Surname		Other Names	
Centre Number			Candidate Number	
Candidate Signature			

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General Certificate of Secondary Education
June 2005

ASSESSMENT and QUALIFICATIONS ALLIANCE

PHYSICS (SPECIFICATION B) 3451/H
HIGHER TIER

Wednesday 22 June 2005 9.00 am to 11.15 am

H

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

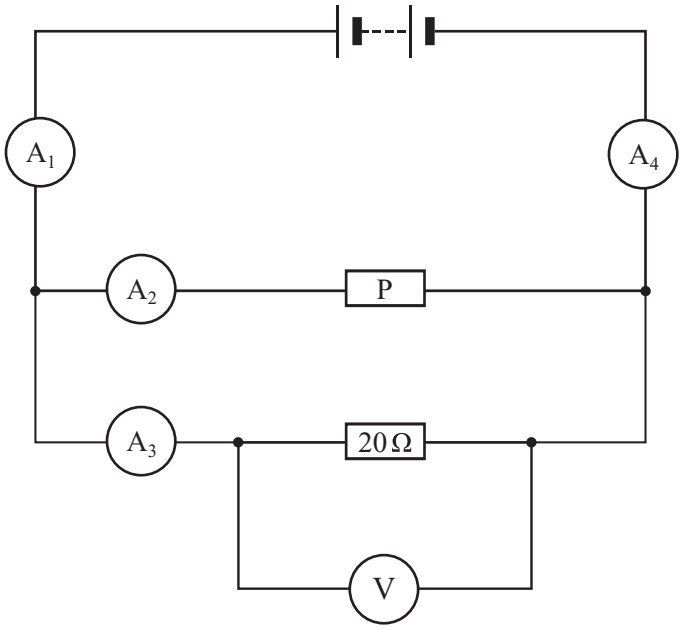
Time allowed: 2 hours 15 minutes

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

1 The circuit shown has four identical ammeters.



(a) The table gives the current through two of the ammeters.

(i) Complete the table to show the current through the other two ammeters.

Ammeter	Reading on ammeter in amps
A_1	
A_2	0.2
A_3	0.3
A_4	

(2 marks)

(ii) Which **one** of the following statements is correct. Tick (✓) the box next to your choice.

The resistance of **P** is more than 20 Ω. ☐

The resistance of **P** is equal to 20 Ω. ☐

The resistance of **P** is less than 20 Ω. ☐

Give a reason for your choice.

.....

.....

.....

(2 marks)

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

.....

(1 mark)

(ii) Calculate the reading on the voltmeter. Show clearly how you work out your answer.

.....

.....

Voltmeter reading = ... volts.

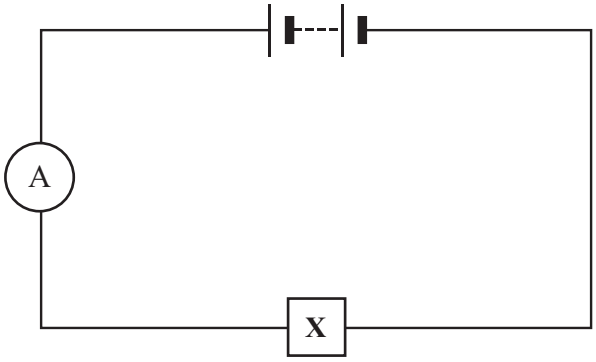
(2 marks)

(iii) State the potential difference of the power supply.

.....

(1 mark)

(c) A second circuit contains an unknown component labelled **X**.



As component **X** is heated, the reading on the ammeter goes up.

What is component **X**?

.....

Give a reason for your answer.

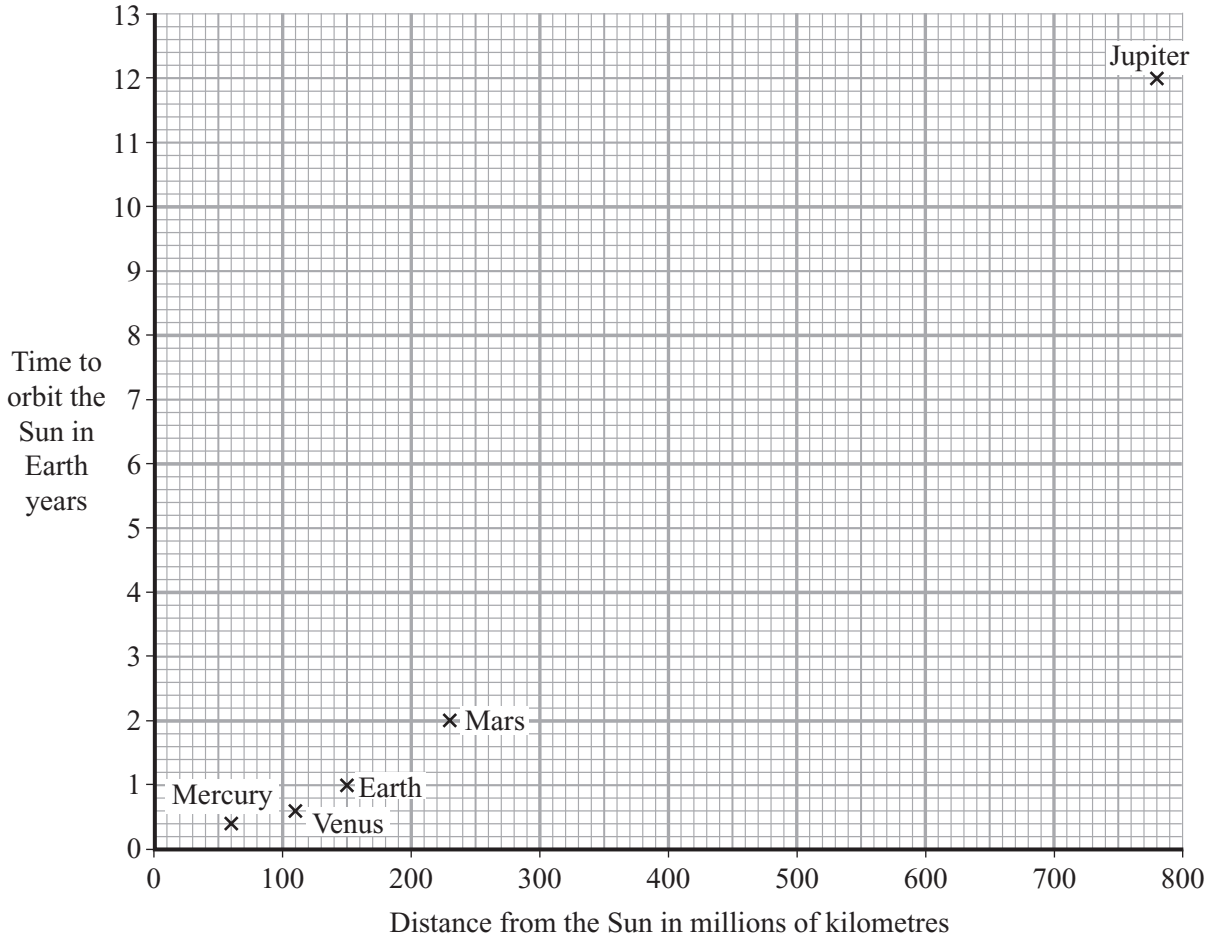
.....

.....

(2 marks)

10

2 (a) The chart shows that the time taken by a planet to orbit the Sun depends on its distance from the Sun.



(i) How does the time taken by a planet to orbit the Sun depend on the distance the planet is from the Sun?

.....

.....

(1 mark)

(ii) Asteroids orbit the Sun. One asteroid is 550 million kilometres from the Sun.

Estimate how long this asteroid takes to orbit the Sun.

Time to orbit the Sun = ... Earth years

(1 mark)

(b) The atmosphere on Venus contains a large percentage of a greenhouse gas.

	Mercury	Venus	Earth
Average surface temperature	230 ºC	470 ºC	20 ºC

(i) Which **one** of these gases increases the greenhouse effect? Draw a ring around your answer.

argon **carbon dioxide** **nitrogen** **oxygen**

(1 mark)

(ii) Explain how the information in the table and the chart shows that the atmosphere of Venus produces a greenhouse effect.

.....

.....

.....

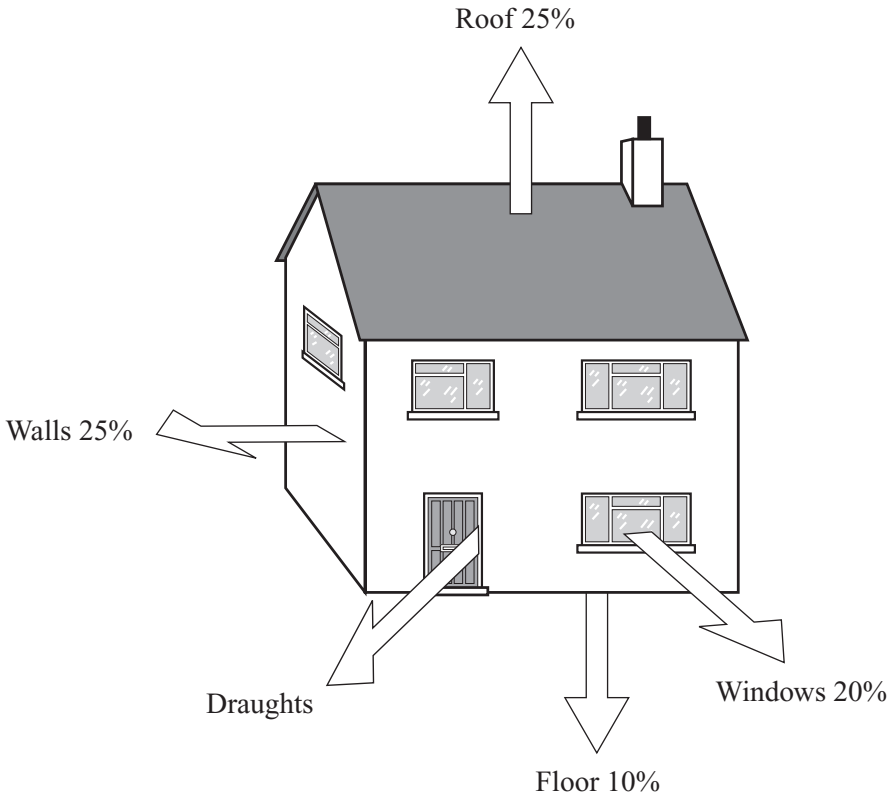
.....

(2 marks)

5

TURN OVER FOR THE NEXT QUESTION

3 (a) The diagram shows the ways in which heat energy can be transferred from an old house.



(i) Calculate the percentage of energy transferred by draughts.

.....

% energy transferred by draughts = ...

(1 mark)

(ii) Complete the following sentence using **one** of the words from the box.

conduction	**convection**	**radiation**

Draughts transfer heat energy by..... .

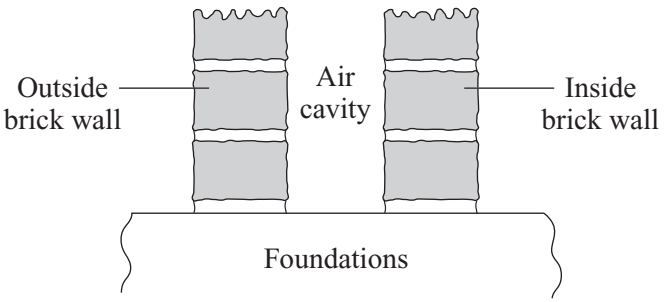
(1 mark)

(iii) State **one** way of reducing the heat transfer by draughts.

.....

(1 mark)

(b) The diagram shows a section through the walls of a house built in 1930.



Explain how the air cavity between the two walls reduces the heat transfer from the house.

.....

.....

.....

.....

(2 marks)

(c) The table shows the installation costs and yearly savings on energy bills for different methods of insulating a house.

Method of insulation	**Installation cost in £**	**Yearly saving on energy bills in £**
Double glazing	4000	65
Loft insulation	240	60
Cavity wall insulation	600	80

(i) Give **one** reason why loft insulation is often fitted to an old house before double glazing or cavity wall insulation.

.....

.....

(1 mark)

(ii) The time it takes for the saving on energy bills to equal the cost of installing the insulation is called the pay-back time.

Calculate the pay-back time for loft insulation.

.....

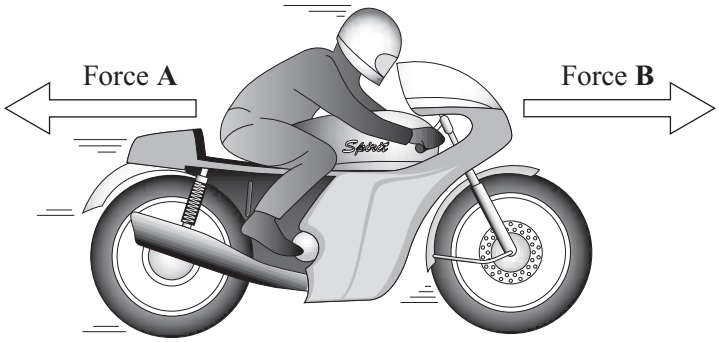
Pay-back time = ... years

(1 mark)

7

Turn over ▶

4 (a) The diagram shows the horizontal forces that act on a **moving** motorbike.



(i) Describe the movement of the motorbike when force **A** equals force **B**.

.....

.....

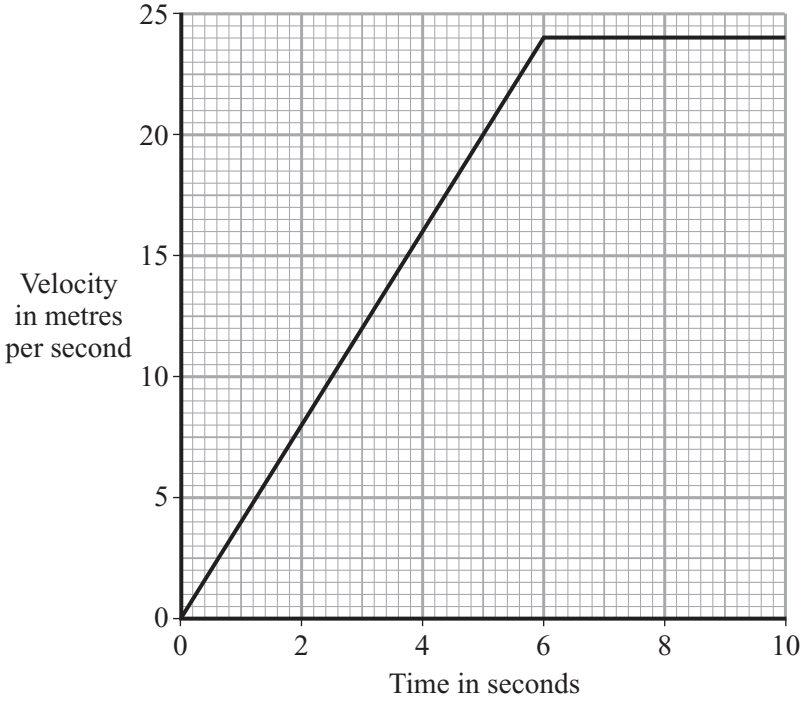
(2 marks)

(ii) What happens to the speed of the motorbike if force **B** becomes smaller than force **A**?

.....

(1 mark)

(b) The graph shows how the velocity of a motorbike changes when it is travelling along a straight road.



(i) What was the change in velocity of the motorbike in the first 5 seconds?

.....

(1 mark)

(ii) Write down the equation which links acceleration, change in velocity and time taken.

.....

(1 mark)

(iii) Calculate the acceleration of the motorbike during the first 5 seconds. Show clearly how you work out your answer and give the unit.

.....

.....

Acceleration = ...

(3 marks)

(c) A car is travelling on an icy road.

Describe and explain what might happen to the car when the brakes are applied.

.....

.....

.....

.....

(2 marks)

(d) Name **three** factors, other than weather conditions, which would increase the overall stopping distance of a vehicle.

1 .....

.....

2 .....

.....

3 .....

.....

(3 marks)

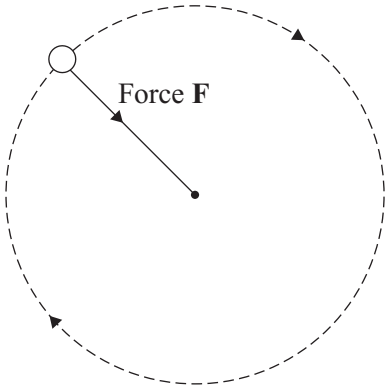
13

Turn over ▶

5 (a) A student has fastened a ball to a piece of string and is swinging it round in a horizontal circle.

(i) The diagram below shows an overhead view of the movement of the ball.

Add an arrow, from the centre of the ball, to show the direction in which the ball would move if the string broke at this instant.



(1 mark)

(ii) Complete the table to show how force **F** changes if the student changes what he is doing. In each case, all the other factors stay the same.

If the student	Force F needs to
uses a ball with a greater mass	.....
swings the ball at a greater speed	.....
swings the ball with a shorter piece of string	.....

(3 marks)

(b) The Moon orbits the Earth in a circular path.

Use words from the box to complete the **three** spaces in the sentence.

direction	**resistance**	**speed**	**velocity**

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

The Moon's ..... is constant but its ..... changes because its ..... changes.

(2 marks)

(c) When any object moves in a circular, or nearly circular, path a force must act towards the centre of the circle.

(i) What word is used to describe this force?

.....

(1 mark)

(ii) The Moon orbits the Earth. What provides the force towards the Earth?

.....

(1 mark)

(iii) In an atom, name the particles which are moving in circular paths around the nucleus.

.....

(1 mark)

(iv) In the case of an atom, what word describes the forces which keep these particles moving in circular paths around the nucleus?

.....

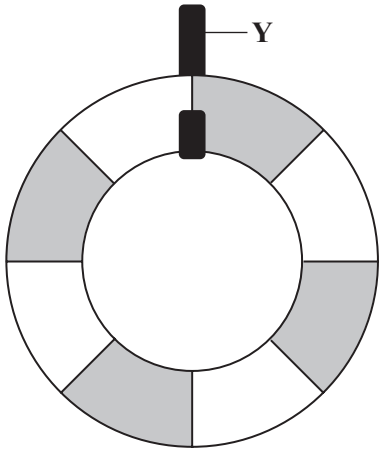
(1 mark)

10

TURN OVER FOR THE NEXT QUESTION

6 (a) The diagram shows a lifebelt. It is hanging freely from hook **Y**.

(i) On the diagram, mark with an **X** the point where you think the centre of mass of the lifebelt will be.



(1 mark)

(ii) Explain why you have chosen this point.

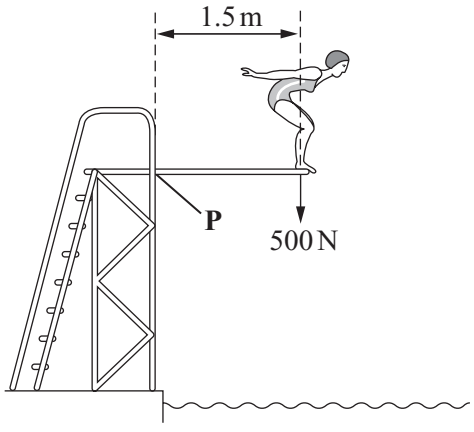
.....

.....

.....

(2 marks)

(b) The drawing shows Susan on a diving board. She is 1.5 metres from point **P** and she weighs 500 N.



Calculate her moment (turning effect) about point **P**.
Show clearly how you work out your answer and give the unit.

.....

.....

Moment about **P** = ...

(3 marks)

(c) Susan has a case with wheels.

When she packs this case, she puts the heaviest items at the end where the wheels are.
This means that the heaviest items are less likely to crush the other contents and it helps her to find things when she opens the case.

Explain another advantage of packing her case in this way.

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.

.....

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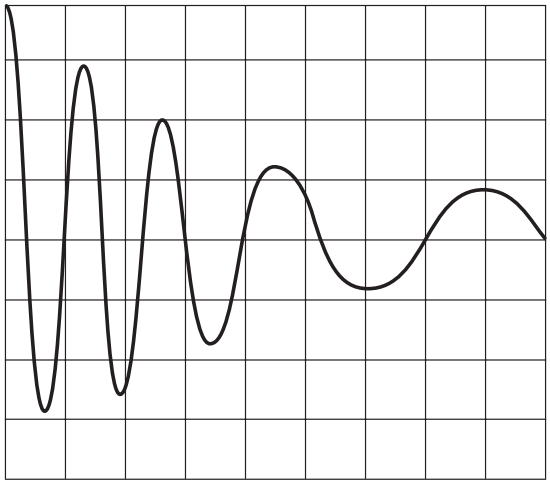
(4 marks)

10

TURN OVER FOR THE NEXT QUESTION

7 (a) A microphone connected to an oscilloscope picks up the sound from a siren. The trace produced on the oscilloscope screen is shown below.



Describe how the wave changes as it goes across the screen from left to right (→).

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) An African bat produces a sound wave with a frequency of 212 kHz and a wavelength of 0.0016 m.

(i) The sound made by the bat is above the limit of human hearing.
What name is given to this type of sound?

.....

(1 mark)

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

.....

(1 mark)

(iii) Calculate the speed of this sound wave through the air. Show clearly how you work out your final answer.

.....

.....

Wave speed = ... m/s

(3 marks)

8

8 Stars do not stay the same forever.

(a) Over billions of years the amount of hydrogen in a star decreases. Why?

.....

.....

(1 mark)

(b) Describe how a massive star (at least five times bigger than the Sun) will change at the end of the main stable period.

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.

.....

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.....

(4 marks)

(c) The inner planets of the solar system contain atoms of the heaviest elements.

(i) Where did these atoms come from?

.....

.....

(1 mark)

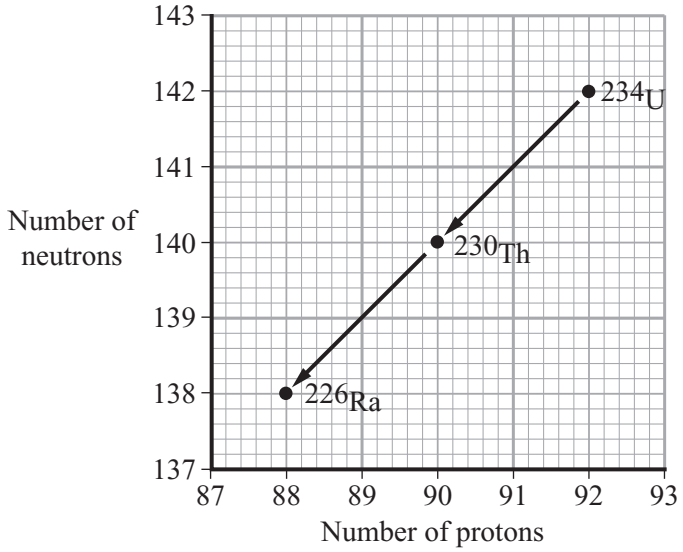
(ii) What does this tell us about the age of the solar system compared with many of the stars in the Universe?

.....

(1 mark)

7

9 (a) Uranium-234 (^{234}U) is a radioactive element. The graph shows the number of protons and neutrons in the nuclei of the elements formed when uranium-234 decays.



(i) How does the graph show that uranium-234 (^{234}U) and thorium-230 (^{230}Th) emit alpha particles?

.....

(1 mark)

(ii) What makes uranium and thorium different elements?

.....

(1 mark)

(iii) Radioactive decay may also produce gamma radiation.

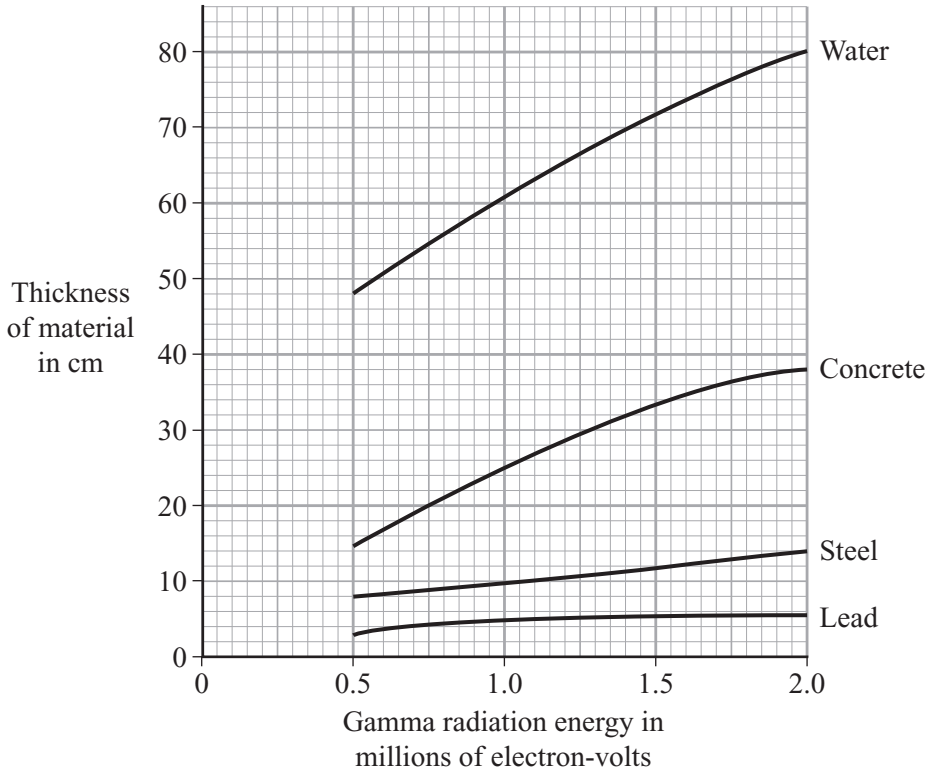
Why does the emission of gamma radiation **not** cause a new element to be formed?

.....

.....

(1 mark)

(b) The graph shows how the thickness of different materials needed to absorb 90% of the gamma radiation emitted by a source depends on the energy of the radiation. The energy of the gamma radiation is given in units called electron-volts.



(i) Which of the materials shown is least effective at absorbing gamma radiation? Use the information in the graph to give a reason for your answer.

.....

.....

(1 mark)

(ii) For gamma radiation of energy 1.5 million electron-volts, how many times more effective is steel than water at absorbing the radiation? Show clearly how you obtain your answer.

.....

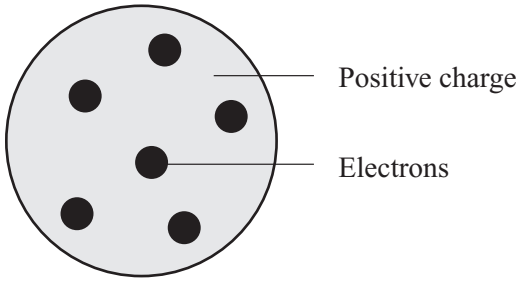
.....

.....

(2 marks)

QUESTION 9 CONTINUES ON THE NEXT PAGE

(c) Scientists in the early twentieth century thought that atoms were made up of electrons scattered inside a ball of positive charge. This was called the 'plum-pudding' model of the atom.



Plum pudding model

Rutherford and Marsden did an experiment, in which a beam of alpha particles was aimed at a thin sheet of gold.
Explain how the results of this experiment led to a new model of the atom. You may include one or more diagrams in your answer.

.....

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.....

.....

.....

(3 marks)

9

10 (a) Information transmitted through an optical fibre communications system is sent as a digital signal.

(i) Name **one** type of electromagnetic wave, other than visible light, used to carry information through an optical fibre.

.....

(1 mark)

(ii) What is a digital signal?

.....

.....

(1 mark)

(b) Information can be sent as an analogue signal. The signals weaken with distance and need to be amplified.
Explain why this causes the quality of the signal to deteriorate.

.....

.....

.....

.....

.....

.....

(3 marks)

(c) Microwaves are used to send information within mobile phone networks.

Explain how microwaves could be harmful to living cells.

.....

.....

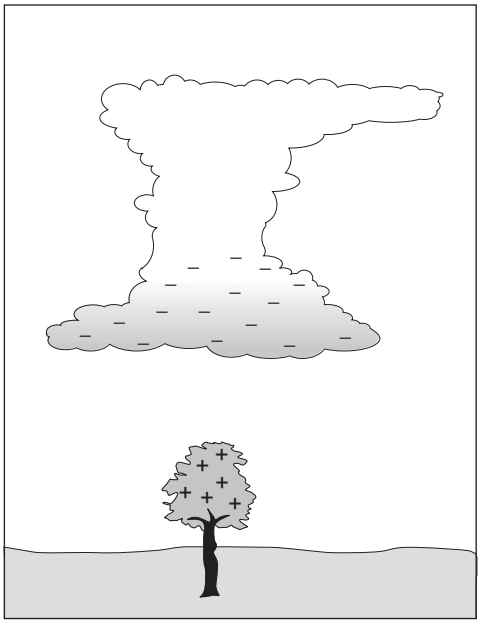
.....

.....

(2 marks)

7

11 The diagram shows a charged thundercloud.



(a) Why does the tree below the thundercloud become positively charged?

.....

.....

(1 mark)

(b) The base of the cloud has a negative charge of 18 coulombs.
The potential difference between the base of the cloud and the ground is 1 200 000 kilovolts.

(i) Write down the equation that links charge, energy transferred and potential difference.

.....

(1 mark)

(ii) Calculate the maximum energy that could be transferred to the ground by a lightning strike. Show clearly how you work out your answer.

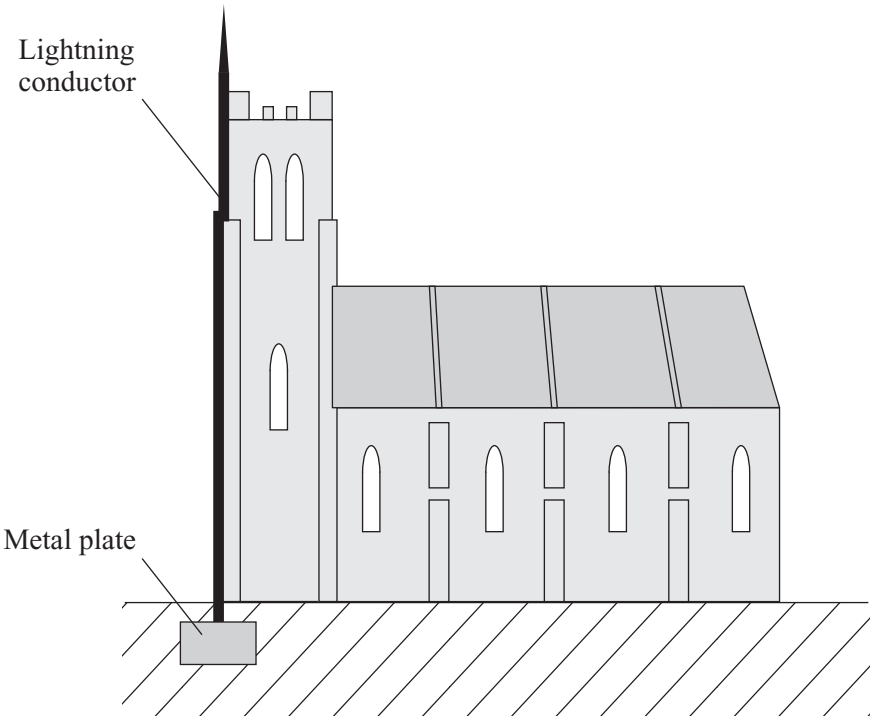
.....

.....

Maximum energy transferred = ... joules

(2 marks)

(c) A lightning conductor is usually attached to tall buildings. This reduces the risk of damage by a lightning strike.



Explain why the lightning conductor is made of copper.

.....

.....

.....

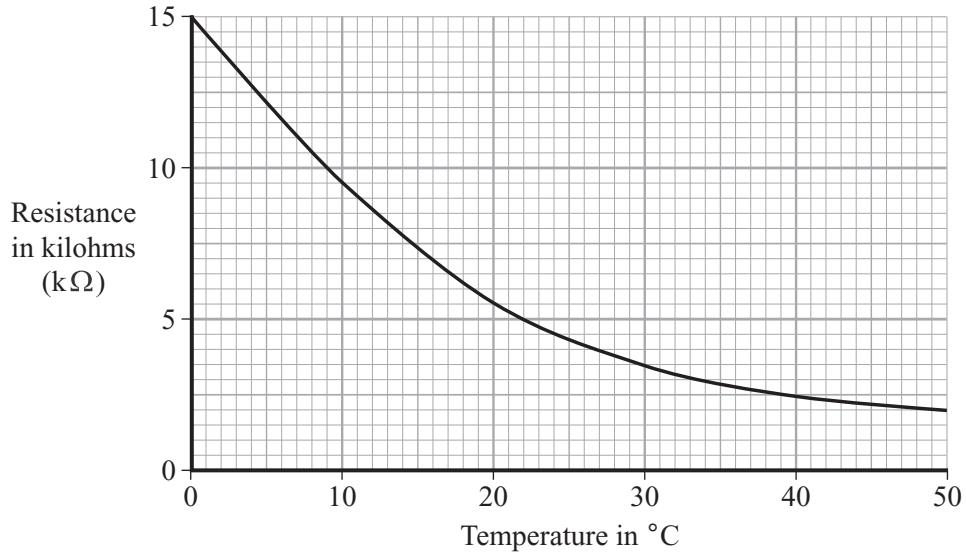
.....

(2 marks)

6

TURN OVER FOR THE NEXT QUESTION

12 (a) The graph shows how the resistance of a thermistor changes with temperature.



Use the graph to find:

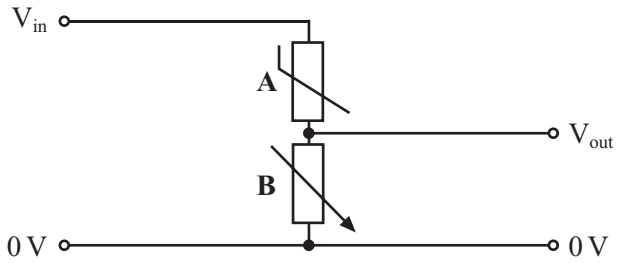
(i) the resistance, in kΩ, of the thermistor at 18 ºC;

Resistance = ... kΩ
(1 mark)

(ii) the temperature, in ºC, when the resistance of the thermistor is 12 500 ohms (Ω).

Temperature = ... ºC
(1 mark)

(b) The diagram shows how a thermistor is used in part of an electronic circuit.



(i) Name the components **A** and **B**.

A is a ..... and **B** is a .....
(1 mark)

(ii) Name the part of the electronic circuit shown in the diagram.

.....
(1 mark)

(iii) What will happen to the value of V_{out} as the temperature increases from the freezing point of water to room temperature?

.....

(1 mark)

(iv) Explain your answer to part (b)(iii).

.....

.....

.....

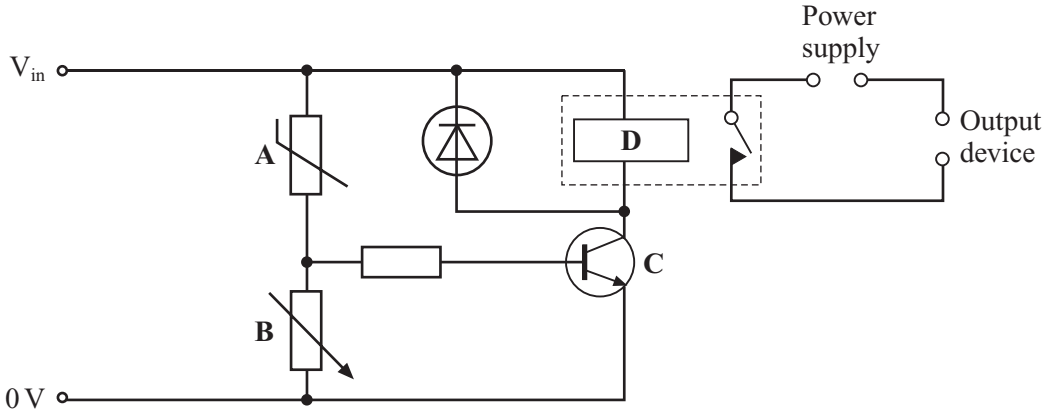
(2 marks)

(c) An electronic circuit switches on an output device when the temperature gets above a certain value. Name a suitable output device.

.....

(1 mark)

(d) The diagram shows an electronic circuit.



(i) Name components **C** and **D**.

C is a ..... and **D** is a .....

(2 marks)

(ii) The circuit is modified by adding a NOT gate. This makes the circuit switch on the output device when the temperature gets too low.

Describe where in the circuit the NOT gate would be put.

.....

.....

(1 mark)

Describe a use for this modified circuit.

.....

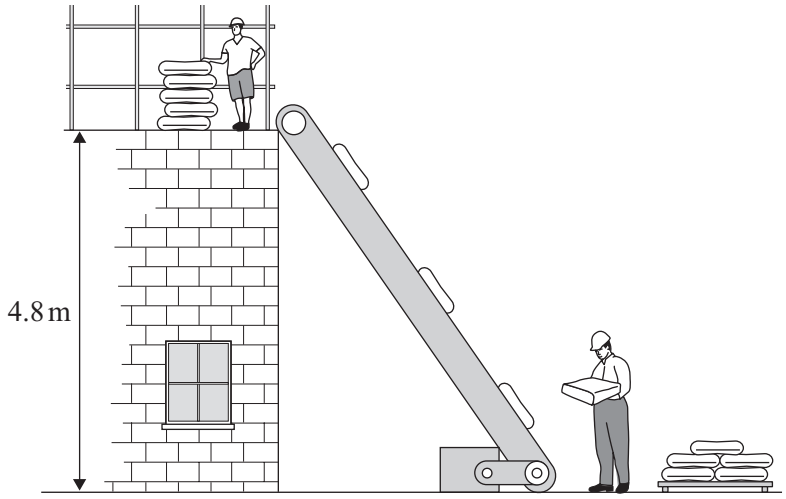
.....

(1 mark)

12

Turn over ▶

13 A machine is used to lift materials on a building site.



(a) (i) Write down the equation that links change in gravitational potential energy, change in vertical height and weight.

.....

(1 mark)

(ii) A 25 kg bag of cement is lifted from the ground to the top of the building.
Calculate the gain in the gravitational potential energy of the bag of cement.

(On Earth a 1 kg mass has a weight of 10 N.)

.....

.....

Change in gravitational potential energy = ... joules
(2 marks)

(b) The conveyor belt delivers six bags of cement each minute to the top of the building.

(i) Calculate the useful energy transferred by the machine each second.

.....

.....

.....

Useful energy transfer each second = ... J
(1 mark)

(ii) The machine is 40 % efficient.
Use the following equation to calculate the total energy supplied to the machine each second. Show how you work out your answer.

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

.....

.....

Total energy supplied each second = ... J
(2 marks)

6

TURN OVER FOR THE NEXT QUESTION

14 (a) When two objects collide, and no other forces act, then *conservation of momentum* applies.

(i) What does the term *conservation of momentum* mean?

.....

.....

.....

(2 marks)

(ii) Apart from collisions and similar events, give another type of event in which *conservation of momentum* applies.

.....

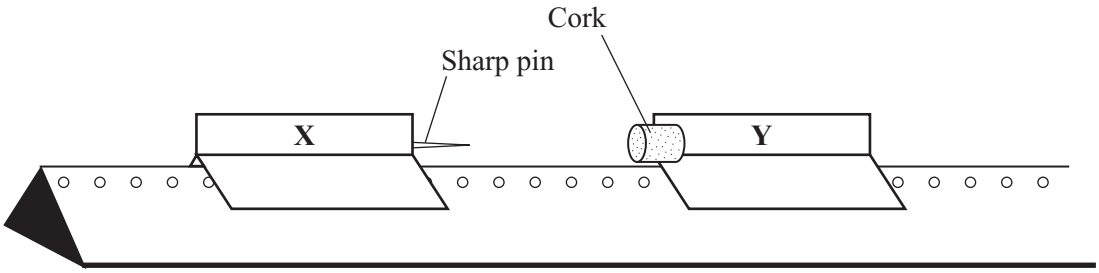
(1 mark)

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

.....

(1 mark)

(iv) The diagram shows a straight and horizontal runway and two trolleys, **X** and **Y**, which can move on the runway.



X has a mass of 0.2 kg and its velocity is 1.2 m/s to the right. **Y** has a mass of 0.1 kg and is stationary. When **X** collides with **Y** they stick together.

Calculate the velocity of the trolleys after the collision.

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

.....

.....

.....

.....

Velocity of the trolleys = ...

(5 marks)

(v) What assumption did you make in order to calculate your answer to part (a)(iv)?

.....

.....

(1 mark)

(b) Just before it hits a target, a bullet has a momentum of 5 kg m/s. It takes 0.00125 s for the target to stop the bullet.

Calculate the force, in newtons, needed to do this.

Write, in words, the equation that you will need to use and show clearly how you work out your answer.

.....

.....

.....

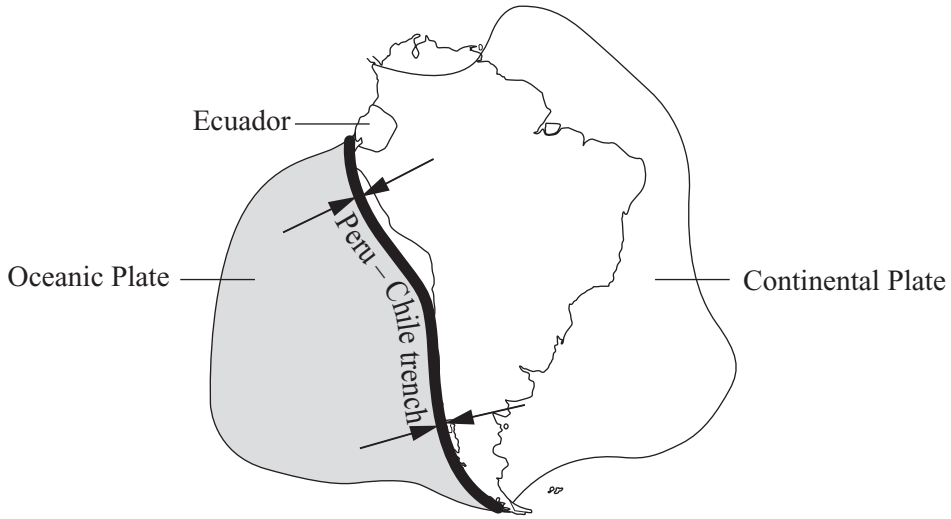
Force = ... newtons

(3 marks)

13

TURN OVER FOR THE NEXT QUESTION

15 The Peru–Chile trench runs down the west coast of South America. It is the boundary between two tectonic plates that are slowly moving towards each other.



Source: WITNEY, DROZDOWSKA AND MAILE, *AQA GCSE Physics* (Hodder & Stoughton) 2002. Adapted and reproduced by permission of Hodder & Stoughton.

(a) Explain what causes the tectonic plates to move.

.....

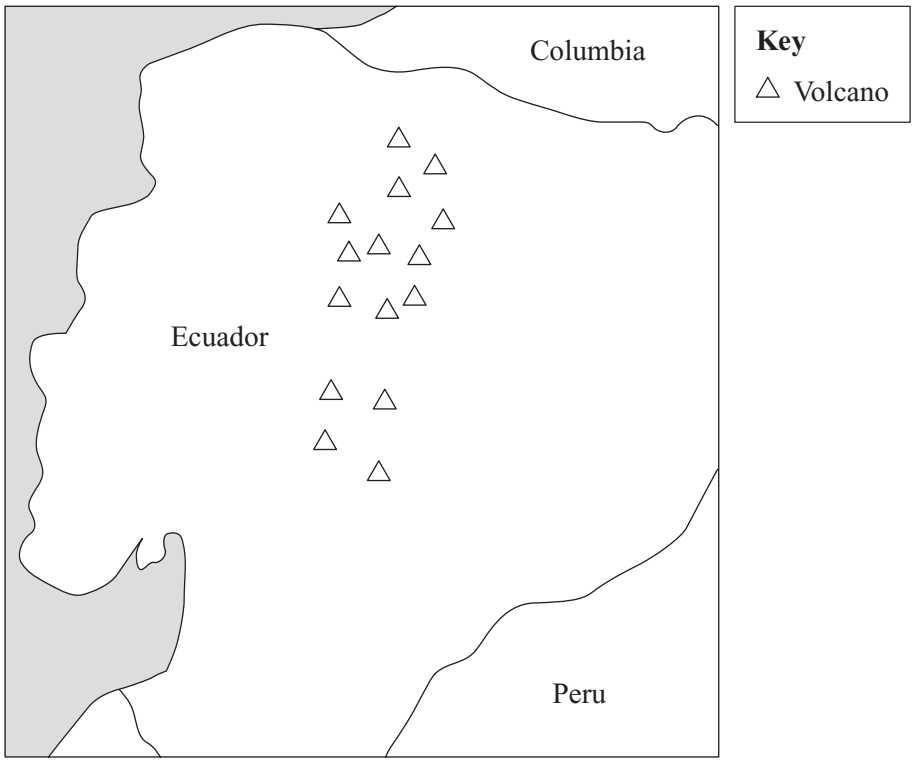
.....

.....

.....

(2 marks)

(b) The map shows the location of some of the volcanoes in Ecuador. The volcanoes are all close to the Peru–Chile trench.



Explain how the volcanoes were formed.

.....

.....

.....

.....

.....

.....

(3 marks)

(c) The eruption of Mount St Helens in the USA is one of the few volcanic eruptions to have been accurately predicted by scientists. The scientists had been monitoring *seismic activity*, levels of sulphur dioxide and changes to the ground level.

(i) What is meant by *seismic activity*?

.....

(1 mark)

QUESTION 15 CONTINUES ON THE NEXT PAGE

(ii) Suggest why scientists find it difficult to predict accurately when a volcano is going to erupt.

.....

.....

.....

.....

(2 marks)

(d) The molten rock flowing from an erupting volcano can reach a speed of 8 m/s.

(i) Write down the equation that links kinetic energy, mass and speed.

.....

(1 mark)

(ii) Calculate the kinetic energy of 1 tonne of molten rock flowing at 8 m/s.
(1 tonne = 1000 kg)

.....

.....

Kinetic energy = ... joules
(1 mark)

(e) Read the information in the box and then answer the questions.

Igneous rocks contain potassium-40. This is a radioactive isotope. It has a half-life of 1300 million years.

Potassium-40 decays into argon-40 which is stable.

Argon escapes from molten rock. Any argon found in an igneous rock must have been produced since the rock solidified.

A sample of an igneous rock has one atom of potassium-40 for every three atoms of argon-40.

(i) What fraction of the potassium-40 has not yet decayed?

.....

(1 mark)

(ii) Calculate the age of the rock.

.....

Age of rock = ... million years
(1 mark)

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END OF QUESTIONS

THERE ARE NO QUESTIONS PRINTED ON THIS PAGE

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