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Centre Number						Candidate Number					
Candidate Signature											

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General Certificate of Secondary Education  
June 2003



**PHYSICS  
HIGHER TIER**

**3451/H**

**H**

Tuesday 17 June 2003 9.00 am to 11.15 am

<p><b>No additional materials are required.</b> You may use a calculator.</p>
-----------------------------------------------------------------------------------

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	
		16	
Total (Column 1)	→		
Total (Column 2)	→		
TOTAL			
Examiner's Initials			

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

1 (a) Some scientists are involved in the search for *extra-terrestrial* intelligence (SETI).

(i) What does *extra-terrestrial* mean?

.....  
(1 mark)

(ii) What equipment is used to carry out this search?

.....  
(1 mark)

(b) In 1967, radio pulses, one every 1.337 seconds, were discovered coming from a point in space. Some scientists thought the pulses were being produced by intelligent life elsewhere in the *Universe*. Later, it was discovered that the pulses were emitted by a *neutron star*.

(i) Complete this sentence.

The *Universe* is made up of at least a billion .....  
(1 mark)

(ii) Suggest **one** reason why scientists might have thought that the pulses were produced by intelligent life.

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

(iii) What is the link between a *neutron star* and a *super nova*?

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

(c) In 2001, equipment was carried by balloons to a height of 41 km above the Earth’s surface. The equipment detected the presence of bacteria.

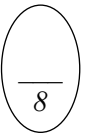
(i) The natural movement of air in the Earth’s atmosphere may have carried the bacteria up **or** the bacteria may have come from outer space.

Suggest **one** other explanation.

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

(ii) Suggest **one** way in which bacteria may have travelled through space to reach the edge of our atmosphere.

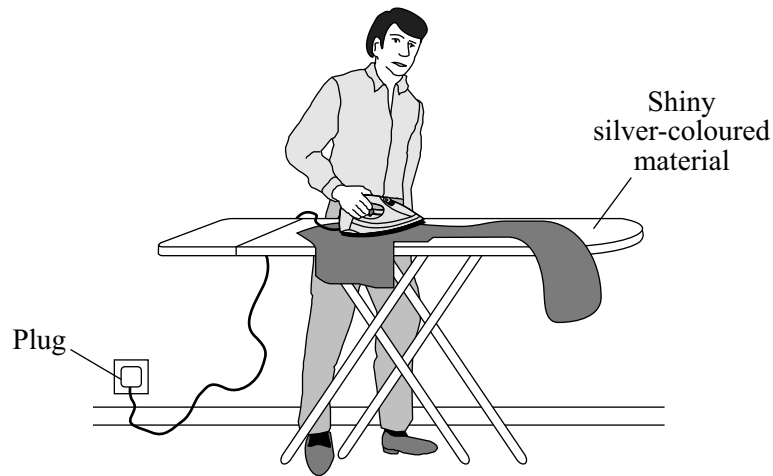
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.....  
*(1 mark)*



**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

- 2 The drawing shows someone ironing a shirt. The top of the ironing board is covered in a shiny silver-coloured material.



- (a) Explain why the shiny silver-coloured material helps to make ironing easier.

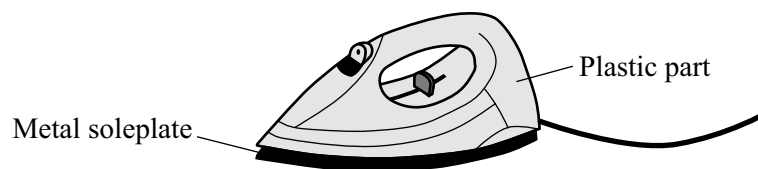
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(2 marks)

- (b) The iron must be earthed to make it safe. Which part of the iron is connected to the earth pin of the plug?



.....

(1 mark)

- (c) Name a material that could be used to make the outside case of the plug.

.....

Give a reason for your choice.

.....

.....

(2 marks)

- (d) *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.*

Some electrical circuits are protected by a circuit breaker. These switch the circuit off if a fault causes a larger than normal current to flow. The diagram shows one type of circuit breaker. A normal current (15 A) is flowing.

The diagram is not reproduced here due to third-party copyright constraints.  
□  
The full copy of this paper can be obtained by ordering 3451/H□  
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Tel: 0161 953 1170□

Explain what happens when a current larger than 15 A flows. The answer has been started for you.

When the current goes above 15 A, the electromagnet becomes stronger and.....

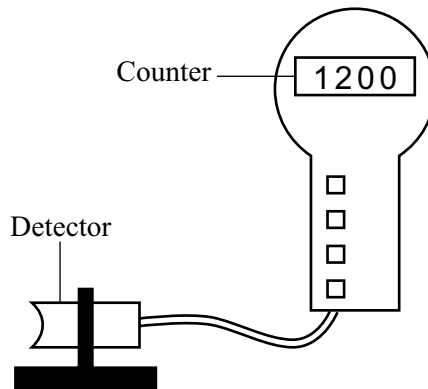
.....  
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(3 marks)

8

Turn over ►

- 3 (a) The diagram shows a radiation detector and counter being used to measure background radiation. The number shows the count ten minutes after the counter was reset to zero.



- (i) Name **one** source of background radiation.

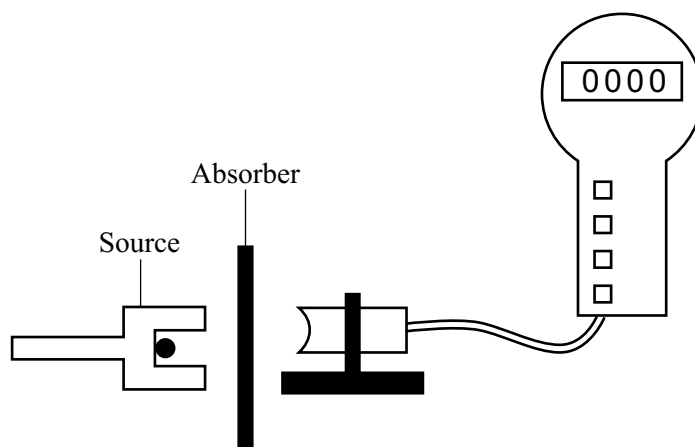
.....  
(1 mark)

- (ii) Calculate the average background radiation level, in counts per second. Show clearly how you work out your answer.

.....  
.....

Background radiation level = .....counts per second  
(2 marks)

- (b) The detector and counter are used in an experiment to show that a radioactive source gives out alpha and beta radiation only.



Two different types of absorber are placed one at a time between the detector and the source. For each absorber, a count is taken over ten minutes and the average number of counts per second worked out. The results are shown in the table.

Absorber used	Average counts per second
No absorber	33
Card 1 mm thick	20
Metal 3 mm thick	2

Explain how these results show that alpha and beta radiation is being given out, but gamma radiation is **not** being given out.

.....

.....

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(3 marks)

6

Turn over ►

4 (a) The table gives information about some planets.

Name of planet	Gravitational field strength in N/kg	Diameter of planet in thousands of km	Time for 1 orbit around the sun in years
Mercury	4	4.9	0.2
Venus	9	12.0	0.6
Earth	10	12.8	1.0
Jupiter	26	143.0	12.0

(i) Write down the equation that links gravitational field strength, mass and weight.

.....  
(1 mark)

(ii) An astronaut has a mass of 75 kg. Calculate the weight of the astronaut on Venus. Show clearly how you work out your answer.

.....  
.....

Weight of astronaut = .....newtons  
(2 marks)

(iii) Why would the astronaut weigh more on the Earth than on Venus?

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

(iv) The radius of the orbit of Jupiter is greater than the radius of the orbit of Mercury, Venus or the Earth. What evidence is given in the table to show this?

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



- (b) *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.*

Explain briefly how stars like the Sun are thought to have been formed.

.....

.....

.....

.....

(2 marks)

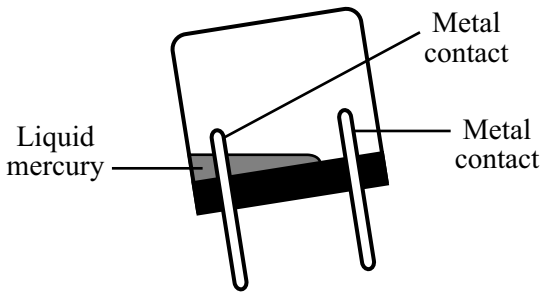


**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

- 5 (a) In one design of tilt switch, two metal contacts are sealed inside a small plastic container. There is some mercury inside the container. Mercury is a metal which is a liquid at room temperature.

The switch is shown in an OFF position. Next to it, draw the same switch in an ON position.

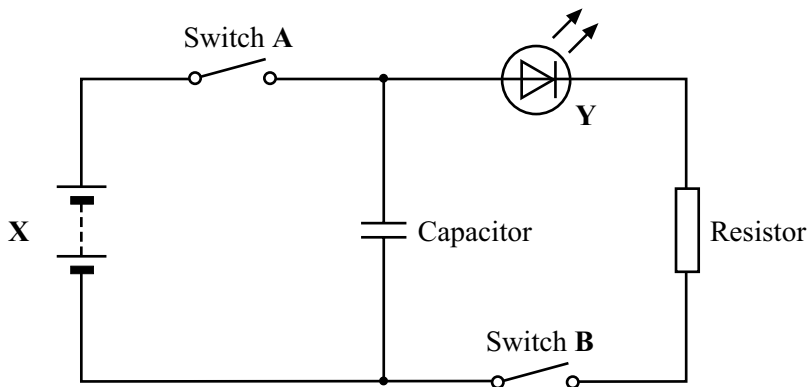


**OFF**

**ON**

(2 marks)

- (b) The diagram shows the circuit used in an experiment. Both switches are shown in the open (off) position.



- (i) Name component **X** and component **Y**.

**X** is a ..... **Y** is a.....  
(2 marks)

- (ii) Switch **A** was closed for three minutes. Switch **A** was then opened. Switch **B** was then closed and the time,  $t$ , was measured for how long component **Y** stayed on.

The experiment was then repeated, using a resistor of greater resistance.

How would this change affect the time,  $t$ ?

.....  
(1 mark)

(iii) Explain the reason for your answer to part (b) (ii).

.....

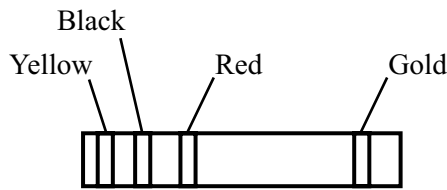
.....

.....

.....

(2 marks)

(c) The diagram shows the coloured bands on a resistor.



The gold band tells you that the tolerance is  $\pm 5\%$ .

The colour code for resistors is given in the table.

Figure	Colour
0	black
1	brown
2	red
3	orange
4	yellow
5	green
6	blue
7	violet
8	grey
9	white

What is the **maximum** value of the resistance of the resistor shown in the diagram?

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

.....

.....

.....

Maximum resistance = .....

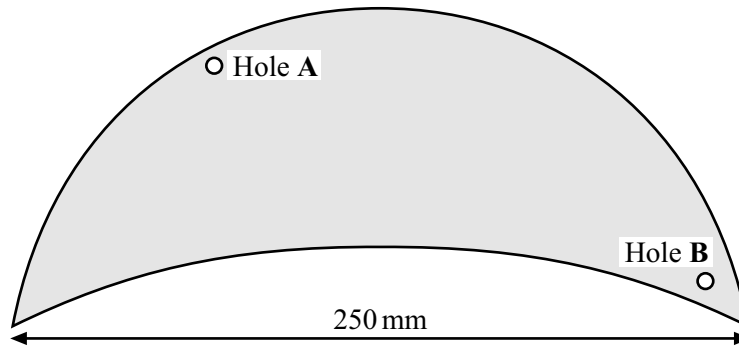
(3 marks)

6 (a) Every object has a *centre of mass*. What is meant by the *centre of mass*?

.....  
.....

(1 mark)

(b) The drawing shows a thin sheet of plastic. The sheet is 250 mm wide. Two holes, each with a radius of 2 mm, have been drilled through the sheet.



Describe how you could use:

- a clamp and stand
- a steel rod 100 mm long and with a radius of 1 mm
- a weight on a thin piece of string (= a plumb line)
- a ruler
- a pen which will write on the plastic sheet

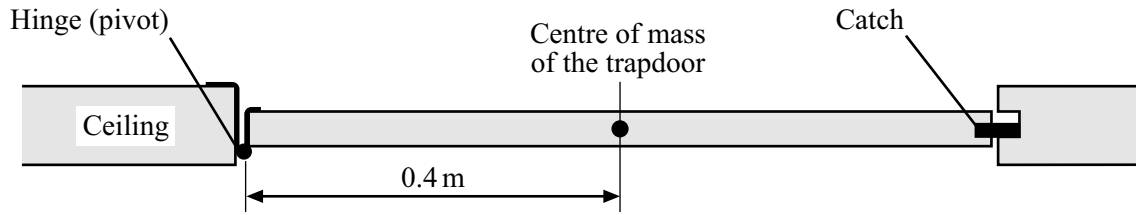
to find the centre of mass of the plastic sheet.

*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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(5 marks)

- (c) There is a trapdoor in the ceiling of a house.  
The trapdoor weighs 44 N.  
The drawing shows a side view of the trapdoor.



- (i) Complete the **three** spaces to give the equation which is used to calculate the turning effect of a force.

..... = ..... × perpendicular .....  
between line of action and pivot  
(1 mark)

- (ii) Calculate the turning effect, about the hinge, due to the weight of the trapdoor.

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

.....  
.....

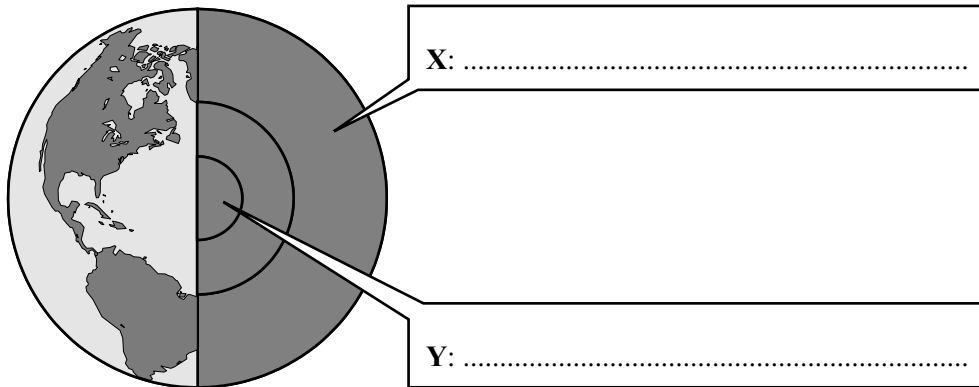
Turning effect = .....  
(3 marks)

10

**TURN OVER FOR THE NEXT QUESTION**

Turn over ►

7 (a) The diagram shows the layered structure of the Earth.



(i) Write in the boxes the name of layer **X** and the name of layer **Y**.

(2 marks)

(ii) The overall density of the Earth is about  $5500 \text{ kg/m}^3$ . The average density of the rocks in the Earth's crust is about  $2800 \text{ kg/m}^3$ . What does this suggest about the material that makes up the lower layers of the Earth?

.....

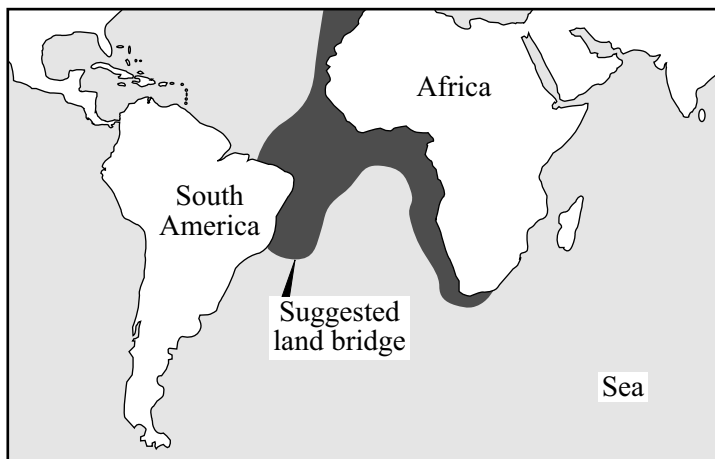
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(2 marks)

- (b) In 1915, the scientist Alfred Wegener suggested that Africa and South America had once been joined but had since drifted apart. Evidence for his theory came from the animal fossils found in the two continents. The fossils are almost the same, although animals now living in Africa and South America are different. Other scientists did not agree with Wegener and suggested that a land bridge had once joined the two continents.



How could scientists use the idea of a land bridge to explain the evidence put forward by Wegener?

.....

.....

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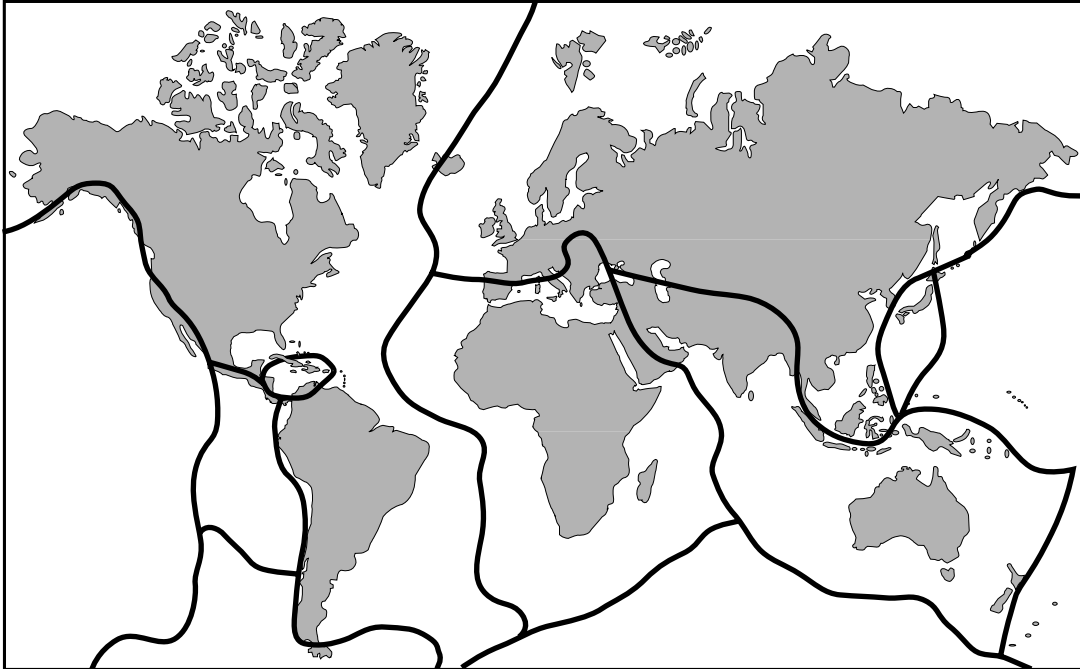
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(2 marks)

**QUESTION 7 CONTINUES ON THE NEXT PAGE**

**Turn over** ►

- (c) Scientists now think that the outer layer of the Earth is cracked into a number of large pieces called tectonic plates. The tectonic plates are moving very slowly. The lines on the diagram show the boundaries between the major tectonic plates.



- (i) Explain why there are no major earthquakes in Britain.

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.....  
.....

(2 marks)

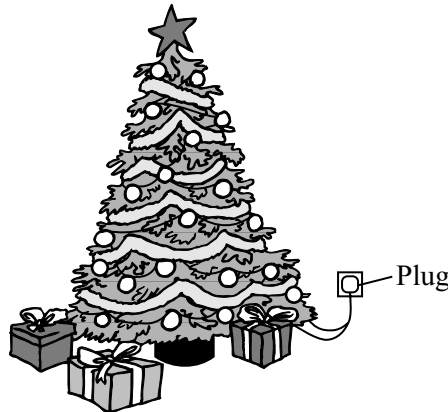
- (ii) What is causing the tectonic plates to move?

.....  
.....

(1 mark)



8 A set of Christmas tree lights is made from twenty identical lamps connected in series.



(a) Each lamp is designed to take a current of 0.25 A. The set plugs directly into the 230 V mains electricity supply.

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

.....  
(1 mark)

(ii) Calculate the resistance of **one** of the lamps. Show clearly how you work out your final answer and give the unit.

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

Resistance = .....  
(4 marks)

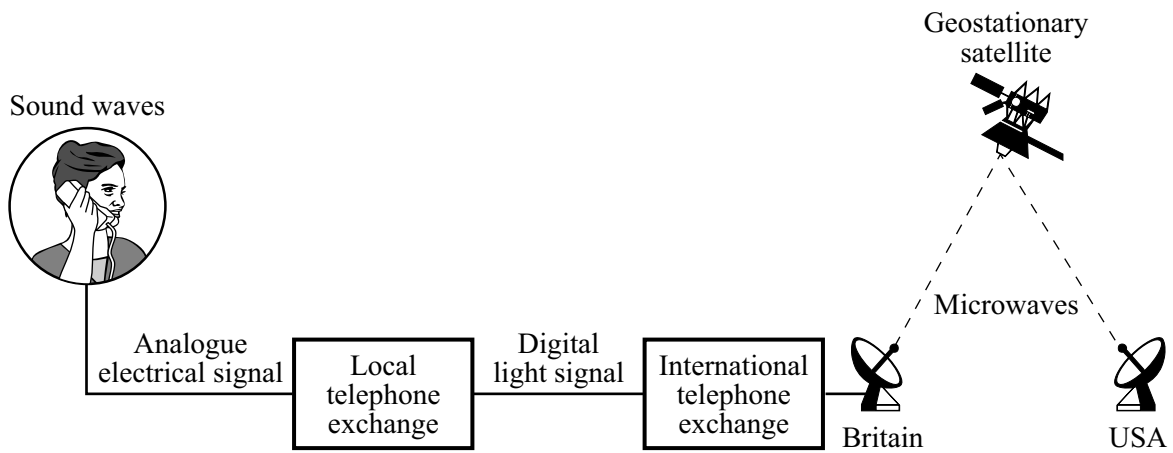
(iii) What is the total resistance of the set of lights?

.....  
Total resistance = .....  
(1 mark)

(b) How does the resistance of a filament lamp change as the temperature of the filament changes?

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

- 9 (a) The diagram shows, in a simplified form, how a telephone call can be transmitted from Britain to the USA.



- (i) What is the difference between an analogue and a digital signal? You may wish to draw a diagram to help your answer.

.....

.....

.....

.....

(2 marks)

- (ii) Explain why the quality of an analogue signal transmitted over a long distance decreases, but the quality of a digital signal transmitted over the same distance does not change.

.....

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.....

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(3 marks)

(iii) Explain why the satellite used to receive and transmit the microwave signals is placed in a geostationary orbit.

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

(2 marks)

(b) The picture shows a pre-natal scan obtained using ultrasonic waves.



(i) Explain how ultrasonic waves are used to produce the image of an unborn baby.

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

(2 marks)

(ii) Give another use for ultrasonic waves.

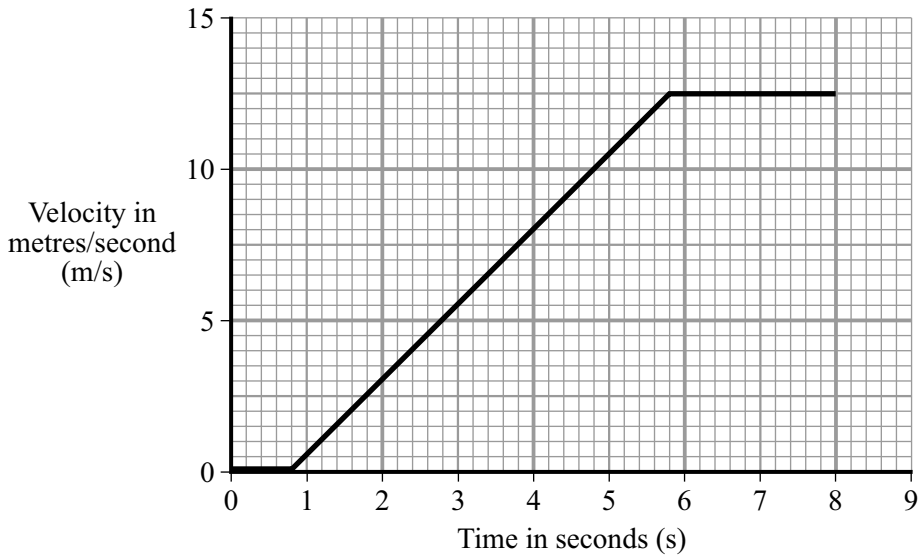
.....

(1 mark)

10

Turn over ►

- 10 A car travelling along a straight road has to stop and wait at red traffic lights. The graph shows how the velocity of the car changes after the traffic lights turn green.



- (a) Between the traffic lights changing to green and the car starting to move there is a time delay. This is called the reaction time. Write down **one** factor that could affect the driver's reaction time.

.....  
(1 mark)

- (b) Calculate the distance the car travels while accelerating. Show clearly how you work out your answer.

.....  
.....

Distance = .....metres  
(3 marks)

- (c) Calculate the acceleration of the car. Show clearly how you work out your final answer and give the units.

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

Acceleration = .....  
(4 marks)

(d) The mass of the car is 900 kg.

(i) Write down the equation that links acceleration, force and mass.

.....  
(1 mark)

(ii) Calculate the force used to accelerate the car. Show clearly how you work out your final answer.

.....  
.....

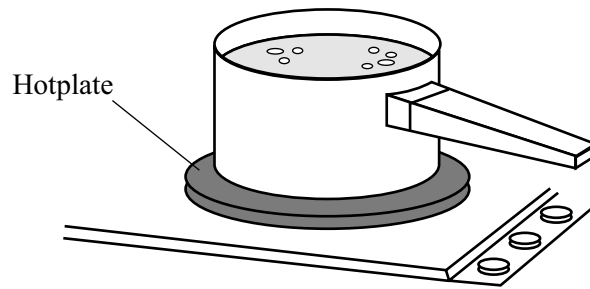
Force = .....newtons  
(2 marks)

11

**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

11 The drawing shows water being heated in a metal saucepan.



(a) Explain, in terms of the particles in the metal, how heat energy is transferred through the base of the saucepan.

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

(2 marks)

(b) Energy is transferred through the water by convection currents. Explain what happens to cause a convection current in the water. The answer has been started for you.

As heat energy is transferred through the saucepan, the water particles at the bottom .....

.....  
.....  
.....  
.....  
.....  
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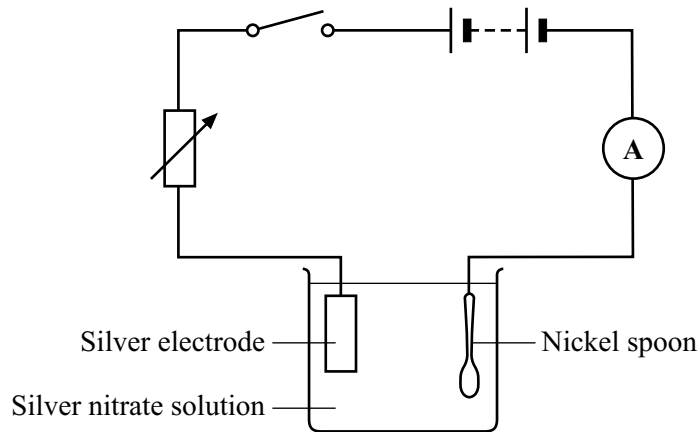
(3 marks)

(c) Some energy is transferred from the hotplate to the air by *thermal radiation*. What is meant by *thermal radiation*?

.....  
.....

(1 mark)

12 The diagram shows a circuit which can be used to silver-plate a nickel spoon.



- (a) Silver nitrate solution contains silver ions. When the switch is closed, the silver ions move towards the spoon. Are the silver ions negatively or positively charged? Give a reason for your answer.

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

- (b) With the switch closed, the ammeter reads 0.5 A. In 30 minutes, 1.0 g of silver is deposited on the spoon.

(i) Write down the equation which links charge, current and time.

.....  
 (1 mark)

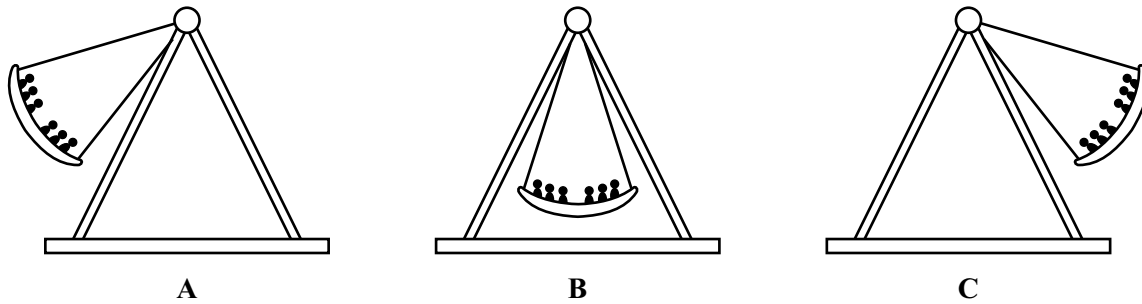
(ii) Calculate the charge which flows in 30 minutes. Show clearly how you get your final answer and give the units.

.....  
 .....  
 Charge = .....  
 (3 marks)

(iii) What mass of silver would have been deposited if the current had been 1 A and the circuit switched on for 1 hour?

.....  
 Mass = .....g  
 (1 mark)

- 13 The Boat is a theme park ride. The Boat swings backwards and forwards. The diagrams show the Boat at the top and bottom of its swing.



- (a) As the Boat swings from its position in **A** to its position in **B**, a child on the ride gains 5070 joules of kinetic energy. The child has a mass of 60 kg and is sitting at the centre.

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

.....  
(1 mark)

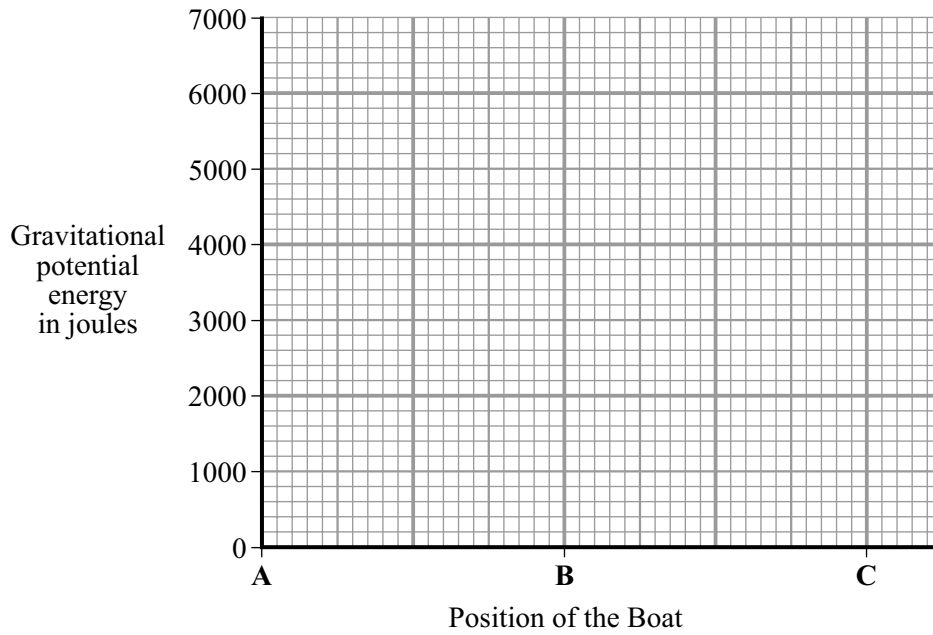
- (ii) Calculate the speed of the child as the Boat passes through **B**. Show clearly how you work out your final answer.

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

Speed = .....m/s  
(2 marks)



- (b) Sketch a graph to show how the gravitational potential energy of the child changes as the Boat swings from **A** to **B** to **C**. The axes have been drawn for you.



(2 marks)

5

**TURN OVER FOR THE NEXT QUESTION**

Turn over ►

- 14 (a) The table gives information about six radioactive isotopes.

Isotope	Type of radiation emitted	Half-life
hydrogen-3	beta particle	12 years
iridium-192	gamma ray	74 days
polonium-210	alpha particle	138 days
polonium-213	alpha particle	less than 1 second
technetium-99	gamma ray	6 days
uranium-239	beta particle	24 minutes

- (i) What is an alpha particle?

.....  
(1 mark)

- (ii) Two isotopes of polonium are given in the table. How do the nuclei of these two isotopes differ?

.....  
(1 mark)

- (iii) A doctor needs to monitor the blood flow through a patient's heart. The doctor injects a radioactive isotope into the patient's bloodstream. The radiation emitted by the isotope is then detected outside the body.

Which **one** of the isotopes in the table would the doctor inject into the bloodstream?

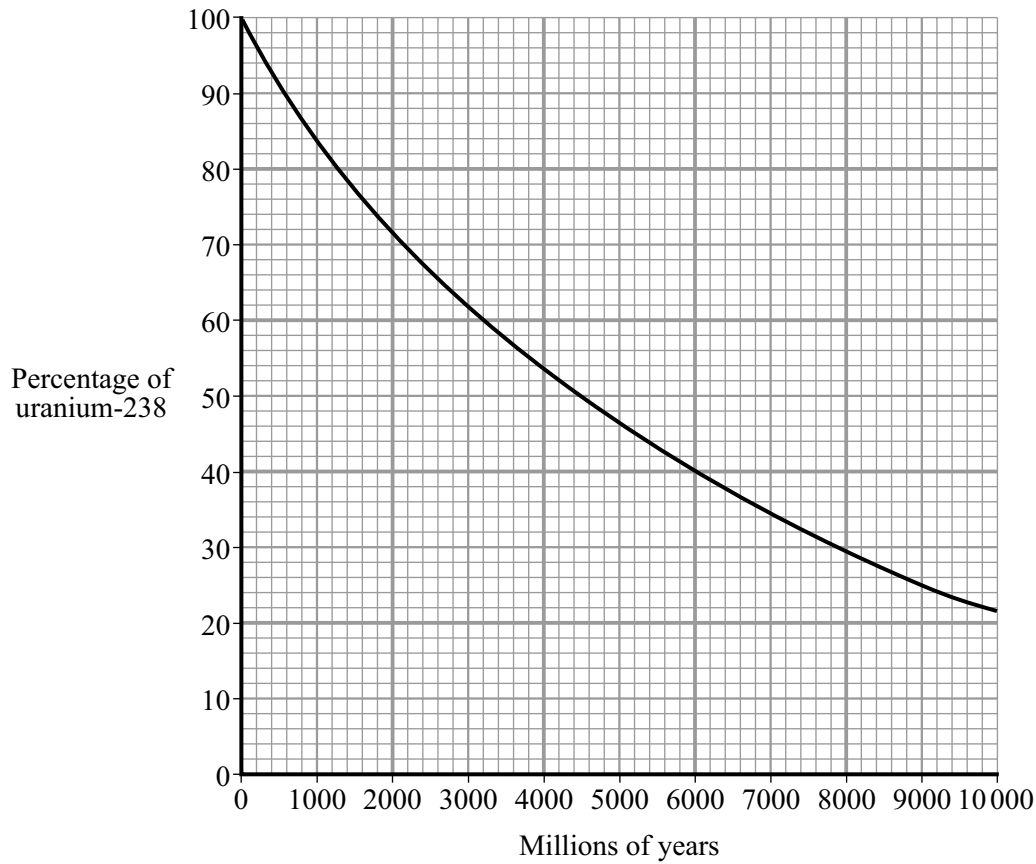
.....

Explain the reasons for your choice.

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

(3 marks)

- (b) Igneous rock contains uranium-238 which eventually changes to the stable isotope lead-206. The graph shows how the percentage of uranium-238 nuclei present in an igneous rock changes with time.



A rock sample is found to have seven atoms of uranium-238 for every three atoms of lead-206. Use the graph to estimate the age of the rock. Show clearly how you obtain your answer.

.....

.....

Age of rock = .....million years  
(2 marks)



**TURN OVER FOR THE NEXT QUESTION**

**Turn over** ►

- 15 (a) An electronic circuit in a freezer contains an alarm. This alarm will sound if the temperature inside the freezer rises above  $-15^{\circ}\text{C}$ . The alarm will also sound if the freezer door is left open for more than 45 seconds.

In the electronic circuit, name:

- (i) the logic gate;

.....  
(1 mark)

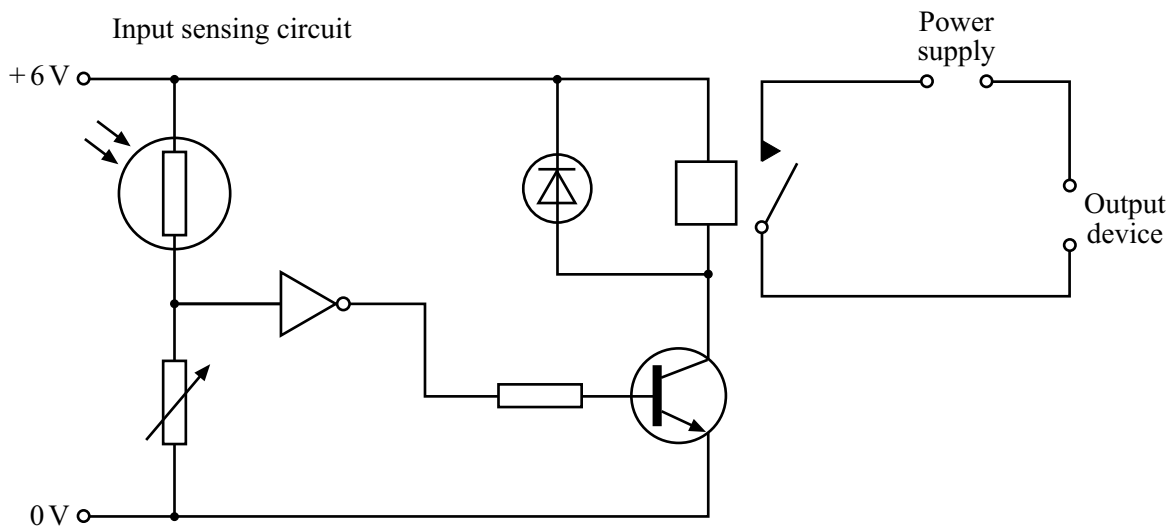
- (ii) an input sensor which could detect the temperature rise;

.....  
(1 mark)

- (iii) a component which could act as a timer.

.....  
(1 mark)

- (b) The diagram shows a different system which could be used to switch on a security light, outside a house, at night. The diagram shows the input sensing circuit and the circuit for an output device.



- (i) Complete the **five** spaces in these sentences to give the correct order for the events which occur.

As it gets dark, the resistance of the light dependent resistor (LDR) increases. The input to the logic gate will be ..... so the output will be ..... Then the ..... will be switched on, the ..... will be switched on and the ..... will be switched on.

(5 marks)

- (ii) Explain why a diode is included in the circuit.

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

(2 marks)

- (iii) Why is the diode reverse-biased?

.....  
 .....

(1 mark)

- (iv) The system, in the diagram, can be modified to control a garden water fountain. This can be done by changing the output device to an electric pump.

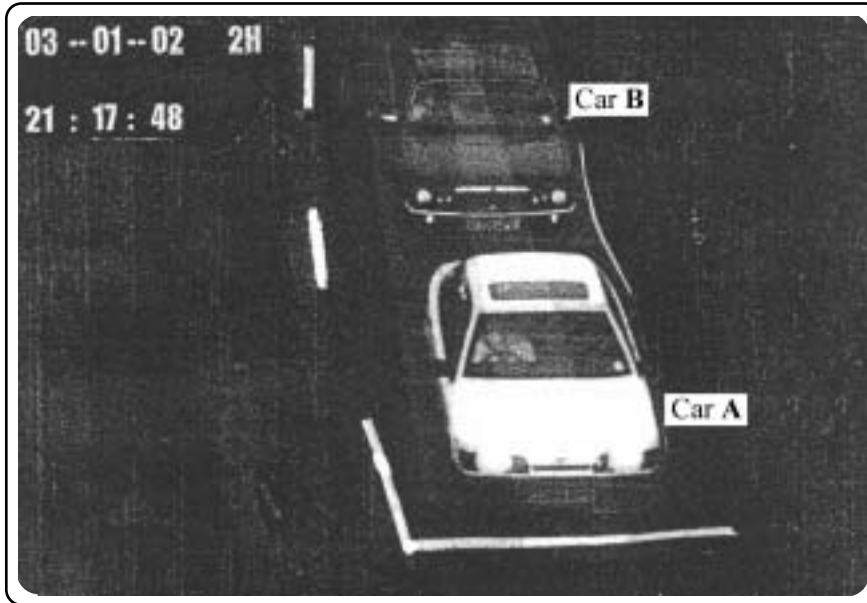
The input sensing circuit could be modified so that the water fountain would operate only during the day.

Suggest **two** alternative ways in which the input sensing circuit could be modified so that it would have this result.

1.....  
 .....  
 2.....  
 .....

(2 marks)

16 The roads were very icy. An accident was recorded by a security camera.



Car **A** was waiting at a road junction. Car **B**, travelling at 10m/s, went into the back of car **A**. This reduced car **B**'s speed to 4m/s and caused car **A** to move forward.

The total mass of car **A** was 1200kg and the total mass of car **B** was 1500kg.

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

.....  
(1 mark)

- (ii) Calculate the change in momentum of car **B** in this accident.

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

.....  
.....

Change in momentum = .....  
(3 marks)

- (iii) Use your knowledge of the conservation of momentum to calculate the speed, in m/s, of car **A** when it was moved forward in this accident.

Show clearly how you work out your final answer.

.....  
.....

Speed = .....m/s  
(3 marks)

