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| Centre Number | | Candidate Number | |
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General Certificate of Secondary Education
June 2006



**PHYSICS (SPECIFICATION B)
Foundation Tier**

3451/F
F

Friday 16 June 2006 9.00 am to 11.15 am

| |
|----------------------------------------------------------------------------------------------------------------------------------------|
| <p>For this paper you must have:</p> <ul style="list-style-type: none"> a ruler <p>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.
- Answer the questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want marked.

Information

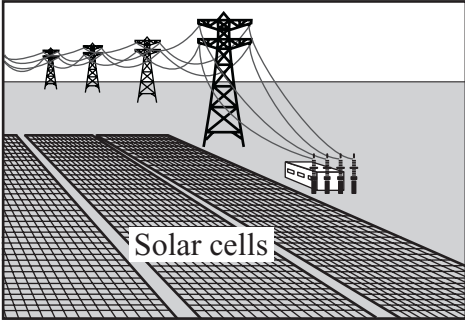
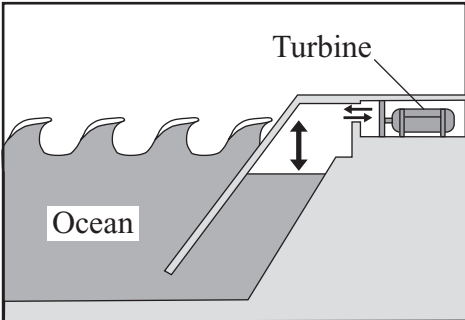
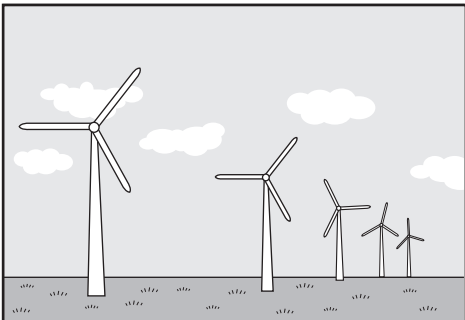
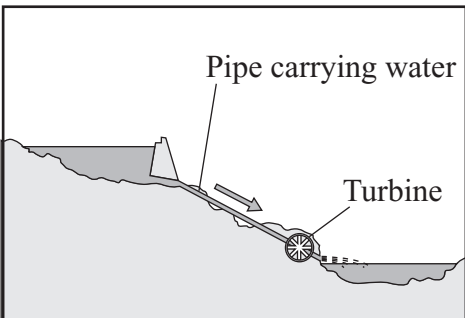
- The maximum mark for this paper is 135.
- The marks for questions are shown in brackets.
- You are reminded of the need for good English and clear presentation in your answers.

| For Examiner's Use | | | |
|---------------------|------|--------|------|
| Number | Mark | Number | Mark |
| 1 | | 12 | |
| 2 | | 13 | |
| 3 | | 14 | |
| 4 | | 15 | |
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| 6 | | 17 | |
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| 8 | | | |
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| Total (Column 2) | | → | |
| TOTAL | | | |
| Examiner's Initials | | | |

Answer **all** questions in the spaces provided

- 1 (a) The diagrams show four types of power station. Each one uses a different energy resource to generate electricity.

Draw straight lines to link each power station to its energy resource. Draw only **four** lines.

| Power station | Energy resource |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|  <p style="text-align: center;">Solar cells</p> | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Falling water</div> |
|  <p style="text-align: center;">Turbine</p> <p style="text-align: center;">Ocean</p> | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Geothermal</div> |
|  | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Sunlight</div> |
|  <p style="text-align: center;">Pipe carrying water</p> <p style="text-align: center;">Turbine</p> | <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Waves</div> <div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">Wind</div> |

(4 marks)

- (b) A coal-burning power station generates 1000 million watts of power. A solar power station generates 250 million watts of power.

How many solar power stations would be needed to replace one coal-burning power station?

.....
(1 mark)

- (c) Electricity is generated at nuclear, coal or natural gas power stations.

- (i) Which **one** of these power stations does **not** produce any waste gases?

.....
(1 mark)

- (ii) Which **one** of these power stations has the shortest start-up time?

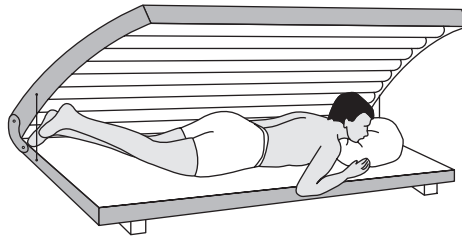
.....
(1 mark)

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| 7 |

Turn over for the next question

Turn over ►

- 2 (a) The diagram shows a person using a sunbed.



- (i) Which type of radiation is used in a sunbed to give a suntan?

Draw a ring around your answer.

infra red **light** **microwave** **ultraviolet**

(1 mark)

- (ii) What can a high dose of radiation from a sunbed do to living cells?

.....
.....

(1 mark)

- (b) The box contains the information shown on the side of a sunbed.

| | |
|--------------|---------------|
| 230 V | 1.8 kW |
| 50 Hz | 7.8 A |

- (i) Which **one** of the following statements is true? Put a tick (✓) in the box next to your choice.

The sunbed uses an alternating current (a.c.) electricity supply.

A 5 amp fuse should be used in the plug of the sunbed.

The sunbed transfers 1.8 joules of energy every second.

(1 mark)

- (ii) In one week the sunbed is used for a total of 6 hours.

Use the following equation to calculate the number of units of energy transferred by the sunbed in 6 hours.

Show clearly how you work out your answer.

$$\begin{array}{ccccc} \text{energy transferred} & = & \text{power} & \times & \text{time} \\ \text{(kilowatt-hour, kWh)} & & \text{(kilowatt, kW)} & & \text{(hour, h)} \end{array}$$

.....

.....

Energy transferred = kWh
(2 marks)

3 (a) Read the following statements.

J – It is made up of at least a billion galaxies.

K – It is one of the stars in the Milky Way.

L – It is a slightly squashed circle.

M – It keeps the Moon in orbit around the Earth.

N – It is a large number of stars grouped together.

O – It is the explosion of a massive star.

Which statement, **J**, **K**, **L**, **M**, **N** or **O**, describes:

(i) the force of gravity;

Letter
(1 mark)

(ii) the Sun;

Letter
(1 mark)

(iii) the Universe;

Letter
(1 mark)

(iv) a supernova?

Letter
(1 mark)

(b) The Sun is in the main stable stage of its lifecycle.

(i) How long will the Sun be in this stage of its lifecycle? Put a tick (✓) in the box next to your choice.

Hundreds of years

Thousands of years

Millions of years

Billions of years

(1 mark)

(ii) Describe what will happen to the Sun after it has reached the end of the main stable stage of its lifecycle. The answer has been started for you.

At the end of the stable stage of its lifecycle the Sun will expand

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

(3 marks)

8

Turn over for the next question

Turn over ▶

4 (a) The diagrams, **A**, **B** and **C**, represent three different nuclei.

Diagram A



2 protons ⊕

4 neutrons ○

Diagram B



3 protons ⊕

3 neutrons ○

Diagram C



2 protons ⊕

2 neutrons ○

(i) Which **two** nuclei are isotopes of the same element?

..... and
(1 mark)

(ii) Which **two** nuclei have the same mass number?

..... and
(1 mark)

(iii) Give a reason for your choice of answer to part (a)(ii).

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

(b) The tables below give examples of some stable nuclei and some unstable nuclei.

| Stable nuclei | Unstable nuclei |
|---------------|-----------------|
| boron-11 | boron-12 |
| carbon-12 | carbon-14 |
| oxygen-16 | oxygen-15 |
| lead-207 | lead-209 |

(i) Write down, from the tables, the names of **two** radioactive nuclei.

..... and
(1 mark)

(ii) Write down, from the tables, the names of **two** non-radioactive nuclei.

..... and
(1 mark)

(c) Complete the following sentence by crossing out the **two** words in the box that are wrong.

The lungs of a person who has breathed in a radioactive gas will be most

damaged if the gas gives out

| |
|-------|
| alpha |
| beta |
| gamma |

 radiation.

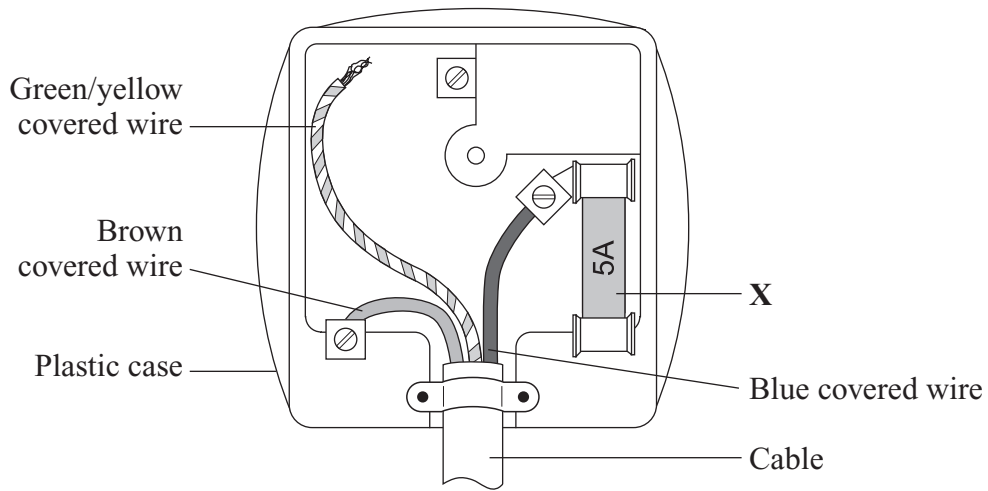
(1 mark)

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Turn over for the next question

Turn over ►

5 The diagram shows a badly wired mains electricity plug.



(a) Why is the outside case of the plug made from plastic?

.....

(1 mark)

(b) What is the part labelled **X** called?

.....

(1 mark)

(c) Describe what must be done to correctly wire the plug.

.....

(2 marks)

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6 Scientists would like to know if there is life, or ever has been life, on other planets.

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

Each word may be used once or not at all.

| | | | | |
|----------------|-------------|---------------|----------------|--------------|
| fossils | gold | helium | sulphur | water |
|----------------|-------------|---------------|----------------|--------------|

If or were found on a planet, it suggests that the planet was or is able to support life.

(2 marks)

(b) We know that living organisms can change the atmosphere of a planet.

Complete the following sentence by crossing out the **two** lines in the box that are wrong.

On Earth plants have

| |
|-------------|
| increased |
| not changed |
| decreased |

the amount of oxygen in the atmosphere.

(1 mark)

(c) Scientists working on the SETI project look for signs of intelligent life by monitoring signals from space.

Which **one** of the following pieces of equipment is used in the SETI project?

Draw a ring around your answer.

binoculars

periscope

radio telescope

telescope

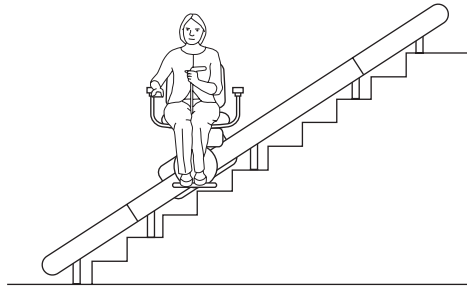
(1 mark)

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Turn over for the next question

Turn over ►

7 A person uses a stairlift to go upstairs. The stairlift is worked by an electric motor.



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

Each word may be used once or not at all.

| | | | | | |
|-----------------|-------------------|-------------|----------------|--------------|--------------|
| chemical | electrical | heat | kinetic | light | sound |
|-----------------|-------------------|-------------|----------------|--------------|--------------|

(i) The electric motor is designed to transfer
energy to energy.

(2 marks)

(ii) When the electric motor is working, the main energy wastages are
..... and

(2 marks)

(b) To lift the person and the chair, the electric motor does 2880 joules of work in 8 seconds.

(i) Use the following equation to calculate the useful power output of the electric motor. Show clearly how you work out your answer.

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

.....
.....

Power = J/s
(2 marks)

(ii) The answer to part (b)(i) is in J/s; this is not the usual unit for power. Which **one** of the following units is usually used for power?

Draw a ring around your answer.

coulomb (C) **joule (J)** **newton (N)** **watt (W)**
(1 mark)

(c) The forces on the stairlift are balanced.

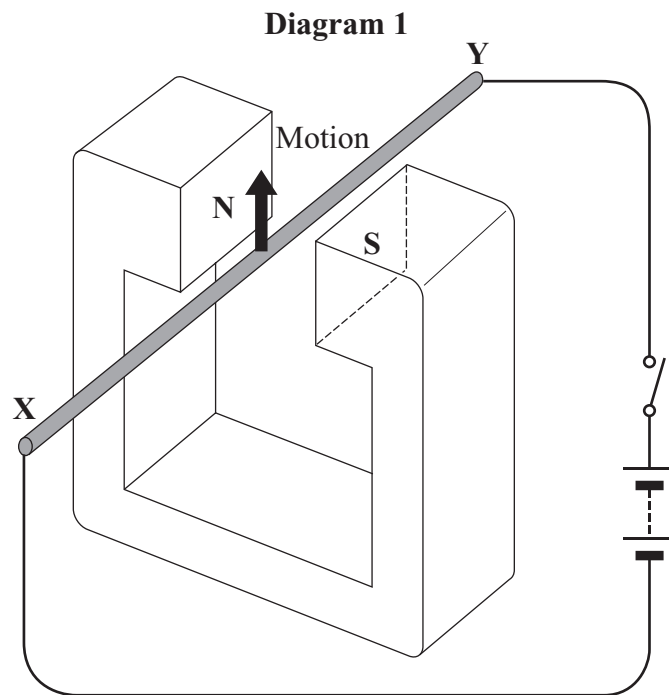
Put a tick (✓) in the boxes next to the **two** statements that describe what the stairlift could be doing.

- The stairlift is not moving.
- The stairlift is moving at a constant speed.
- The stairlift is speeding up.
- The stairlift is slowing down.

(1 mark)

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8 **Diagram 1** shows a metal rod, **XY**, connected to a battery. The rod is between the poles of a magnet.



When the switch is closed the rod moves upwards.

(a) How would the rod move if:

(i) the current through the rod was increased;

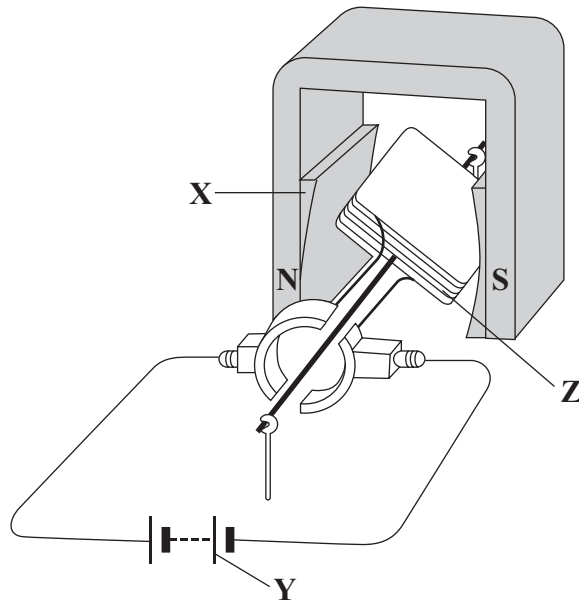
.....
(1 mark)

(ii) the connections to the battery were reversed?

.....
(1 mark)

- (b) **Diagram 2** shows a simple d.c. motor.

Diagram 2



- (i) What do the letters d.c. stand for?

.....
(1 mark)

- (ii) Which part of the motor, **X**, **Y** or **Z**, acts as an electromagnet?

Letter
(1 mark)

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Turn over for the next question

Turn over ►

9 **Diagram 1** shows how beta (β) and gamma (γ) radiation pass through aluminium.

Diagram 1

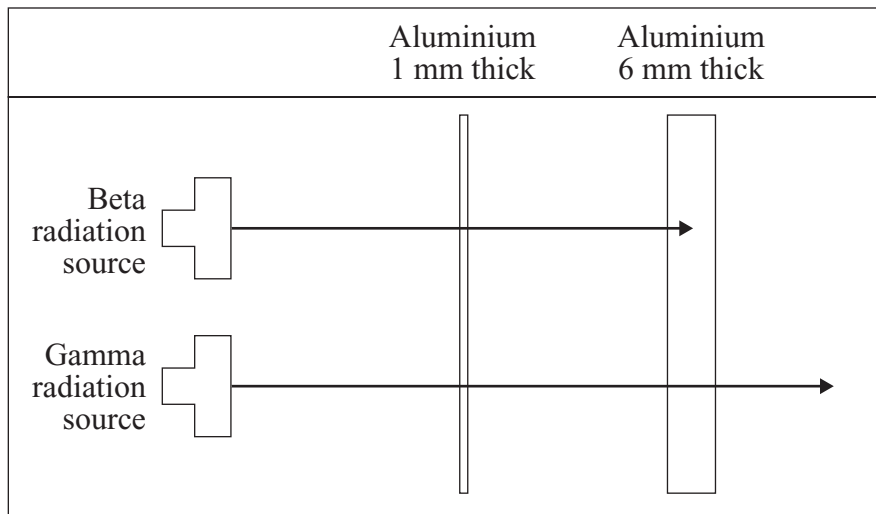
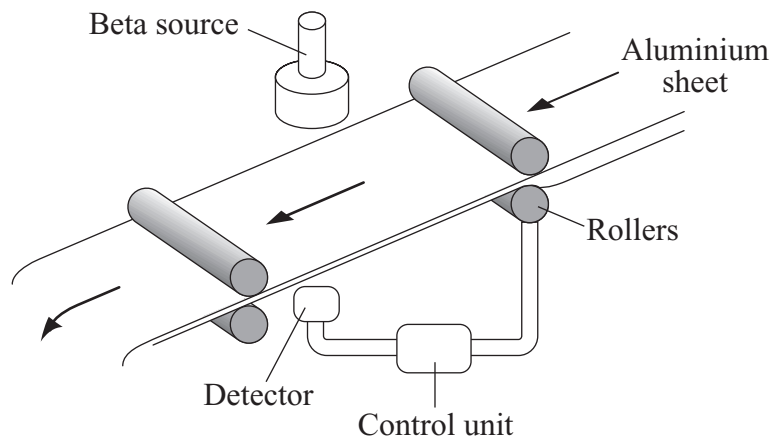


Diagram 2 shows how a beta radiation source is used to monitor and control the thickness of an aluminium sheet as it is made.

Diagram 2



- (a) Explain why a gamma radiation source cannot be used to monitor the thickness of the aluminium 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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.....

.....

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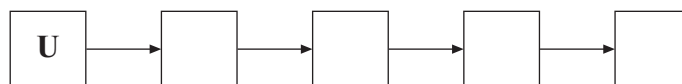
(3 marks)

- (b) The following sentences describe what happens if the aluminium sheet is being made too thin.

The sentences are in the wrong order.

- S** The aluminium sheet absorbs less beta radiation so more reaches the detector.
- T** The gap between the rollers is increased.
- U** The gap between the rollers is too small, making the aluminium sheet too thin.
- V** The aluminium sheet is now rolled a little thicker.
- W** A signal goes from the detector to the control unit.

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



(3 marks)

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Turn over ►

10 (a) The diagram shows an electronic system.



Use a word from the box to fill in each space. Each word should be used only once.

buzzers LDRs LEDs motors switches thermistors

Input sensors include:

- which respond to changes in temperature;
- which respond to changes in light;
- which respond to changes in pressure.

Processors can be made using logic gates.

Output devices include:

- which produce light;
- which produce sound;
- which produce movement.

(6 marks)

(b) Complete the truth tables by writing **1** or **0** in each space in the output column.

(i) AND gate

| 1 st input | 2 nd input | Output |
|-----------------------|-----------------------|--------|
| 0 | 0 | ..... |
| 1 | 0 | ..... |
| 0 | 1 | ..... |
| 1 | 1 | 1 |

(1 mark)

(ii) NOT gate

| Input | Output |
|-------|--------|
| 0 | |
| 1 | |

(1 mark)

(iii) OR gate

| 1 st input | 2 nd input | Output |
|-----------------------|-----------------------|--------|
| 0 | 0 | 0 |
| 1 | 0 | ..... |
| 0 | 1 | ..... |
| 1 | 0 | ..... |

(1 mark)

(c) Capacitors can be used as simple timers in electronic circuits.

(i) Draw a circuit symbol for a capacitor.

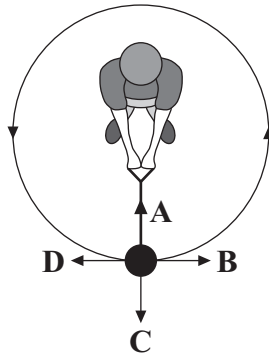
(1 mark)

(ii) Complete the sentence.

When a current flows to an uncharged capacitor, is stored
and the potential difference across the capacitor

(2 marks)

- 11 (a) The diagram shows an overhead view of an athlete who is about to throw a hammer. The hammer is a metal mass joined to a strong wire. The athlete swings the mass round in a circular path.



- (i) In which direction, **A**, **B**, **C** or **D**, does the centripetal force act?
(1 mark)
- (ii) The athlete lets go of the wire.
In which direction, **A**, **B**, **C** or **D**, does the mass move?
(1 mark)
- (iii) Complete the sentences by ticking (✓) the correct ending.

When the mass moves in a circle at a steady speed the centripetal force is larger

| | | |
|--------|-------------------|--|
| if the | mass is larger | |
| | mass is smaller | |
| | speed decreases | |
| | weight is smaller | |

(1 mark)

When the mass moves in a circle at a steady speed the centripetal force is larger

| | | |
|--------|-------------------|--|
| if the | speed decreases | |
| | weight is smaller | |
| | wire is longer | |
| | wire is shorter | |

(1 mark)

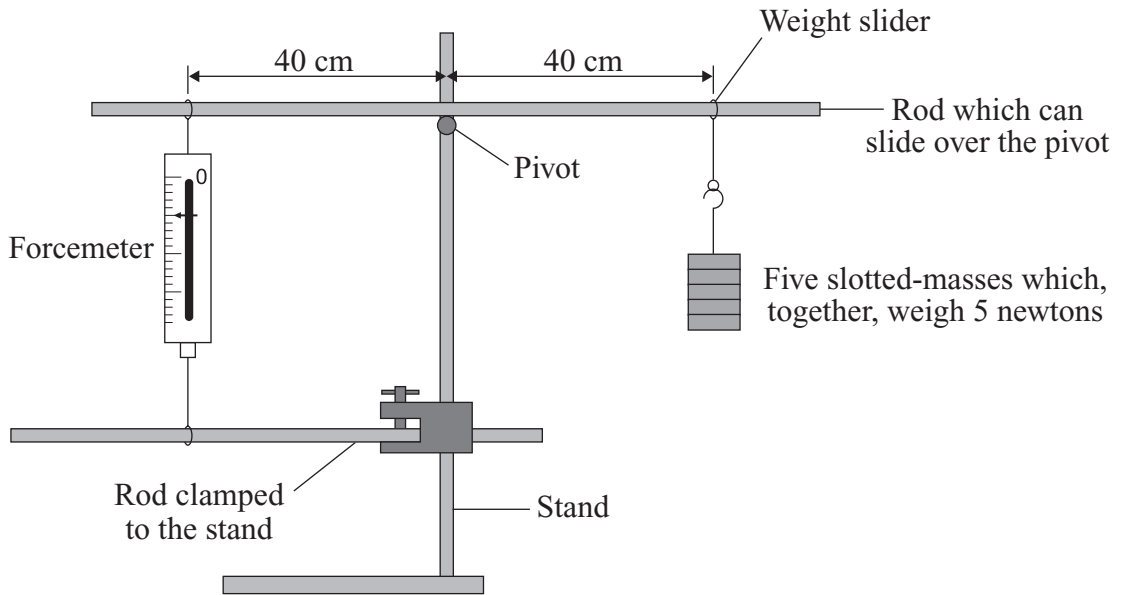
- (b) The following equation is used to calculate the turning effect of a force.

Choose **two** words from the box to complete the equation.

| | | | | |
|-----------------|---------------|-------------|---------------|---------------|
| distance | energy | mass | moment | weight |
|-----------------|---------------|-------------|---------------|---------------|

..... = force × perpendicular between line of action and pivot.
(2 marks)

- (c) A student investigates turning effects.
The equipment she uses is shown below.

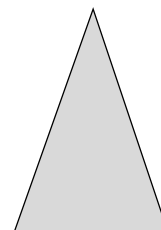
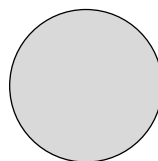


- (i) What is the weight, in newtons, of each of the slotted masses? N
(1 mark)
- (ii) What will the reading be, in newtons, on the forcemeter? N
(1 mark)
- (iii) Briefly describe **two** different ways to adjust the apparatus so that the reading on the forcemeter is **less** than the weight of the slotted masses.

1.....
.....

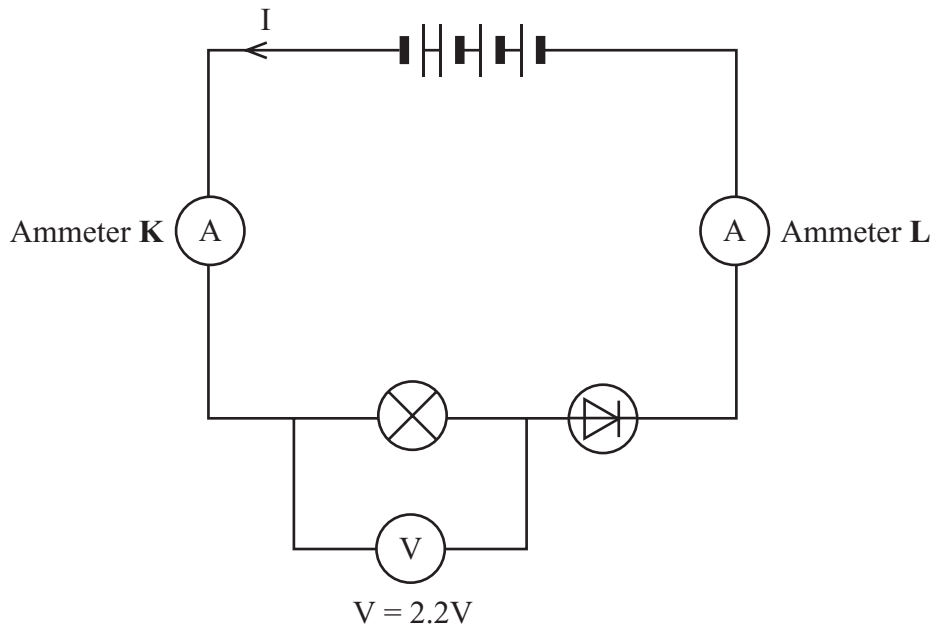
2.....
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(2 marks)

- (d) The diagrams show three thin sheets of plastic.
Label the centre of mass of each sheet with an **X**.



(3 marks)

- 12 The diagram shows how a student joined several components, including a 6-volt lamp and four identical 1.5 volt cells, in a circuit.



- (a) The reading on ammeter **K** is 0.05 A.

What is the reading on ammeter **L**?

.....
(1 mark)

- (b) The student expected the lamp in the diagram to be much brighter and the reading on the voltmeter to be 6 volts.

- (i) Give **two** reasons why the reading on the voltmeter is much less than 6 volts.
The voltmeter is working correctly.

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

(2 marks)

- (ii) The student decides that the lamp is dim because the diode is connected the wrong way round. When the student reverses the connections to the diode the lamp goes out.

Explain why.

.....

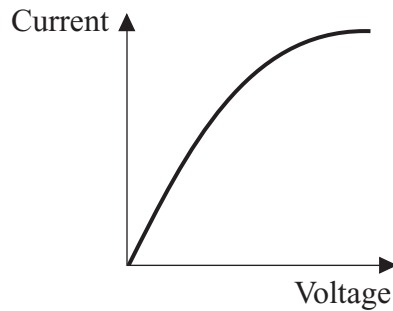
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(2 marks)

- (c) The graph shows how the current through a filament lamp changes as the voltage (potential difference) across it changes.



Explain why the graph is not a straight line.

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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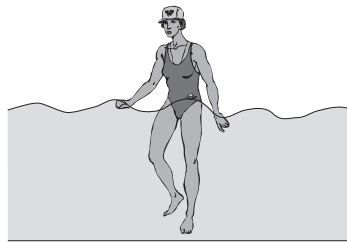
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(4 marks)

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Turn over ►

13 (a) The diagram shows water waves made by a wave machine in a swimming pool.



In 10 seconds 5 complete waves go past a person standing in the pool.

Calculate the frequency of the water waves and give the unit.

Show how you work out your answer.

.....

Frequency =
(2 marks)

(b) Water waves are transverse waves.

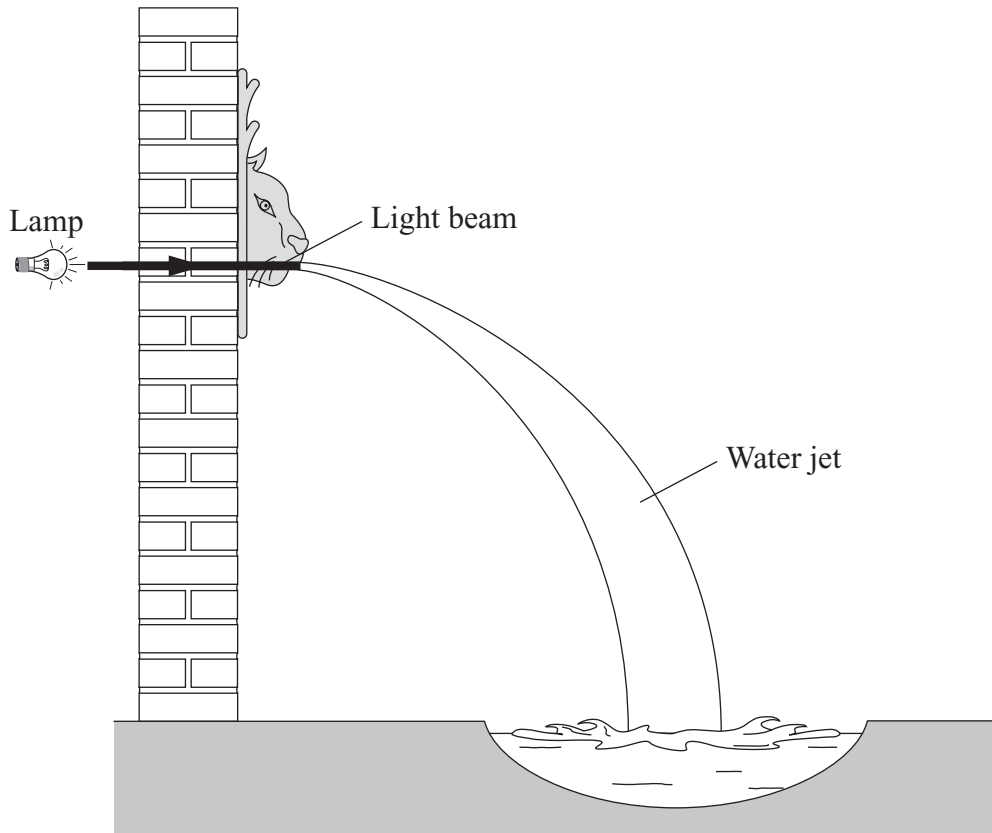
Give **one** other example of a transverse wave.

.....
(1 mark)

(c) How is a transverse wave different from a longitudinal wave? You may draw a diagram to help you with your answer.

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

- (d) The diagram shows a garden fountain. The fountain features a light beam that is totally internally reflected by the water jet.



- (i) Draw the path of the light beam through the water jet. (1 mark)
- (ii) Complete the following sentence by crossing out the **two** lines in the box that are wrong.

For light to be totally internally reflected the angle between the light ray and the

normal must be

| |
|--------------|
| smaller than |
| equal to |
| bigger than |

 the critical angle.

(1 mark)

| |
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| 7 |

Turn over ►

- 14 Converting sound waves into electrical signals allows information to be sent over long distances.

The diagram shows three analogue signals and one digital signal.



U



V



W



X

- (a) Which signal, **U**, **V**, **W** or **X**, is the digital signal?

.....

Give a reason for your choice.

.....

.....

(2 marks)

- (b) Give **one** advantage of sending information as a digital signal instead of as an analogue signal.

.....

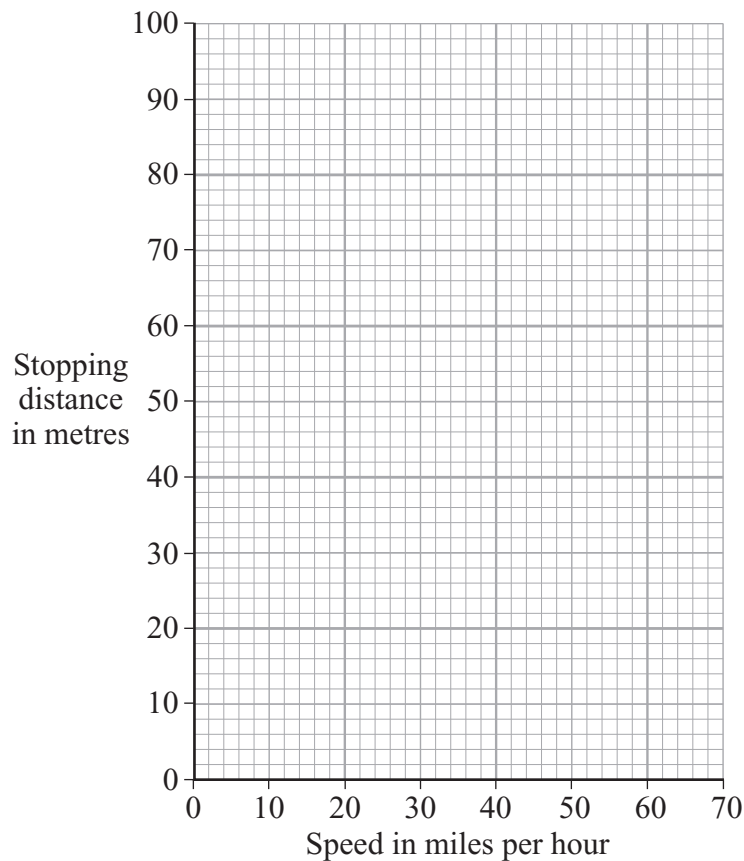
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(1 mark)

- 15 (a) The table shows how the stopping distance of a car, in metres (m), depends on the speed of the car, in miles per hour (mph).

| | | | | | | |
|-----------------------|----|----|----|----|----|----|
| Speed (mph) | 20 | 30 | 40 | 50 | 60 | 70 |
| Stopping distance (m) | 12 | 23 | 36 | 53 | 73 | 96 |

- (i) Draw a graph of stopping distance against speed.



(3 marks)

- (ii) The speed limit outside a school is 20 mph.

Use the graph to estimate **how much further** a car will travel before it stops when driven at 25 mph instead of 20 mph.

Show clearly how you work out your answer.

.....

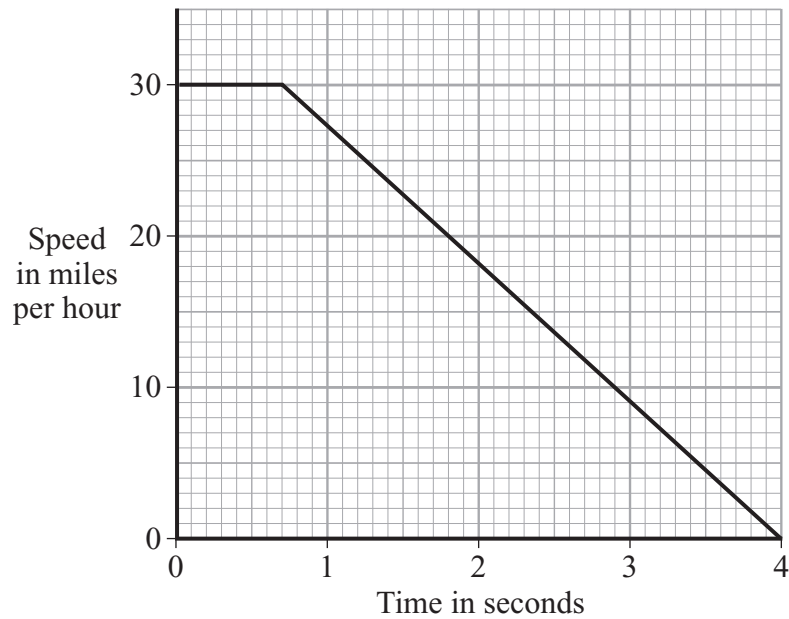
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(2 marks)

Question 15 continues on the next page

Turn over ►

- (b) A child ran out in front of a car causing the driver to make an emergency stop. The graph shows how the speed of the car changed from the moment the driver saw the child.



- (i) What was the driver's reaction time?

.....
(1 mark)

- (ii) Describe the motion of the car during the first 0.5 seconds.

.....
(1 mark)

- (iii) How long did it take the car to stop once the brakes were applied?

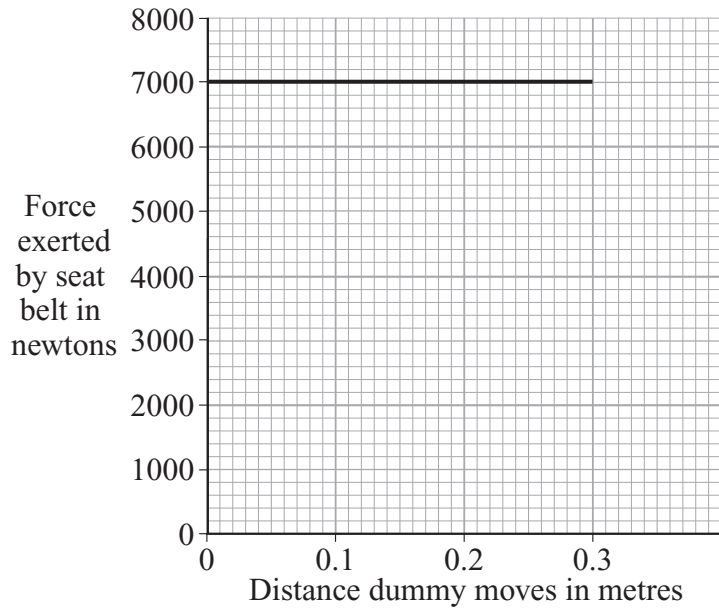
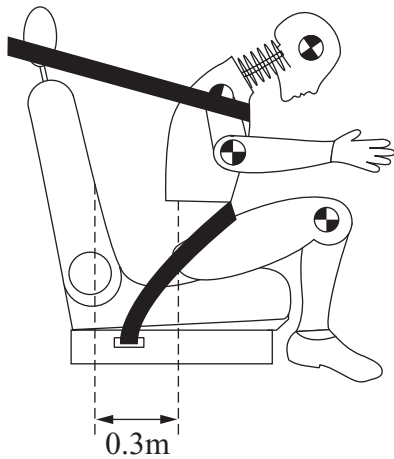
.....
(1 mark)

- (iv) The drug cannabis makes the reactions of a person slower.

Explain how the stopping distance of the car would change if the driver had been smoking cannabis.

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

- (c) The diagram shows how far a dummy in a car crash test moves before it is stopped by the seat belt. The graph shows the force exerted by the seat belt on the dummy during the crash.



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

.....
(1 mark)

- (ii) Calculate the work done to stop the dummy.

Show clearly how you work out your answer.

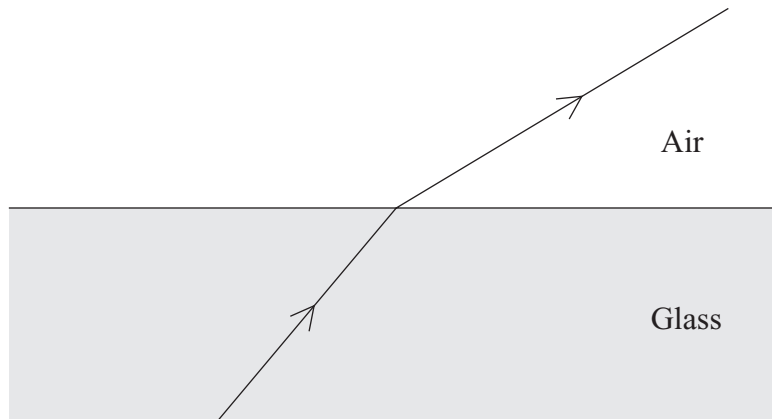
.....
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Work done = joules
(2 marks)

- (iii) How much energy is transferred from the dummy during the crash?

.....
(1 mark)

- 16 (a) The diagram shows a ray of light changing direction as it goes from glass into air.



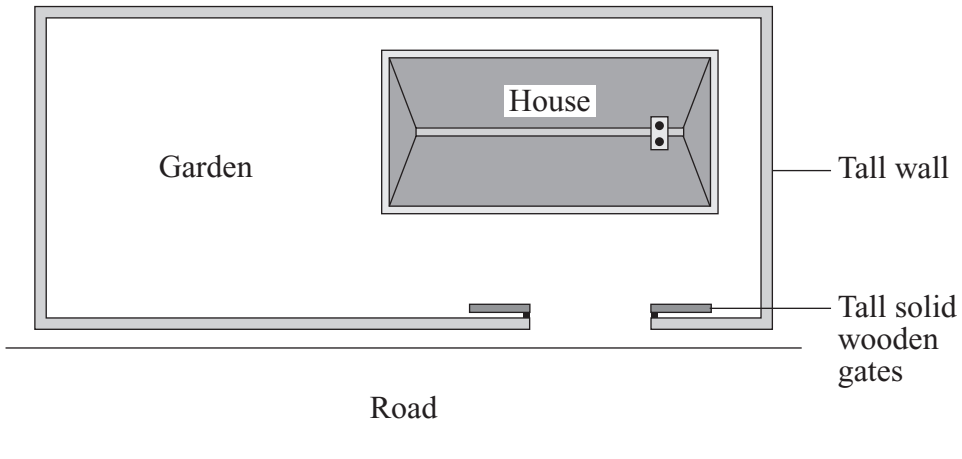
- (i) What name is given to this effect?

.....
(1 mark)

- (ii) Why does light change direction when it goes from glass into air?

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

(b) The diagram, drawn from above, shows the position of a house next to a busy road.



(i) Explain why traffic noise is heard in the garden.

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

(2 marks)

(ii) The tall solid gates are closed. The traffic noise heard in the garden is quieter.

Explain why.

.....
.....

(1 mark)

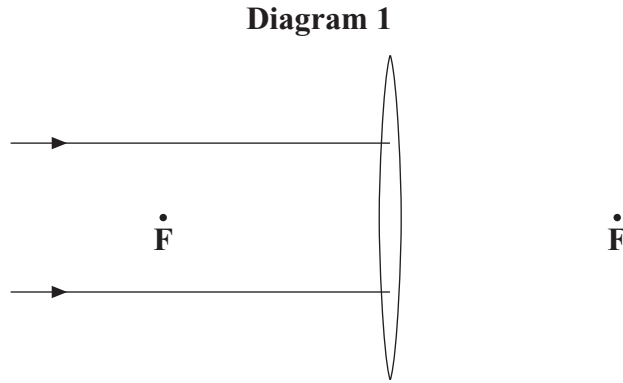
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Turn over for the next question

Turn over ►

- 17 (a) **Diagram 1** shows parallel rays of light and a converging lens. The points, **F**, show the focus on each side of the lens.

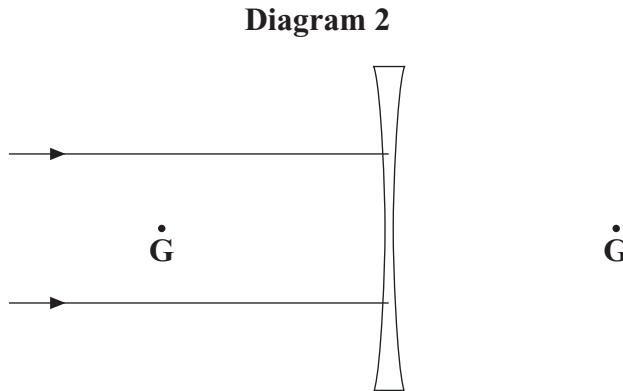
Complete **Diagram 1** to show what happens to the rays of light. Use a ruler to do this.



(2 marks)

- (b) **Diagram 2** shows parallel rays of light and a diverging lens. The points, **G**, show the focus on each side of the lens.

Complete **Diagram 2** to show what happens to the rays of light. Use a ruler to do this.



(2 marks)

- (c) Use words from the box to complete the sentences.

| | | |
|--------------|-------------|---------------|
| image | lens | object |
|--------------|-------------|---------------|

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

In a camera, a converging is used to produce an of an on a film. The is smaller than the and nearer to the

(3 marks)

(d) (i) What is the difference between a real image and a virtual image for a lens?

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

(2 marks)

(ii) Why does a real image, rather than a virtual image, need to be formed in a camera?

.....
.....

(1 mark)

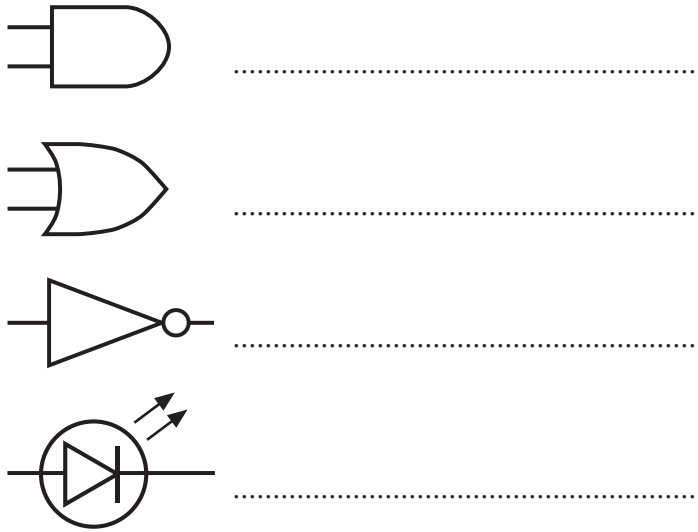
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Turn over for the next question

Turn over ►

18 (a) Electronic circuits have symbols for the components.

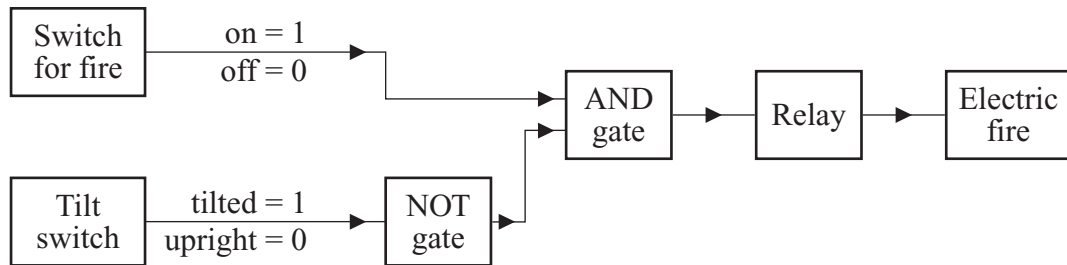
Name the components with these symbols.



(4 marks)

(b) A 2 kW electric fire has an electronic control system. The system will switch off the fire if it falls over.

The diagram shows the system.



(i) Which parts are the processors in this system?

.....
(1 mark)

- (ii) Complete the end column of the truth table by writing **1** or **0** in each of the four spaces.

| Switch for fire | Tilt switch | Signal to relay |
|-----------------|-------------|-----------------|
| 0 | 0 | ..... |
| 0 | 1 | ..... |
| 1 | 0 | ..... |
| 1 | 1 | ..... |

(1 mark)

- (iii) Explain why the relay is needed.

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.

.....

.....

.....

.....

.....

.....

.....

.....

.....

(4 marks)

| |
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END OF QUESTIONS

There are no questions printed on this page