**Q1.** Carefully read the following extract from a safety leaflet. Then answer the questions.

> An RCD adaptor is an automatic safety switch. It should be used when there is a particular risk of electric shock. For example, it is recommended that it is used with an electric lawnmower.
>
> Inside one make of RCD is an electromagnet that holds the switch closed so that the RCD is switched on. An electronic circuit in the RCD monitors the difference between the current in the live wire and the current in the neutral wire.
>
> If something goes wrong and this difference is greater than 30 milliamps then the RCD will trip (= switch off) within 40 milliseconds.

(a) Suggest **two** reasons why there is a particular risk of an electric shock when using an electric lawnmower.

1. .....

.....

2. .....

.....

**(2)**

(b) Why will there be a difference between the current in the live wire and the current in the neutral wire if something goes wrong?

.....

.....

**(1)**

(c) (i) Use the words charge, current and time to write an equation which shows the relationship between them.

.....

**(1)**

(ii) Calculate how much charge flows when a current of 30 milliamps passes for 40 milliseconds.

Clearly show how you get to your answer and give the unit.

.....

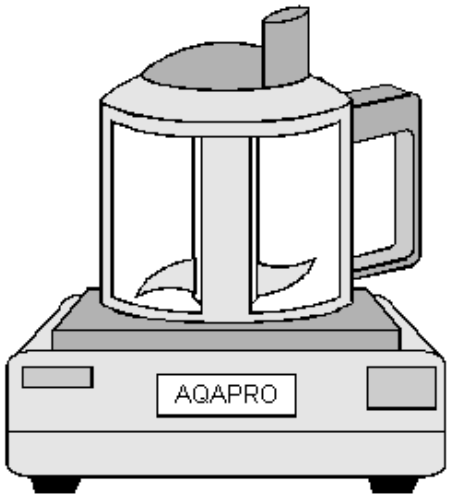
.....

Charge = .....

**(3)**

**(Total 7 marks)**

**Q2.** The drawing shows a food processor. It has an electric motor. Inside is a blade which spins round and cuts up the food.




The food processor is designed to transfer electrical energy to kinetic energy. However some of the energy is wasted as heat and sound.

The power input to the food processor is 1150 W. The power of the spinning blade is 900 W.

(i) Calculate how much energy is wasted when the food processor is used for two minutes.

Show clearly how you get to your answer and give the unit.

$$\text{power} = \frac{\text{energy transferred}}{\text{time taken}}$$

.....

.....

Energy = .....

**(3)**

(ii) Why does the food processor produce sound when it is switched on?

.....

.....

**(1)**

**(Total 4 marks)**

##

A combination oven can cook food by using three methods; a microwave generator, a grill and a heating element.

| | |
|---|---|
| voltage | 230 V |
| microwave power (max) | 900 W |
| grill power | 1300 W |
| convection heater power | 1200 W |

(a) What is the current when the oven is operating using full microwave power? Give the equation and show your working.

.....

.....

.....

Current = ..... A

**(3)**

(b) It is possible to cook using infrared radiation, from the grill, and microwaves. What is the maximum current in the oven when using both together?

.....

.....

.....

Current = ..... A

**(2)**

(c) For baking and roasting, the microwave is used at 450 W and the convection heating element is on fully at 1200 W. A thawed or fresh medium-sized chicken takes 30 minutes to cook.

Calculate the energy transferred in kilowatt-hours.

Use:

units (kWh) = power (kW) × time (h)

.....

.....

.....

Energy = ..... kWh

**(2)**

(d) Why is a combination oven of this sort more economical than a convection-only oven?

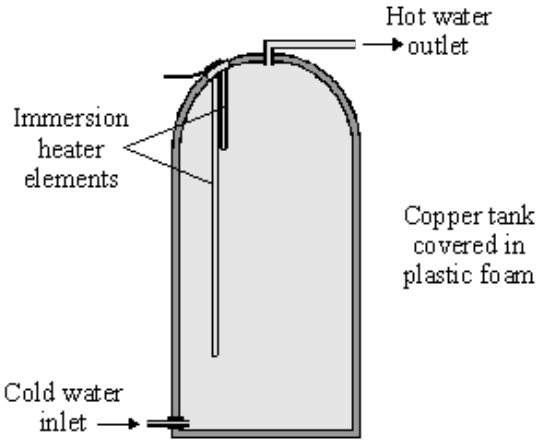
.....

.....

**(1)**

**(Total 8 marks)**

**Q4.** The diagram shows a type of electric immersion heater in a hot water tank. These hot water tanks are normally found in airing cupboards.




Information on the immersion heater states:

230 V
10 A

(a) (i) What is the equation which shows the relationship between power, current and voltage?

.....

**(1)**

(ii) Calculate the power of the heater. Show clearly how you get to your answer and give the units.

.....

Power = .....

**(2)**

(b) (i) What rating of fuse should be in the immersion heater circuit?

.....

**(1)**

(ii) There are three wires in the cable to the immersion heater. Two of the wires are connected to the immersion heater. The third wire is connected to the copper tank.

Explain the function of this third wire and the fuse in the circuit.

.....

.....

.....

.....

**(3)**

(c) (i) What is the equation which shows the relationship between resistance, current and voltage?

.....

**(1)**

(ii) Calculate the resistance of the heater. Show clearly how you get to your answer and give the units.

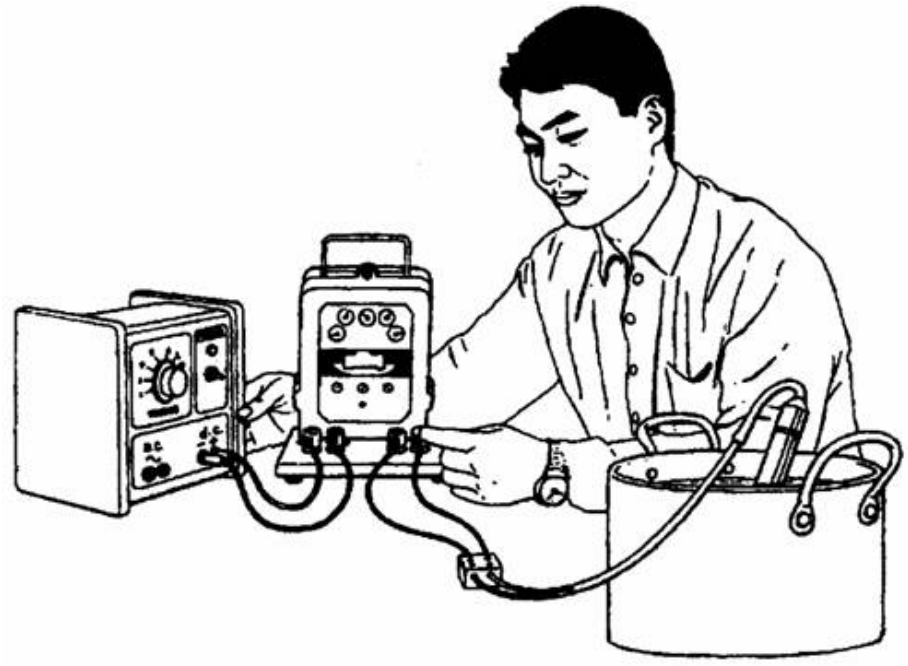
.....

Resistance = .....

**(2)**

**(Total 10 marks)**

**Q5.** The drawing shows an experiment using a low voltage supply, a joulemeter, a small immersion heater and a container filled with water.



The voltage was set at 6 V d.c. The reading on the joulemeter at the start of the experiment was 78 882 and 5 minutes later it was 80 142.

(i) Use the equation:

$$\text{voltage} = \frac{\text{energy}}{\text{charge}}$$

to work out the total charge which flowed through the immersion heater in five minutes. Clearly show how you get to your answer and give the unit.

.....

.....

.....

Charge = .....

**(3)**

(ii) Calculate the current through the immersion heater during the 5 minutes. Write the equation you are going to use, show clearly how you get to your answer and give the unit.

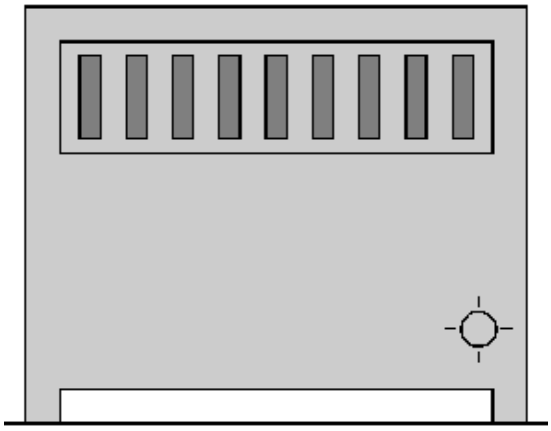
.....

.....

Current = .....

**(3)**
**(Total 6 marks)**

**Q6.** (a) The diagram shows a fan heater.



(i) A current of 11A flows when the fan heater is working normally.
Fuses of value 3A, 5A, 10A and 13A are available.
Which one should be used in the plug of the fan heater?

.....

**(1)**

(ii) A fault caused a much higher than normal current to flow in the heater.
Describe what happened to the wire in the fuse.

.....

.....

.....

.....

**(2)**

(b)

You may find this equation useful when answering this part of the question

**energy transferred (kWh) = power (kilowatt, kW) × time (hour, h)**

(i) The power of the fan heater is 2.75 kW.
Calculate how many kilowatt hours of energy are transferred when the fan heater is used for 6 hours.

.....

.....

.....

Number of kilowatt hours .....

**(2)**

(ii) How much will it cost to use the fan heater for 6 hours if one Unit of electricity costs 7p?

.....

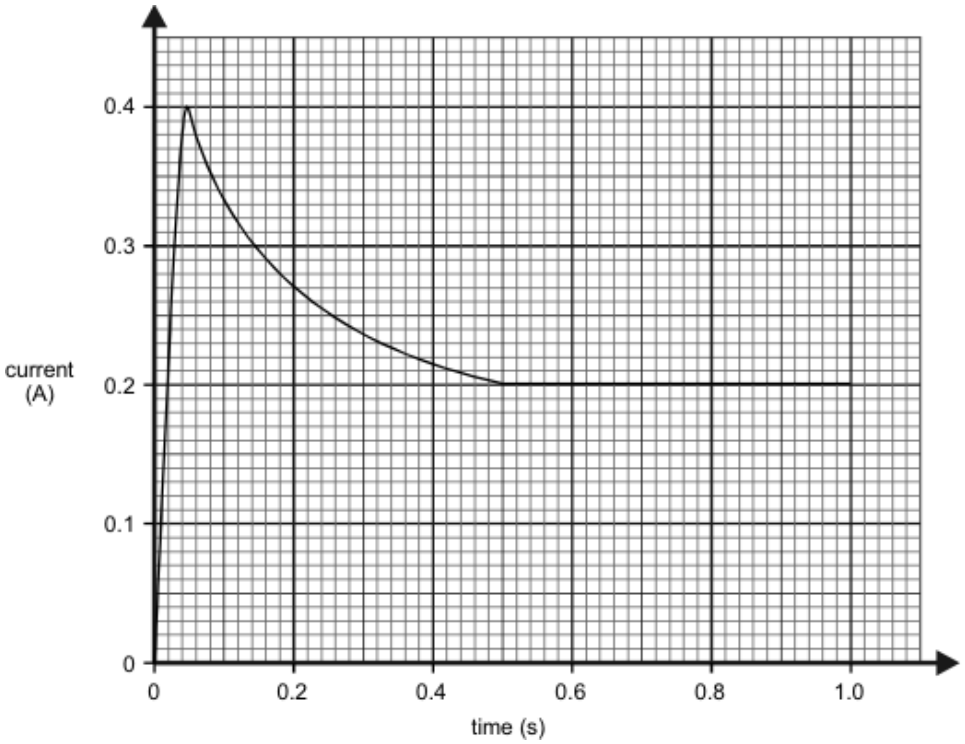
.....

Cost ..... p

**(2)**

**(Total 7 marks)**

**Q7.** When a mains lamp is switched on it takes 0.5 seconds for the filament to reach its normal operating temperature. The way in which the current changes during the first second after switching on is shown in the sketch graph below. Mains voltage is 240 V.




(a) Calculate the resistance of the filament whilst the lamp is drawing the **maximum** current.

.....

.....

.....

**(3)**

(b) Describe how the resistance of the lamp changes after the current has reached its maximum value.

.....

.....

**(2)**

(c) Calculate the **maximum** power taken by the lamp.

.....

.....

.....

**(2)**

(d) Calculate the power of the lamp in normal use.

.....

.....

.....

**(2)**

(e) Calculate the energy used by the lamp in six hours of normal use.

.....

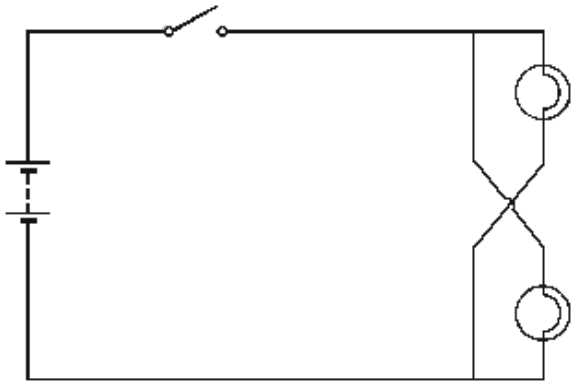
.....

.....

**(3)**

**(Total 12 marks)**

**Q8.** The circuit diagram below shows a circuit used to supply electrical energy to the two headlights of a car.



The current through the filament of one car headlight is 3.0 A. The potential difference across each of the two headlights is 12 V.

(a) Suggest a suitable fuse for the circuit. .....

**(1)**

(b) Calculate the resistance of the headlight filament when in use.

.....

.....

.....

.....

Answer ..... W

**(2)**

(c) Calculate the power supplied to the two headlights of the car.

.....

.....

.....

Answer ..... W

**(2)**

(d) The fully charged car battery can deliver 72 kJ of energy at 12 V. How long can the battery keep the headlights fully on?

.....

.....

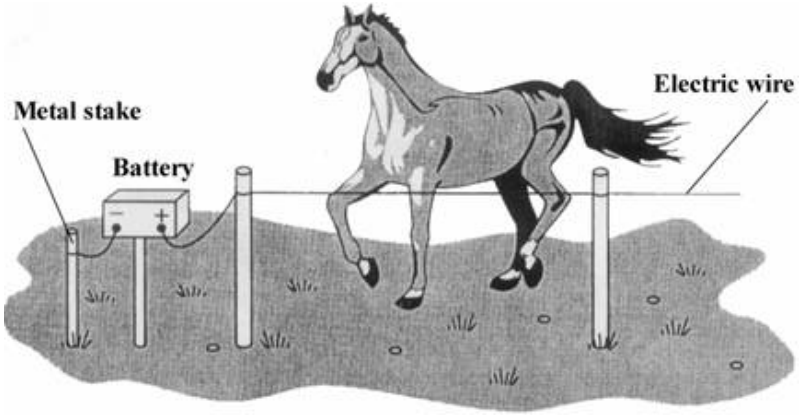
.....

Answer ..... s

**(2)**

**(Total 7 marks)**

**Q9.** (a) The diagram shows an electric fence, designed to keep horses in a field.




When a horse touches the wire the horse receives a mild electric shock. Explain how.

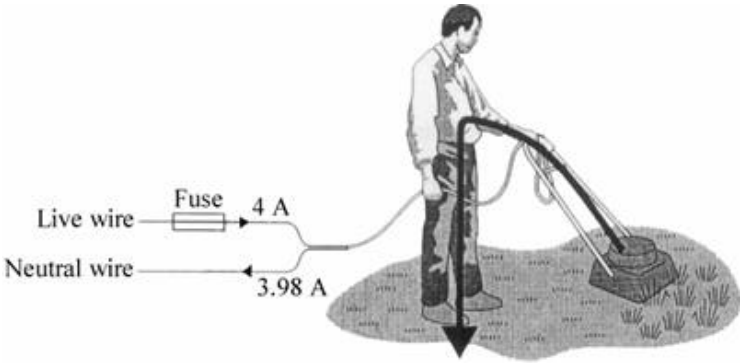
.....

.....

.....

**(2)**

(b) The diagram shows how a person could receive an electric shock from a faulty electrical appliance. Using a residual circuit breaker (RCB) can help to protect the person against receiving a serious shock.




(i) Compare the action of an RCB to that of a fuse.

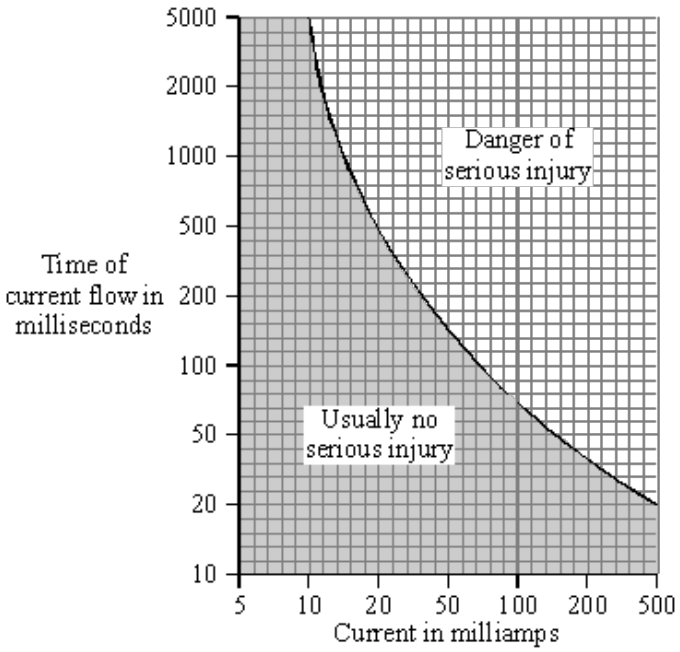
.....

.....

.....

**(2)**

(ii) The graph illustrates how the severity of an electric shock depends upon both the size of the current and the time for which the current flows through the body.




Within how long must the RCB cut off the current if the person using the lawnmower is to be in no danger of serious injury?

.....

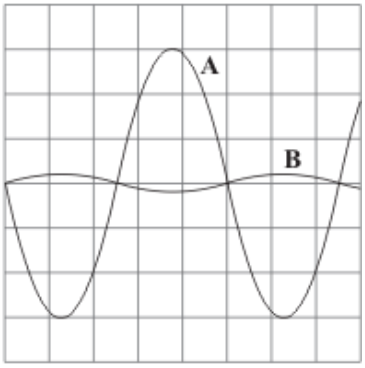
.....

Time = ..... milliseconds

**(2)**

**(Total 6 marks)**

**Q10.** The diagram shows two oscilloscope traces, **A** and **B**.




Trace **A** shows how the potential difference between the live and neutral terminals of an electricity supply changes with time.

(a) Describe how the potential of the live terminal varies with respect to the neutral terminal of the electricity supply.

.....

.....

**(2)**

(b) What does trace **B** show?

.....

.....

**(1)**

(c) Each horizontal division on the oscilloscope represents 0.005 s.

(i) What is the period of this electricity supply?

.....

Period = ..... seconds

**(1)**

(ii) Calculate the frequency of the supply.

.....

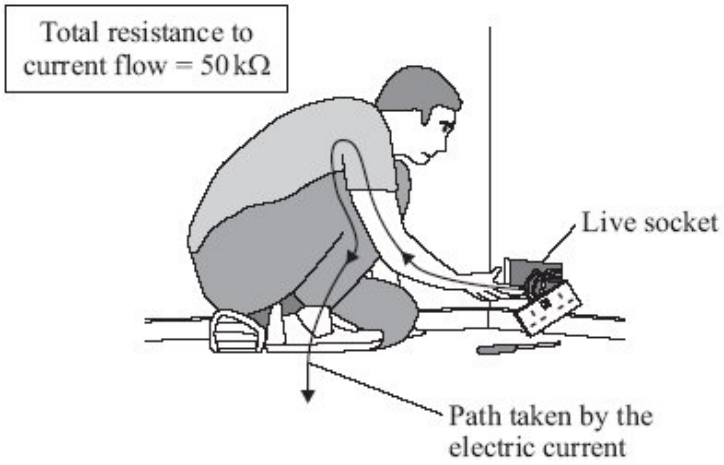
Frequency = ..... hertz

**(1)**

**(Total 5 marks)**

**Q11.** The diagram shows someone accidentally touching the live wire inside a dismantled 230 volt mains electricity socket.

A current flows through the person giving him an electric shock.




(a) (i) Use the equation in the box to calculate the current that will flow through the person.

| potential difference = current × resistance |
|---|

Show clearly how you work out your answer.

.....

.....

Current = ..... A

**(2)**

(ii) Rubber is a good insulator.

Explain why it is a good idea for electricians to wear rubber soled boots when working.

.....

.....

.....

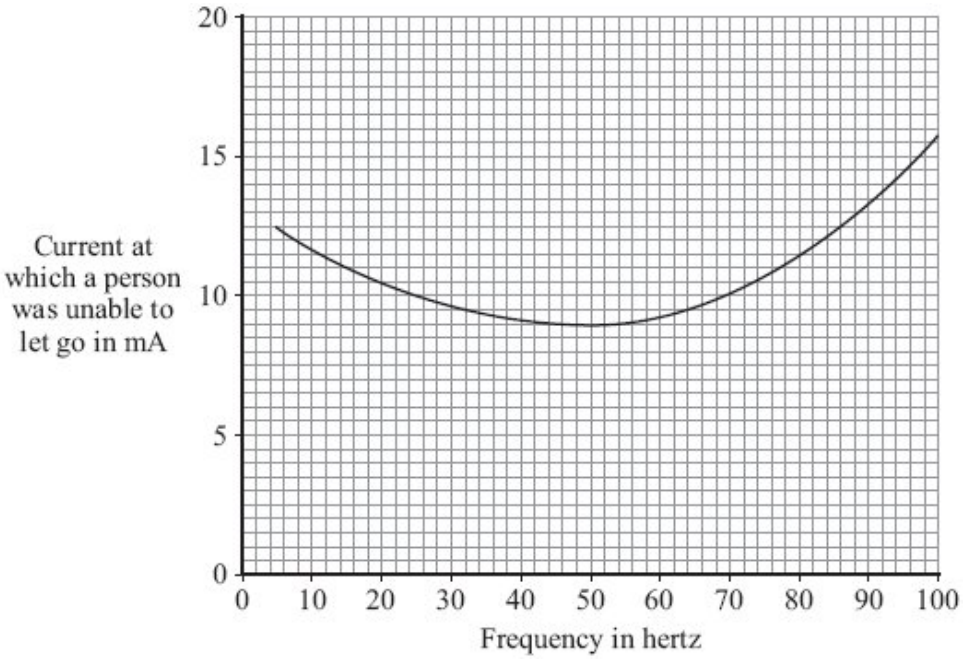
.....

**(2)**

(b) If the current flowing through a person is too high, the person cannot let go of the electrical source.

Different people were tested to see whether the ability to let go of an electrical source depended on the frequency of the current.

The results of the test are shown in the graph.




(i) What is the frequency of the mains electricity supply in the UK?

.....

**(1)**

(ii) From a safety point of view, is the frequency of the UK mains electricity supply suitable?

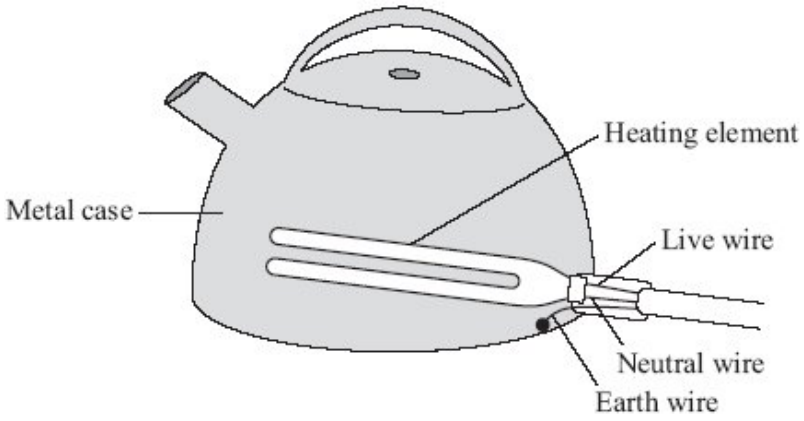
Give a reason for your answer.

.....

.....

**(1)**

(c) The diagram shows how the electric supply cable is connected to an electric kettle. The earth wire is connected to the metal case of the kettle.




If a fault makes the metal case live, the earth wire and the fuse inside the plug protect anyone using the kettle from an electric shock.

Explain how.

.....

.....

.....

.....

**(2)**

**(Total 8 marks)**

**Q12.** (a) Describe the difference between an alternating current (a.c.) and a direct current (d.c.).

.....

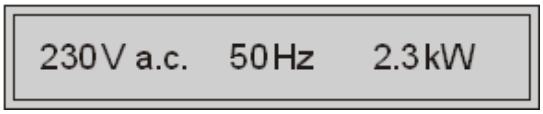
.....

.....

.....

**(2)**

(b) The diagram shows the information plate on the bottom of an electric wallpaper steamer.



(i) Use the equation in the box to calculate the current used by the steamer.

| power = current × potential difference |
|---|

Show clearly how you work out your answer.

.....

.....

Current ..... A

**(2)**

(ii) Which **one** of the following fuses should be used inside the plug of the steamer?

Draw a ring around your answer.

**1 A** **3 A** **5 A** **10 A** **13 A**

**(1)**

**(Total 5 marks)**

**Q13.** In the UK mains electricity is a 230 volt a.c. supply.

(a) What is the frequency of the a.c. mains electricity in the UK?

.....

**(1)**

(b) (i) What is an electric current?

.....

**(1)**

(ii) Explain the difference between an a.c. (alternating current) electricity supply and a d.c. (direct current) electricity supply.

.....

.....

.....

.....

**(2)**

(c) A householder has a 10.8 kW electric shower installed in the bathroom.

(i) Calculate the current drawn from the mains electricity supply by the shower.

Write down the equation you use, and then show clearly how you work out your answer.

.....

.....

.....

.....

Current = ..... A

**(2)**

(ii) The table gives the maximum current that can safely pass through electric cables of different cross-sectional area.

| **Cross-sectional area in mm $^2$** | **Maximum safe current in amps** |
|---|---|
| 1.0 | 11.5 |
| 2.5 | 20.0 |
| 4.0 | 27.0 |
| 6.0 | 34.0 |
| 10.0 | 46.0 |
| 16.0 | 62.0 |

The existing power sockets in the house are wired to the mains electricity supply using 2.5 $mm^2$ cable.

Use the data in the table to explain why the shower must **not** be connected to the mains electricity supply using 2.5 $mm^2$ cable.

.....

.....

.....

.....

**(2)**

(iii) The circuit connecting the shower to the mains electricity supply must include a residual current circuit breaker (RCCB) and not a fuse.

Give **two** advantages of using a RCCB to protect a circuit rather than a fuse.

1 .....

.....

2 .....

.....

**(2)**
**(Total 10 marks)**

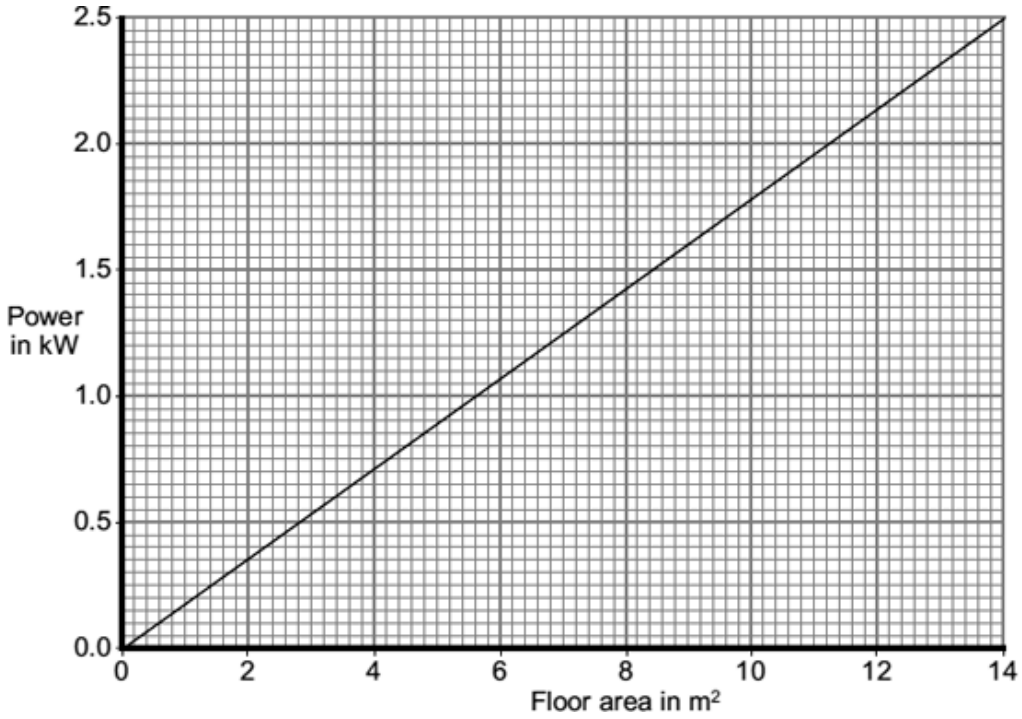
**Q14.** A homeowner has installed electric underfloor heating in the kitchen. When the heating is switched on, an electric current flows through wires running under the tiled floor surface.

(a) What is an electric current?

.....

**(1)**

(b) The graph shows how the power output of an underfloor heating system depends on the area of the floor that is heated.




The area of the homeowner's kitchen floor is 9.0 $m^{2.}$

Use the graph and the equation in the box to calculate the current drawn from the 230 V mains supply by the heating system.

| power = current × potential difference |
|---|

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

.....

.....

.....

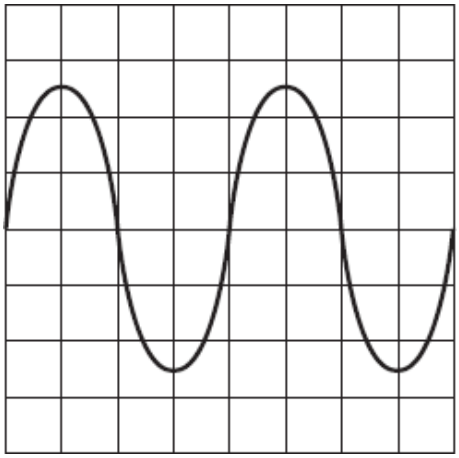
.....

Current = .....

**(4)**

**(Total 5 marks)**

**Q15.** An oscilloscope is connected to an alternating current (a.c.) supply.
The diagram shows the trace produced on the oscilloscope screen.



Each horizontal division on the oscilloscope screen represents 0.002 s.

(a) Calculate the frequency of the alternating current supply.

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

.....

.....

.....

Frequency = .....

**(3)**

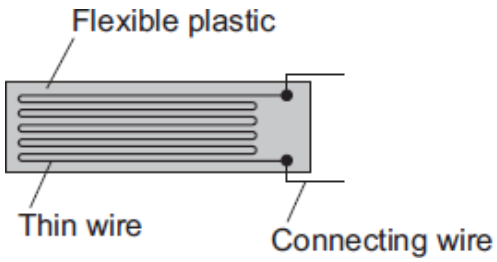
(b) What is the frequency of the a.c. mains electricity supply in the UK?

.....

**(1)**
**(Total 4 marks)**

**Q16.** The diagram shows a strain gauge, which is an electrical device used to monitor a changing force.

Applying a force to the gauge causes it to stretch.
This makes the electrical resistance of the wire change.




(a) (i) Using the correct symbols, **add** to the diagram to show how a battery, an ammeter and a voltmeter can be used to find the resistance of the strain gauge drawn above.

**(2)**

(ii) When in use, the strain gauge is always connected to a d.c. power supply, such as a battery.

How is a d.c. (direct current) power supply different from an a.c. (alternating current) power supply?

.....

.....

.....

**(1)**

(b) Before any force is applied, the unstretched gauge, correctly connected to a 3.0 V battery, has a current of 0.040 A flowing through it.

(i) Use the equation in the box to calculate the resistance of the unstretched gauge.

| potential difference = current × resistance |
|---|

Show clearly how you work out your answer.

.....

.....

Resistance = ..... Ω

**(2)**

(ii) Stretching the gauge causes the current flowing through the gauge to decrease.

What happens to the resistance of the gauge when it is stretched?

.....

.....

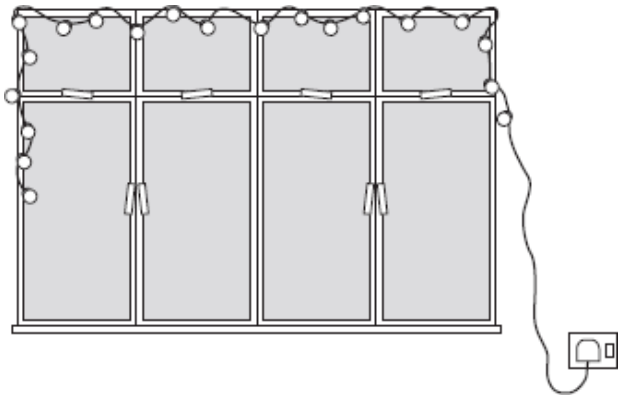
**(1)**

(iii) What form of energy is stored in the gauge when a force is applied and the gauge stretches?

.....

**(1)**
**(Total 7 marks)**

**Q17.** A set of lights consists of 20 lamps connected in series to the 230 V mains electricity supply.



(a) When the lights are switched on and working correctly, the current through each lamp is 0.25 A.

(i) What is the total current drawn from the mains supply?

.....

**(1)**

(ii) Use the equation in the box to calculate the charge passing through **one** of the lamps in 5 minutes.

| charge = current × time |
|---|

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

.....

.....

.....

.....

Total charge = .....

**(3)**

(b) One of the lamps in the set is a fuse lamp. This contains a filament which melts if a fault occurs. A short time after the lights are switched on, a fault causes the filament inside the fuse lamp to melt and all the lamps go out.

The householder cannot find another fuse lamp so connects a piece of aluminium foil across the contacts inside the fuse lamp holder.
When switched on, the nineteen remaining lamps work.
What the householder has done is dangerous.

Explain why.

.....

.....

.....

.....

**(2)**
**(Total 6 marks)**

**Q18.** (a) The picture shows a person using a set of electronic 'Body Fat Scales'. When the person stands on the scales, a small, harmless, electric current passes through the person's body. The scales then calculate the resistance of the person's body and convert the resistance into a *prediction* of body fat content.

(i) The scales contain two 3 V cells joined in series.

Calculate the resistance of a person's body, if when he stands on the scales, a current of 0.12 mA passes through his body.

1000 mA = 1 A

Use the correct equation from the Physics Equations Sheet.

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

.....

.....

.....

Resistance = .....

**(3)**

(ii) The scales can only produce a *prediction* of body fat content and not an accurate measurement.

Suggest why.

.....

.....

.....

**(1)**

(iii) It is recommended that the scales are **not** used immediately after a person has drunk a large amount of water.

Suggest why.

.....

.....

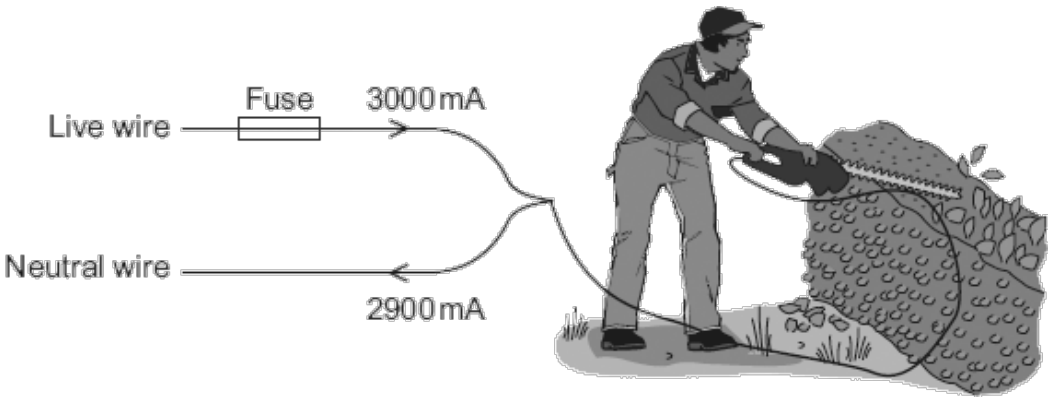
.....

.....

.....

**(2)**

(b) The diagram shows how someone could get an electric shock from accidentally cutting into an electric cable. If this happens, and a Residual Current Circuit Breaker (RCCB) is being used, the circuit will switch off automatically.




(i) A faulty appliance or circuit can be switched off by a RCCB or a fuse.

Compare the action of a RCCB with the action of a fuse.

.....

.....

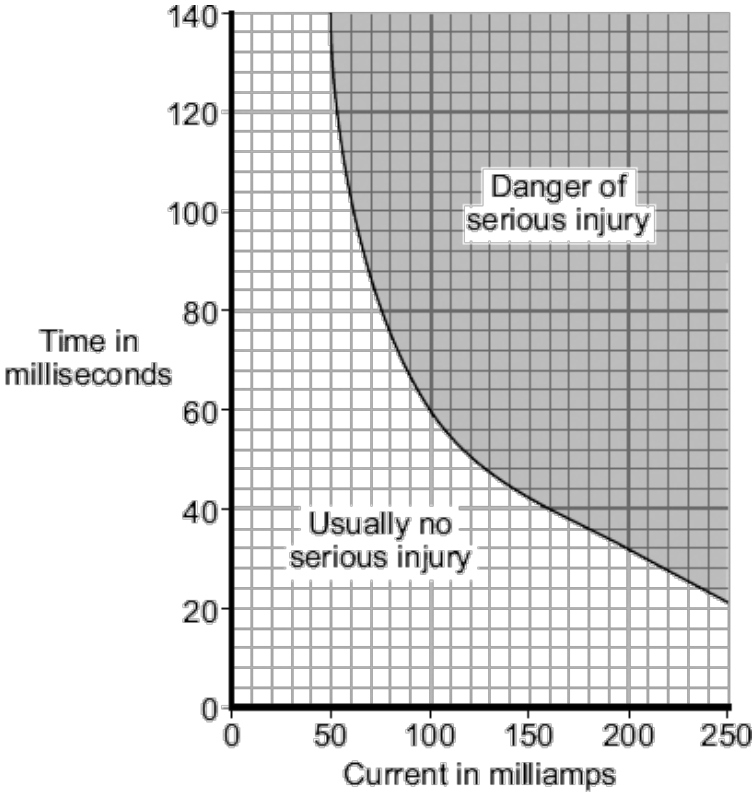
.....

.....

.....

**(2)**

(ii) The graph shows how the severity of an electric shock depends on the size of the current and the time that the current flows through the body.




Using the RCCB helps prevent an electric shock seriously injuring the person using the hedge trimmers.

Using information from both the diagram and the graph explain how.

.....

.....

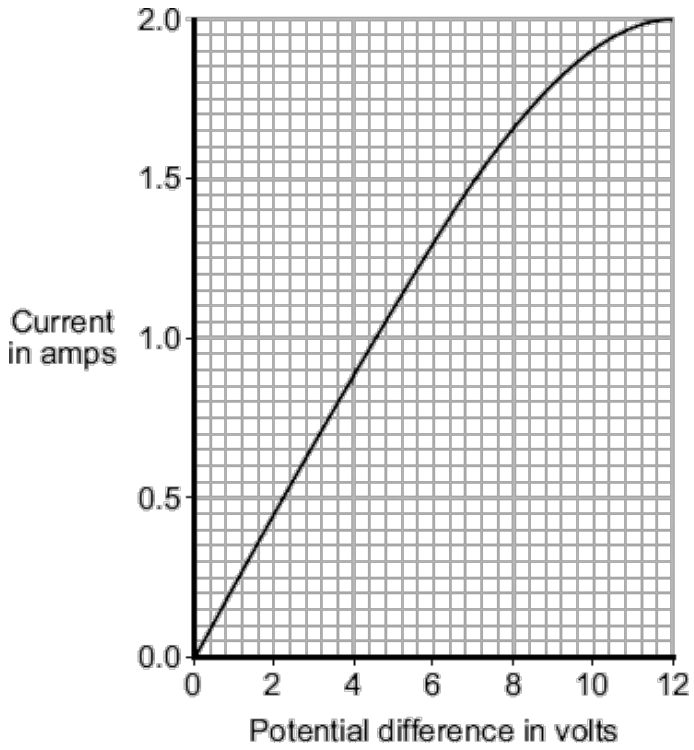
.....

.....

.....

**(2)**
**(Total 10 marks)**

**Q19.** The graph shows how the electric current through a 12 V filament bulb varies with the potential difference across the bulb.




(a) What is the meaning of the following terms?

electric current

.....

.....

potential difference

.....

.....

**(2)**

(b) The resistance of the metal filament inside the bulb increases as the potential difference across the bulb increases.

Explain why.

.....

.....

.....

.....

.....

.....

.....

.....

**(3)**

(c) Use data from the graph to calculate the rate at which the filament bulb transfers energy, when the potential difference across the bulb is 6 V.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

.....

.....

Rate of energy transfer = ..... W

**(2)**
**(Total 7 marks)**

**Q20.** (a) Describe the difference between an alternating current (a.c.) and a direct current (d.c.).

.....

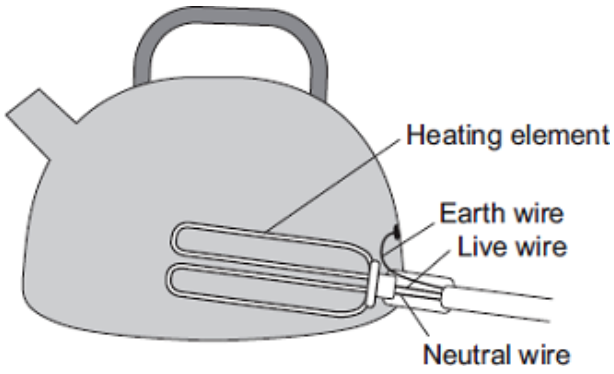
.....

.....

.....

**(2)**

(b) The diagram shows how the electric supply cable is connected to an electric kettle. The earth wire is connected to the metal case of the kettle.




If a fault makes the metal case live, the earth wire and the fuse inside the plug protect anyone using the kettle from an electric shock.

Explain how.

.....

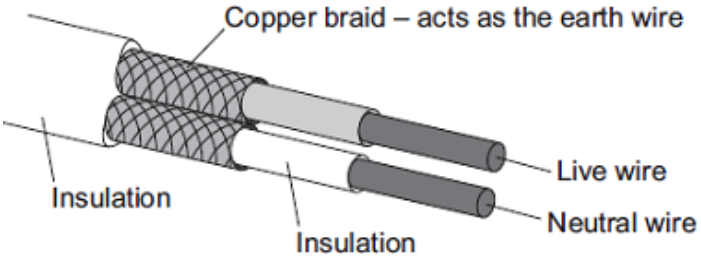
.....

.....

.....

**(2)**
**(Total 4 marks)**

**Q21.** The diagram shows the structure of a cable. The cable is part of an undersoil heating circuit inside a large greenhouse.




(a) The cable is connected to the mains electricity supply through a residual current circuit breaker (RCCB). If the cable is accidentally cut the RCCB automatically switches the circuit off.

(i) What is the frequency of the mains electricity supply in the UK?

.....

**(1)**

(ii) What happens, as the cable is cut, to cause the RCCB to switch the circuit off?

.....

.....

.....

.....

**(2)**

(iii) A circuit can also be switched off by the action of a fuse.

Give **one** advantage of using a RCCB to switch off a circuit rather than a fuse.

.....

.....

**(1)**

(b) The 230 volt mains electricity supply causes a current of 11 amps to flow through the cable.

(i) Calculate the amount of charge that flows through the cable when the cable is switched on for 2 hours and give the unit.

Use the correct equation from the Physics Equations Sheet.

.....

.....

.....

Charge = .....

**(3)**

(ii) Calculate the energy transferred from the cable to the soil in 2 hours.

Use the correct equation from the Physics Equations Sheet.

.....

.....

Energy transferred =..... J

**(2)**

(c) The heating circuit includes a thermistor. The thermistor is buried in the soil and acts as a thermostat to control the increase in the temperature of the soil.

Describe how an **increase** in the temperature of the soil affects the thermistor.

.....

.....

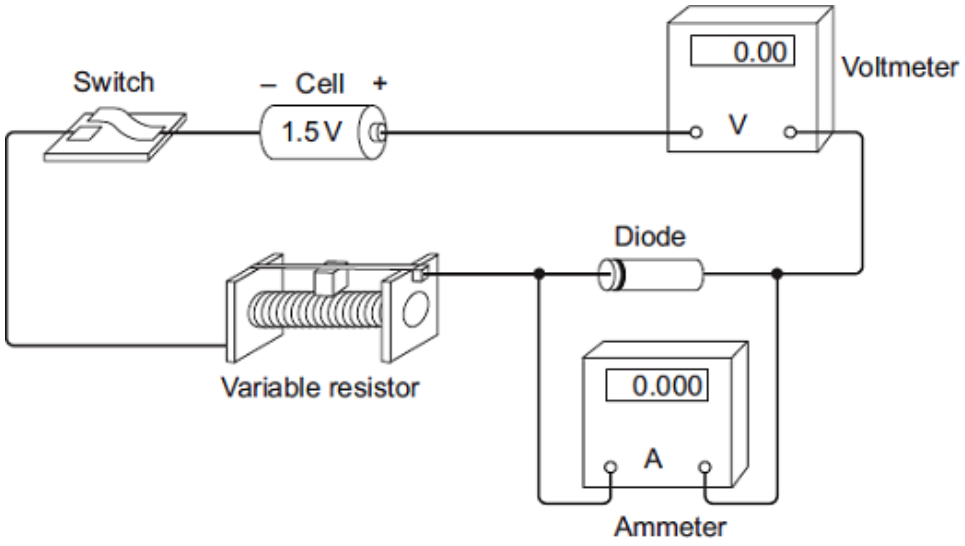
.....

.....

**(2)**

**(Total 11 marks)**

**Q22.** (a) A student set up the circuit shown in the diagram. The student uses the circuit to obtain the data needed to plot a current - potential difference graph for a diode.




(i) Draw, in the boxes, the circuit symbol for a diode and the circuit symbol for a variable resistor.

| **Diode** | **Variable resistor** |
| --- | --- |
| | |

**(2)**

(ii) The student made two mistakes when setting up the circuit.

What **two** mistakes did the student make?

1 .....

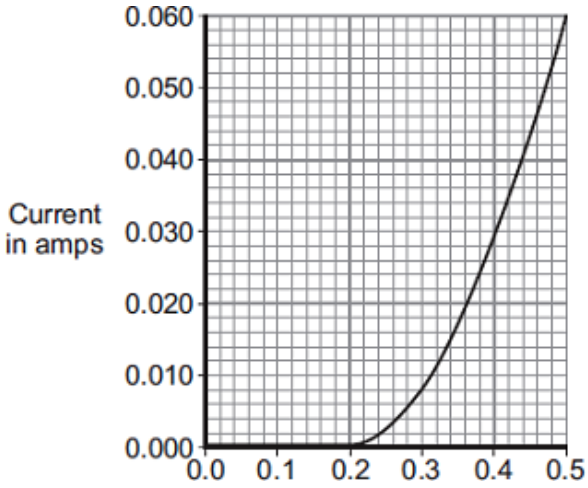
.....

2 .....

.....

**(2)**

(b) After correcting the circuit, the student obtained a set of data and plotted the graph below.




(i) At what potential difference did the diode start to conduct an electric current?

..... V

**(1)**

(ii) Use data from the graph to calculate the resistance of the diode when the potential difference across the diode is 0.3 V.

Use the correct equation from the Physics Equations Sheet.

.....

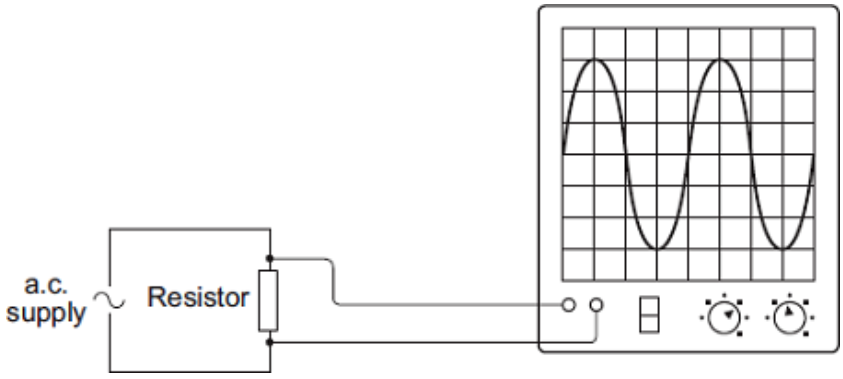
.....

.....

Resistance = ..... ohms

**(3)**

(c) The diagram shows the trace produced by an alternating current (a.c.) supply on an oscilloscope.




Each horizontal division on the oscilloscope screen represents a time of 0.01s.

(i) Calculate the frequency of the a.c. supply.

.....

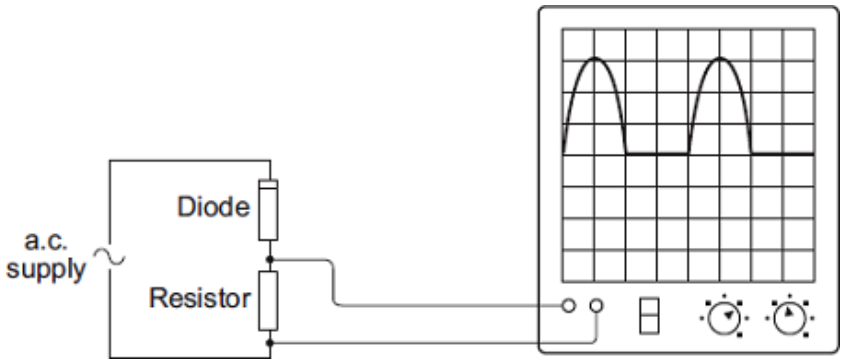
.....

.....

Frequency = ..... hertz

**(2)**

(ii) A diode is now connected in series with the a.c. power supply.




Why does the diode cause the trace on the oscilloscope screen to change?

.....

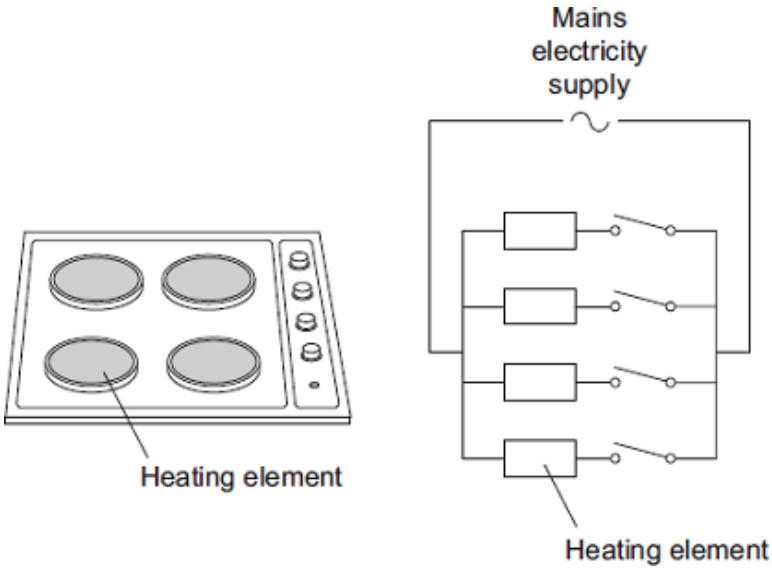
.....

.....

.....

**(2)**
**(Total 12 marks)**

**Q23.** The picture shows an electric cooker hob. The simplified circuit diagram shows how the four heating elements connect to the mains electricity supply. The heating elements are identical.




When all four heating elements are switched on at full power the hob draws a current of 26 A from the 230 V mains electricity supply.

(a) Calculate the resistance of one heating element when the hob is switched on at full power.

Use the correct equation from the Physics Equations Sheet.

Give your answer to 2 significant figures.

.....

.....

.....

Resistance = ..... Ω

**(3)**

(b) The table gives the maximum current that can safely pass through copper wires of different cross-sectional area.

| Cross-sectional area in $mm^2$ | Maximum safe current in amps |
|---|---|
| **1.0** | **11.5** |
| **2.5** | **20.0** |
| **4.0** | **27.0** |
| **6.0** | **34.0** |

(i) The power sockets in a home are wired to the mains electricity supply using cables containing 2.5 $mm^2$ copper wires. Most electrical appliances are connected to the mains electricity supply by plugging them into a standard power socket.

It would **not** be safe to connect the electric cooker hob to the mains electricity supply by plugging it into a standard power socket.

Why?

.....

.....

.....

.....

**(2)**

(ii) Describe the structure of the cable that should be used to connect the electric cooker hob to the mains electricity supply.

.....

.....

.....

.....

.....

.....

.....

.....

**(3)**

(c) Mains electricity is an alternating current supply. Batteries supply a direct current.

What is the difference between an alternating current and a direct current?

.....

.....

.....

.....

**(2)**
**(Total 10 marks)**