxes.

$$^{131}_{53}I \rightarrow {}^{\square}_{\square}Xe + \text{beta particle}$$

(2 marks)

b) What is a beta particle composed of? *(1 mark)*

27 (a) The decay of radon-222 can be represented by the equation below.

Complete the equation by writing the correct number in each of the **two** boxes.

$$^{222}_{86}Rn \rightarrow {}^{\square}_{\square}Po + \text{alpha particle}$$

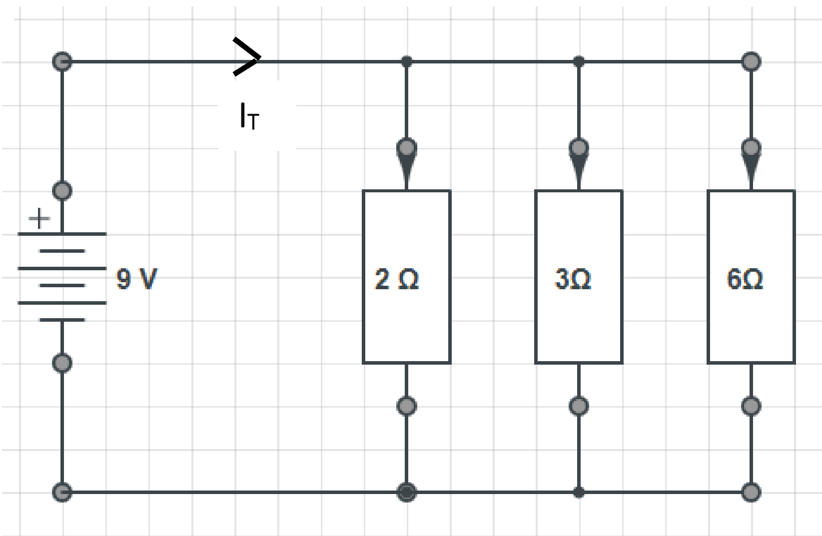
(2 marks)

(b) What is an alpha particle composed of? *(1 mark)*

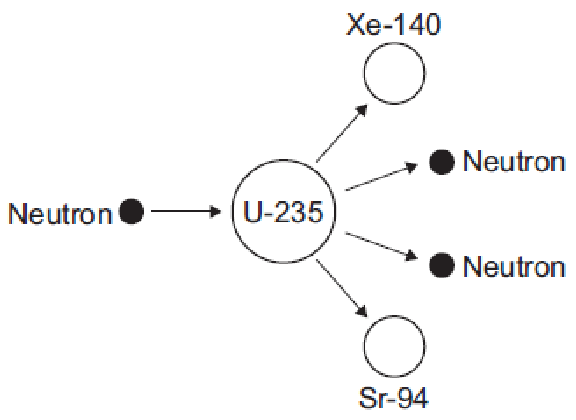
28. By first calculating the total resistance of the three resistors in parallel, calculate the total current in the circuit, I_T.

You must show all of your working.

(2 marks)



29. The diagram shows the nuclear fission process for an atom of uranium-235. Complete the diagram to show how the fission process starts a chain reaction.

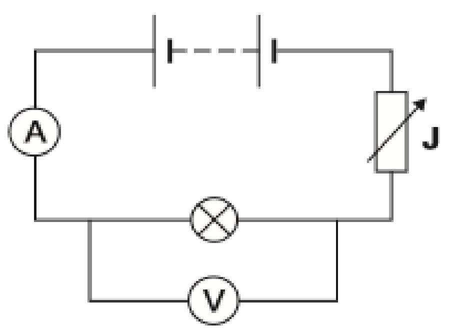


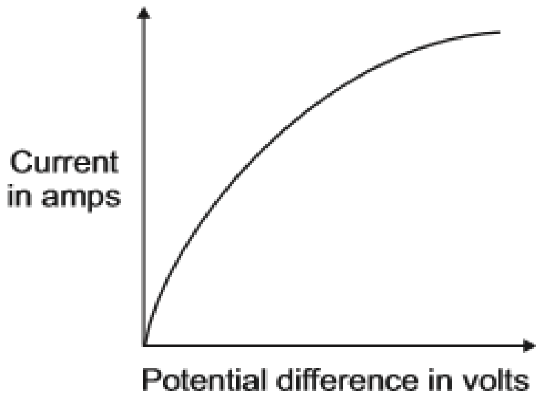
(2 marks)

30. Arrange in order of increasing energy the following: *(1 marks)*

UV, visible,Gamma, IR,X-ray and radio waves

31. The diagram shows the circuit used to obtain the data needed to plot the current – potential difference graph for a filament bulb.





Why is the component labelled '**J**' included in the circuit?

....

....

(1 mark)

The resistance of the bulb increases as the potential difference across the bulb increases. Why?

....

END OF TEST. TOTAL MARKS: 60.

Physics A level: Course Preparation

Task 2

Throughout the AS Physics course ***Measurements and their errors*** is a continuing study for a student of physics.

A working knowledge of the specified fundamental (base) units of measurement is vital.
The SI system, also called the metric system, is used around the world. There are seven basic units in the SI system: the meter (m), the kilogram (kg), the second (s), the kelvin (K), the ampere (A), the mole (mol), and the candela (cd).

You will study and use many different physical quantities and their associated SI units and symbols. You must learn to manipulate the SI units derived, SI prefixes, values and standard form.

Here is a link from The National Physical Laboratory (NPL) to read more about the SI units:
https://www.npl.co.uk/si-units

To give you the skills needed for the successful study of Physics at A level please read the following notes. The activities will help you to become confident with these basic skills, which will help the start of your Physics studies to be more productive and enjoyable.
Be prepared to dedicate a lot of time revising and learning thoroughly the content – simply memorising won't help.

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.

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 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

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.

You will come across some of these in the context of:

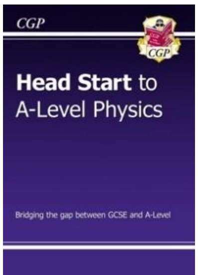
- Particles – many particles are given Greek letters, e.g. π meson.
- Physics equations, e.g. $c = f\lambda$

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

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.

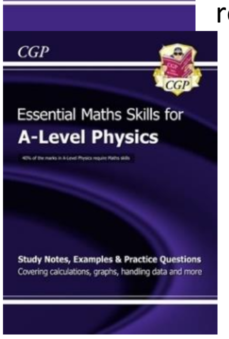
<u>Preparatory Reading</u>

The following book from CGP looks at providing a guide to the key topics that bridge across from GCSE to A Level.



https://www.cgpbooks.co.uk/secondary-books/as-and-a-level/science/physics/pbr72-head-start-to-a-level-physics-with

Physics at A Level involves more maths than in GCSE, so it is recommended to consider A level maths. You will be expected to use several formulas that need numbers putting in to them. Some of the things you'll need to be able to do are rearrange formulas confidently, round correctly and be able to multiply and divide accurately.



https://www.cgpbooks.co.uk/secondary-books/as-and-a-level/science/physics/pmr71-a-level-physics-essential-maths-skills

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 1 mark in the exam, which is 2 %. Repeated across a paper, it can mean the difference of two grades.

Converting areas and volumes causes a lot of problems.

Area:

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

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

Volume:

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

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

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. 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:

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.

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.

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) $\frac{3.4\times10^{-3}\times6.0\times10^{23}}{235}$	
(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

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 which are added or subtracted, we need to progress like this:

$$Ek = hf - \Phi$$

We want to find *h*.

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

$$Ek + \Phi = hf - \Phi + \Phi$$

$$Ek + \Phi = hf$$

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

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

Which gives us our final result of:

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

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

Practical skills

One of the course's requirements is to complete practical activities which will give students the opportunity to embed their skills and knowledge.

Practical skills should be developed by carrying out practical work throughout the course, for example by carrying out the Core Practicals listed in the Specification. This is to ensure that students are able to access the Common Practical Assessment Criteria (CPAC) requirements of the course.

To study a science subject at many universities, you need to pass the Practical Endorsement. The assessment of these skills will be through examination questions.

A variable is a quantity that takes place in an experiment. There are three types of variables:

Independent variable – *this is the quantity that you **change***

Dependent variable – *this is the quantity that you **measure***

Control variable – *this is a quantity that you **keep the same** so that it does not affect the results*

You can only have one independent variable and one dependent variable, but the more control variables you have the more accurate your results will be.

Further to these, you can also split the independent variable category – this can be continuous or discrete.

A continuous variable can take *any* numerical value, including decimals. You will construct line graphs for continuous variables.

A discrete variable can only take *specific* values or labels (eg. integers or categories). You will construct bar charts for discrete variables.

For each case study below, state the independent variable, dependent variable, and any control variables described. ***Add further control variables****, and state what type the independent variable is and what type of graph you will present the results with (if required).*

10.variables

Case study 1 – *Measuring the effect of gravity*

The aim of this experiment is to find out how fast objects of different masses take to fall from height. To conduct this experiment we used a number of spheres of the same diameter, which had different masses. Each sphere had its mass measured on electronic scales, before being dropped from a marker exactly 2.000 m from the floor. The time the sphere took to drop was timed on a stopwatch, and repeated 3 times for each sphere to gain an average time.

Independent variable: ______________________________

Dependent variable: ______________________________

Control variables: ______________________________

____

Type of independent variable: ______________________________

Graph: ______________________________

Case study 2 – *The number of children involved in different after school activities.*

The aim of this study is to discover which activities are most popular so the correct resources can be supplied to the correct member of staff. On a certain day after school the number of children were recorded for the different activities they took.

Independent variable: ______________________________

Dependent variable: ______________________________

Control variables: ______________________________

Type of independent variable: ______________________________

Graph: ______________________________

Case study 3 – *How far does the spring stretch?*

The aim of this experiment is to find how far different masses stretch a spring. A spring was hung from a clamp stand, and its length end to end measured. A 10g mass was then added and the length of the spring measured and recorded. This was repeated adding 10g between 0g and 100g.

Independent variable: ______________________________

Dependent variable: ______________________________

Control variables: ______________________________

Type of independent variable: ______________________________

Graph: ______________________________

Constructing tables

The **left hand column** is for your **independent variable**.

The **right hand column** is for your **dependent variable**. You may split this up into further columns if repeats are carried out, and make sure you include an average column. Each sub column must come under the main heading (including the average column).

Place results in the table in order of independent variable, usually starting with the smallest value first.

Ensure each column contains a heading with units in brackets. No units should be placed in the table.

All measured values in one column should be to the same decimal place – don't forget to add zeros if necessary!

Any averages should be given to the same number of decimal places as the measured values. Remember to remove any anomalies by circling the results and do not include them in calculating your average.

Any calculated values should be given to a suitable number of significant figures/ precision.

At AS/A Level we don't use brackets to separate the quantity heading from the units but use a / .

Example: **mass (kg)** should be written as **mass / kg.**

speed of car (m/s) should be written as **speed of car / m s^{-1}**

Independent Variable Heading /unit	Dependent Variable Heading /unit			
	1	2	3	Average

A student forgot his exercise book when doing a practical on electrical resistance for a resistor. Below are his readings in the practical. He measured the current in the circuit three times for five different voltages. He has made many errors. Construct a suitable table for his results

V : 0.11A, 0.1A, 0.12A
2.0V : 0.21A, 0.18A, 0.24

5V : 0.5, 5.1, 0.48   4.0V : 0.35A, 0.40A, 0.45

3.0V: 0.33A, 0.6   0.30

Additional research:

Spend some time looking at the **minutephysics** videos on youtube:

https://www.youtube.com/user/minutephysics

You could also look at: **CERN: The Standard Model of Particle Physics**

https://www.youtube.com/watch?v=V0KjXsGRvoA

Here is a list of all the website to help revising physics over the holiday:

https://www.gcsephysicsonline.com/covid-19

http://www.physicsclassroom.com/

http://studywise.co.uk/a-level-revis...hysics_section

The all important formulae sheets (It's 5 pages!) for the complete A Level.

Entry test preparation: ensure to look over GCSE Physics to prepare for the entry test.

Task 3

Lesson activity: GCSE to A-level progression (Physics)

Student booklet with information and key skills activities to support the move from GCSE to A-level.

Published: November 2020

Aim of the booklet

This booklet will support your transition from GCSE science to A-level. At first, you may find the jump in demand a little daunting, but if you follow the tips and advice in this guide, you'll soon adapt. As you follow the course you will see how the skills and content you learnt at GCSE will be developed and your knowledge and understanding of all these elements will progress.

We have organised the guide into two sections:

1. Understanding the specification and the assessments
2. Transition activities to bridge the move from GCSE to the start of the A-level course.

Understanding the specification and the assessments

Specification at a glance

The specification is a useful reference document for you. You can download a copy from our website here.

The most relevant areas of the specification for students are the following:

Section 3: Subject content

Section 6: Maths requirements and examples

Section 7: Practical assessment

In Physics the subject content is split between AS and A-level. Sections 3.1–3.5 are common for AS and A-level, sections 3.6–3.8 are A-level only content, and the A- level only options are in sections 3.9–3.13. You will study one of the option choices at A-level, this is usually decided by your teacher depending on resources.

The section titles are listed here.

3.1 Measurements and their errors
3.2 Particles and radiation
3.3 Waves
3.4 Mechanics and materials
3.5 Electricity
3.6 Further mechanics and thermal physics (A-level only)
3.7 Fields and their consequences (A-level only)
3.8 Nuclear physics (A-level only)
3.9 Astrophysics (A-level option)
3.10 Medical physics (A-level option)
3.11 Engineering physics (A-level option)
3.12 Turning points in physics (A-level option)
3.13 Electronics (A-level option)

Each section of the content begins with an overview, which describes the broader context and encourages an understanding of the place each section has within the subject. This overview will not be directly assessed.

The specification is presented in a two-column format. The left-hand column contains the specification content that you must cover, and that can be assessed in the written papers.

The right-hand column exemplifies the opportunities for Maths and practical skills to be developed throughout the course. These skills can be assessed through any of the content on the written papers, not necessarily in the topics we have signposted.

Assessment structure

AS

The assessment for the AS consists of two exams, which you will take at the end of the course.

Paper 1	+	Paper 2
What's assessed Sections 1–5		**What's assessed** Sections 1–5
How it's assessed • Written exam: 1 hour 30 mins • 70 marks • 50% of the AS		**How it's assessed** • Written exam: 1 hour 30 mins • 70 marks • 50% of the 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

A-level

The assessment for the A-level consists of three exams, which you will take at the end of the course.

Paper 1

What's assessed

- Sections 1–5 and 6.1 (Periodic motion)

How it's assessed

- Written exam: 2 hours
- 85 marks
- 34% of the A-level

Questions

- 60 marks of short and long answer questions and 25 multiple choice questions on content.

Paper 2

What's assessed

- Sections 6.2 (Thermal Physics), 7 and 8
- Assumed knowledge from sections 1–6.1

How it's assessed

- Written exam: 2 hours
- 85 marks
- 34% of the A-level

Questions

- 60 marks of short and long answer questions and 25 multiple choice questions on content.

Paper 3

What's assessed

- Section A: Compulsory section: Practical skills and data analysis
- Section B: Students enter for **one** of sections 9, 10,11,12 or 13

How it's assessed

- Written exam: 2 hours
- 80 marks
- 32% of the A-level

Questions

- 45 marks of short and long answer questions on practical experiments and data analysis.
- 35 marks of short and long answer question on optional topic

Assessment objective

As you know from GCSE, we have to write exam questions that address the Assessment objectives (AOs). It is important you understand what these AOs are, so you are well prepared. In Physics there are three AOs.

- AO1: Demonstrate knowledge and understanding of scientific ideas, processes, techniques, and procedures (A-level about 30% of the marks).
- AO2: Apply knowledge and understanding of scientific ideas, processes, techniques, and procedures:
  - in a theoretical context
  - in a practical context
  - when handling qualitative data
  - when handling quantitative data

  (A-level about 45% of the marks).

- AO3: Analyse, interpret, and evaluate scientific information, ideas, and evidence, including in relation to:
  - make judgements and reach conclusions
  - develop and refine practical design and procedures

  (A-level about 25% of the marks).

Other assessment criteria

At least 40% of the marks for AS and A-level Physics will assess mathematical skills, which will be equivalent to Level 2 (Higher Tier GCSE Mathematics) or above.

At least 15% of the overall assessment of AS and A-level Physics will assess knowledge, skills and understanding in relation to practical work.

Command words

Command words are used in questions to tell you what is required when answering the question. You can find definitions of the command words used in Physics assessments on the website. They are very similar to the command words used at GCSE.

Subject-specific vocabulary

You can find a list of definitions of key working scientifically terms used in our AS and A-level specification here.

You will become familiar with, and gain understanding of, these terms as you work through the course.

Transition activities

The following activities cover some of the key skills from GCSE science that will be relevant at AS and A-level. They include the vocabulary used when working scientifically and some maths and practical skills.

You can do these activities independently or in class. The booklet has been produced so you can complete it electronically or print it out and do the activities on paper.

The activities are **not a test**. Try the activities first and see what you remember and then use textbooks or other resources to answer the questions. **Don't** just go to Google for the answers, as actively engaging with your notes and resources from GCSE will make this learning experience much more worthwhile.

The answer booklet guides you through each answer. It is not set out like an exam mark scheme but is to help you get the most out of the activities.

Understanding and using scientific vocabulary

Understanding and applying the correct terms are key for practical science. Much of the vocabulary you have used at GCSE for practical work will not change but some terms are dealt with in more detail at A-level so are more complex.

Activity 1 Scientific vocabulary: Designing an investigation	
Link each term on the left to the correct definition on the right.	
Hypothesis	The maximum and minimum values of the independent or dependent variable
Dependent variable	A variable that is kept constant during an experiment
Independent variable	The quantity between readings, eg a set of 11 readings equally spaced over a distance of 1 metre would give an interval of 10 centimetres
Control variable	A proposal intended to explain certain facts or observations
Range	A variable that is measured as the outcome of an experiment
Interval	A variable selected by the investigator and whose values are changed during the investigation

Activity 2 Scientific vocabulary: Making measurements

Link each term on the left to the correct definition on the right.

Term	Definition
True value	The range within which you would expect the true value to lie
Accurate	A measurement that is close to the true value
Resolution	Repeated measurements that are very similar to the calculated mean value
Precise	The value that would be obtained in an ideal measurement where there were no errors of any kind
Uncertainty	The smallest change that can be measured using the measuring instrument that gives a readable change in the reading

Activity 3 Scientific vocabulary: Errors

Link each term on the left to the correct definition on the right.

Term	Definition
Random error	Causes readings to differ from the true value by a consistent amount each time a measurement is made
Systematic error	When there is an indication that a measuring system gives a false reading when the true value of a measured quantity is zero
Zero error	Causes readings to be spread about the true value, due to results varying in an unpredictable way from one measurement to the next

Understanding and using SI units

All measurements have a size (eg 2.7) and a unit (eg metres or kilograms). Sometimes, there are different units available for the same type of measurement. For example, milligram, gram, kilogram and tonne are all units used for mass. Some values like strain and refractive index are not followed by a unit.

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.

There are seven SI base units, which are given in the table.

Physical quantity	Unit	Abbreviation
Mass	kilogram	kg
Length	metre	m
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
luminous intensity	candela	cd

All other units can be derived from the SI base units. For example, area is measured in metres square (written as m^2) and speed is measured in metres per second
(written as $m\ s^{-1}$ this is a change from GCSE, where it would be written as m/s).

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

Physical quantity	Unit	Abbreviation	SI unit
Force	newton	N	$kg\ m\ s^{-2}$
Energy	joule	J	$kg\ m^2\ s^{-2}$
Frequency	hertz	Hz	s^{-1}

Using prefixes and powers of ten

Very large and very small numbers can be complicated to work with if written out in full with their SI unit. For example, measuring the width of a hair or the distance from Manchester to London in metres (the SI unit for length) would give numbers with a lot of zeros before or after the decimal point, which would be difficult to work with.

So, we use prefixes that multiply or divide the numbers by different powers of ten to give numbers that are easier to work with. You will be familiar with the prefixes milli (meaning 1/1000), centi (1/100), and kilo (1 × 1000) from millimetres, centimetres and kilometres.

There is a wide range of prefixes. Most of the quantities in scientific contexts will be quoted using the prefixes that are multiples of 1000. For example, we would quote a distance of 33 000 m as 33 km.

Kg is the only base unit with a prefix.

The most common prefixes you will encounter are given in the table.

Prefix	Symbol	Power of 10	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 4 SI units and prefixes

1. Re-write the following quantities using the correct SI units.

    a. 1 minute
    b. 1 milliamp
    c. 1 tonne

2. What would be the most appropriate unit to use for the following measurements?

    a. The wavelength of a wave in a ripple tank
    b. The temperature of a thermistor used in hair straighteners
    c. The half-life of a source of radiation used as a tracer in medical imaging
    d. The diameter of an atom
    e. The mass of a metal block used to determine its specific heat capacity
    f. The current in a simple circuit using a 1.5 V battery and bulb

Activity 5 Converting data

Re-write the following quantities.

1. 1.5 kilometres in metres

2. 450 milligrams in kilograms

3. 96.7 megahertz in hertz

4. 5 nanometers in metres

5. 3.9 gigawatts in watts

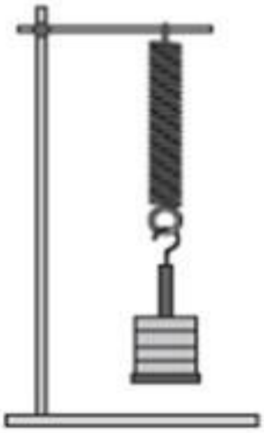
Practical skills

The practical skills you learnt at GCSE will be further developed through the practicals you undertake at A-level. Your teacher will explain in more detail the requirements for practical work in Physics.

There is a practical handbook for AS and A-level Physics, which has lots of very useful information to support you in developing these important skills. You can download a copy here.

Activity 6 Investigating springs

A group of students investigated how the extension of a spring varied with the force applied. They did this by hanging different weights from the end of the spring and measuring the extension of the spring for each weight.



The results are below.

Weight added to the spring / N	Extension of spring / cm			
	Trial 1	Trial 2	Trial 3	Mean
2	3.0	3.1	3.2	
4	6.0	5.9	5.8	
6	9.1	7.9	9.2	
8	12.0	11.9	12.1	
10	15.0	15.1	15.12	

1. What do you predict the result of this investigation will be?
2. What are the independent, dependent and control variables in this investigation?
3. What is the difference between repeatable and reproducible?
4. What would be the most likely resolution of the ruler you would use in this investigation?
5. Suggest how the student could reduce parallax errors when taking her readings.
6. Random errors cause readings to be spread about the true value.

   What else has the student done in order to reduce the effect of random errors and make the results more precise?

7. Another student tries the experiment but uses a ruler which has worn away at the end by 0.5 cm. What type of error would this lead to in his results?

8. Calculate the mean extension for each weight.

9. A graph is plotted with force on the *y* axis and extension on the *x* axis. What quantity does the gradient of the graph represent?

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 µm = 0.000 000 001 m)
- as symbols for particular quantities.

The Greek alphabet is shown below.

Capital letter	Lower case letter	Name
Α	α	alpha
Β	β	beta
Γ	γ	gamma
Δ	δ	delta
Ε	ε	epsilon
Ζ	ζ	zeta
Η	η	eta
Θ	θ	theta

Capital letter	Lower case letter	Name
Ι	ι	iota
Κ	κ	kappa
Λ	λ	lambda
Μ	μ	mu
Ν	ν	nu
Ξ	ξ	ksi
Ο	ο	omicron
Π	π	pi

Capital letter	Lower case letter	Name
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 7 Using Greek letters

Use your knowledge from GCSE to complete the table. The first line has been completed for you.

Object or quantity represented by the Greek letter	Greek letter
Wavelength	λ
Type of ionising radiation which cannot pass through paper and is used in smoke detectors	
	Ω
Type of ionising radiation which is an electron ejected from the nucleus. Can be used to monitor paper thickness	
Very short wavelength electromagnetic wave	

The Physics formula and data sheet

You will need to use the AQA Physics formula and data sheet in your exams.

You can download a copy here.

Activity 8 Using the Physics formula and data sheet

1. Use the sheet to find the symbols used to represent the following particles. (You will learn about these particles when you study particle physics.)

   a. Photon
   b. Neutrino
   c. Muon
   d. Meson (two letters used depending on type of meson)

2. Look through the Electricity and Materials formula sections on the data sheet.

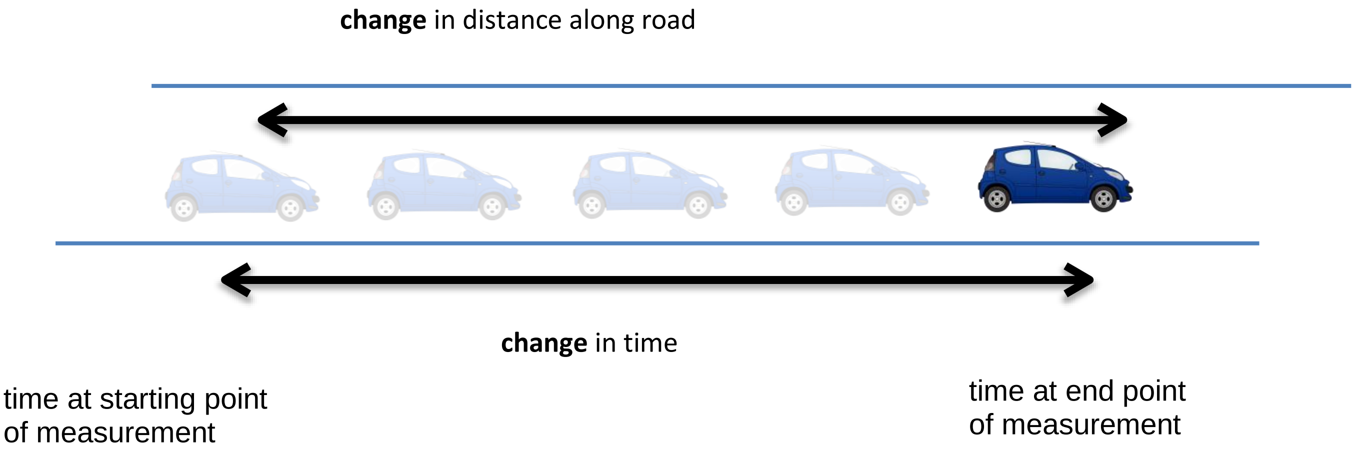
   There is one Greek letter that is used to represent two different quantities. Give the letter and the quantities is it used to represent.

The delta symbol (Δ)

The delta symbol (Δ) is used to mean ‘change in’. For example, at GCSE, you would have learned the formula:

$$\text{speed} = \frac{\text{distance}}{\text{time}} \qquad \text{which can be written as} \quad s = \frac{d}{t}$$

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.



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

$$\text{velocity} = \frac{\text{displacement}}{\text{time}} \qquad \text{which can be written as} \quad v = \frac{\Delta s}{\Delta t}$$

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 9 Using the delta symbol

1. What is the difference between:

   a. speed and **velocity**
   b. distance and **displacement**

2. Look at the A-level Physics formula sheet (https://filestore.aqa.org.uk/sample- papers-and-mark-schemes/2018/june/AQA-74081-INS-JUN18.PDF) *.*

   Which equations look similar to ones you used at GCSE, but now include the delta symbol?

3. A coffee machine heats water from 20 °C to 90 °C. The power

   output of the coffee machine is 2.53 kW. The specific heat

   capacity of water is 4200 J/kg °C

   Calculate the mass of water that the coffee machine can heat in 20 s.

4. An unused pencil has a length of 86.0 mm.

   A student uses the pencil to draw 20 lines on a piece of paper. Each line has

   a length of 25 cm.

   The length of the pencil has changed to 84.5 mm.

   Calculate the length of line that would need to be drawn for the original length to be halved.

Activity 10 Rearranging formulas

1. Rearrange $c = f\lambda$ to make f the subject.
2. Rearrange $\rho = \frac{m}{V}$ to make m the subject.
3. Rearrange $w = \frac{\lambda D}{s}$ to make s the subject
4. Rearrange $P = I^2 R$ to make I the subject
5. Rearrange $E = ½\, m\, v^2$ to make v the subject.
6. Rearrange $h f = \varphi + E_k$ to make φ the subject
7. Rearrange $v = u + a t$ to make a the subject.
8. Rearrange $s = u t + ½\, a\, t^2$ to make a the subject.
9. Rearrange $\varepsilon = I(R + r)$ to make r the subject.
10. Rearrange $f = \frac{1}{2l}\sqrt{\frac{T}{\mu}}$ to make T the subject.

Using maths skills

Physics uses the language of mathematics to make sense of the world. It is important that you are able to apply maths skills in Physics. The maths skills you learnt and applied at GCSE are used and developed further at A-level.

Activity 11 Standard form

1. Write the following numbers in standard form. a. 379 4
   b. 0.0712

2. Use the data sheet to write the following as ordinary numbers.

   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

Activity 12 Significant figures and rounding

1. A rocket can hold 7 tonnes of material.

   Calculate how many rockets would be needed to deliver 30 tonnes of material to a space station.

2. A power station has an output of 3.5 MW.

   The coal used had a potential output of 9.8 MW. Calculate the

   efficiency of the power station.

   Give your answer as a percentage to an appropriate number of significant figures.

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 13 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.

   $^2/_5$ 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?

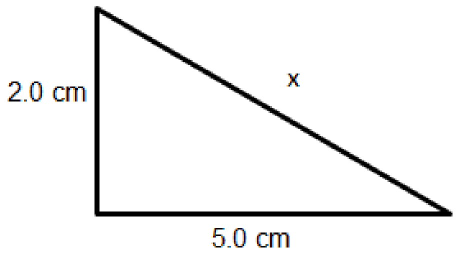
8. Power station A was online 94% of the 7500 days it worked for. Power station

   B was online $^8/_9$ of the 9720 days it worked for. Which power station was

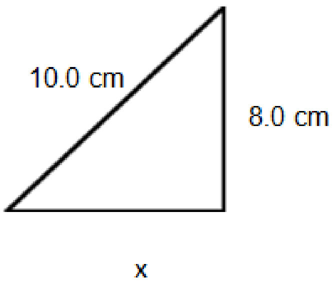
   offline for longer?

Activity 14 Pythagoras' theorem

1. Calculate the length of side x.

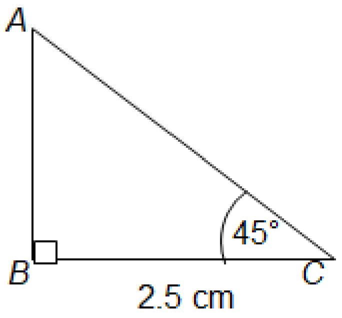


2. Calculate the length of side x.



Activity 15 Using sine, cosine and tangent

1. Calculate length AB



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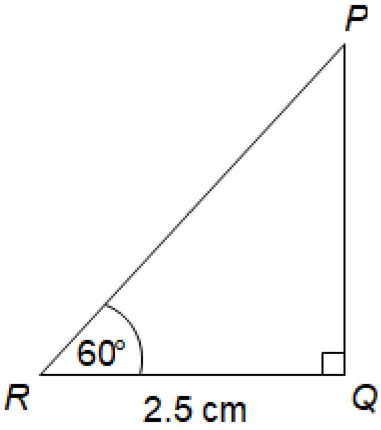
2. Calculate length PR



(not drawn accurately)

Activity 16 Arithmetic means

1. The mean mass of 9 people is 79 kg.

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

   mass of the 10th person?

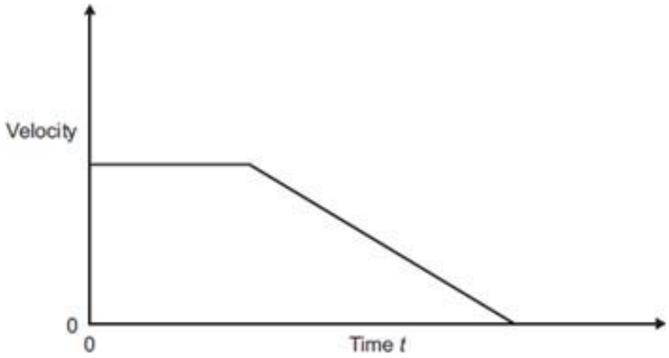
2. A pendulum completes 12 swings in 150 s.

   Calculate the mean swing time.

Activity 17 Gradients and areas

1. A car is moving along a road. The driver sees an obstacle in the road at time $t = 0$ and applies the brakes until the car stops.

   The graph shows how the velocity of the car changes with time.

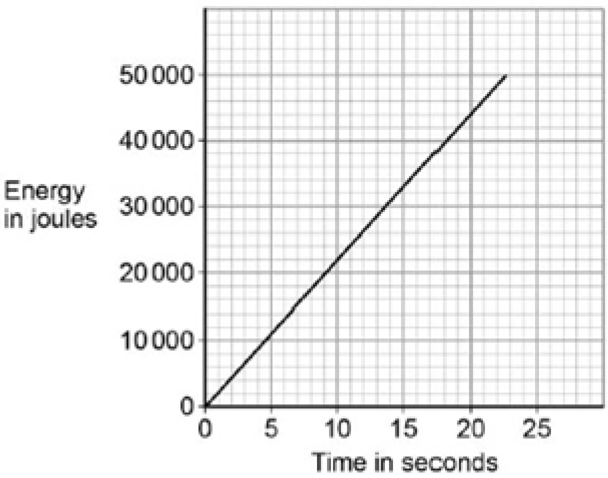


From the list below, which letter represents:

- the negative acceleration of the car
- the distance travelled by the car?

a. The area under the graph
b. The gradient of the sloping line
c. The intercept on the y axis

2. The graph shows how the amount of energy transferred by a kettle varies with time.



The power output of the kettle is given by the gradient of the graph. Calculate the power output of the kettle.

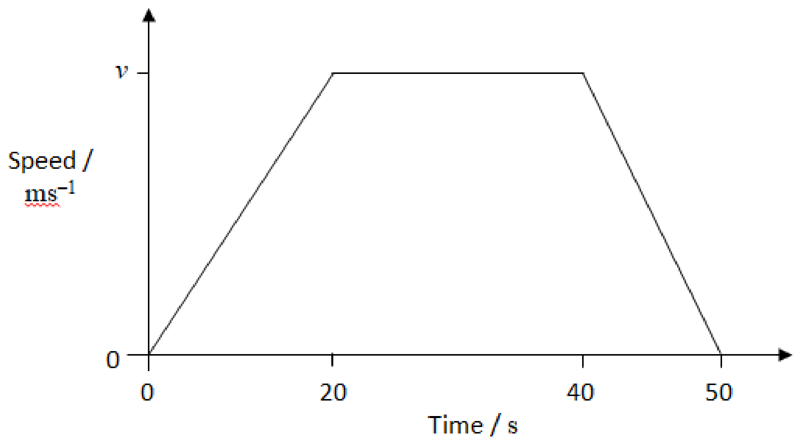
Activity 17 Gradients and areas

3. 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

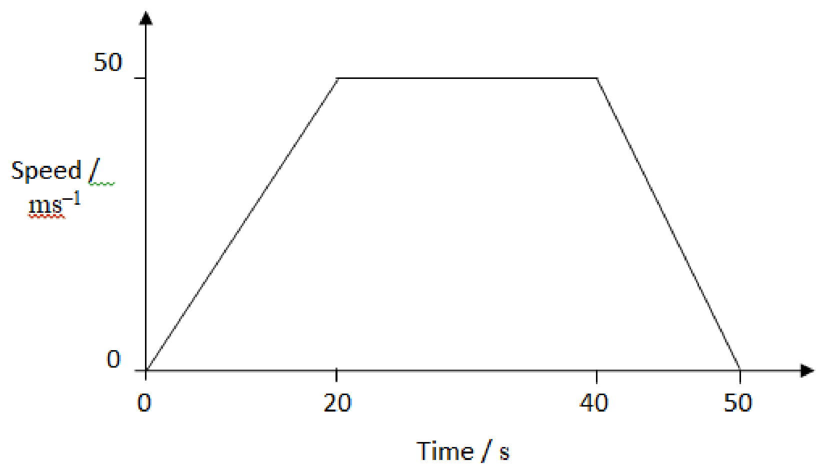
   travels for 50 seconds.

   The distance between the traffic lights is 625 metres.



   Calculate the value of v.

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



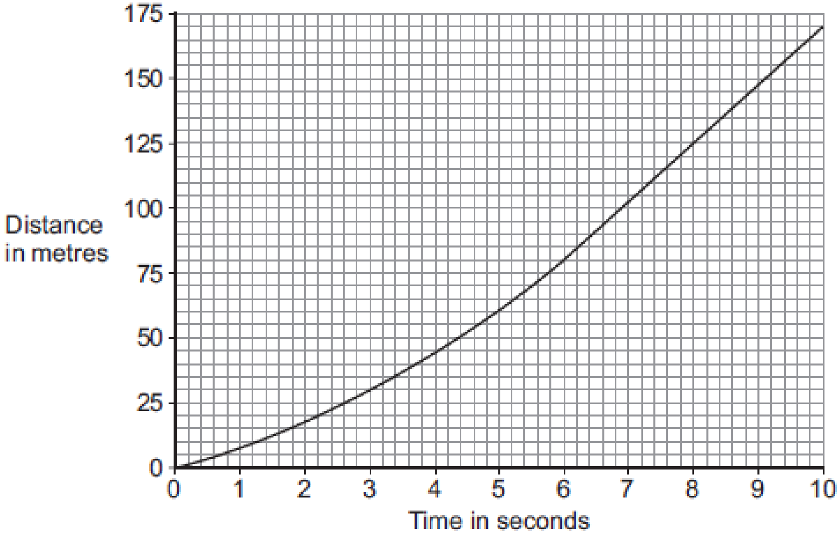
   (not drawn accurately)

   Calculate the distance between the stations.

Activity 18 Using and interpreting data in tables and graphs

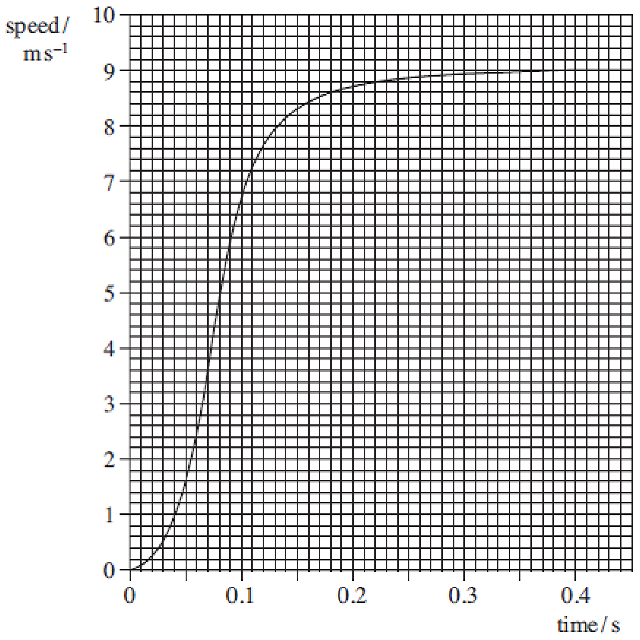
1. The graph shows the motion of a car in the first 10 seconds of its journey.

Figure 1



Use the graph to calculate the maximum speed the car was travelling at.

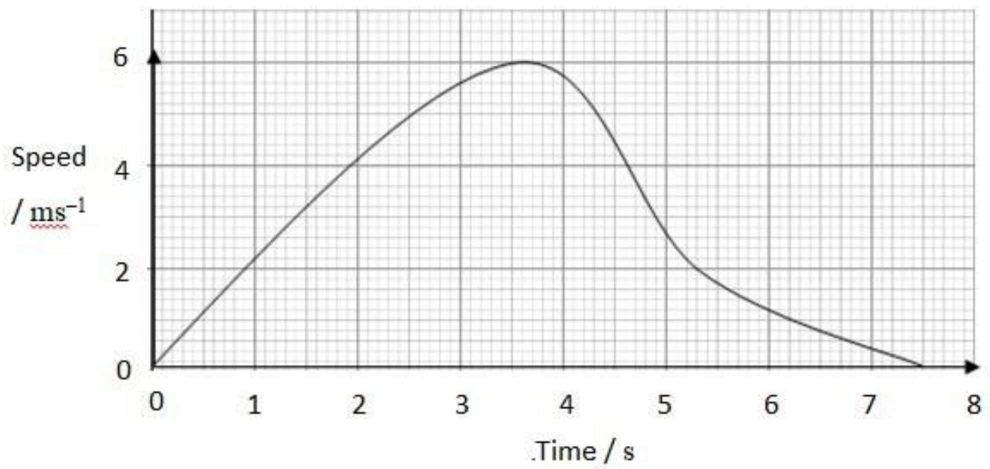
2. The figure below is a speed–time graph for a sprinter at the start of a race.



Determine the distance covered by the sprinter in the first 0.3 s of the race.

Activity 18 Using and interpreting data in tables and graphs

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

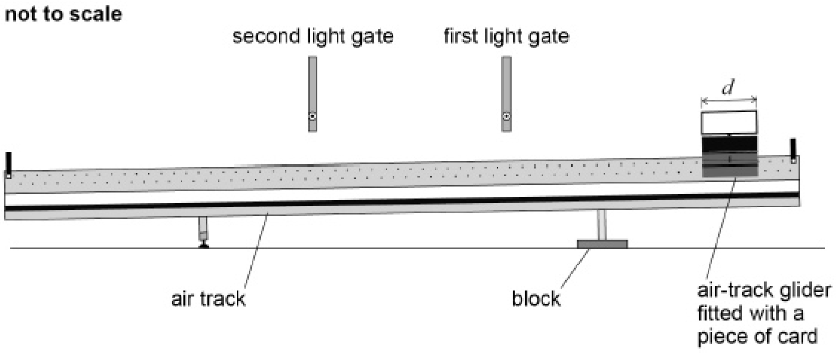


Use the graph to determine:

a. the maximum speed of the car
b. the total distance travelled
c. the average speed for the journey.

Activity 18 Using and interpreting data in tables and graphs

4. The diagram shows the apparatus used by a student to measure the acceleration due to gravity (*g*).



In the experiment:

- a block is used to raise one end of the air track
- an air-track glider is released from rest near the raised end of the air track and passes through the first light gate and then through the second light gate
- a piece of card of length *d* fitted to the air-track glider interrupts a light beam as the air-track glider passes through each light gate
- a data logger records the time taken by the piece of card to pass through each light gate and also the time for the piece of card to travel from one light gate to the other.

a. The table gives measurements recorded by the data logger.

The length *d* of the piece of card is 10.0 cm.

Time to pass through first light gate / s	Time to pass through second light gate / s	Time to travel from first to second light gate / s
0.50	0.40	1.19

Assume there is negligible change in velocity while the air-track glider passes through a light gate.

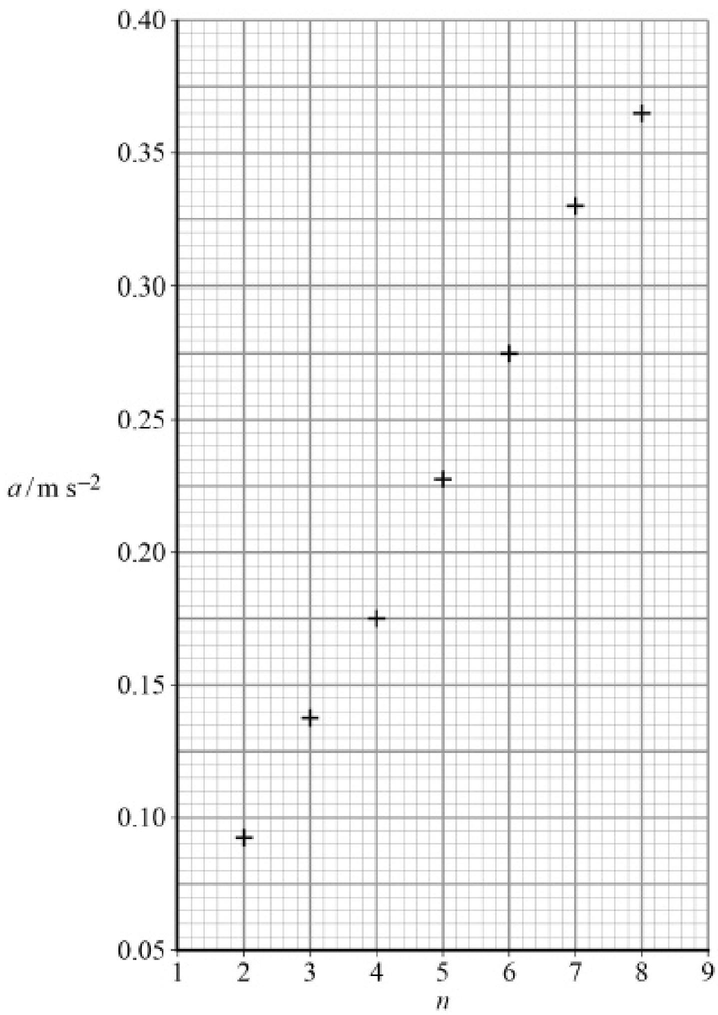
Determine the acceleration *a* of the air-track glider.

b. Additional values for the acceleration of the air-track glider are obtained by further raising the end of the air track by using a stack consisting of identical blocks.

Adding each block to the stack raises the end of the air track by the same distance.

Activity 18 Using and interpreting data in tables and graphs

Below is a graph of these results showing how *a* varies with *n*, the number of blocks in the stack.



Draw a line of best fit and then determine the gradient of your line (A).

c. It can be shown that, for the apparatus used by the student, g is equal to $\frac{2A}{h}$ where h is the thickness of each block used in the experiment.

The student obtains a value for g of 9.8 m s^{-2}

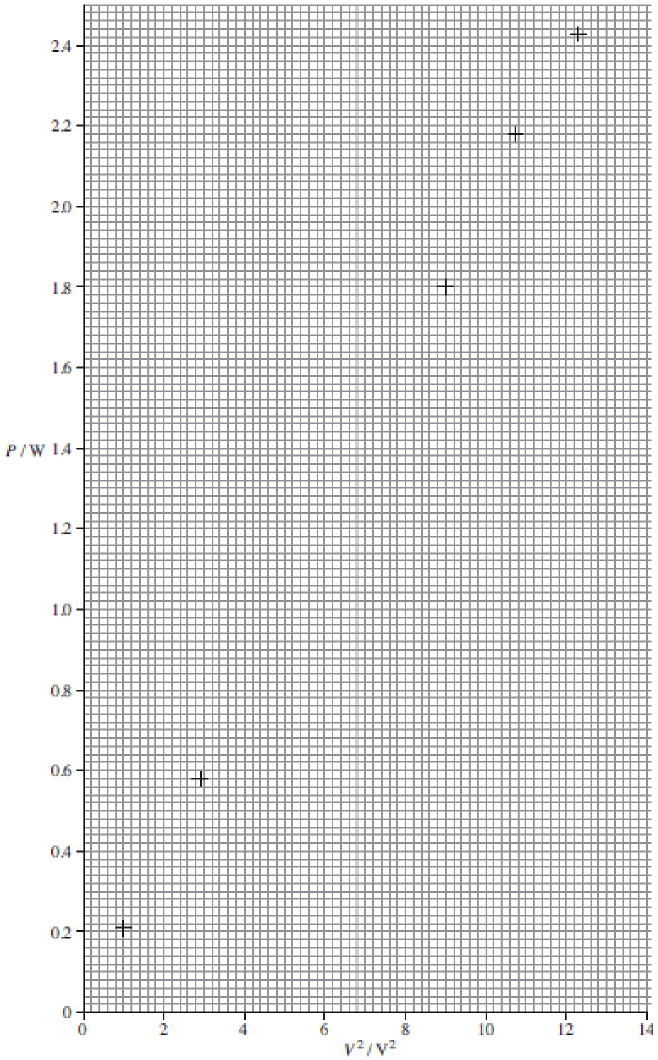
Calculate h.

5. The power *P* dissipated in a resistor of resistance *R* is measured for a range of values of the potential difference *V* across it. The results are shown in the table.

V / V	V^2 / V^2	P / W
1.00	1.0	0.21
1.71	2.9	0.58
2.25		1.01
2.67		1.43
3.00	9.0	1.80
3.27	10.7	2.18
3.50	12.3	2.43

a. Complete the table.

b. Complete the graph below, and draw a line of best fit.



Activity 18 Using and interpreting data in tables and graphs

c. Determine the gradient of the graph.

d. Use the gradient of the graph to obtain a value for *R*.

The relationship is power = potential difference ^{2} / resistance

6. To answer these questions, you will need a copy of the A-level Physics formula sheet.

In an experiment, a set of LEDs that emitted light of different colours was used.

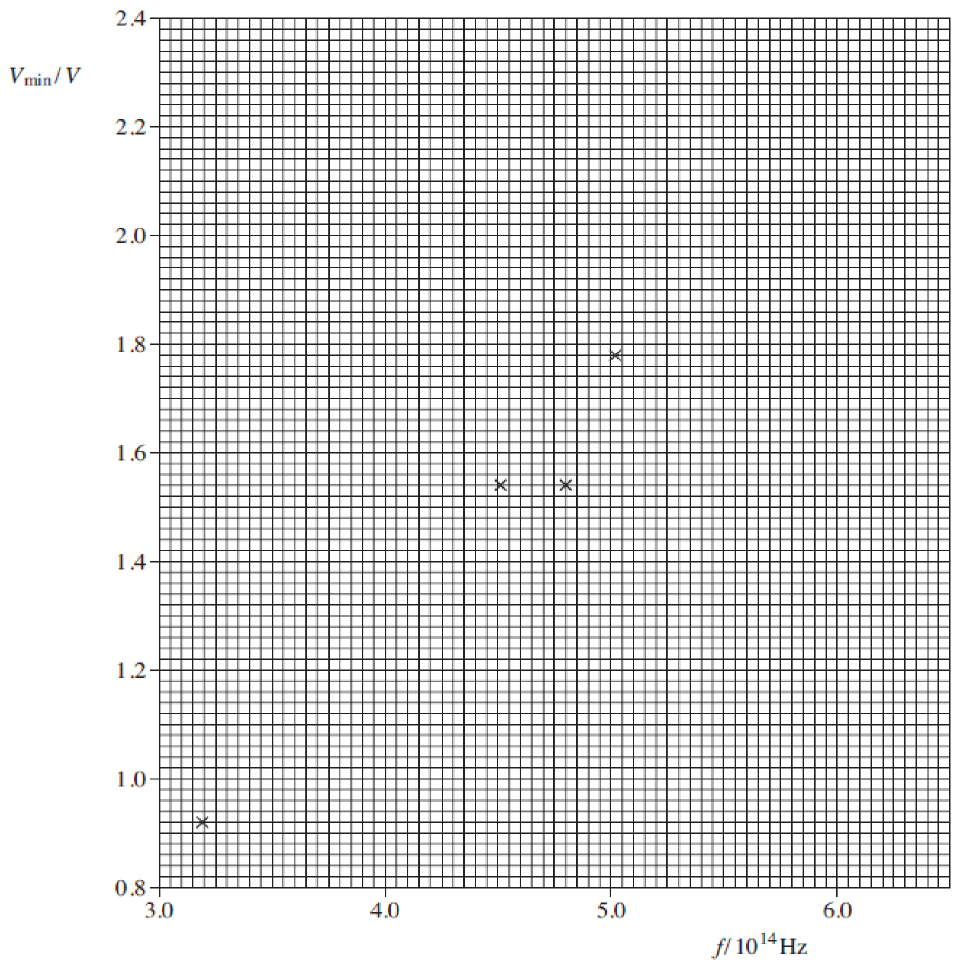
The table below shows the data collected.

Colour	Wavelength λ / nm	Frequency f / 10^{14} Hz	Minimum pd V_{min} /V
Infrared	940	3.19	0.92
Red	665	4.51	1.54
Orange	625	4.80	1.54
Yellow	595	5.04	1.78
Green	565		1.87
Blue	470		2.37

a. Complete the missing values for frequency.

b. Complete the graph by plotting the missing two points and drawing a line of best fit.

Activity 18 Using and interpreting data in tables and graphs



c. Determine the gradient of the graph.

d. Theory predicts that the energy lost by the electron in passing through the LED is the energy of the emitted photon. Hence

$eV_{min} = hf$,

where h is the Planck constant and $e = 1.60 \times 10^{-19}$ C.

Find a value for h by using the general equation of a straight line, $y = mx + c$, and your answer to part (c).

e. The accepted value for $h = 6.63 \times 10^{-34}$ J s. Calculate the percentage difference between the value calculated in part (d) and the accepted value.

~~TED~~ SALVO talk

Task 4

Topic

Notes