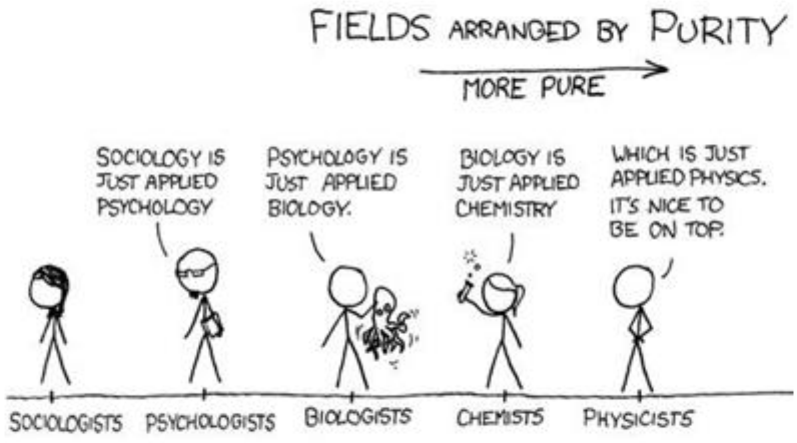
Transition Guide – From GCSE Science to A level Physics



Why physics teachers should not be given playground duty

The transition from KS4 to KS5 is never entirely easy, and physics throws up its own unique challenges in this regard. It is both helped and hindered by the similarity between the concepts covered at GCSE and A-Level. While familiar topics such as Electrical Circuits and Motion Graphs will be reassuring to you they can also encourage a false sense of security. You may not fully appreciate the additional skillset you need to apply to familiar material; a simple and common example being using speed = distance/time when equations of motion for constant acceleration would be the appropriate way to approach a problem. This guide attempts to revisit familiar topics and direct you to the skills expected of a KS5 physicist. Don't worry if you don't get this to start with but with hard work it will make sense.

To help you further it might be a good idea to get yourself copies of

New Head Start to A-level Physics and Head Start to AS Maths

http://www.amazon.co.uk/New-Head-Start--level-Physics/dp/1782942815/ref=sr_1_8?s=books&ie=UTF8&qid=1434714074&sr=1-8&keywords=cgp+books+physics

http://www.amazon.co.uk/Head-Start-Maths-CGP-Books/dp/1841469939/ref=pd_bxgy_14_text_z

The skills covered are made explicit in this overview. There are two sections:

Section A (compulsory) includes a baseline test. This is a test that helps you revise your GCSE motion and electricity topics. Please hand it in to me on your fist physics lesson.

Section B (advisory) includes information to help you make sense of the first term of the A level physics. It includes A level questions which you should be able to answer when we have completed each of the sections.

GCSE Physicists often compartmentalise topics. Many of you see the study of Motion, Electricity and Waves as entirely separate without appreciating the fundamental skills and logic reasoning that link them together. Therefore this guide covers both "Motion and Electricity", the activities should hopefully demonstrate that the same underlying approach is used when studying both topics. It also offers an opportunity for revision of a topic that won't be covered until the half-term before Christmas, when GCSE knowledge is all but forgotten.

The transition materials include:

- baseline assessment
- subject ideas
- practice questions

This guide will help you decide very early on in the course whether A level physics is really a suitable subject choice for you.

The guide is designed to touch upon some of the key content at AS level as well as revising ideas from GCSE. Alongside the content they also introduce some of the critical skills for a KS5 physicist such as:

- applying mathematics to graphs
- using positive and negative number to convey direction
- re-arranging equations and logical deduction.

The guide is designed to encourage you to be independent. I hope to encourage good note-taking and academic resilience, both key attributes of successful KS5 learners in all subjects.

Transition guide overview

Topic	**Specification links**	
	AS objectives covered	**GCSE objectives reviewed**
Motion: Constant Acceleration	12. Understand scalar and vector quantities and know examples of each type of quantity and recognise vector notation. 9. Be able to use the equations for uniformly accelerated motion in one dimension.	3.1 Demonstrate an understanding of the following as vector quantities: **a** displacement **b** velocity **c** acceleration **d** force. 3.3 Recall that velocity is speed in a stated direction. 3.4 Use the equation for speed. 3.5 Use the equation for acceleration.
Motion: Motion Graphs	10. Be able to draw and interpret displacement/time, velocity/time and acceleration/time graphs. 11. Know the physical quantities derived from the slopes and areas of displacement/time, velocity/time and acceleration/time graphs, including cases of non-uniform acceleration and understand how to use the quantities.	3.2 Interpret distance/time graphs including determination of speed from the gradient. 3.6 Interpret velocity/time graphs to: **a** compare acceleration from gradients qualitatively **b** calculate the acceleration from the gradient (for uniform acceleration only).

Forces: Mass and Weight	18. Be able to use the equations for gravitational field strength and weight.	3.14 Use the equation for gravitational field strength. 3.16 Recall that in a vacuum all falling bodies accelerate at the same rate.

Electricity: Series Circuits	31. Understand that electric current is the rate of flow of charged particles and be able to use the equation link current charge and time. 32. Understand how to use the equation linking voltage charge and energy. 33. Understand that resistance is defined by $V = IR$ and that Ohm's law is a special case when $I \propto V$ for constant temperature. 35. Understand how the distribution of potential differences in a circuit is a consequence of energy conservation.	1.9 Recall that an electric current is the rate of flow of charge. 2.1 Describe how an ammeter is placed in series with a component to measure the current, in amps, in the component. 2.3 Explain how the current in a circuit depends on the potential difference of the source. 2.5 Demonstrate an understanding that potential difference (voltage) is the energy transferred per unit charge passed and hence that the volt is a joule per coulomb. 2.4 Describe how a voltmeter is placed in parallel with a component to measure the potential difference (voltage), in volts, across it. 2.8 Use the equation $V = IR$. 5.1 Describe current as the rate of flow of charge and voltage as an electrical pressure giving a measure of the energy transferred.

Electricity: Parallel Circuits	34. Understand how the distribution of current in a circuit is a consequence of charge conservation. 36. Be able to derive the equations for combining resistances in series and parallel using the principles of charge and energy conservation, and be able to use these equations.	1.11 Use the equation Relating charge current and time. 2.2 Explain how current is conserved at a junction.

Section A

Try and do this test before you start the course and bring it with you to your first A level physics lesson.

Baseline assessment

Name: ______________________________ Form: ____________

Physics group: ______________________________

GCSE Physics/Science grade: ____________________

Date: ______________________________

Question	Marks
1	/5
2	/6
3	/10
4	/8
Motion total	/29
1	/6
2	/6
3	/12
Electricity total	/24
Grand Total	/53
%	
Grade	

Target grade

☐ **OT**

☐ **BT**

☐ **AT**

Targets for improvement

☐

☐

☐

☐

☐

☐

☐

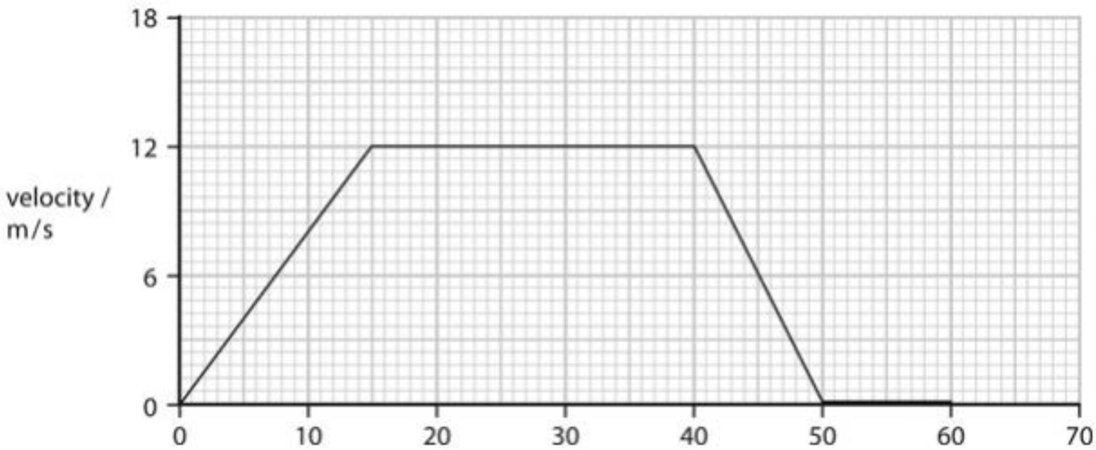
Motion

1. A car is travelling along a level road.

(a) The car travels at constant velocity. It covers 250 m in 40 s. Calculate the average velocity during this time (2 marks).

(b) The car now accelerates in a straight line. Its average acceleration is $12 ms^{-2}$. Calculate the increase in velocity of the car in 4.0 s (3 marks).

2. The graph shows a velocity-time graph for a cyclist over a time of 60 s



(a) (i) When is the cyclist travelling with greatest velocity? Place a cross in the box next to your answer (1 mark).

A for the first 15 seconds

B between 15 and 40 seconds

C between 40 and 50 seconds

D for the last 10 seconds

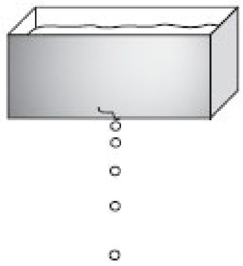
(ii) How long is the cyclist stationary for in seconds (1 mark)?

(iii) Calculate how far the cyclist travels in metres during the first 40 seconds (1 mark).

(b) A different cyclist accelerates for 8 s. During this time they accelerate from 3 ms^{-1} to 14.2 ms^{-1}.

Calculate the acceleration during this time (3 marks).

3. A water tank drips water.



(a) Scientists could use four quantities to describe the movement of the water drops.

Three of these quantities are vectors.

The other quantity is a scalar.

acceleration force mass velocity

(i) Complete the sentence by putting a cross in the box next to your answer (1 mark).

The scalar quantity is…

A acceleration ☐

B force ☐

C mass ☐

D velocity ☐

(ii) State any vector quantity not listed above (1 mark).

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(iii) Complete the following sentence using one of the quantities from the word box above. In a vacuum, all bodies falling towards the Earth's surface have the same (1 mark).

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(b) The mass of one water drop is 0.00008 kg. Calculate its weight in Newtons (2 marks). (Gravitational field strength is 10 Nkg^{-1})

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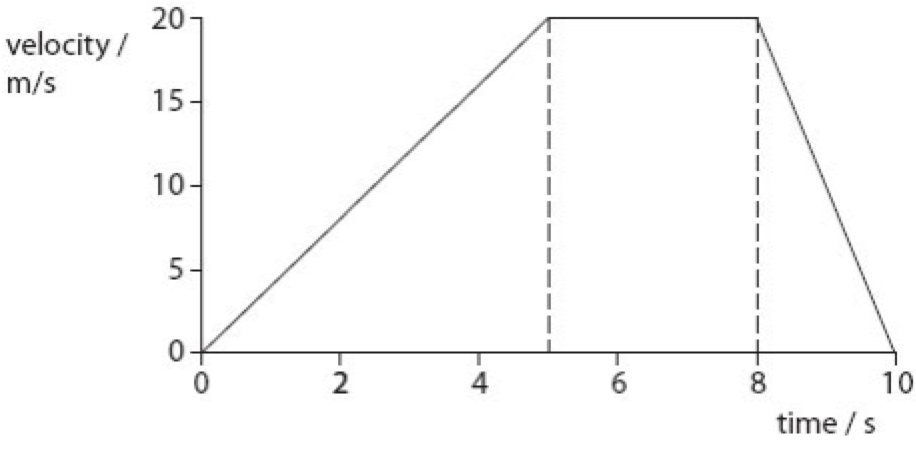
(c) The water drop falls to the ground, 13 m below, in 1.7 s. Calculate the average speed in m/s of the drop while it is falling (2 marks).

(d) Assuming the droplet starts at rest calculate the velocity just before it hits the ground. Ignore air resistance. ($g = 10ms^{-2}$) (2 marks).

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



(a) Use the graph to estimate the velocity of the car at three seconds (1 mark).

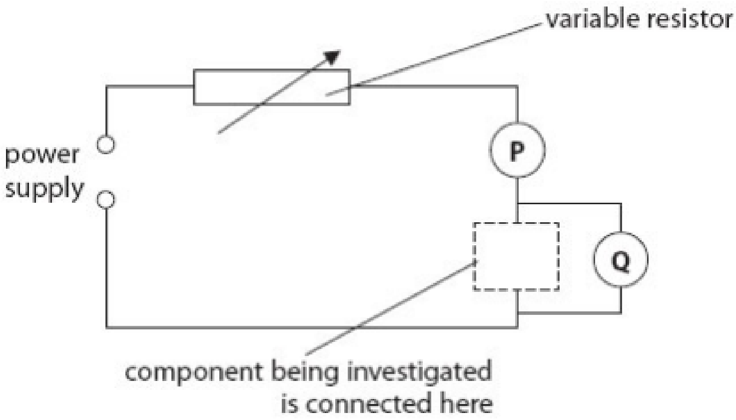
(b) Calculate the acceleration in ms^{-2} of the car when it is speeding up (2 marks).

(c) Explain why the units of acceleration are ms^{-2} (2 marks)

(d) Show that the car travels further at a constant velocity than it does when it is slowing down (3 marks).

Electricity

1. Some students investigate the electrical resistance of different components using the circuit shown overleaf.



(a) Which row of the table is correct for both meters P and Q? Place a cross in the box next to your answer (1 mark).

		Meter P is	Meter Q is
A	☒	An ammeter	an ammeter
B	☒	An ammeter	a voltmeter
C	☒	A voltmeter	a voltmeter
D	☒	A voltmeter	an ammeter

(b) One of the components being investigated is a 12 ohm resistor. When it is in the circuit, the ammeter reading is 0.50 A. Calculate the voltmeter reading (2 marks).

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(c) The students reduce the resistance of the variable resistor. State what happens to the readings on each of the meters P and Q. Explain what happens to P (2 marks).

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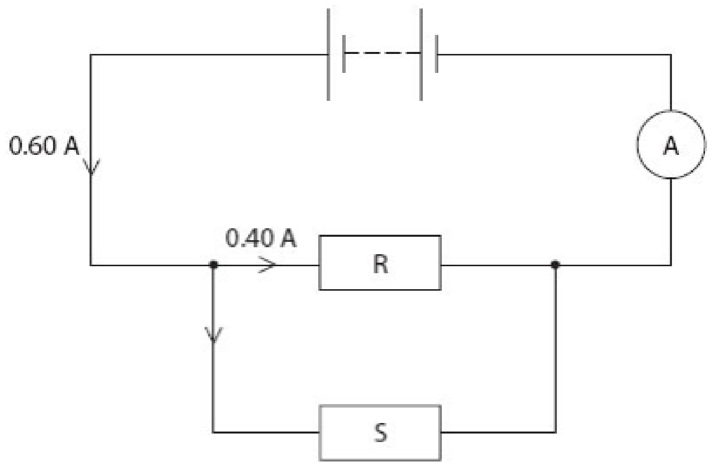
(d) The students then reduce the voltage of the power supply. State what happens to the current in the circuit (1 mark).

2. (a) The diagram shows an electric circuit with two resistors, R and S.



(i) R has a resistance of 11 ohms. Calculate the potential difference across R (2 marks).

(ii) Use information from the diagram to calculate the current in S (1 mark).

(iii) Calculate the resistance of S (2 marks).

(b) Complete the sentence by putting a cross in the box next to your answer.

A student wants to measure the battery voltage with a voltmeter (1 mark).

The voltmeter should be placed…

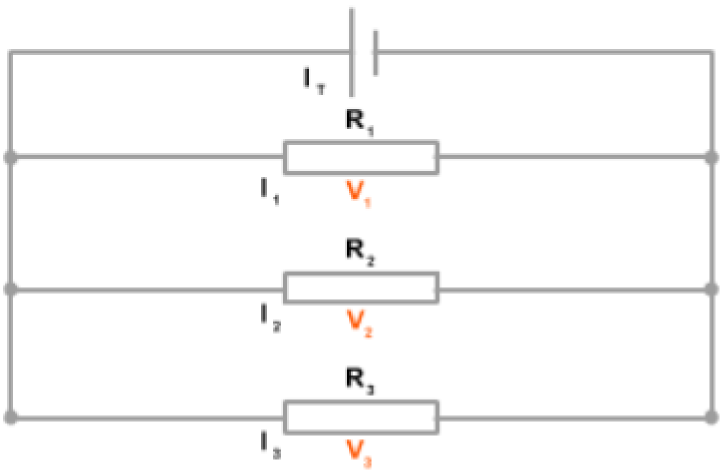
A in series with the battery

B in parallel with the battery

C in parallel with the ammeter

D in series with either resistor R or S

3) The diagram shows an electric circuit with three resistors, R_1, R_2 and R_3.



(a) (i) R_1 has a resistance of 5 ohms. The current flowing in it is 2A. Calculate the potential difference across R_1 (2 marks).

(ii) State the voltage provided by the battery (1 mark).

(b) (i) The resistance of R_2 is 10 ohms and R_3 is 4 ohms. Calculate the combined resistance of R_1, R_2 and R_3 in this arrangement (4 marks).

(ii) Calculate the current being produced by the battery (2 marks).

(c) Calculate the current flowing in (3 marks):

(i) R_2

(ii) R_3

Section B

This section looks at the A level work in more depth and there are questions you might like to attempt as the first term of A level physics progresses. Feel free to do the questions and give them in for marking. Note the different way of writing units. I will explain this in the first lesson.

Part 1: Constant acceleration

Students' strengths and common misconceptions

The table below outlines the areas in which most students do well and the common mistakes and misconceptions across the topics listed.

	Strengths	**Common mistakes**
Vectors and Scalars	Most students will already be able to state some vectors and scalars and recall the definition of a vector.	At GCSE applying mathematics to vector quantities is taught in a huge variety of ways. Some learners will have covered the topic with full mathematical detail while others will have been given a scaffolded approach that works for GCSE but does not give the full picture. These formulaic methods are often deeply entrenched and must be challenged at KS5.
Using Equations	Students will be familiar with applying equations and know some of the equations being used. Most, but not all, candidates will be confident with re-arranging equations, particularly if your centre requires B grades in GCSE Maths and Physics to take the course. It is probable that students how have chosen the course *like* using equations, as this is one of the major parts of GCSE.	As the equations being used for uniform motion are all similar and contain four rather than three variables the often taught GCSE approach of 'find an equation in the formula sheet that fits and plug in the numbers' tends to fail. Students struggle in particular with distinguishing initial and final velocity. The issues with negative numbers discussed above apply here.

Vectors and scalars

This activity is designed to aid recall of GCSE material and enable you to define what a vector is.

Sort the quantities into vectors and scalars.

Explain your reasoning for each one.

Mass, Weight, Force, Speed, Velocity, Acceleration,

Distance, Displacement, Energy, Time

A Tale of Two Cities

This is a challenging activity designed to really make you think about the vector nature of velocity. It should really highlight vectors misconceptions from GCSE. It also provides revision of graphs, which are covered in the next topic.

The cities of Principia and Mathematica are connected by a straight 100km long road.

1. Cars A and B leave Mathematica at the same time. Car A travels at 60 $kmhr^{-1}$ while car B travels at 40 $kmhr^{-1}$. What is the difference in time between their arrivals in Principia?

2. Car C starts in Mathematica, travelling at 60 $kmhr^{-1}$. Car D starts in Principia, travelling at 40 $kmhr^{-1}$. They leave at the same time.

(a) Draw a diagram to show where both cars are after half an hour.

(b) When and where do the cars pass each other?

(c) There are at least two ways of solving part B. Find another way of getting the solution.

(d) Sketch displacement time graphs for both cars on the same axis. Consider their starting points and gradients carefully. What do you notice?

(e) Extension – both cars turn around when they reach their respective cities but maintain the same speeds. Have their velocities changed? When will they next pass? When will C overtake D (same position travelling in the same direction)?

Practice questions

1) Which of the following is a scalar quantity?

Place a cross in the box next to your answer (1 mark).

A acceleration ☒

B displacement ☒

C force ☒

D work ☒

2) A cyclist travelling at a speed of 4.2 m s^{-1} accelerates at 1.1 m s^{-2}. In a time of 7.4 s what is the distance travelled?

Place a cross in the box next to your answer.

A 30 m ☒

B 35 m ☒

C 61 m ☒

D 91 m ☒

3) Complete the sentence by putting a cross in the box next to your answer.

A building has 5 floors. The windows on successive floors are separated by the same vertical distance. A brick is dropped from a window on each floor at the same time. The bricks should hit the ground at…

A decreasing time intervals ☒

B equal time intervals ☒

C increasing time intervals ☒

D the same time ☒

4) (a) Explain the difference between scalar and vector quantities (1 mark).

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(b) When asked to run one complete lap around a track, a student says, 'However fast I run, my average velocity for the lap will be zero.' Comment on his statement (3 marks).

5) This photograph shows an athlete performing a long jump.

At take-off his horizontal speed is 8.0 m s^{-1} and his vertical speed is 2.8 m s^{-1}.

(a) Show that the total time the athlete spends in the air is about 0.6 s. Assume that his centre of gravity is at the same height at take-off and landing (3 marks).

(b) Calculate the horizontal distance jumped by the athlete (2 marks).

(c) In reality, when the athlete lands his centre of gravity is 50 cm lower than its position at take-off. Calculate the extra horizontal distance this enables the athlete to jump (4 marks).

Part 2: Motion graphs

Students' strengths and common misconceptions

The table below outlines the areas in which most students do well and the common mistakes and misconceptions across the topics listed.

	Strengths	**Common mistakes**
Velocity and Displacement Time Graphs	Students will be familiar with the graphs from GCSE and probably already recall the rules for interpreting them.	Students frequently mix up displacement and velocity graphs. Students will be unfamiliar with graphs going below the x-axis
Calculating Areas and Gradients	Has been covered at GCSE and covered in some detail in Maths GCSE.	Most students find this one of the most challenging parts of GCSE. Methods taught are often inconsistent with Maths, leading to confusion and difficulty applying skills learnt.
y= mx + c	Introduced in Maths GCSE	Conceptually very challenging. Requires re-visiting several times before most students grasp it.

Remember that the gradient of a displacement-time graph is the velocity of the object and that the gradient of a velocity-time graph is the acceleration of an object. The area under a velocity-time graph is the displacement.

You will be able to plot displacement-time graphs and velocity-time graphs and use them to solve problems involving constant acceleration.

You will be able to use y = mx + c to link equations to graphs.

Graphs for a car

This activity revises the equation covered in the last section and invites you to revisit your GCSE knowledge of motion graphs.

A car, travelling at 20 m/s begins to accelerate uniformly, with a = 3 ms^{-2}. Fill out the following table.

Time/s	0	1	4	10	20
Velocity (ms^{-1}). (Use v = u + at)	20				
Displacement (m) (There are two equations you can use for this. Pick one)				350	

Plot two graphs, one of time against displacement, one of time against velocity.

Comment on the shapes of your graphs, using your GCSE knowledge to explain what they mean.

Graph for Isaac Newton

This activity is hard but worthwhile. It asks you to sketch a graph from information given, often overlooked when most (but not all) AS questions ask you to interpret rather than draw.

Sketch a speed/time graph or a velocity/time graph for this passage.

Isaac set off for the lab one day, walking at a steady pace of 2 ms^{-1}. After 10 s he realised he had forgotten the book he was working on. It took him 3 s to change his velocity, after that he sprinted home twice as fast as he had been walking.

He stopped instantly and stayed stationary in the house for 5 s while finding his book. Once he had found it he took 2 s to accelerate to a quick walk, and then headed to the lab at this slightly faster pace. He reached the lab 15.75 s later.

Why is the total time 40 s?

Why does he sprint backwards for 4.25 s?

What does a negative area mean?

Is stopping instantly realistic?

How far away is the lab?

What is the total distance travelled?

What would a displacement/time or distance/time graph look like?

Are the speeds realistic?

Practice questions

Complete the sentence by putting a cross in the box next to your answer.

Distance travelled can be found from the…

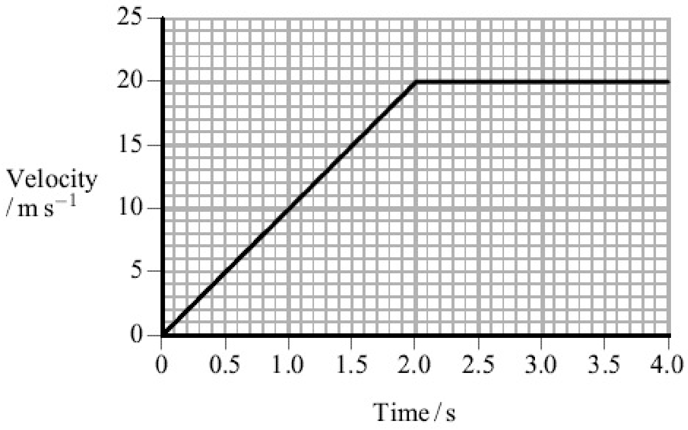
A area under a velocity-time graph ☒

B area under an acceleration-time graph ☒

C gradient of a force-time graph ☒

D gradient of a velocity-time graph ☒

2) Complete the sentence by putting a cross in the box next to your answer (1 mark)



The graph shows how velocity varies with time for an object. The acceleration at 3 s is…

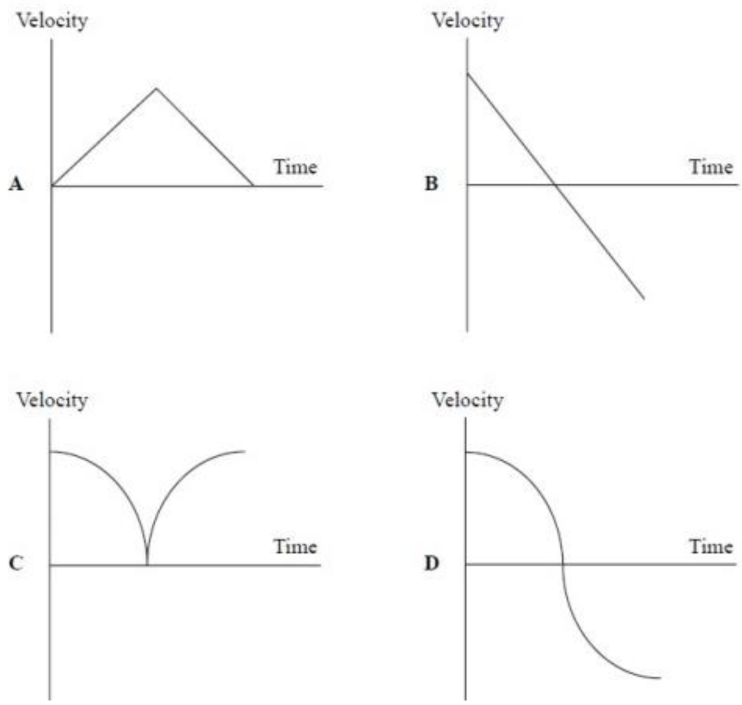
A 10 m s^{-2}

B 7 m s^{-2}

C 5 m s^{-2}

D 0 m s^{-2}

3) A ball is thrown straight up in the air and caught when it comes down. Which graph best shows the velocity of the ball from the moment it is released until just before it is caught?



Select one answer from A to D and put a cross in the box (1 mark).

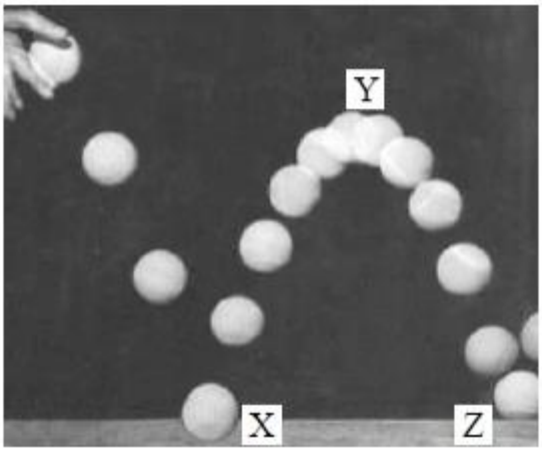
A ☒

B ☒

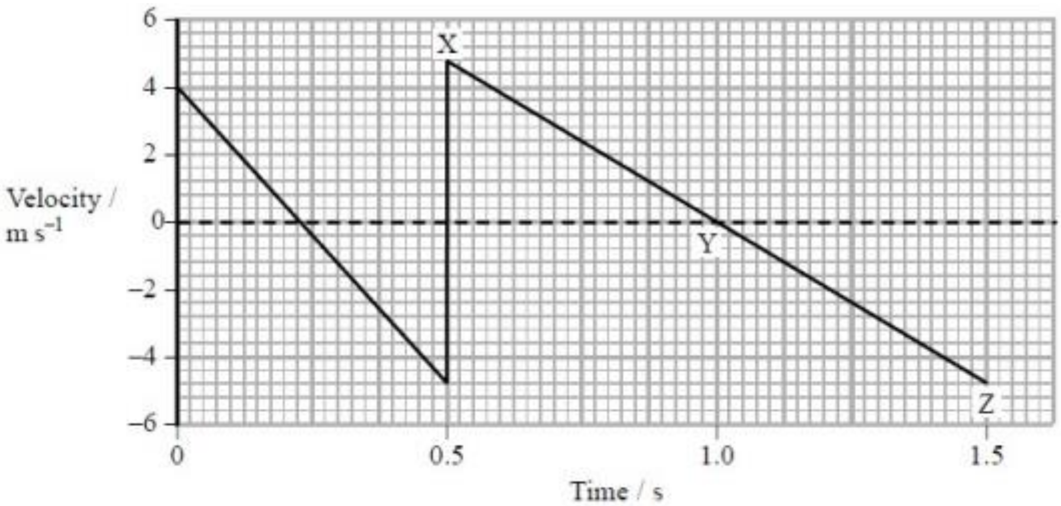
C ☒

D ☒

4) The photograph shows a sequence of images of a bouncing tennis ball.



A student plots the following graph and claims that it shows the vertical motion of the ball in the photograph.



(a) Without carrying out any calculations describe how the following can be found from the graph (2 marks):

(i) the vertical distance travelled by the ball between 0.5 s and 1.0 s

(ii) the acceleration at Y

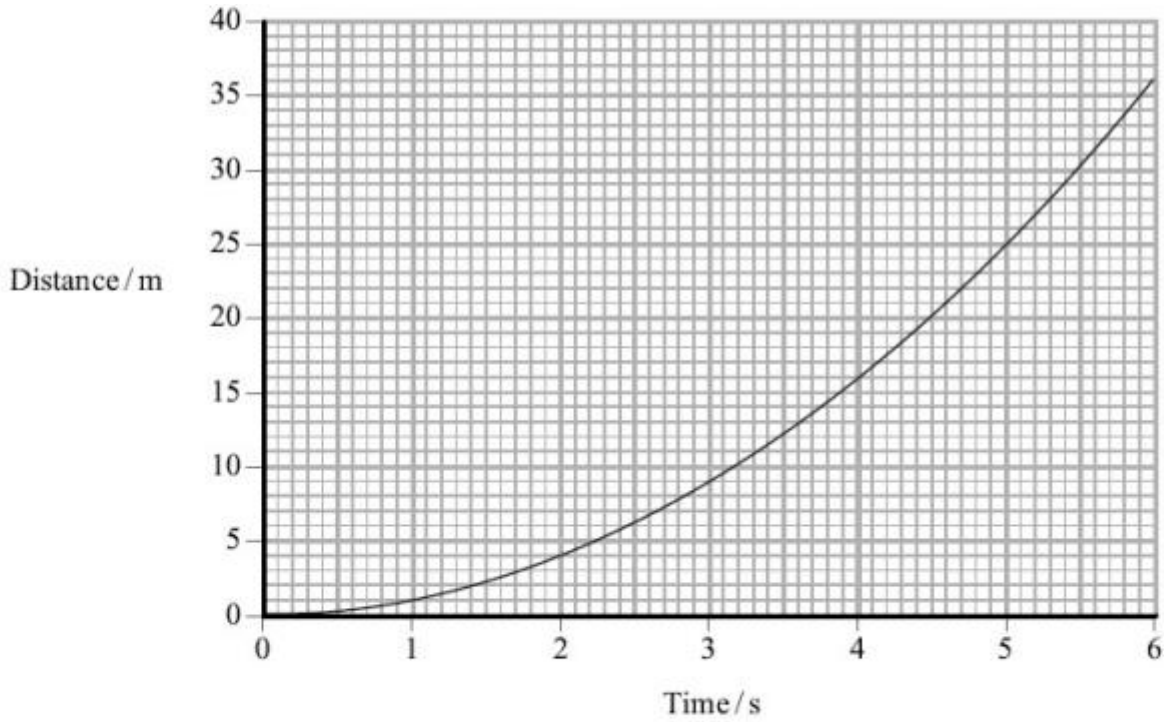
The graph contains several errors in its representation of the motion of the ball.

Explain two of these errors (4 marks).

Error 1

Error 2

5) The graph shows how displacement varies with time for an object which starts from rest with constant acceleration.



(a) Use the distance-time graph to determine the speed of the object at a time of 4.0 s (3 marks).

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(b) Calculate the acceleration (2 marks).

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Part 3: Weight and mass

Students' strengths and common misconceptions

The table below outlines the areas in which most students do well and the common mistakes and misconceptions across the topics listed.

	Strengths	Common mistakes
Weight and Mass	Students tend to find using *W = mg* relatively straightforward as it is a simple three variable equation.	Whilst students are good at using *W = mg* they often neglect to do so. Through a combination of carelessness and misconception GCSE students mix weight and mass, or forget to convert, with alarming frequency. The added sting in the tail is that the value and unit of *g* is inconsistent across centres and specifications (10, 9.8 or 9.81 m/s^2 or N/kg).
Use of Graphs	Students will have plotted scatter graphs before and be familiar with drawing lines of best fit.	Finding gradients will be challenging for weaker students. The concept of the gradient revealing a constant will be new.

Explain the difference between weight and mass and use units to identify them.

- Use and re-arrange the equation W = mg.
- Use graphs to find gravitational field strength.

What is wrong?

This activity challenges the misconceptions surrounding weight and mass and highlights the lack of overlap between everyday language and physics.

Identify the mistake in these statements.

- I've put on weight.
- The object's big mass made it hard to lift.
- I weighed myself today and found I was 80 kg.
- The extra mass of the ballast made the ship sink.

What do you know?

This activity encourages you to extract information from text. It also asks you to interconvert mass and weight.

Extract as much information as you can from these passages a) by reading them and b) by using what you have read to work things out.

The 90 kg rugby player sprinted 50 m in 6 s.

The aeroplane remained at constant height due to an upward pressure of 20 000 N. It covered 450 km in its 2 hr flight.

The fully laden ship displaced 5000 kg of water, whilst when empty it only displaced 300 kg.

A 3 cm long grasshopper can jump 20 times its own body length. The jump takes 0.35s.

Acceleration in free fall

Drop an object from various heights and record the time taken for it to fall. How will timing errors and air resistance affect your results?

Too short a distance will be subject to huge timing errors and too long a distance will underestimate g due to air resistance.

Why should you repeat readings? Plot a graph of distance fallen against t. Why it is curved.

Plot a graph of distance fallen against t^2. What is the link between the equation $s = ut + \frac{1}{2}at^2$ and the data?

Find the gradient and discuss its meaning.

Why does acceleration due to gravity also convert mass into weight?

Practice questions

1) Complete the sentence by putting a cross in the box next to your answer (1 mark).

On a newly discovered planet, an object of mass 8.0 kg has a weight of 60 N.

The gravitational field strength on this planet is…

A 0.13 N kg^{-1} ☐

B 7.5 N kg^{-1} ☐

C 9.8 N kg^{-1}

D 480 N kg^{-1}

2) A person weighing 100 N stands on some bathroom scales in a lift. If the scales show a reading of 110 N, which answer could describe the motion of the lift?

Select one answer from A to D and put a cross in the box (1 mark).

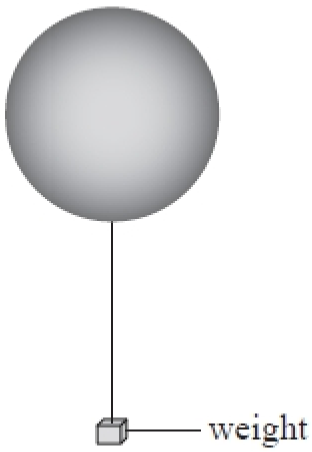
A Moving downwards and decelerating

B Moving downwards with a constant velocity

C Moving upwards and decelerating

D Moving upwards with a constant velocity

3) A student is asked to calculate the magnitude of a weight required to keep a spherical helium filled balloon stationary in the air.



The only measurement taken is the diameter d of the balloon. The student is given the values of the density of air ρ_a, the density of helium ρ_h and gravitational field strength g.

(a) Using the symbols given, write an expression for:

(i) the volume V of the balloon (1 mark)

(ii) the mass of the helium inside the balloon (1 mark)

(iii) the mass of the air displaced by the balloon (1 mark)

(iv) the upthrust on the balloon. (1 mark)

(b) Assuming the weight of the balloon and string are negligible, write an expression for the magnitude of the required weight (1 mark).

4) You are asked to determine the acceleration of free fall at the surface of the Earth, g, using a free fall method in the laboratory.

(a) Describe the apparatus you would use, the measurements you would take and explain how you would use them to determine g (6 marks).

(b) Give one precaution you would take to ensure the accuracy of your measurements. (1 mark)

Part 4: Series circuits

Students' strengths and common misconceptions

The table below outlines the areas in which most students do well and the common mistakes and misconceptions across the topics listed.

	Strengths	**Common mistakes**
Definitions	Students will have met current, voltage and resistance before.	Electricity contains a plethora of variables, symbols, units and equations, some of which are counterintuitive. Mixing up units and symbols (plenty of GCSE students seem to think the unit of current is I) is common.
V = IR	Students will be familiar with this equation applied in simple situations from GCSE	Mixing variables as mentioned above. Students are more used to applying *V* = *IR* to whole circuits, rather than individual components.

Define Current, Voltage and Resistance.

- Discover/Prove the rules for voltage, current and resistance in series.
- Use the equation V = IR.

Quantities, units and symbols

This activity is designed to provide you with a clear reference for electricity, to aid you in not getting things mixed up.

Use your GCSE knowledge, or a textbook, to fill out this table

Quantity	**Symbol**	**Unit**	**Unit symbol**	**Relevant equations**	**SI base units**
	Q		C		
current					amps
		volt			
	R				
power					

Electric metaphors

This task will improve your explanation skills, and get you thinking about what electricity really is.

Without using any technical language, how would you explain what electricity is to a five year old?

Draw a series circuit. Decide on the Voltage of the battery and the resistance of the resistors.

Calculate the current.

Give some but not all of the information to another student and see if they can work out the missing value(s).

Practice questions

1 Complete the sentence by putting a cross in the box next to your answer (1 mark).

The unit of potential difference can be expressed as…

A $C\ s^{-1}$ ☐

B $J\ C^{-1}$ ☐

C $A\ \Omega^{-1}$ ☐

D $J\ A^{-1}$ ☐

2 Complete the sentence by putting a cross in the box next to your answer (1 mark).

A rechargeable cell stores a maximum energy of 4200 J. The cell has an e.m.f. of 1.5 V and after 2.0 hours use the cell is completely discharged.

Assuming the e.m.f. stays constant, the charge passing through the cell during this time is…

A 1400 C ☐

B 2800 C ☐

C 5600 C ☒

D 6300 C ☒

3 An electric torch uses two 1.5 V cells. The torch bulb is marked 2.4 V, 270 mA.

What is the resistance of the torch bulb? Put a cross in the box next to your answer (1 mark).

A 0.81 Ω ☒

B 0.65 Ω ☒

C 8.9 Ω ☒

D 11 Ω ☒

4) A student is taking measurements in order to determine the resistance of a component in a circuit. He connects a voltmeter in parallel with the component and an ammeter in series with the component.

Explain why the voltmeter should have a very high resistance (2 marks).

____

____

____

____

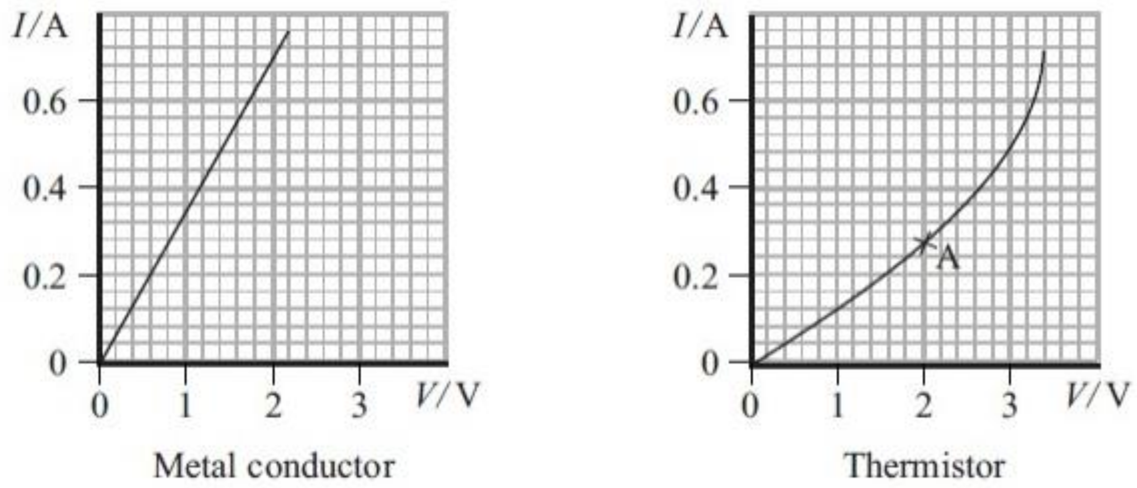
5) (a) Show how the ohm is derived (1 mark).

____

____

____

The graphs show the current-potential difference (I-V) characteristics for a metal conductor and for a thermistor.



(i) Calculate the resistance of the thermistor at point A (2 marks).

(ii) Use the graphs to describe how the resistance varies with potential difference for each component (2 marks).

(iii) Explain, in terms of electrons, why the thermistor behaves in this way (2 marks).

Part 5: Parallel circuits

Students' strengths and common misconceptions

The table below outlines the areas in which most students do well and the common mistakes and misconceptions across the topics listed.

	Strengths	**Common mistakes**
Parallel Circuits	Students will instantly recognise parallel circuits as they have met them at GCSE	Concepts such as increased current with more resistors are counterintuitive. Students frequently mix up the rules for series and parallel
Resistance in Parallel Equation	Some simple checks can be taught for answers, such as is R_t smaller than any of the resistances used.	Consistently one of the most misapplied equations in GCSE and A-Level Physics.

Prove/discover the rules for current and voltage in parallel circuits.

Analyse circuits to find unknown quantities.

Christmas trees

This activity adds mathematical detail to a well-known example of series and parallel circuits used in the GCSE.

A set of Christmas tree lights are powered from a 20V source. There are 10 bulbs in series. Each light needs a power of 10W.

(a) What is the voltage across each bulb?

____

(b) What is the current in each bulb?

____

(c) What must the total resistance of the lights be?

____

(d) What is the resistance of each light? There are two ways of working this out...

____

____

(e) If one light was to be powered from a 20 V source what would the current need to be in the bulb? It still needs a power of 10 W. What would the resistance of this new bulb need to be?

____

(f) What is the advantage of:

(i) Lower current;

____

____

(ii) Higher resistance?

____

____

(g) Is there a practical way of giving the full voltage to each bulb?

____

____

(h) What is the additional advantage of this?

____

____

Electrical metaphors

Use the analogy of pipes, roads or ski-runs to explain how parallel circuits behave. Must include issues with the model, what it does not explain and other flaws.

Draw a parallel circuit.

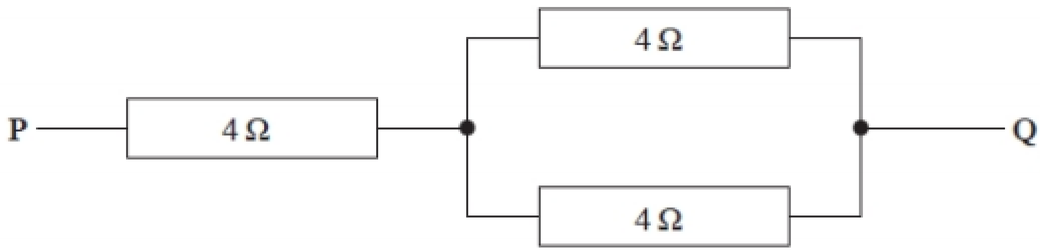
Decide on the Voltage of the battery and the resistance of the resistors.

Calculate the current.

Give some but not all of the information to another student and see if they can work out the missing value(s).

Practice questions

1) The diagram shows a combination of three identical resistors



What is the combined resistance between P and Q?

Put a cross in the box next to your answer (1 mark).

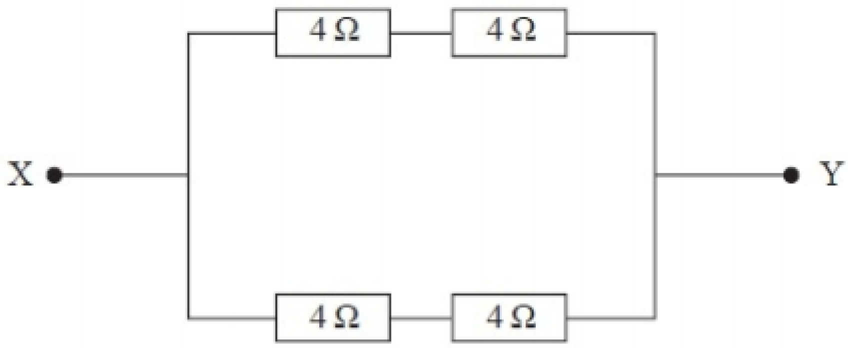
A 4 Ω ☐

B 6 Ω ☐

C 8 Ω ☐

D 12 Ω ☐

2) The diagram shows a resistor network.



Complete the sentence by putting a cross in the box next to your answer (1 mark).

The total resistance between points X and Y is…

A 0.25 Ω ☒

B 1.0 Ω ☒

C 4.0 Ω ☒

D 16 Ω ☒

3) Complete the sentence by putting a cross in the box next to your answer (1 mark).

Two identical resistors connected in series have a total resistance of 8 Ω.

The same two resistors when connected in parallel have a total resistance of…

A 0.5 Ω ☒

B 2 Ω ☒

C 4 Ω ☒

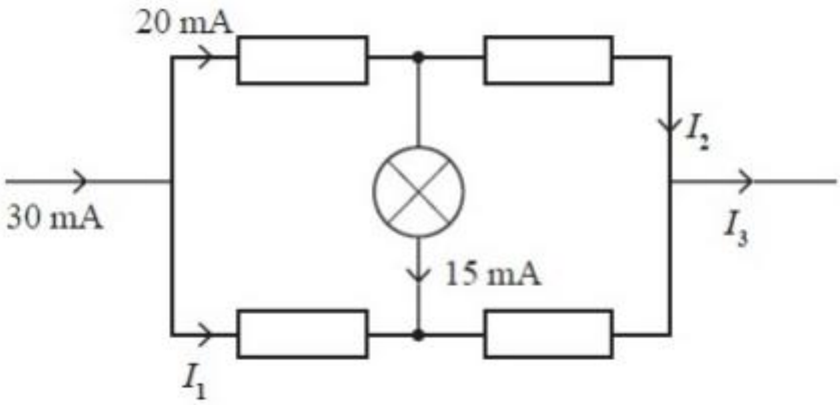
D 8 Ω ☒

4) (a) What is the coulomb in base units? (1 mark)

____

____

(b) The diagram shows part of an electrical circuit.



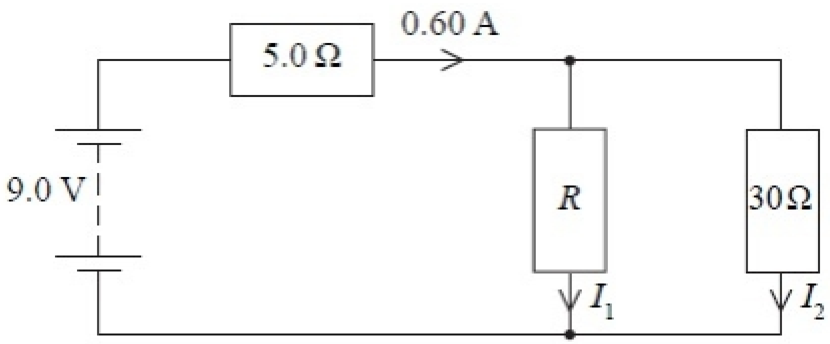
Determine the magnitudes of the currents I_1, I_2 and I_3 (3 marks).

I_1 =

I_2 =

I_3 =

5) The circuit diagram shows a battery of negligible internal resistance connected to three resistors.



(a) Calculate the potential difference across the 5 Ω resistor (2 marks).

____

____

____

(b) Calculate the current I_2 (2 marks).

____

(c) Calculate the resistance R (2 marks)