Surname		Other Names	
Centre Number		Candidate Number	
Candidate Signature			

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General Certificate of Secondary Education
June 2004

AQA
ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS
HIGHER TIER

3451/H

H

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.

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.

For Examiner's Use			
Number	Mark	Number	Mark
1		9	
2		10	
3		11	
4		12	
5		13	
6		14	
7		15	
8		16	
		17	
Total (Column 1) →			
Total (Column 2) →			
TOTAL			
Examiner's Initials			

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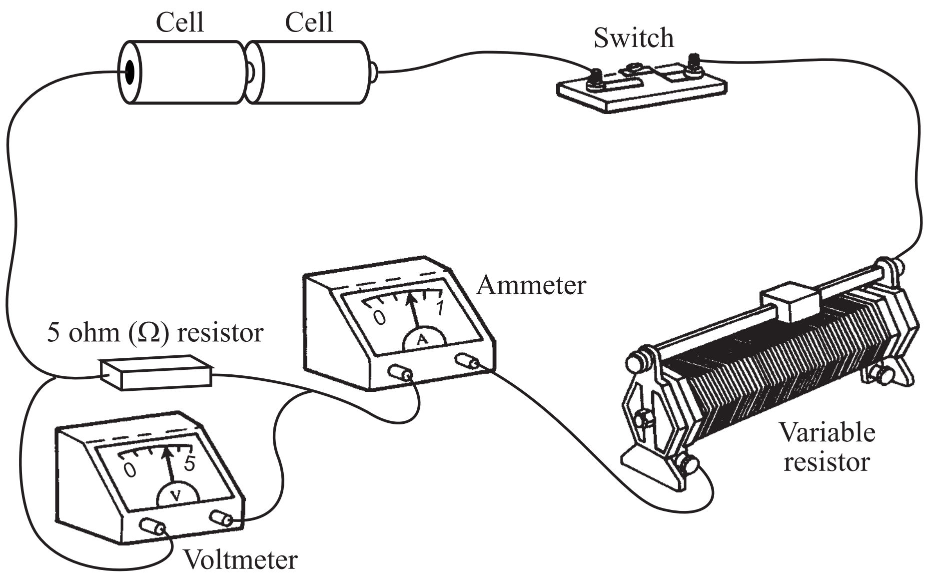
Answer **all** questions in the spaces provided.

1 The drawing shows the circuit used to investigate how the current through a 5 ohm (Ω) 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)

LEAVE MARGIN BLANK

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

....

(1 mark)

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

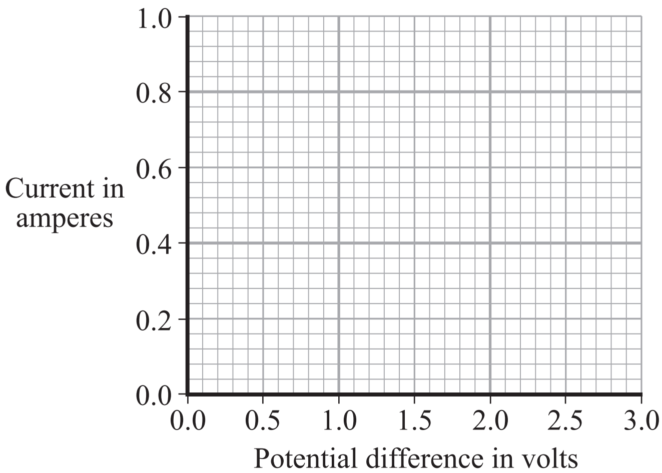
....

....

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)

8

Turn over ▶

2 The diagram represents the electromagnetic spectrum.

Gamma rays	**X-rays**	**Ultraviolet**	**Visible light**	**Infra red**	**Microwaves**	**Radio waves**

(a) Name the type of electromagnetic radiation that is used:

(i) to sterilise surgical instruments;

....

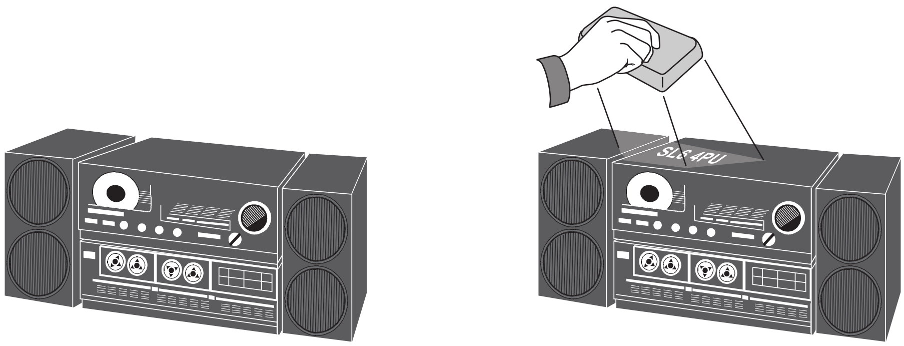
(1 mark)

(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

....

....

....

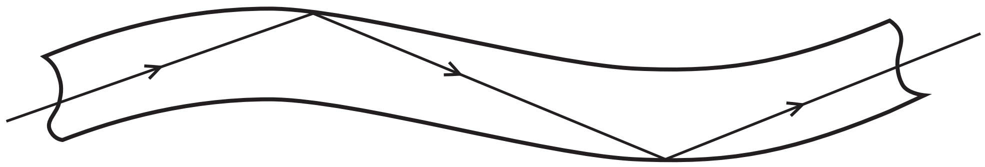
energy transferred = ...kWh

(2 marks)

9

Turn over ▶

3 (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.

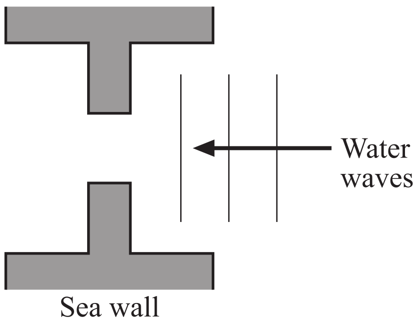
....

....

....

....
(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)

5

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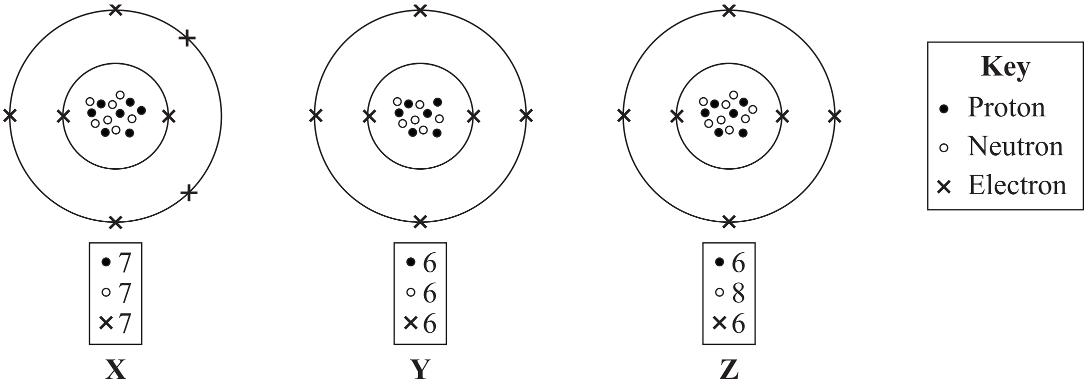
4 (a) The diagrams represent three atoms **X**, **Y** and **Z**.



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

....

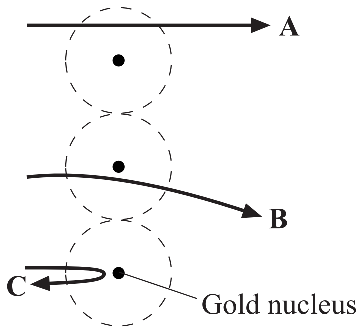
Give a reason for your answer.

....

....

(2 marks)

(b) In the early part of the 20th 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.

....

....

....

....

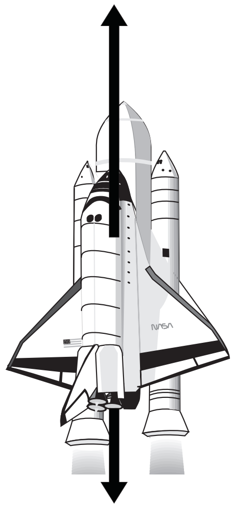
....

(3 marks)

5

Turn over ▶

5 (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 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 =...m/s^2

(2 marks)

LEAVE MARGIN BLANK

(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 1200ºC.

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

....

....
(1 mark)

9

TURN OVER FOR THE NEXT QUESTION

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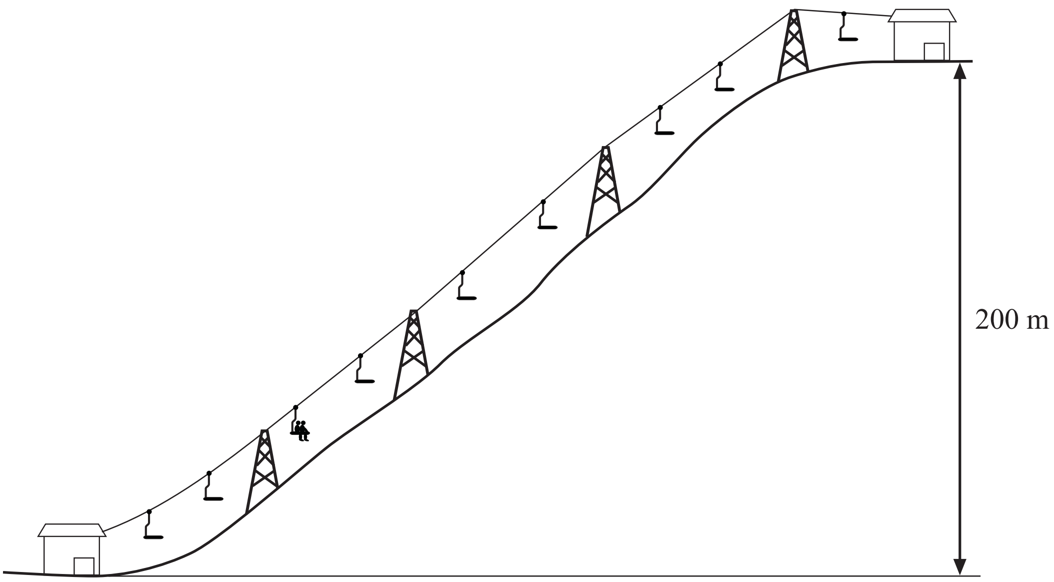
6 (a) A chair lift carries two skiers, Greg and Jill, to the top of a ski slope. Greg weighs 700 N and Jill weighs 500 N.



(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)

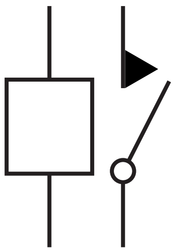
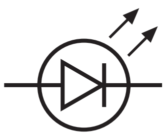
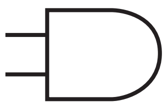
(ii) Complete the following sentence.

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

8

TURN OVER FOR THE NEXT QUESTION

7 (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
	....	It allows a small current to ....
	....	It lights if a current flows through it ....
	....	It switches on if ....

(6 marks)

LEAVE MARGIN BLANK

(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.

....

....

....

....

....

....

....

....

....

....

(4 marks)

10

TURN OVER FOR THE NEXT QUESTION

8 (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)

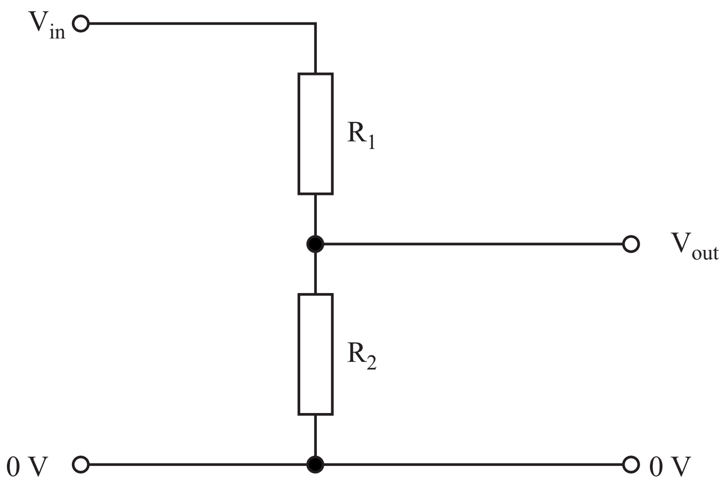
(b) Draw straight lines to link each part of an electronic circuit with its description.

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)

LEAVE MARGIN BLANK

(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_1 is 15 ohms and the value of R_2 is 30 ohms.

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

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

....

....

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

(iii) The resistor R_1 is replaced by another resistor with a higher value. The resistor R_2 is not changed.

What effect will this have on:

the potential difference across the new resistor;

....

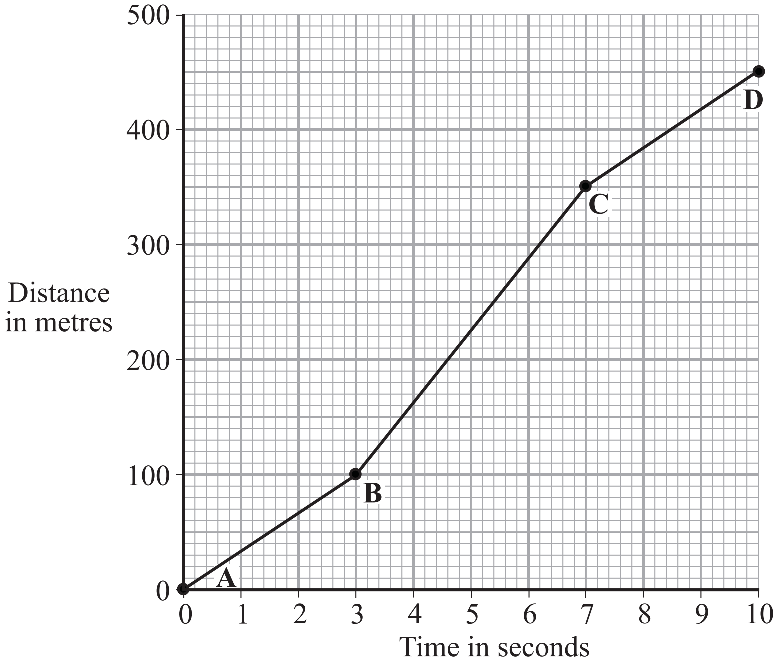
the potential difference across R_2?

....
(2 marks)

10

Turn over

9 The distance-time graph represents the motion of a car during a race.



(a) Describe the motion of the car between point **A** and point **D**. You should not carry out any calculations.

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)

(b) Calculate the gradient of the graph between point **B** and point **C**. Show clearly how you get your answer.

....

....

....

gradient = ...

(3 marks)

6

10 (a) Nuclear power stations use the energy released by *nuclear fission* to generate electricity.

(i) Explain what is meant by *nuclear fission*.

....

....

....

(2 marks)

(ii) How does nuclear fission lead to a chain reaction?

You may give your answer as a labelled diagram.

....

....

(1 mark)

(b) Although nuclear fuels are relatively cheap the total cost of generating electricity using nuclear fuels is expensive. Why?

....

....

(1 mark)

(c) The table compares the energy released from 1 kg of coal and 1 kg of uranium.

Coal	29 MJ
Uranium	580 000 MJ

1 MJ = 1000 000 joules

State **one** benefit to the environment of using a concentrated fuel like uranium to generate electricity rather than using the energy from coal.

....

....

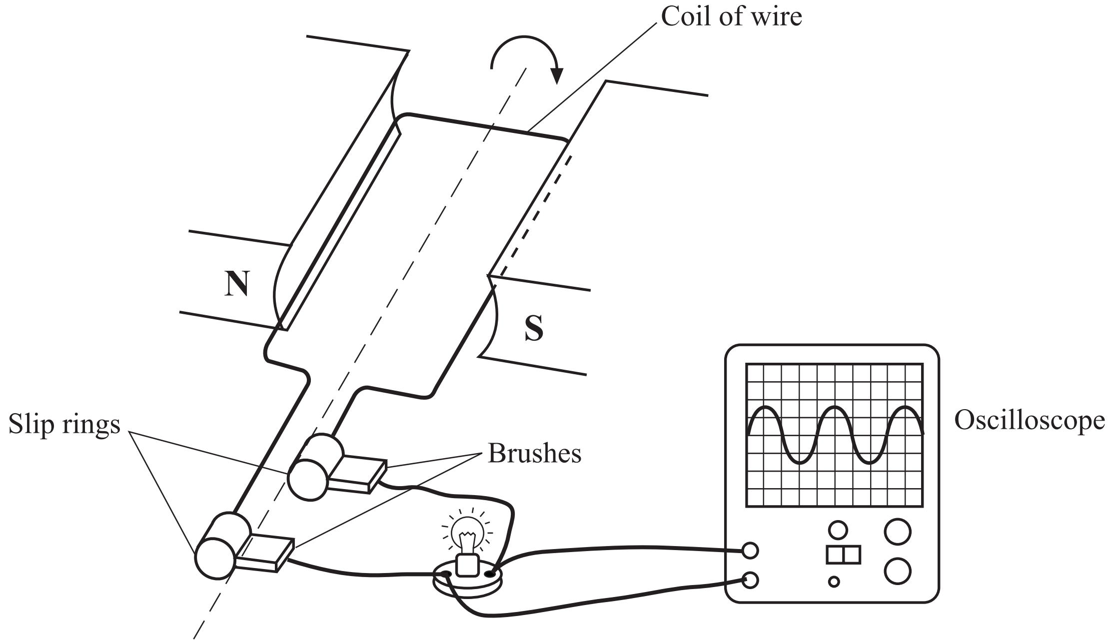
(1 mark)

5

Turn over

LEAVE MARGIN BLANK

11 (a) The diagram shows a simple generator. The trace on the oscilloscope shows that the generator produces an alternating current.



(i) Explain how the generator works. Include in your answer the reasons why the slip rings and brushes are needed.

....

....

....

....

....

....

....

....

(4 marks)

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MARGIN
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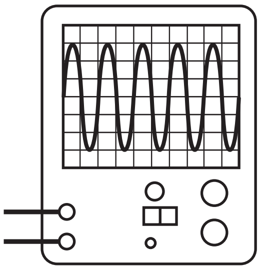
(ii) What should be done to make the generator give the oscilloscope trace drawn below? Assume the controls on the oscilloscope are unchanged.



....

....

....

....
(2 marks)

(b) Explain why electricity is transmitted through the National Grid as alternating current (a.c.) rather than direct current (d.c.).

....

....

....

....

....

....
(3 marks)

9

TURN OVER FOR THE NEXT QUESTION

12 (a) Explain how stars produce energy.

....

....

....

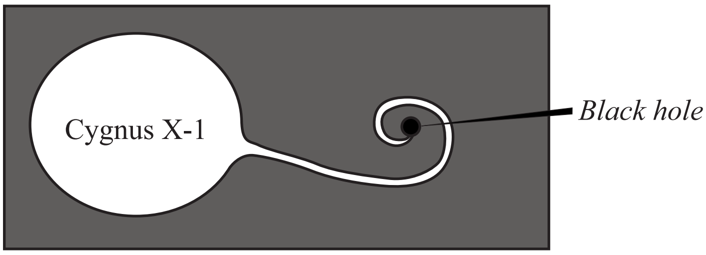
....
(2 marks)

(b) What evidence is there to suggest that the Sun was formed from the material produced when an earlier star exploded?

....

....
(1 mark)

(c) It is thought that gases from the massive star Cygnus X-1 are spiralling into a black hole.



(i) Explain what is meant by the term *black hole*.

....

....
(2 marks)

(ii) What is produced as the gases from a star spiral into a black hole?

....
(1 mark)

(d) The light spectrum from a distant galaxy shows a red shift.

What is meant by *red shift* and what does it tell us about distant galaxies?

....

....

....

....

(2 marks)

(e) What name is given to the theory that the Universe started with a massive explosion?

....

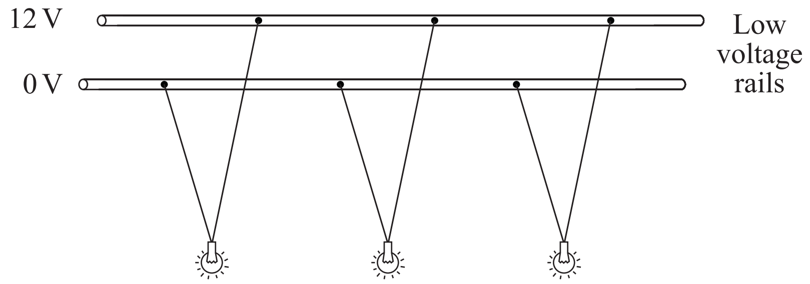
(1 mark)

9

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

13 (a) The diagram shows a 12 volt lighting system. Each lamp has a power of 32 watts.



(i) Write down the equation that links current, potential difference and power.

....

(1 mark)

(ii) Calculate the input current to the lighting system. Show clearly how you work out your answer.

....

....

current = ... A

(2 marks)

(b) A transformer is used to reduce the 230 V a.c. mains to the 12 V supply required for the lighting system. The transformer has 1150 turns on its primary coil.

(i) Write down the equation which links the number of turns of each transformer coil to the voltage across each transformer coil.

....

....

(1 mark)

(ii) Calculate the number of turns on the secondary coil of the transformer. Show clearly how you work out your answer.

....

....

....

number of turns on the secondary coil = ...

(2 marks)

6

LEAVE MARGIN BLANK

14 (a) Use the theory of plate tectonics to explain sea floor spreading.

....

....

....

....

(2 marks)

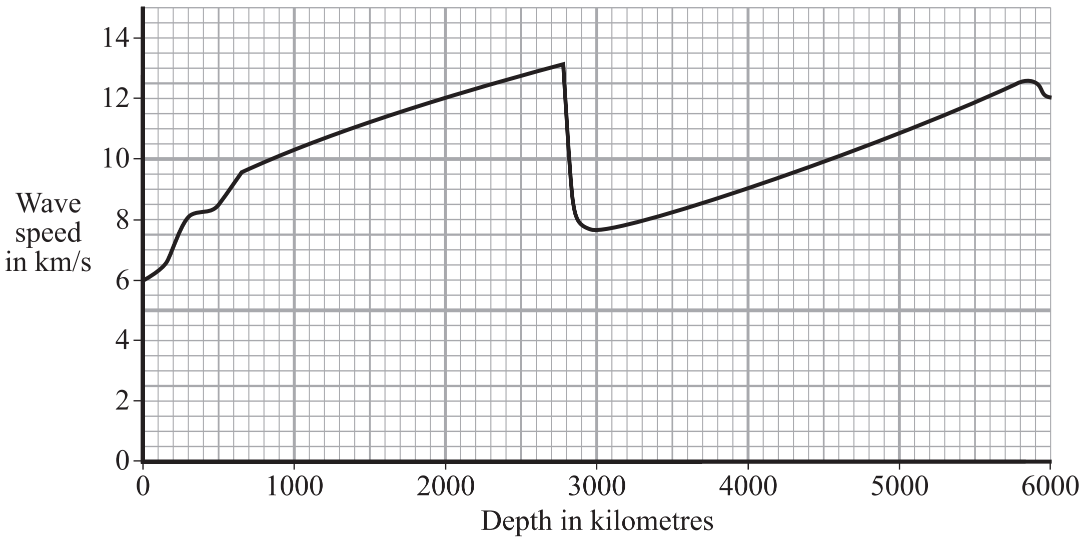
(b) What evidence is there to support the idea of sea floor spreading?

....

....

(1 mark)

(c) The diagram shows how the speed of a P-wave produced by an earthquake changes as it travels through the Earth.



(i) Write down the equation that links frequency, wavelength and wave speed.

....

(1 mark)

(ii) At a depth of 2000 km the P-wave has a wavelength of 24 000 m. Calculate the frequency of the P-wave. Show clearly how you work out your answer.

....

....

frequency = ...Hz

(2 marks)

6

Turn over

15 (a) The diagram shows a lens used as a magnifying glass. The position of the eye is shown and the size and position of an object standing at point **O**.

(i) What type of lens is shown in the diagram?

....

(1 mark)

(ii) Two points are marked as **F**. What are these points?

....

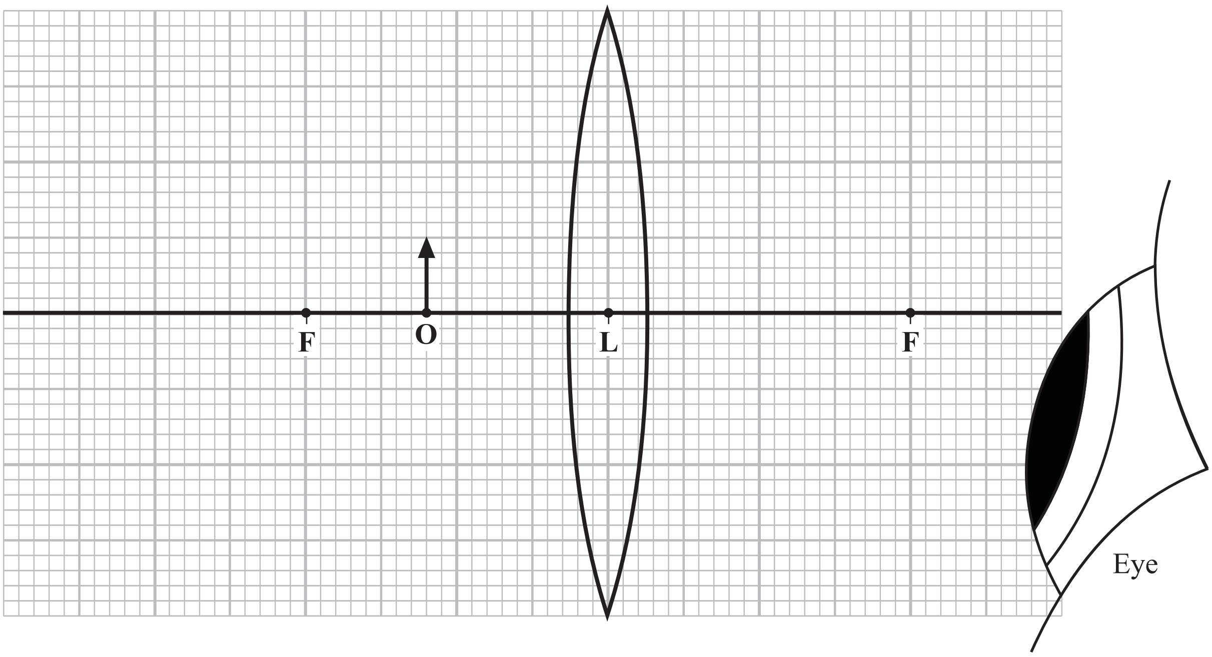
(1 mark)

(iii) What is the name of the straight line which goes through the point **F**, through the point **L** at the centre of the lens, and through the point **F** on the other side?

....

(1 mark)

(iv) On the diagram, use a ruler to construct accurately the position of the image. You should show how you construct your ray diagram and how light appears to come from this image to enter the eye.



(5 marks)

(v) The image is *virtual*. What is a *virtual* image?

....

....

(1 mark)

LEAVE MARGIN BLANK

(b) The lens shown in the diagram in part (a)(iv) can be used in a camera to produce a *real* image.

Explain why a *real* image must be produced in a camera and how the object and the lens are positioned to produce a *real* image which is **smaller** than the object.

Do **not** draw a ray diagram as part of your answer.

....

....

....

....

....

....

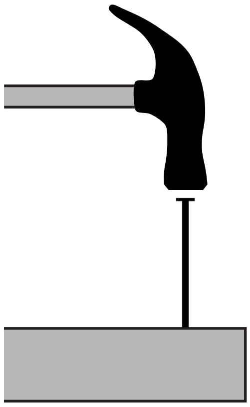
(3 marks)

12

TURN OVER FOR THE NEXT QUESTION

Turn over ▶

16 (a) The diagram shows a hammer which is just about to drive a nail into a block of wood.



The mass of the hammer is 0.75 kg and its velocity, just before it hits the nail, is 15.0 m/s downward. After hitting the nail, the hammer remains in contact with it for 0.1 s. After this time both the hammer and the nail have stopped moving.

(i) Write down the equation, in words, which you need to use to calculate momentum.

....

(1 mark)

(ii) What is the momentum of the hammer just before it hits the nail?

Show how you work out your answer and give the units and direction.

....

....

....

Momentum = ...

(3 marks)

(iii) What is the change in momentum of the hammer during the time it is in contact with the nail?

....

(1 mark)

LEAVE MARGIN BLANK

(iv) Write down an equation which connects *change in momentum*, *force* and *time*.

....

(1 mark)

(v) Calculate the force applied by the hammer to the nail.

Show how you work out your answer and give the unit.

....

....

....

Force = ...

(3 marks)

(b) A magazine article states that:

"Wearing a seat belt can save your life in a car crash."

Use your understanding of momentum to explain how this is correct.

....

....

....

....

....

....

....

....

(4 marks)

13

TURN OVER FOR THE NEXT QUESTION

17 (a) A beta particle is a high-energy electron.

(i) Which part of an atom emits a beta particle?

....

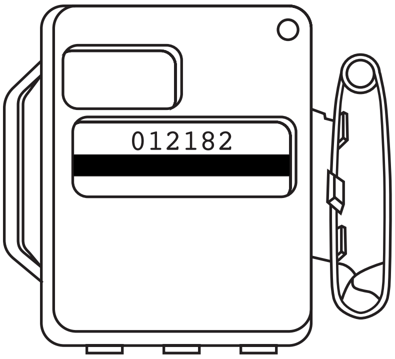
(1 mark)

(ii) How does the composition of an atom change when it emits a beta particle?

....

(1 mark)

(b) The diagram shows a badge used to monitor radiation. It measures the amount of radiation a worker has been exposed to in one month.



(i) What is used inside the badge to detect radiation?

....

(1 mark)

(ii) What would indicate that the worker has been exposed to a high level of radiation as opposed to a low level of radiation?

....

....

(1 mark)

(iii) Why is it important to monitor the amount of radiation the worker has been exposed to?

....

....

(1 mark)

5

END OF QUESTIONS