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Subject to Second DRAFT accreditation

FORMULAE

You may find the following formulae useful

charge = current × time $Q = I \times t$

potential difference = current × resistance $V = I \times R$

electrical power = current × potential difference $P = I \times V$

energy transferred = current × potential difference × time $E = I \times V \times t$

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

acceleration = $\frac{\text{change in velocity}}{\text{time taken}}$ $a = \frac{(v - u)}{t}$

force = mass × acceleration $F = m \times a$

weight = mass x gravitational field strength $W = m \times g$

momentum = mass x velocity

work done = force × distance moved in the direction of the force $E = F \times d$

power = $\frac{\text{work done}}{\text{time taken}}$ $P = \frac{E}{t}$

gravitational potential energy =mass × gravitational field strength × vertical height

GPE $= m \times g \times h$

kinetic energy = ½ × mass × velocity^2 KE $= \frac{1}{2} \times m \times v^2$

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Static electricity

1. (a) Ellie slides down a plastic tube.

Her hair becomes charged.

(i) Ellie's hair is charged by the transfer of

A ☒ atoms

B ☒ electrons

C ☒ neutrons

D ☒ protons

(1)

(ii) Strands of Ellie's hair repel each other.

This is because they have

A ☒ the same electric charge

B ☒ a different electric charge

C ☒ the same magnetic charge

D ☒ a different magnetic charge

(1)

(b) The photograph shows an aircraft being refuelled.

(i) The aircraft is refuelled using a plastic fuel pipe.
The plastic pipe can become charged with static electricity.

Give the reason for this.

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(1)

(ii) Explain how static electricity could cause an explosion during refuelling.

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(2)

(iii) A metal safety cable is used during refuelling.

Explain how this cable reduces the risk of an explosion.

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(2)

(Total for Question 1 = 7 marks)

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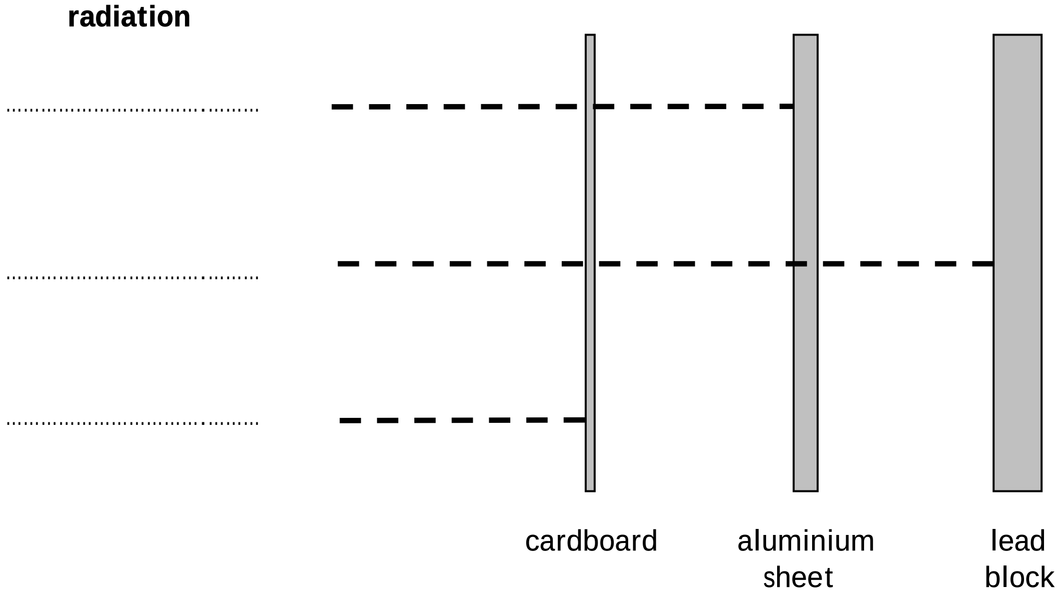
Radioactivity

2. Alpha, beta and gamma are three types of radiation.

(a) Label the diagram to show the different penetrating powers of alpha, beta and gamma.



(2)

(b) Radioactive substances can be used in many ways.

Alpha radiation is

A ☒ used to study stars

B ☒ used to monitor the thickness of paper

C ☒ used in smoke detectors

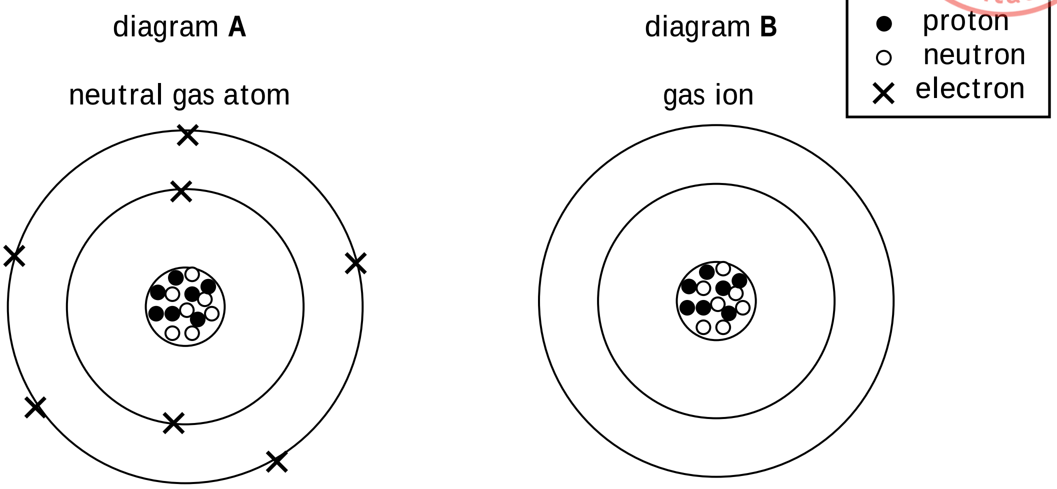
D ☒ used to irradiate fruit

(1)

Leave blank

(c) (i) Diagram **A** represents a neutral gas atom.
The gas atom is ionised when an alpha particle passes close to the atom.

Complete diagram **B** for the gas ion.



(1)

(ii) Explain how the alpha particle produces a gas ion from the neutral gas atom

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(2)

(d) An alpha-emitting radioactive isotope has a half-life of 1 hour.
A sample contains 4.0 g of the isotope.

Calculate the mass of this isotope that will remain after 2 hours.
Show your working.

mass remaining = ...g

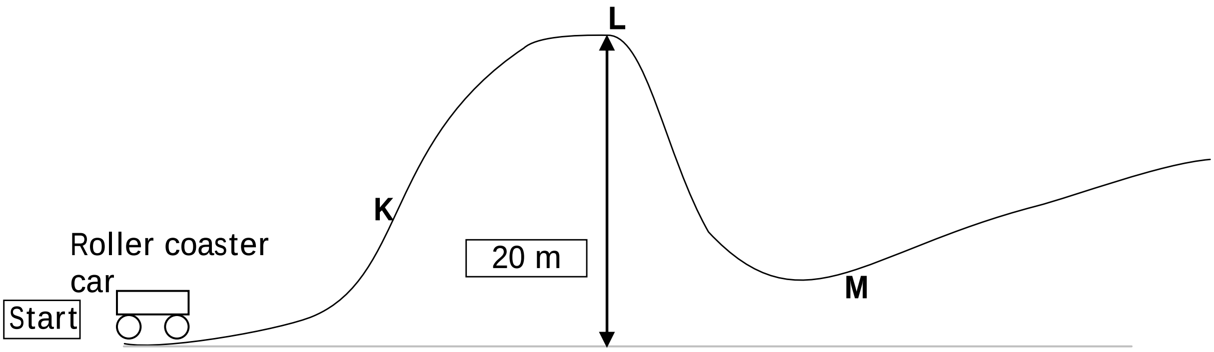
(2)

(Total for Question 2 = 8 marks)

Energy, work and power

3. The photograph shows people on a roller coaster ride.

The diagram shows part of the roller coaster track.



An electric motor pulls the roller coaster car slowly up the slope
The car passes point **K** and stops briefly at point **L**.
The motor is switched off at **L** and the car rolls down past point **M**.

(a) (i) The **most useful** energy transfer **in the motor** between **K** and **L** is electrical energy to

A ☒ chemical energy

B ☒ light energy

C ☒ thermal (heat) energy

D ☒ gravitational potential energy

(1)

(ii) Sound energy is also produced by the roller coaster motor.
What happens to this energy?

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(1)

Leave blank

(b) Describe what happens to the energy of the car as it moves from L to M.

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(2)

(c) The weight of the car is 6000 N.

Calculate the work done on the car when it is raised from the start to **L.**

work done = ...J

(2)

(d) The motor does 300 000 J of work in a time of 100 s.

Calculate the power of the motor.

power = ...W

(2)

(e) At one part of the ride the car has a velocity of 10 m/s.
The mass of the car is 600 kg.

What is the kinetic energy of the car?

kinetic energy = ...J

(2)

(Total for Question 3 = 10 marks)

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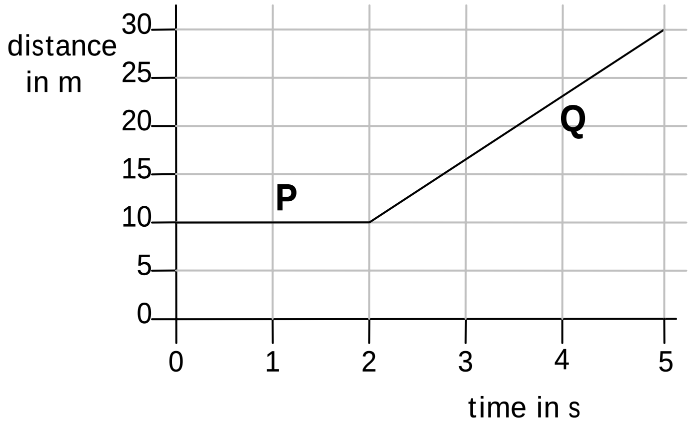
Investigating motion

4. (a) The graph shows the motion of a car at the start of a race.



(i) In section **P**, the car is

A ☒ moving with a steady acceleration

B ☒ moving at a steady speed

C ☒ moving backwards

D ☒ not moving

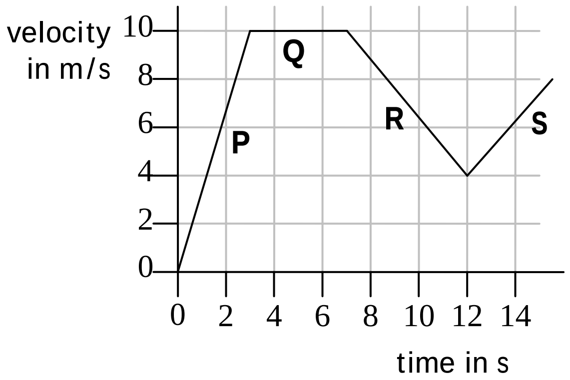
(1)

(ii) Calculate the speed of the car in section **Q**.
Show all your working.
Give the unit.

speed = ... unit ....

(3)

(b) The graph below shows the motion of the car for a different part of the race.



In which section does the car have the biggest acceleration?

A ☒ **P**

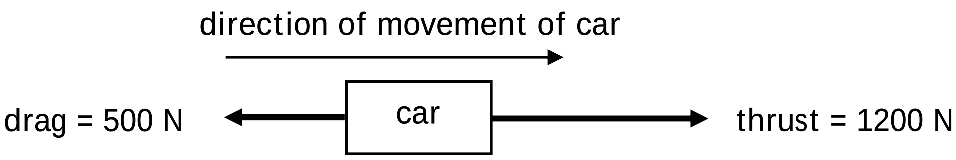
B ☒ **Q**

C ☒ **R**

D ☒ **S**

(1)

(c) The diagram shows the horizontal forces acting on the car at one point in the race.



Calculate the resultant horizontal force acting on the car.
State the direction of this resultant force.

resultant force = ...N

direction of the resultant force = ...

(2)

Leave blank

(d) The photograph shows a skydiver a few seconds after beginning his jump.

He is falling at a steady speed and has not yet opened his parachute.

Photo: Shutterstock

(i) Gravity is one force acting on the skydiver in the photograph.

Give **one** other force acting on the skydiver.

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(1)

(ii) Explain why the skydiver is falling at a steady speed.

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(3)

(Total for Question 4 = 11 marks)

Uses of radioactive isotopes

5. In 2008, there were 19 nuclear power stations in the UK.

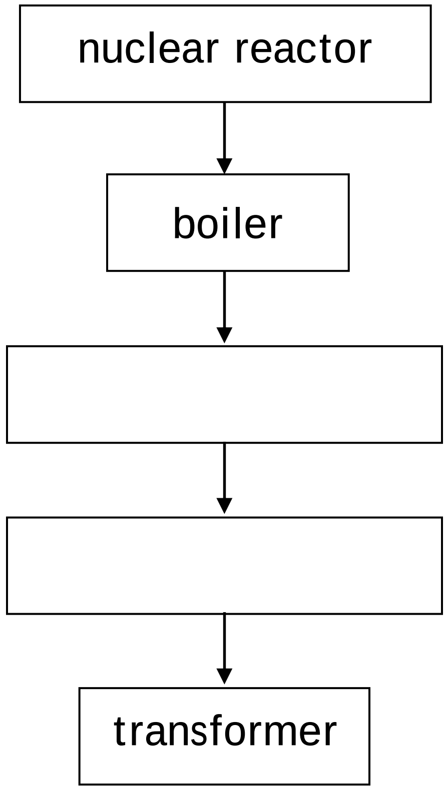
   These power stations provided around 12.5% of the UK's electricity.

   The percentage of the UK's energy needs which are provided by nuclear power stations has been falling over the past ten years.

(a) The flow chart shows some of the main stages in the production of electrical energy in a nuclear power station.

Use words from the box to complete the flow chart.

control rods	moderator	furnace	generator	motor	turbine



(2)

(b) The nuclear reactor in part (a) uses the nuclear **fission** of uranium.

Describe what happens in the nuclear **fission** of uranium

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(2)

Leave blank

*(c) The UK government plans to build ten new nuclear power stations to help meet the UK's future energy needs.

Discuss the benefits **and** drawbacks of nuclear power stations.

(6)

(d) Scientists are developing a different nuclear reactor.
This type of reactor uses nuclear **fusion** with hydrogen as the fuel.

Describe what happens in the nuclear **fusion** of hydrogen.

(2)

(Total for Question 5 = 12 marks)

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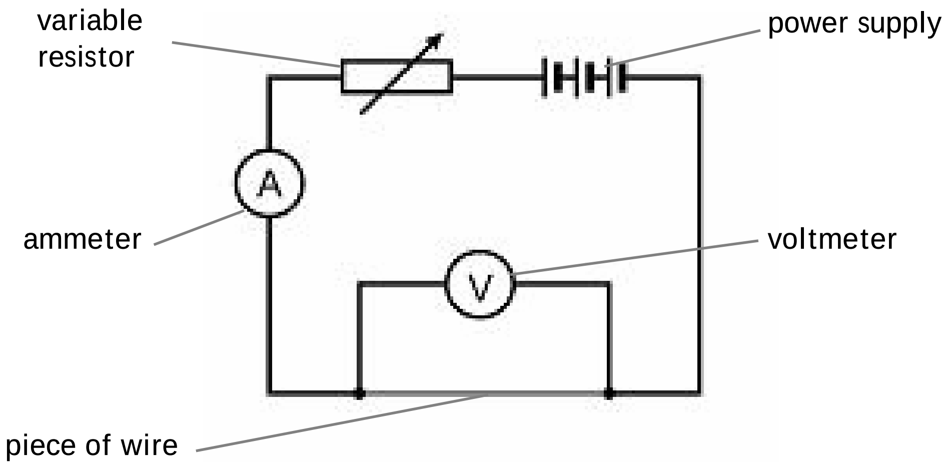
Investigating current and voltage

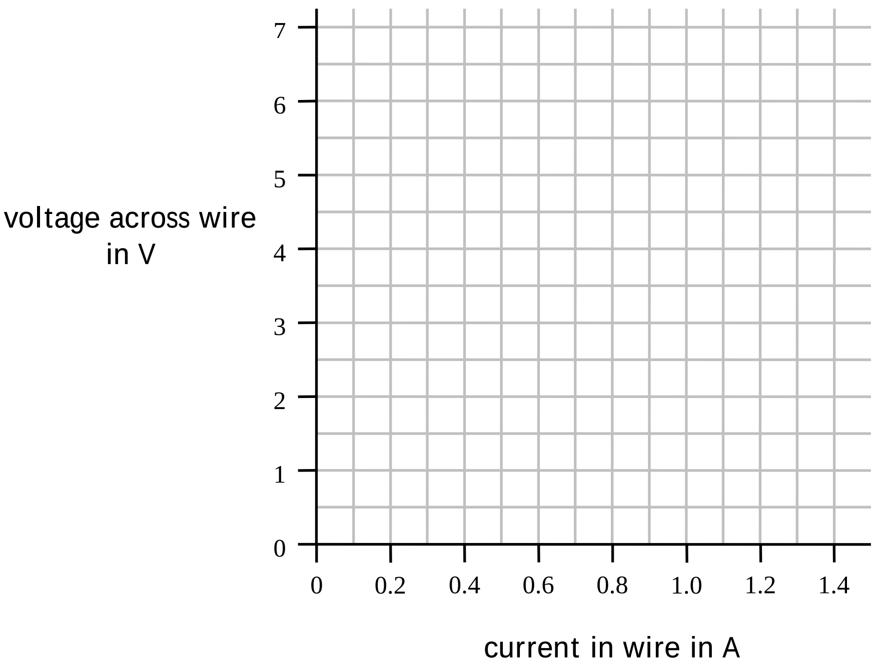
6. The circuit below is used to investigate how the current in a piece of wire varies with potential difference (voltage) across it.



(a) Here are some results from the investigation.

current in wire (A)	**voltage across wire (V)**
0.0	0.0
0.2	1.0
0.6	3.0
0.8	4.0
1.2	6.0

(i) Plot the points on the axes below



(2)

Leave blank

(ii) Draw a line of best fit through the plotted points.

(1)

(iii) What is the current in the wire when the voltage across it is 5.0 V?

current = ...A

(1)

(iv) What is the power developed in the wire when the voltage across it is 4 V?

power = ...W

(2)

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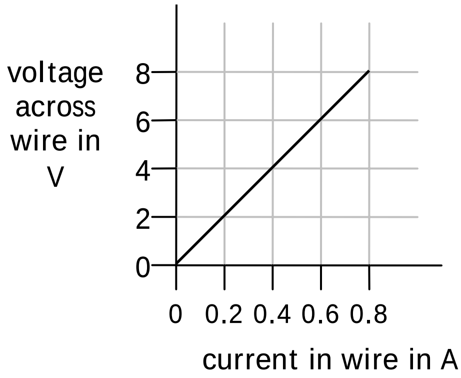
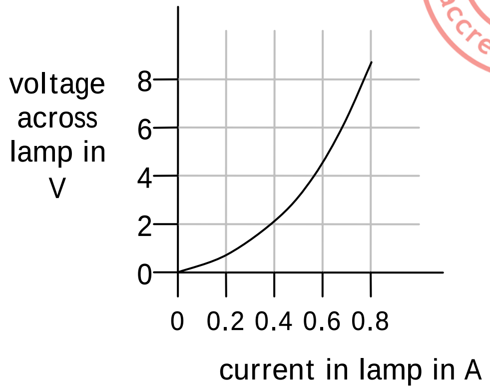
(b) The voltage-current graphs for a different piece of wire and a filament lamp are shown below.

voltage-current graph for a wire



voltage-current graph for a filament lamp



The temperature of the wire is kept constant at 20 °C.

The temperature of the lamp filament is about 2500 °C at 8 V.

Using the information above, explain the differences in resistance between the wire and filament lamp.

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(6)

(Total for Question 6 = 12 marks)

TOTAL FOR PAPER = 60 MARKS