

Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Secondary Education  
June 2004



**PHYSICS  
FOUNDATION TIER**

**3451/F**

**F**

Tuesday 22 June 2004 9.00 am to 11.15 am

**In addition to this paper you will require:**  
a ruler.  
You may use a calculator.

For Examiner's Use			
Number	Mark	Number	Mark
1		9	
2		10	
3		11	
4		12	
5		13	
6		14	
7		15	
8		16	
Total (Column 1)	→		
Total (Column 2)	→		
TOTAL			
Examiner's Initials			

Time allowed: 2 hours 15 minutes

**Instructions**

- Use blue or black ink or ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.

**Information**

- The maximum mark for this paper is 135.
- Mark allocations are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.

Answer **all** questions in the spaces provided.

- 1 (a) Complete the sentences by choosing the correct word or phrase from the box.

Each word or phrase may be used once or not at all.

<b>circular</b>	<b>comet</b>	<b>elliptical</b>	<b>Milky Way</b>
<b>Moon</b>	<b>solar system</b>	<b>Universe</b>	

A planet and a ..... both move in ..... orbits around the Sun.

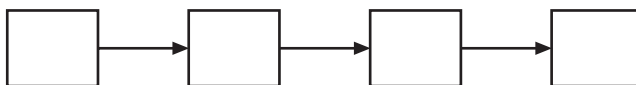
The Sun is part of the ..... galaxy.

The ..... contains at least a billion galaxies. (4 marks)

- (b) The following sentences describe the stages that a star such as the Sun goes through during its life.

- A** The star is stable.
- B** The star contracts to a white dwarf.
- C** The star expands into a red giant.
- D** The star is formed when the force of gravity pulls dust and gases together.

- (i) Arrange the sentences in the order in which the stages happen.



(3 marks)

- (ii) The Sun is at which stage in its life, **A**, **B**, **C** or **D**?

.....  
(1 mark)

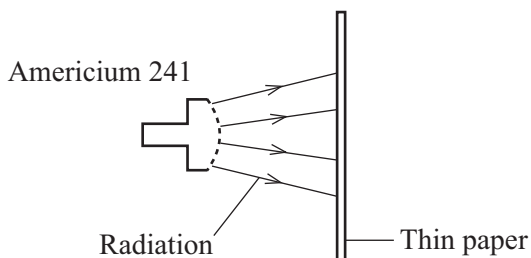
2 A smoke detector fitted inside a house contains a radioactive source, americium 241.

(a) Complete the following table of information for an atom of americium 241.

Number of neutrons	146
Number of protons	95
Number of electrons	

(1 mark)

(b) The diagram shows that the radiation given out by americium 241 does not go through paper.



Which type of radiation, alpha ( $\alpha$ ), beta ( $\beta$ ), or gamma ( $\gamma$ ) is given out by americium 241?

.....  
(1 mark)

(c) Explain why the radiation given out by the americium 241 is unlikely to do any harm to people living in the house.

.....  
.....  
.....  
.....  
(2 marks)

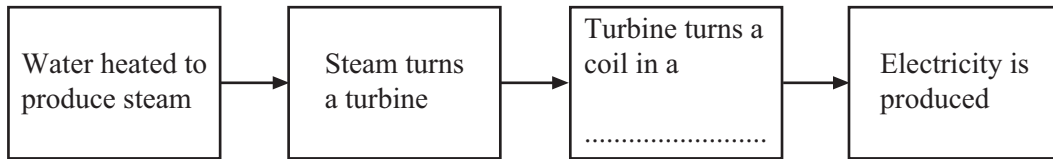
(d) Complete the sentence by choosing an answer from the box.

<b>less than</b>	<b>more than</b>	<b>the same as</b>
------------------	------------------	--------------------

After many years the radiation emitted by americium 241 will be ..... when the smoke detector was new.

(1 mark)

- 3 (a) In Britain most power stations burn fuel to produce heat. The diagram shows the stages by which the heat is transferred into electrical energy. Complete the diagram by filling in the missing word.



(1 mark)

- (b) A fuel burning power station uses 2000 joules of fuel energy to generate 600 joules of electrical energy. The rest of the fuel energy is wasted as heat.
- (i) For every 600 joules of electrical energy generated, how much fuel energy is wasted as heat?

.....  
(1 mark)

- (ii) Use the following equation to calculate the efficiency of the power station. Show clearly how you work out your answer.

$$\text{efficiency} = \frac{\text{useful energy transferred by device}}{\text{total energy supplied to device}}$$

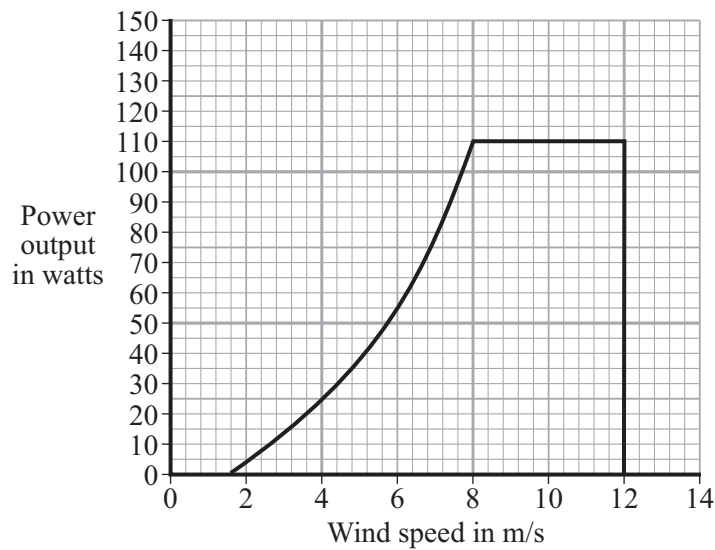
.....  
.....  
efficiency = .....  
(2 marks)

- (c) List **A** gives three energy resources used to generate electricity. List **B** gives environmental problems that may be caused by using different energy resources. Draw a straight line from each energy resource in List **A** to the environmental problem it may cause in List **B**. Draw **three** lines only.

List A Energy resource	List B Environmental problem that may be caused
Wind	Destroys the habitat of wading birds in river estuaries
Tides	Produces a lot of noise
Falling water (hydroelectricity)	Produces the gas sulphur dioxide
	Floods land used for farming or forestry

(3 marks)

- (d) A small wind generator is used to charge a battery. The graph shows the power output of the generator at different wind speeds.



- (i) What is the maximum power produced by the generator?

..... watts  
(1 mark)

- (ii) The generator is designed to stop if the wind speed is too high.

At what wind speed does the generator stop working?

..... m/s  
(1 mark)

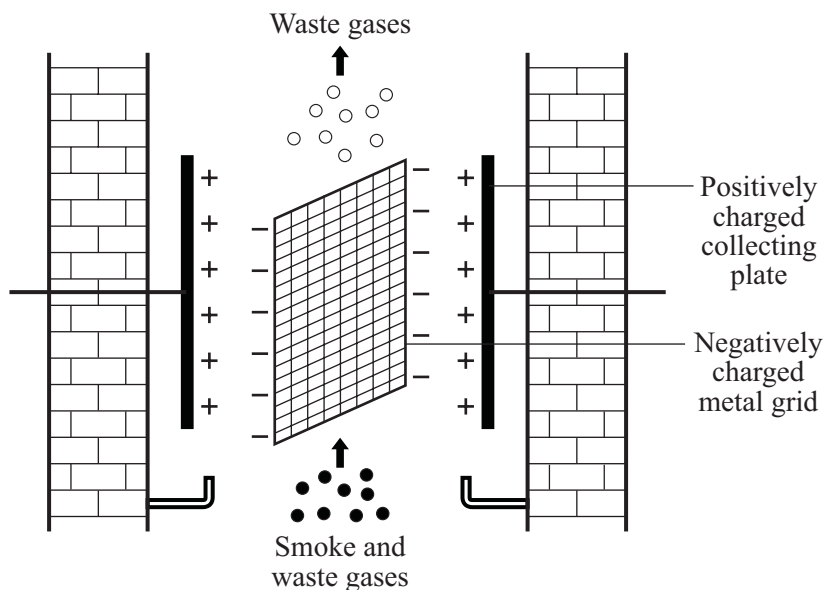
- (iii) Give **one** disadvantage of using a wind generator to charge a battery.

.....  
.....  
(1 mark)

**TURN OVER FOR THE NEXT QUESTION**

Turn over ►

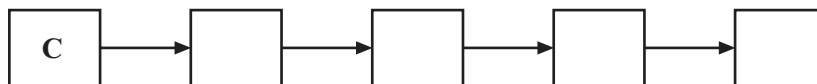
- 4 (a) Burning fuels produce smoke particles and waste gases. An electrostatic smoke precipitator can remove the smoke particles from the waste gases.



The following sentences **A** to **E** describe how an electrostatic smoke precipitator works. The sentences are in the wrong order.

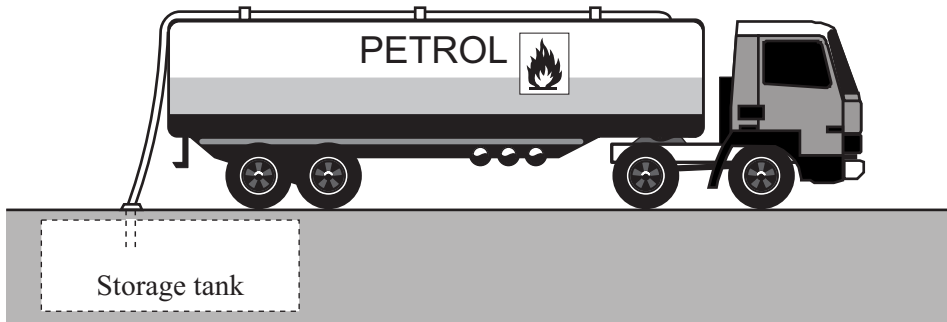
- A** The smoke particles stick to the positively charged collecting plates.
- B** The smoke particles are given a negative charge.
- C** The waste gases and smoke pass through a negatively charged metal grid.
- D** The collecting plates are knocked so the smoke particles fall and can be taken away.
- E** The smoke particles are repelled from the grid and attracted to the positively charged collecting plates.

Arrange the sentences in the right order. Start with sentence **C**.



(3 marks)

- (b) The underground storage tanks at petrol stations are filled from tankers. A static electric charge can build up on the tanker as the petrol flows through the pipe to the storage tank. This could be dangerous.



Why is the static electric charge dangerous and what should be done to stop the charge building up?

.....

.....

.....

.....

(2 marks)

- (c) A 3-pin plug should always be fitted with the correct value fuse for a particular electrical appliance. The fuse protects the appliance and wires from damage.

Explain how a fuse works.

*To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

.....

.....

.....

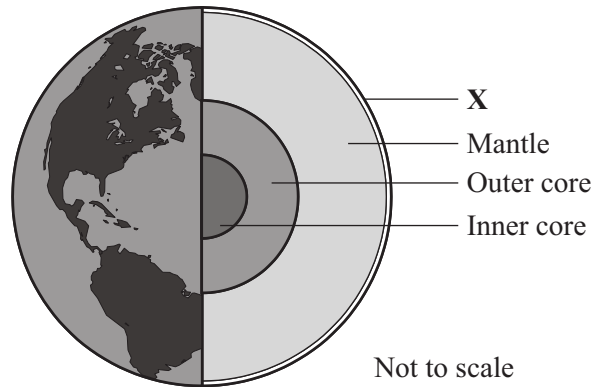
.....

.....

.....

(3 marks)

- 5 (a) The diagram gives information about some of the layers that make up the Earth.



- (i) What name is given to the outer layer of the Earth labelled X?

.....  
(1 mark)

- (ii) What is the difference between the inner core and the outer core?

.....  
.....  
(2 marks)

- (b) Which of the following is used to detect the waves produced by an earthquake?

Draw a ring around your answer.

**barograph**

**seismograph**

**tachograph**

(1 mark)



- (c) Most earthquakes happen where tectonic plates meet. Tectonic plates are large pieces of the Earth’s outer layer that move very slowly. Sometimes the plates slide against each other. Earthquakes happen when the force built up in the rock below the Earth’s surface is large enough to make the plates move suddenly.

Suggest why it is difficult to accurately predict when an earthquake will happen.

.....

.....

.....

.....

(2 marks)

- (d) In some parts of the world heat from the rock in the Earth’s outer layer produces high pressure steam. The steam is used to generate electricity.

Which **one** of the following words is used to describe this type of energy resource?

Draw a ring around your answer.

**geometric**

**geostationary**

**geothermal**

(1 mark)

- (e) A rock sample contains 10 000 atoms of a radioactive uranium isotope. The half-life of this isotope is 4500 million years.

- (i) How many atoms of the uranium isotope will be in the rock sample after 4500 million years?

.....

(1 mark)

- (ii) How many atoms of the uranium isotope will be in the rock sample after 9000 million years?

.....

(1 mark)



Turn over ►

6 Malik uses a camera to photograph the Moon.



(a) Complete each sentence by choosing the correct words from the box.

You may use each word once, more than once or not at all.

<b>converging</b>	<b>diverging</b>	<b>image</b>	<b>longer</b>
<b>object</b>	<b>real</b>	<b>shorter</b>	<b>virtual</b>

In a camera a ..... lens is used to produce an .....  
of an ..... on a film. The ..... is smaller than  
the ..... and it is a ..... distance from the lens.  
(6 marks)

(b) The Moon moves in a nearly circular path around the Earth.

(i) What is the name of the force which causes the Moon to move around the Earth?

.....  
(1 mark)

(ii) In which direction does this force act?

.....  
(1 mark)

(c) A force is needed to make a car change direction when it goes round a bend.

(i) What is the name of this force and where does it act?

.....  
.....

(2 marks)

(ii) Complete the **two** spaces in the sentence.

The force needed is greater if the ..... of the car is greater and the  
..... of the bend is smaller.

(2 marks)

(d) What word is used to describe any force which causes an object to move in a circular path?

.....

(1 mark)

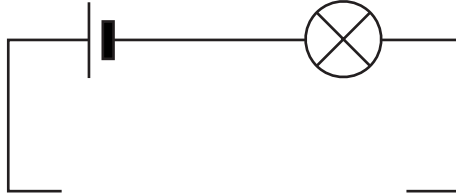


**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

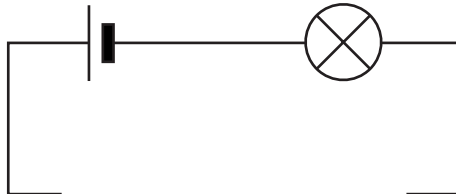
7 (a) Each diagram shows a cell connected to a lamp.

- (i) Add **two** switches and connecting wires to the diagram below so that the lamp will light **only** when **both** switches are closed.



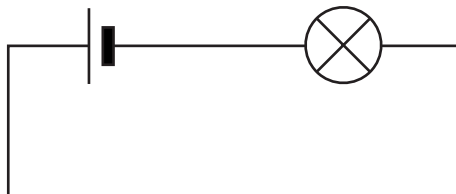
(1 mark)

- (ii) Add **two** switches and connecting wires to the diagram below so that the lamp will light when either **one** or **both** switches are closed.



(1 mark)

- (iii) Add **one** switch and connecting wires to the diagram below so that the lamp is **on** when the switch is **open** and the lamp is **off** when the switch is **closed**.



(1 mark)

- (iv) Complete the table to name the type of logic gate represented by each circuit in parts (i), (ii) and (iii) above.

Circuit	Name of the logic gate
(a)(i)	.....
(a)(ii)	.....
(a)(iii)	.....

(3 marks)

(b) The block diagram represents an electronic system.



(i) Describe how the system works.

.....  
 .....  
 .....

(2 marks)

(ii) Suggest a practical use for this system.

.....  
 .....

(1 mark)

(c) (i) Draw the symbol used in electronic circuits for a NOT gate.

(1 mark)

(ii) Use 0 and 1 to complete the table for a NOT gate.

Input	Output
.....	.....
.....	.....

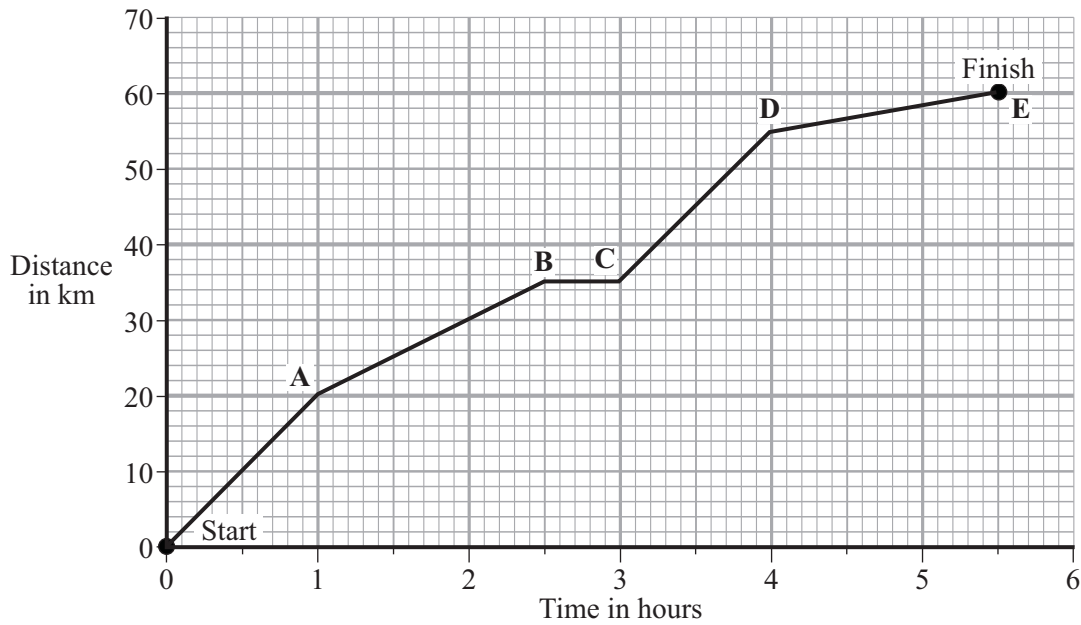
(1 mark)

(iii) What is the name of the sort of table shown in part (c)(ii)?

.....

(1 mark)

- 8 A horse and rider take part in a long distance race. The graph shows how far the horse and rider travel during the race.



- (a) What was the distance of the race?

distance = ..... km  
(1 mark)

- (b) How long did it take the horse and rider to complete the race?

.....  
(1 mark)

- (c) What distance did the horse and rider travel in the first 2 hours of the race?

distance = ..... km  
(1 mark)

- (d) How long did the horse and rider stop and rest during the race?

.....  
(1 mark)

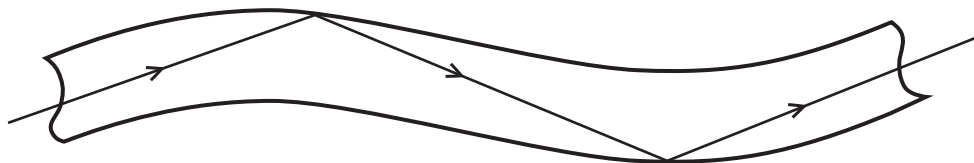
- (e) Not counting the time it was resting, between which two points was the horse moving the slowest?

..... and .....

Give a reason for your answer.

.....  
.....  
(2 marks)

9 (a) The diagram shows the path of a light ray through part of an optical fibre.



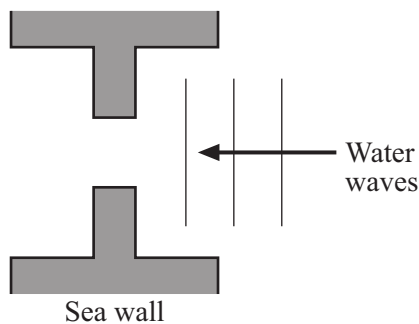
(i) Give **one** practical use for optical fibres.

.....  
(1 mark)

(ii) Explain, as fully as you can, why the light ray stays inside the optical fibre.

.....  
.....  
.....  
.....  
(2 marks)

(b) The diagram drawn from above shows water waves moving towards a gap in a sea wall.



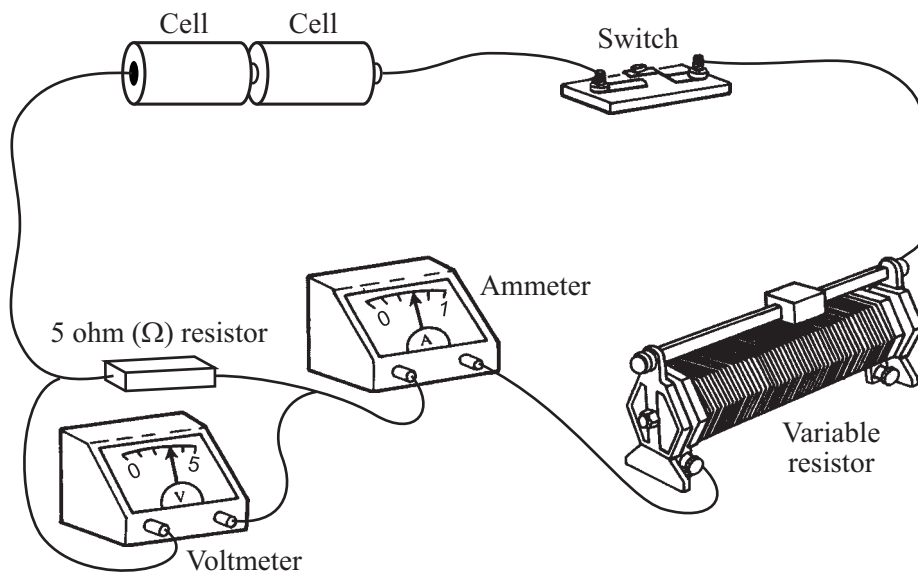
**View From Above**

(i) Complete the diagram to show what happens to the water waves after they pass through the gap in the sea wall. (1 mark)

(ii) What name is given to this effect?

.....  
(1 mark)

- 10 The drawing shows the circuit used to investigate how the current through a 5 ohm ( $\Omega$ ) resistor changes as the potential difference (voltage) across the resistor changes.



- (a) Draw, in the space below, a circuit diagram of this circuit. Use the correct symbols for each part of the circuit.

(2 marks)



- (b) (i) Write down the equation that links current, potential difference and resistance.

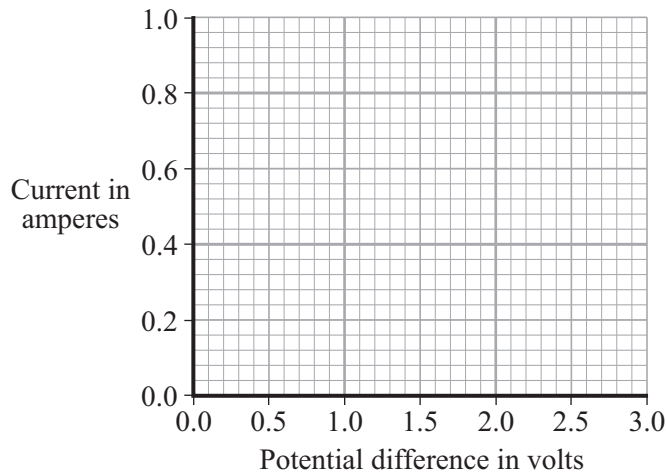
.....  
(1 mark)

- (ii) Calculate the potential difference across the 5 ohm ( $\Omega$ ) resistor when the current through the resistor equals 0.4 A. Show clearly how you work out your final answer.

.....  
.....

potential difference = .....volts  
(2 marks)

- (iii) Complete the graph to show how the current through the resistor changes as the potential difference across the resistor increases from 0 V to 3 V. Assume the resistor stays at a constant temperature.



(2 marks)

- (c) The resistor is replaced by a 3 V filament lamp. The resistance of the lamp increases as the potential difference across it increases. Why?

.....  
.....  
(1 mark)

11 The diagram represents the electromagnetic spectrum.

<b>Gamma rays</b>	<b>X-rays</b>	<b>Ultraviolet</b>	<b>Visible light</b>	<b>Infra red</b>	<b>Microwaves</b>	<b>Radio waves</b>
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(a) Name the type of electromagnetic radiation that is used:

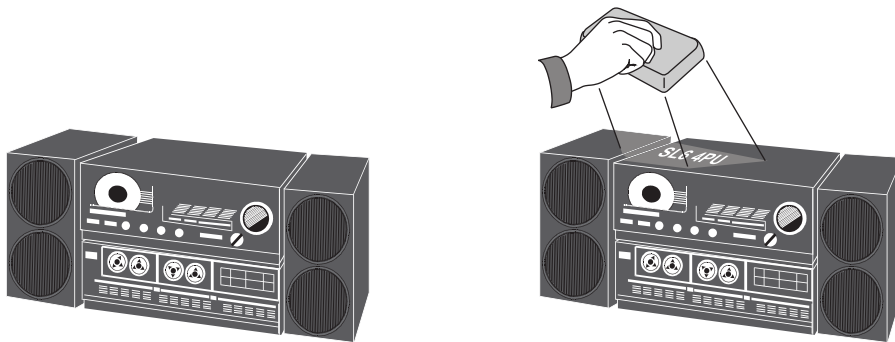
(i) to sterilise surgical instruments;

.....  
(1 mark)

(ii) to send a signal to a TV from a remote control.

.....  
(1 mark)

(b) Valuable items can be security marked using special ink. The ink can only be seen in ultraviolet radiation.



Explain what happens to make the ink visible.

.....  
.....  
.....  
.....

(2 marks)

(c) Explain why skin cells need to be protected from ultraviolet radiation.

.....  
.....  
.....  
.....

(2 marks)

(d) The following information is from an oven that combines a microwave and a grill.

Voltage	230 V
Microwave power	0.65 kW
Grill power	1.15 kW

(i) Name the **two** types of electromagnetic radiation that the oven can use to cook food.

..... and .....  
(1 mark)

(ii) A joint of meat is cooked using both the microwave and the grill. Both are switched on at full power for half an hour.

Use the following equation to calculate the energy transferred, in kilowatt-hours, by the oven. Show clearly how you obtain your answer.

energy transferred = power × time

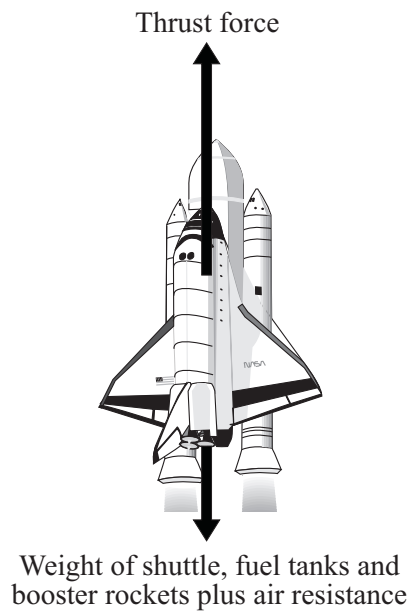
.....  
.....  
.....

energy transferred = .....kWh  
(2 marks)



Turn over ►

- 12 (a) The arrows in the diagram represent the size and direction of the forces on a space shuttle, fuel tank and booster rockets one second after launch. The longer the arrow the bigger the force.



- (i) Describe the upward motion of the space shuttle one second after launch.

.....  
(1 mark)

- (ii) By the time it moves out of the Earth's atmosphere, the total weight of the space shuttle, fuel tank and booster rockets has decreased and so has the air resistance.

How does this change the motion of the space shuttle? (Assume the thrust force does not change).

.....  
(1 mark)

- (b) The space shuttle takes 9 minutes to reach its orbital velocity of 8100 m/s.

- (i) Write down the equation that links acceleration, change in velocity and time taken.

.....  
(1 mark)

- (ii) Calculate, in  $\text{m/s}^2$ , the average acceleration of the space shuttle during the first 9 minutes of its flight. Show clearly how you work out your answer.

.....  
.....

average acceleration = ..... $\text{m/s}^2$   
(2 marks)

(iii) How is the velocity of an object different from the speed of an object?

.....  
.....

(1 mark)

(c) The space shuttle can stay in orbit around the Earth for several weeks.



Not to scale

Explain why the space shuttle stays in orbit and does not fall to the Earth.

.....  
.....  
.....  
.....

(2 marks)

(d) As the shuttle returns to Earth, friction causes its outside temperature to go as high as 1200°C.

Why is the underneath of the shuttle covered with black tiles?

.....  
.....

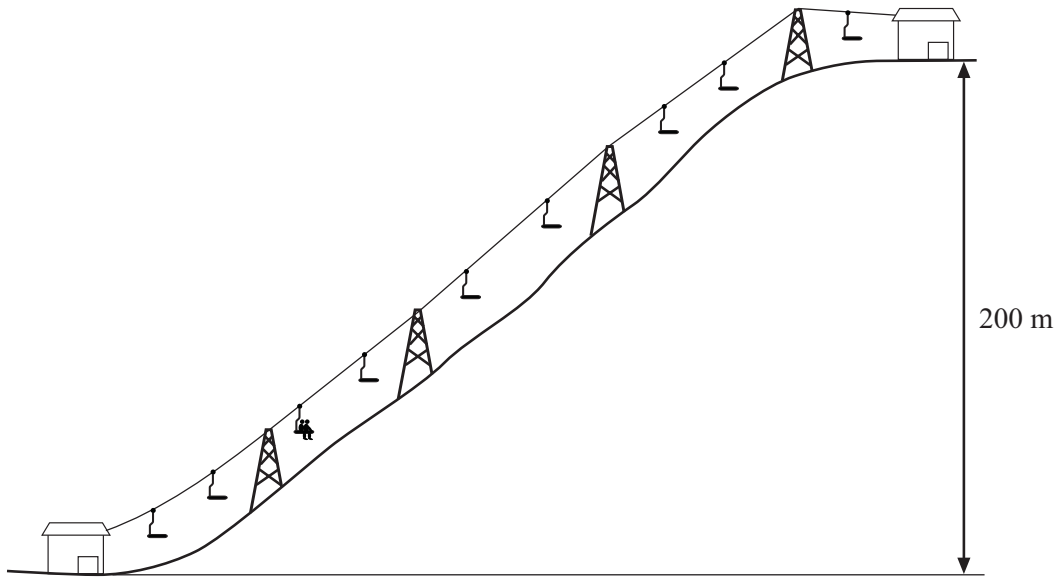
(1 mark)



**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

- 13 (a) A chair lift carries two skiers, Greg and Jill, to the top of a ski slope. Greg weighs 700 N and Jill weighs 500 N.



- (i) Write down the equation that links distance moved, force applied and work done.

.....  
(1 mark)

- (ii) Calculate the work done to lift Greg and Jill through a vertical height of 200 m. Show clearly how you work out your answer and give the unit.

.....  
.....  
.....

work done = .....  
(3 marks)

(b) The chair takes 5 minutes to move from the bottom to the top of the ski slope.

Use the following equation to calculate the power required to lift Greg and Jill to the top of the ski slope. Show clearly how you work out your answer.

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

.....  
.....

power = .....watts  
(2 marks)

(c) The chair lift is driven by an electric motor.

(i) Why would the power output of the electric motor need to be larger than your answer to part (b)?

.....  
.....  
(1 mark)

(ii) Complete the following sentence.

When the ski lift is working ..... energy supplied to the motor is usefully transferred as gravitational ..... energy. (1 mark)

**TURN OVER FOR THE NEXT QUESTION**



Turn over ►

14 (a) A physics textbook says that:

“The *flow of electrons* through a circuit can be controlled by using a fixed resistor or a variable resistor.”

(i) What word can be used for the *flow of electrons*?

.....  
(1 mark)

(ii) The flow of electrons can also be controlled by a *thermistor*.

How is a *thermistor* affected by an increase in temperature?

.....  
.....  
.....  
(2 marks)

(b) Draw straight lines to link each part of an electronic circuit with its description.

**Part of  
electronic  
circuit**

**Description**

input sensor

controlled by the processor

processor

detects changes in the environment

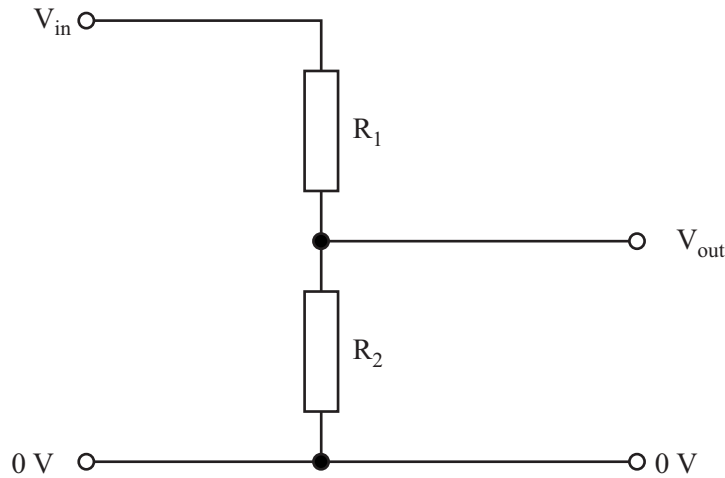
output device

decides what action is needed

(2 marks)



(c) The diagram shows part of an electronic circuit. This part is connected to the processor.



(i) What is the name of this part?

.....  
(1 mark)

(ii) The input potential difference (voltage) is 6 volts, the value of R<sub>1</sub> is 15 ohms and the value of R<sub>2</sub> is 30 ohms.

Use the following equation to calculate the value of the output potential difference.

$$V_{\text{out}} = V_{\text{in}} \times \frac{R_2}{(R_1 + R_2)}$$

.....  
.....

Output potential difference = .....volts  
(2 marks)

(iii) The resistor R<sub>1</sub> is replaced by another resistor with a higher value. The resistor R<sub>2</sub> is not changed.

What effect will this have on:

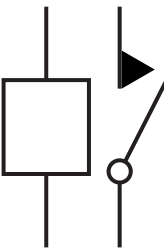
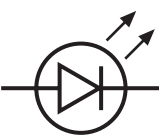
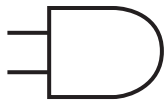
the potential difference across the new resistor;

.....

the potential difference across R<sub>2</sub>?

.....  
(2 marks)

- 15 (a) In circuit diagrams, symbols are used for the different components. Complete the table by identifying each of these components and finish each sentence which says what the component does.

Symbol	Name of component	What the component does
	<p>.....</p>	<p>It allows a small current to</p> <p>.....</p> <p>.....</p> <p>.....</p>
	<p>.....</p>	<p>It lights if a current flows through it .....</p> <p>.....</p> <p>.....</p> <p>.....</p>
	<p>.....</p>	<p>It switches on if .....</p> <p>.....</p> <p>.....</p> <p>.....</p>

(6 marks)

- (b) We now make use of many electronic systems. Two of these systems are mobile phones and the Internet.

Apart from their costs, explain **one** benefit and **one** drawback of each of these.

*To gain full marks you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

.....

.....

.....

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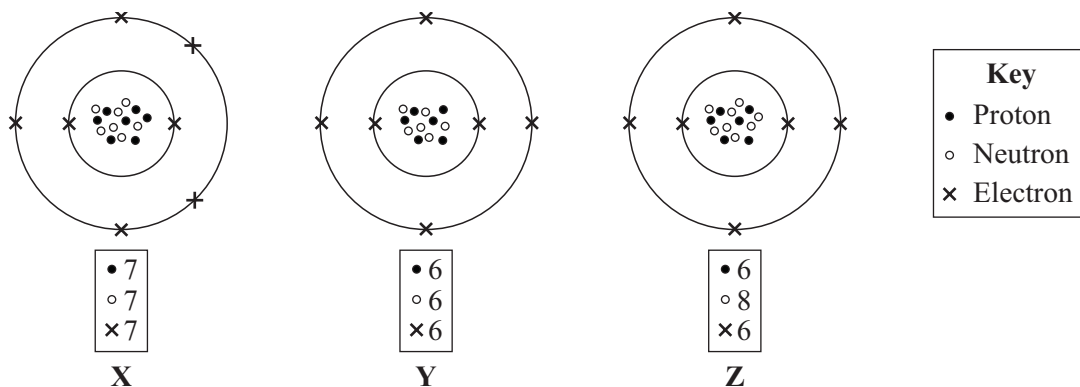
(4 marks)

10

**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

16 (a) The diagrams represent three atoms X, Y and Z.



Which **two** of the atoms are from the same element?

.....

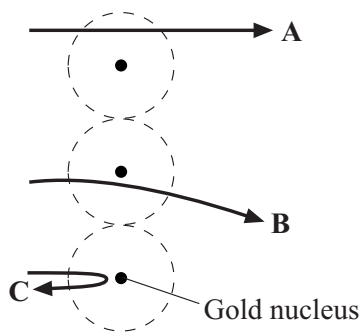
Give a reason for your answer.

.....

.....

(2 marks)

(b) In the early part of the 20<sup>th</sup> century some scientists investigated the paths taken by positively charged alpha particles into and out of a very thin piece of gold foil. The diagram shows the paths of three alpha particles.



Explain the different paths **A**, **B** and **C** of the alpha particles.

*To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.*

.....

.....

.....

.....

.....

(3 marks)