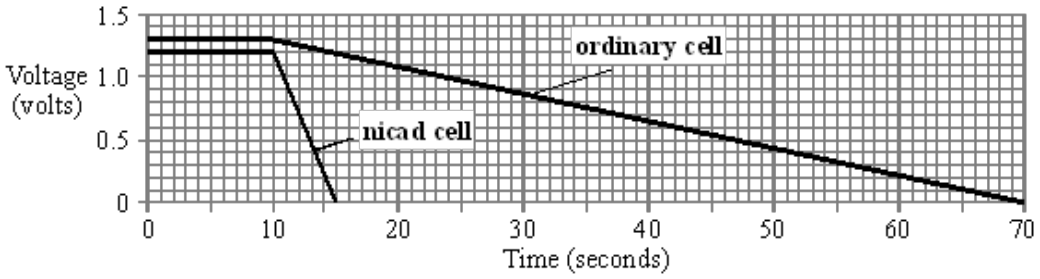
Q1. A small torch uses a single cell to make the bulb light up.

(a) The graphs show the voltage across two different types of cell as they transfer the last bit of their stored energy through the torch bulb.



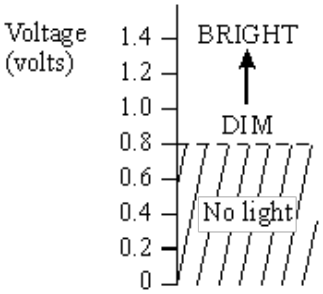
Describe the differences that the graphs show between the two types of cell.

.....

.....

(3)

(b) The diagram shows how bright the torch bulb is for different voltages.



From the point when the voltage of each cell starts to fall, how long will the bulb stay lit:

(i) with the ordinary cell?

.....

(ii) with the nicad cell?

.....

(4)

(c) When the voltage across the bulb falls to half, the current through the bulb falls by **less than** half. Why is this?

.....

.....

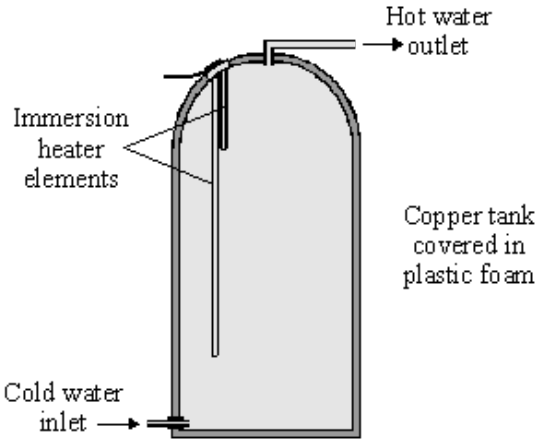
.....

.....

(3)

(Total 10 marks)

Q2. 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)

Q3. The following specification is taken from the instruction booklet of a combination microwave oven.

AC voltage	240 V 50 Hz
Power required	
Microwave	1.5 kW
Dual (Roast/Bake)	2.8 kW
Dual (Grill)	2.5 kW
Convection	1.35 kW
Grill	2.3 kW
Output power	
Microwave	850 W
Convection heater	1350 W
Grill heater	1000 W
Microwave frequency	2450 MHz

(a) (i) What is the current when the oven is being used to cook in the dual (roast/bake) mode? Show clearly how you work out your answer.

.....

.....

Current = ... A

(2)

(ii) Calculate the resistance of this combination microwave oven when it is being used in the dual (roast/bake) mode. Show clearly how you work out your answer and give the units.

.....

.....

.....

Resistance = ...

(3)

(b) What is the percentage efficiency of the oven when it is working in the microwave mode?

$$\text{Efficiency} = \frac{\text{useful energy output}}{\text{total energy input}} \times 100\%$$

.....

.....

.....

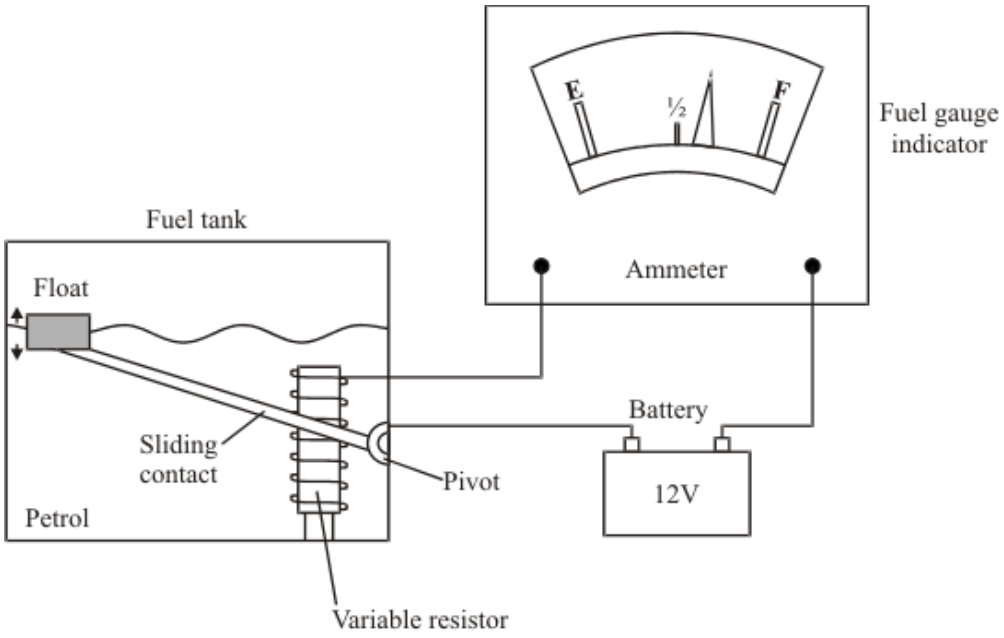
Percentage efficiency = ... %

(2)

(Total 7 marks)

Q4. The diagram shows the fuel gauge assembly in a car.

- The sliding contact touches a coil of wire and moves over it.
- The sliding contact and the coil form a variable resistor.
- The sliding contact is connected to a float via a pivot.
- The fuel gauge indicator is an ammeter.
- When the petrol level changes, the resistance of the circuit changes.
- This causes the pointer in the fuel gauge indicator to move.



(a) Use standard symbols to draw a circuit diagram for the fuel gauge assembly.

(3)

(b) How will the current in the circuit change as the level of petrol in the tank falls?

.....

Explain the reason for your answer.

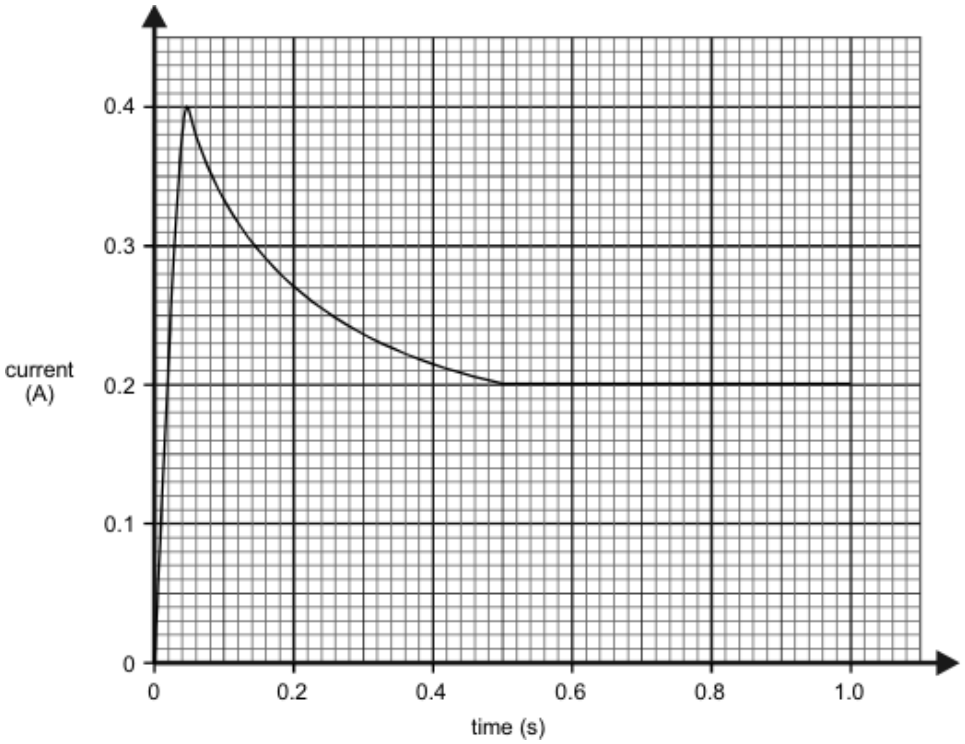
.....

.....

.....

(2)
(Total 5 marks)

Q5. 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.

.....

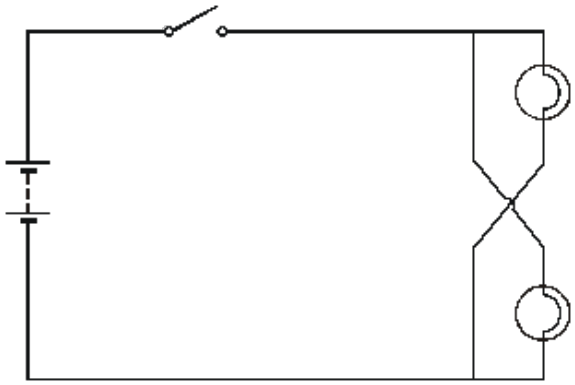
.....

.....

(3)

(Total 12 marks)

Q6. 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?

.....

.....

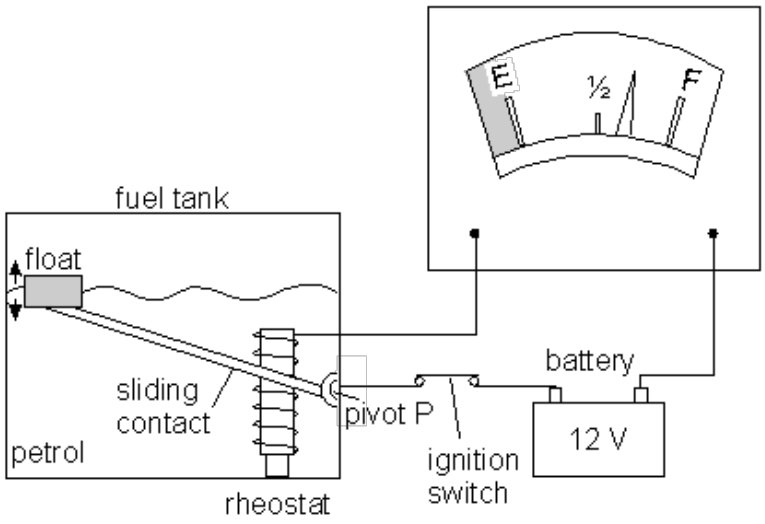
.....

Answer ..... s

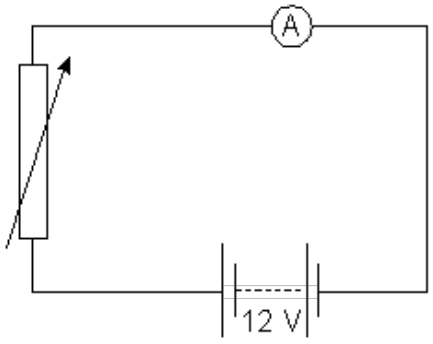
(2)

(Total 7 marks)

Q7. The diagram below shows how one type of fuel gauge in a car works. A sliding contact makes contact with a resistance wire wound in a coil (rheostat). It is connected to a float via a pivot P. When the petrol level changes the circuit resistance changes. This causes the pointer in the fuel gauge to move and show how much petrol is in the petrol tank.



The circuit diagram is shown below.



The petrol gauge is an ammeter. Explain why the reading on the ammeter falls as the petrol is used.

.....

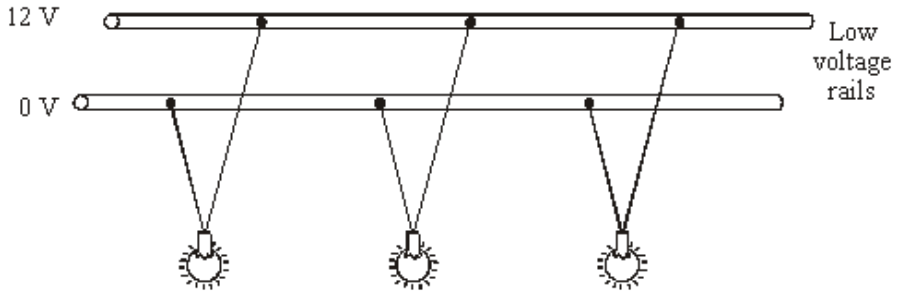
.....

.....

.....

(Total 3 marks)

Q8. The diagram shows a 12 volt lighting system. Each lamp has a power of 32 watts.



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

.....

(1)

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

.....

.....

current = ... A

(2)

(Total 3 marks)

Q9. 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)

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

.....

.....

.....

.....

Resistance = ...

(4)

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

.....

.....

Total resistance = ...

(1)

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

.....

.....

.....

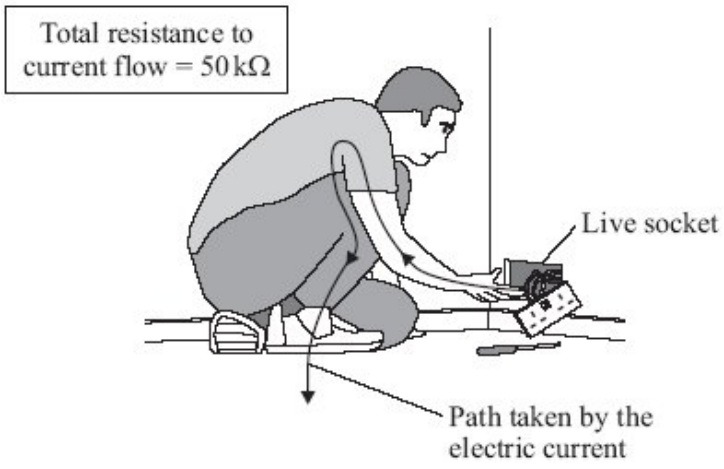
.....

(1)

(Total 7 marks)

Q10. 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.

.....

.....

.....

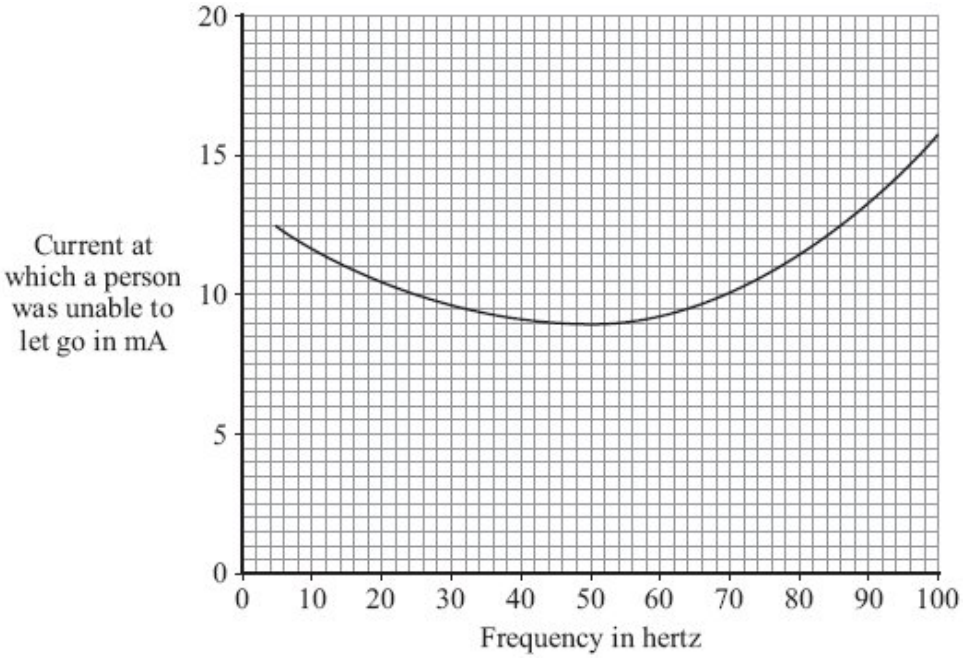
.....

(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?

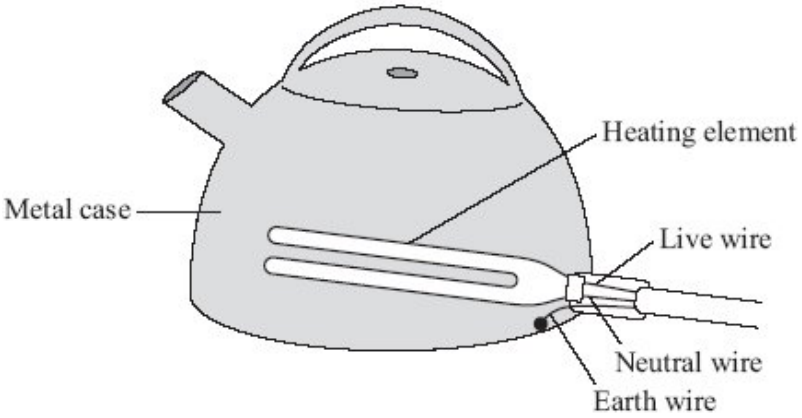
Give a reason for your answer.

.....

.....

(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.

.....

.....

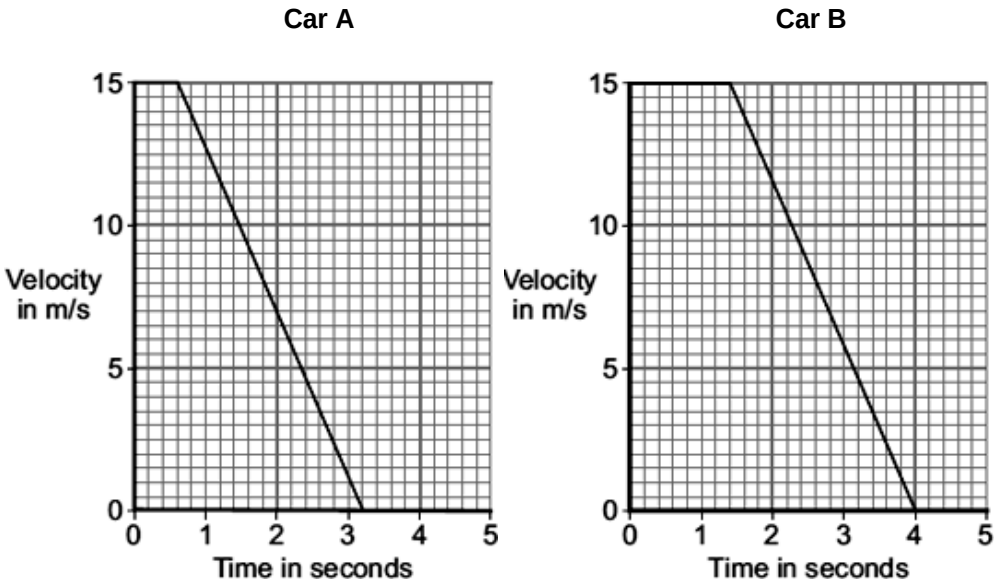
.....

.....

(2)

(Total 8 marks)

Q11. (a) The graphs show how the velocity of two cars, **A** and **B**, change from the moment the car drivers see an obstacle blocking the road.



One of the car drivers has been drinking alcohol. The other driver is wide awake and alert.

(i) How does a comparison of the two graphs suggest that the driver of car **B** is the one who has been drinking alcohol?

.....

.....

(1)

(ii) How do the graphs show that the two cars have the same deceleration?

.....

.....

(1)

(iii) Use the graphs to calculate how much further car **B** travels before stopping compared to car **A**.

Show clearly how you work out your answer.

.....

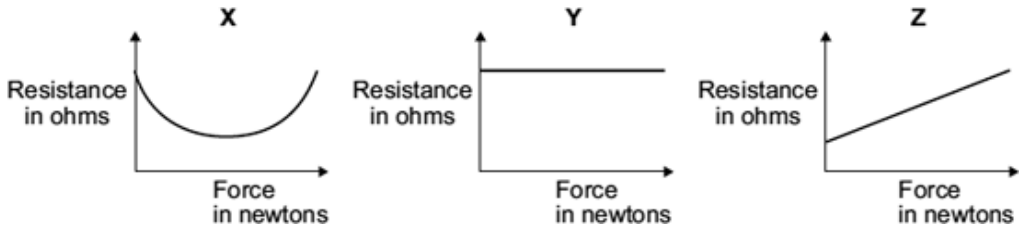
.....

.....

Additional stopping distance = ... m

(3)

(b) In a crash test laboratory, scientists use sensors to measure the forces exerted in collisions. The graphs show how the electrical resistance of 3 experimental types of sensor, **X**, **Y** and **Z**, change with the force applied to the sensor.



Which of the sensors, **X**, **Y** or **Z**, would be the best one to use as a force sensor?

.....

Give a reason for your answer.

.....

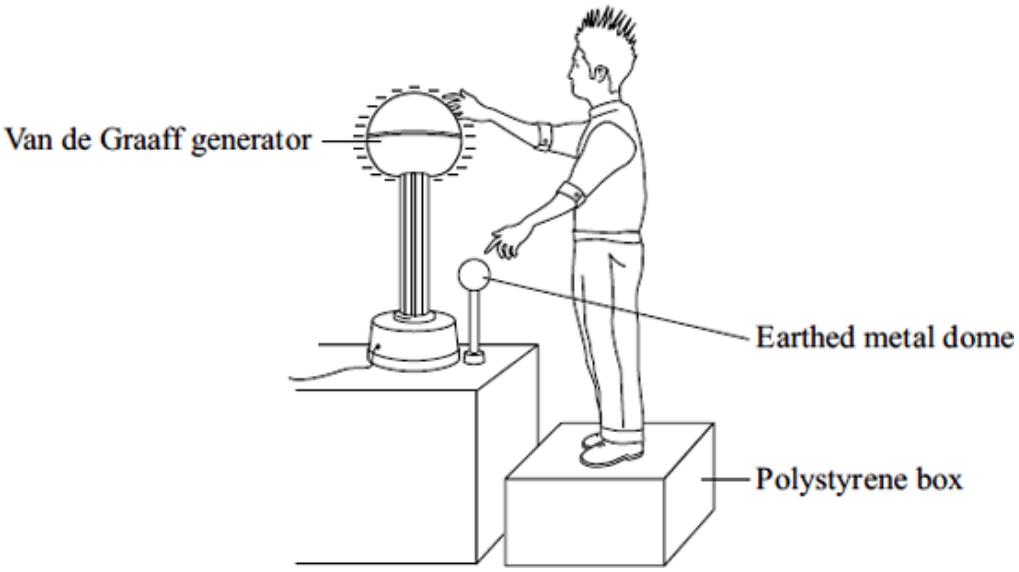
.....

.....

.....

(2)
(Total 7 marks)

Q12. (a) The diagram shows a student touching the metal dome of a Van de Graaff generator. When the generator is switched on, the metal dome becomes negatively charged.



Explain why the student's hair stands on end when the generator is switched on.

.....

.....

.....

(2)

(b) When the potential difference between the student and a nearby earthed metal dome reached 15 kV, a spark jumped between the student and the earthed dome. The spark transformed 30 mJ of energy into heat, light and sound. (1 mJ = 0.001 J)

Use the equation in the box to calculate the charge carried by the spark.

energy transformed = potential difference × charge

.....

.....

Charge transferred =..... coulombs

(2)

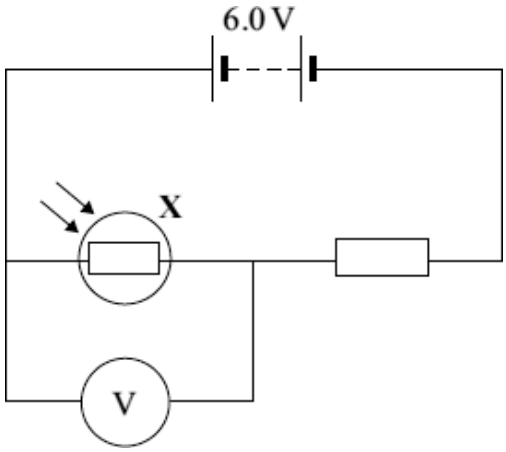
(c) What name is given to the rate of flow of charge?

.....

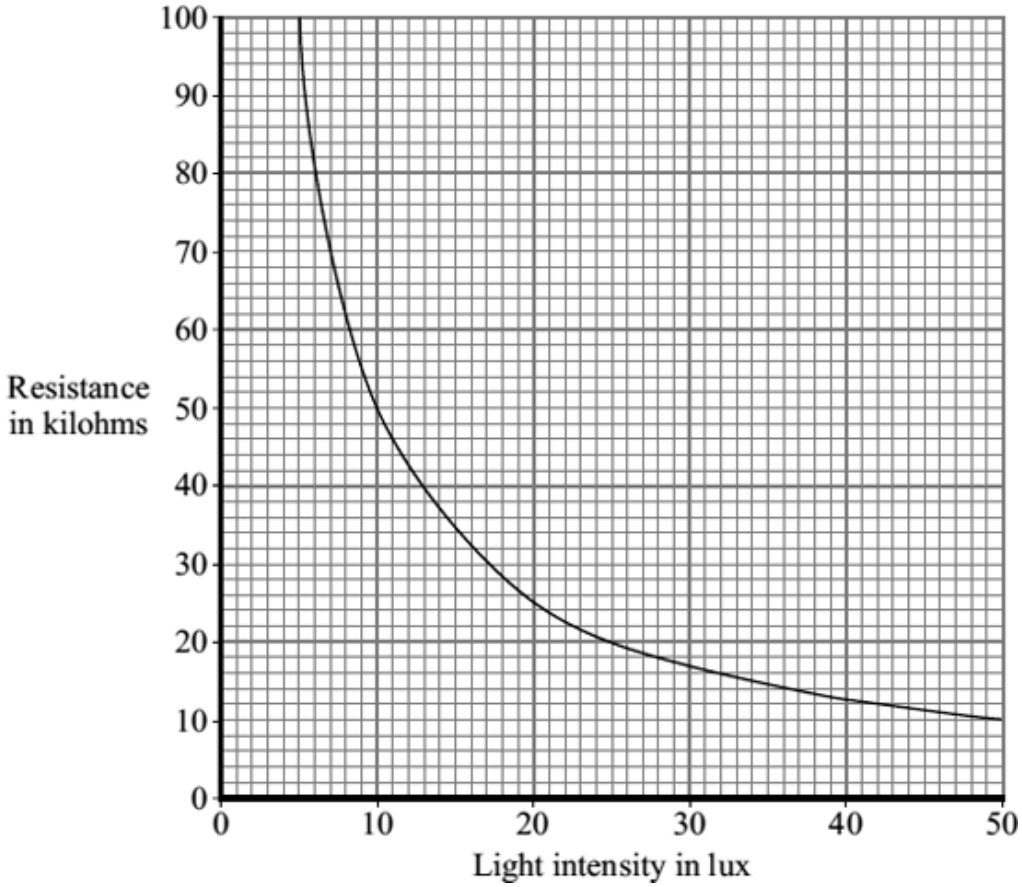
(1)

(Total 5 marks)

Q13. The diagram shows a simple light-sensing circuit.



(a) The graph, supplied by the manufacturer, shows how the resistance of the component labelled **X** varies with light intensity.



(i) What is component **X**?

.....

(1)

(ii) Use the graph to find the resistance of component **X** when the light intensity is 20 lux.

.....

(1)

(iii) When the light intensity is 20 lux, the current through the circuit is 0.0002 A.

Use the equation in the box to calculate the reading on the voltmeter when the light intensity is 20 lux.

potential difference = current × resistance

Show clearly how you work out your answer.

.....

.....

Voltmeter reading =..... volts

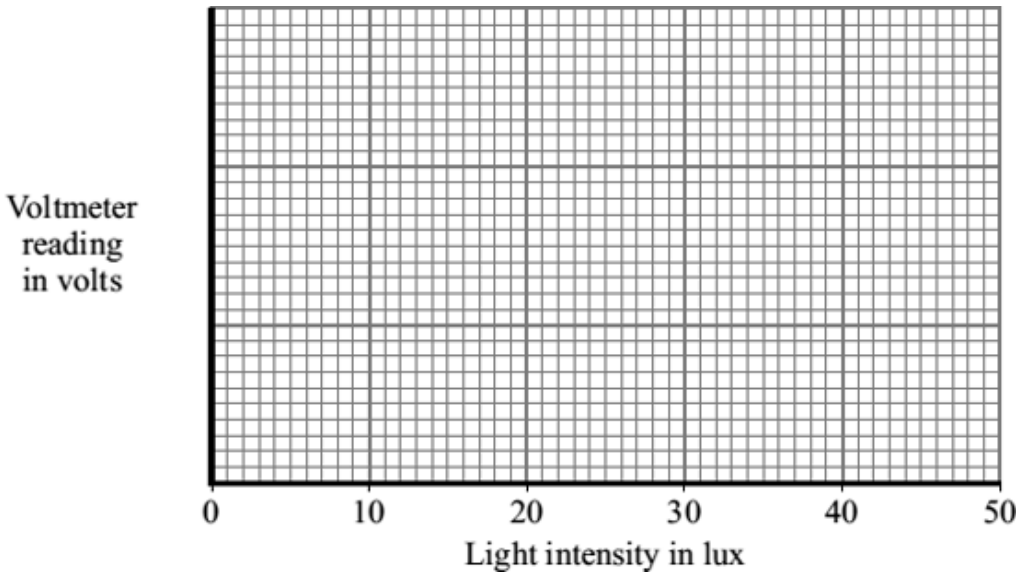
(2)

(b) Use the grid below to show how the voltmeter reading in the light-sensing circuit varies with light intensity.

(i) Add a suitable scale to the *y*-axis (vertical axis).

(1)

(ii) Complete the sketch graph by drawing a line on the grid to show how the voltmeter reading will vary with light intensity.



(2)

(c) The following passage is taken from the technical data supplied for component **X** by the manufacturer.

> For any given light intensity, the resistance of this component can vary by plus or minus 50% of the value shown on the **graph of light intensity and resistance**.

(i) Calculate the maximum resistance that component **X** could have at 20 lux light intensity.

.....

Maximum resistance =..... kilohms

(1)

(ii) Explain why this light-sensing circuit would **not** be used to measure values of light intensity.

.....

.....

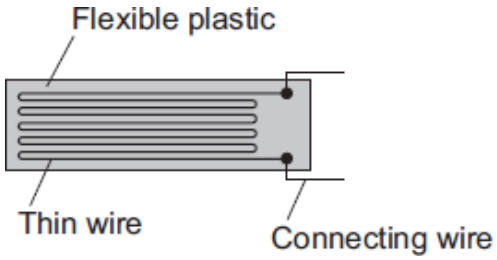
.....

(2)

(Total 10 marks)

Q14. 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)

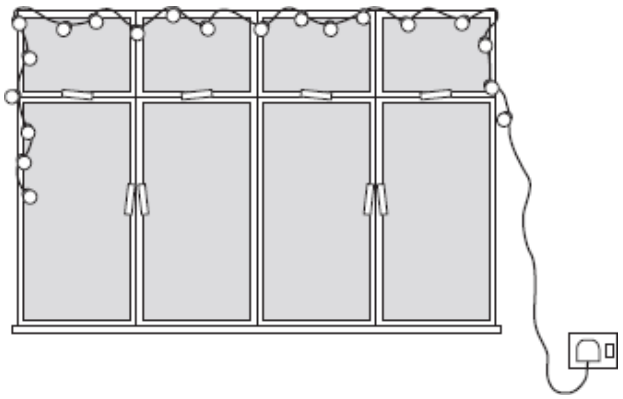
(iii) What form of energy is stored in the gauge when a force is applied and the gauge stretches?

.....

(1)

(Total 7 marks)

Q15. 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.

.....

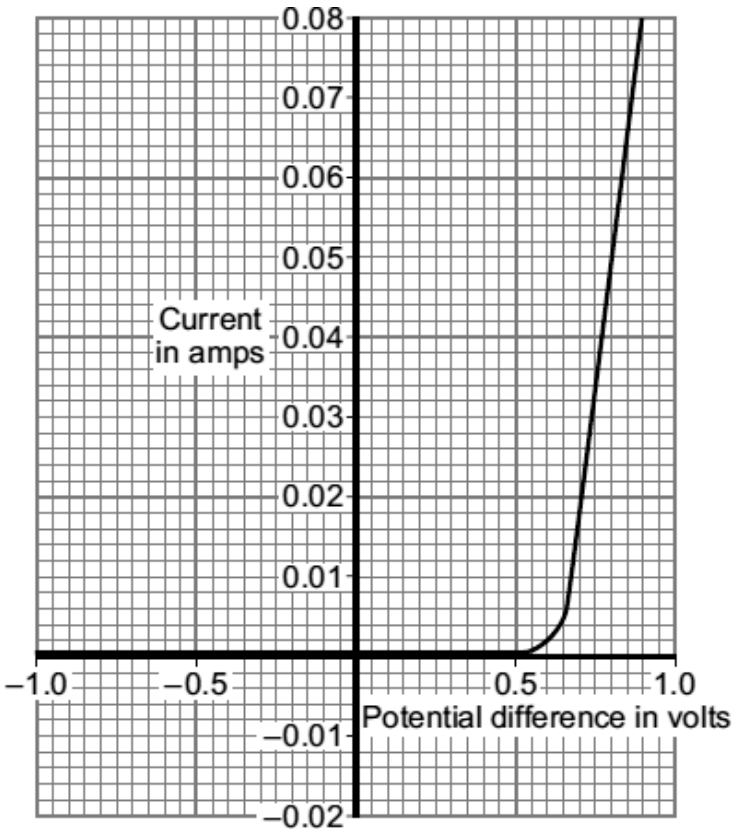
.....

.....

.....

(2)
(Total 6 marks)

Q16. The current–potential difference graph for one type of electrical component is drawn below.

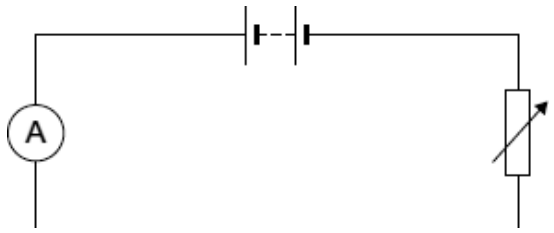


(a) What is the component?

.....

(1)

(b) Complete the diagram to show a circuit that can be used to obtain the data needed to plot the graph. Use the correct circuit symbol for each component that you add to the diagram.



(2)

(c) (i) What is the current through the component when the potential difference across the component is 0.8 volts?

Current ..... amps

(1)

(ii) Use the equation in the box to calculate the resistance of the component when the potential difference across it is 0.8 volts.

potential difference = current × resistance

Show clearly how you work out your answer.

.....

.....

Resistance = ... Ω

(2)

(Total 6 marks)

Q17. The picture shows an electric bicycle. The bicycle is usually powered using a combination of the rider pedalling and an electric motor.

(a) A 36 volt battery powers the electric motor. The battery is made using individual 1.2 volt cells.

(i) Explain how a 36 volt battery can be produced using individual 1.2 volt cells.

To gain full marks, you must include a calculation in your answer.

.....

.....

.....

.....

(2)

(ii) The battery supplies a direct current (d.c.).

What is a *direct current (d.c.)*?

.....

.....

(1)

(iii) When fully charged, the battery can deliver a current of 5 A for 2 hours. The battery is then fully discharged.

Use the equation in the box to calculate the maximum charge that the battery stores.

charge = current × time

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

.....

.....

Charge stored = ...

(3)

(b) When powered only by the electric motor, the bicycle can carry a 90 kg rider at a maximum speed of 6 m/s. Under these conditions, the maximum distance that the bicycle can cover before the battery needs recharging is 32 km.

The bicycle has a mass of 30 kg.

(i) Use the equation in the box to calculate the maximum kinetic energy of the bicycle **and** rider when the rider is not pedalling.

$$\text{kinetic energy} = \frac{1}{2} \times \text{mass} \times \text{speed}^2$$

Show clearly how you work out your answer.

.....

.....

Kinetic energy = ... J

(2)

(ii) The bicycle can be fitted with panniers (bags) to carry a small amount of luggage.

What effect would fitting panniers and carrying luggage have on the distance the bicycle can cover before the battery needs recharging?

.....

Give a reason for your answer.

.....

.....

(2)

(Total 10 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.

.....

.....

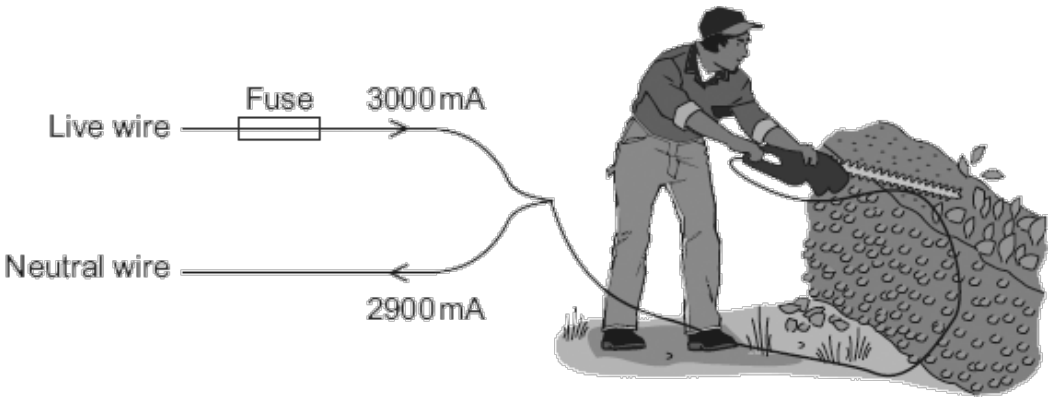
.....

.....

.....

(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.

.....

.....

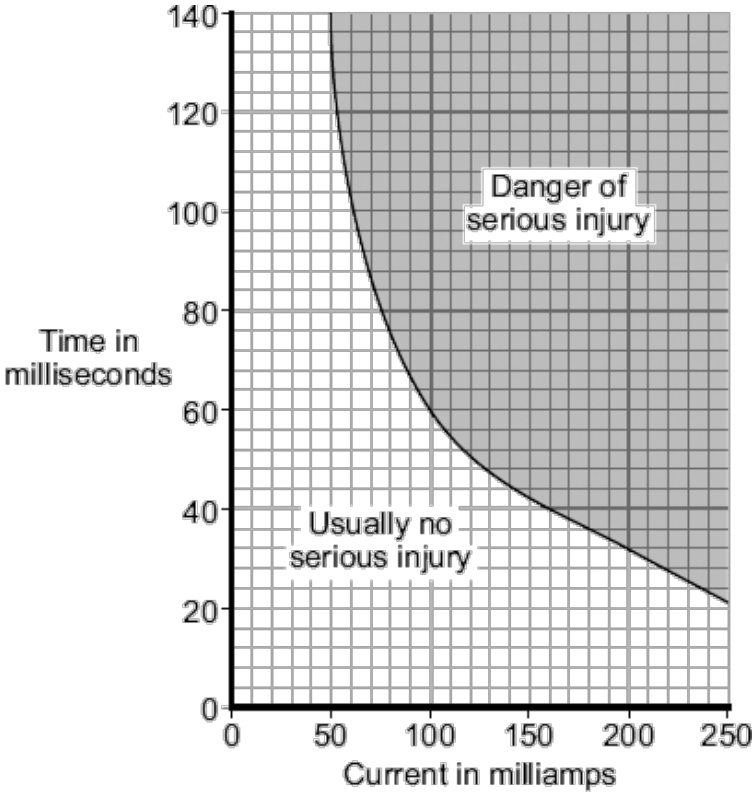
.....

.....

.....

(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.

.....

.....

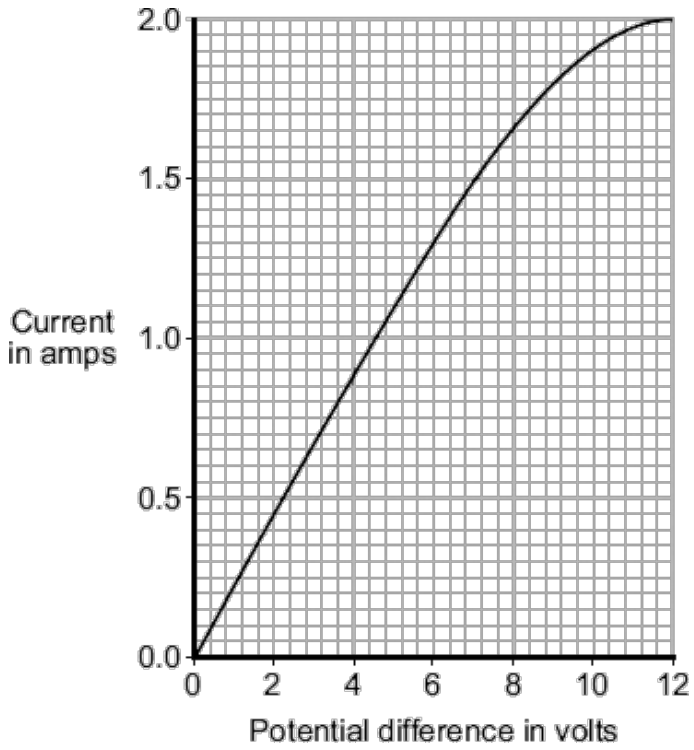
.....

.....

.....

(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.

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(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) The resistance of a 24 W, 12 V filament lamp depends on the current flowing through the lamp. For currents up to 0.8 A, the resistance has a constant value of 2.5 Ω.

(i) Use the equation in the box to calculate the potential difference across the lamp when a current of 0.8 A flows through the lamp.

potential difference = current × resistance

Show clearly how you work out your answer.

.....

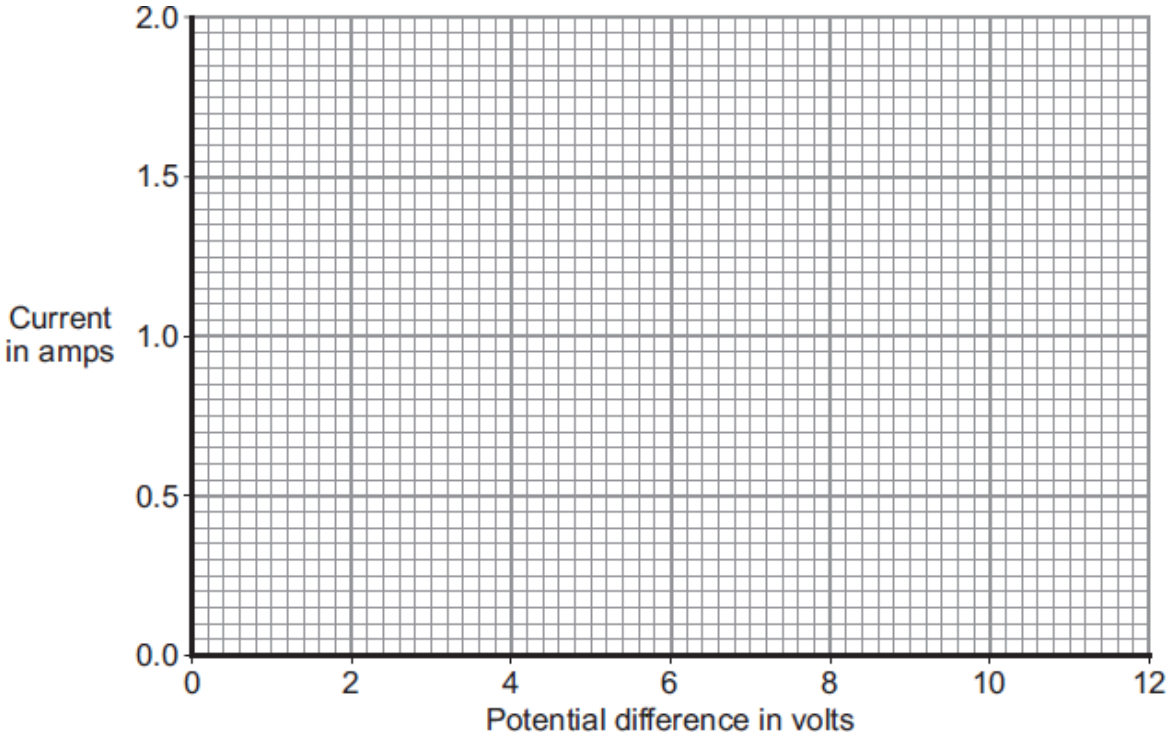
.....

Potential difference = ... V

(2)

(ii) When the potential difference across the lamp is 12 V, the current through the lamp is 2 A.

On the axes below, draw a current–potential difference graph for the filament lamp over the range of potential difference from 0 to 12 volts.



(2)

(iii) Why does the resistance of the lamp change when the current through the lamp exceeds 0.8 A?

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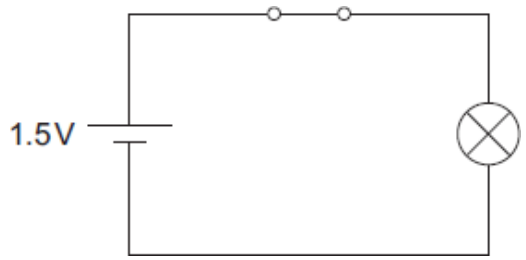
.....

(1)

(b) The lamp is now included in a circuit. The circuit is switched on for 2 minutes. During this time, 72 coulombs of charge pass through the lamp.



Use the equation in the box to calculate the energy transformed by the lamp while the circuit is switched on.

energy transformed = potential difference × charge

Show clearly how you work out your answer.

.....

.....

Energy transformed = ... J

(2)

(Total 7 marks)

Q21. (a) Describe the difference between an alternating current (a.c.) and a direct current (d.c.).

.....

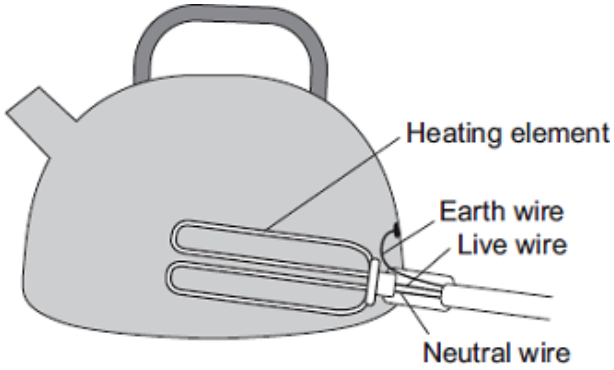
.....

.....

.....

(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.

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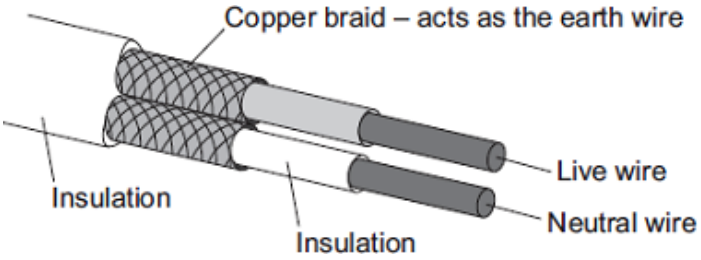
(2)
(Total 4 marks)

Q22. 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?

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.....

(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.

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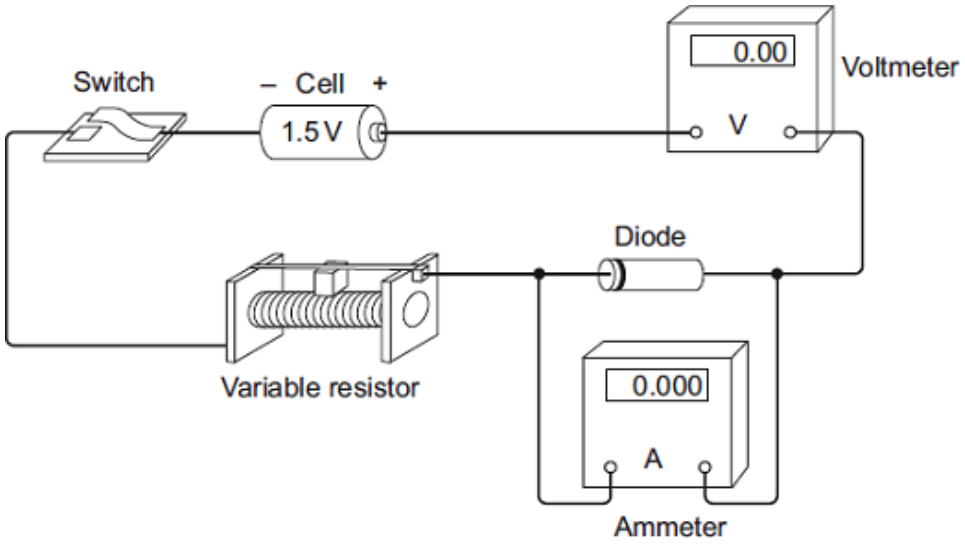
(2)

(Total 11 marks)

Q23. (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 .....

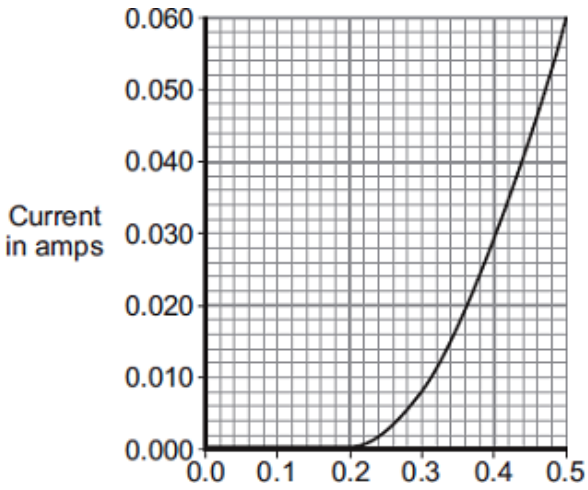
.....

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.

.....

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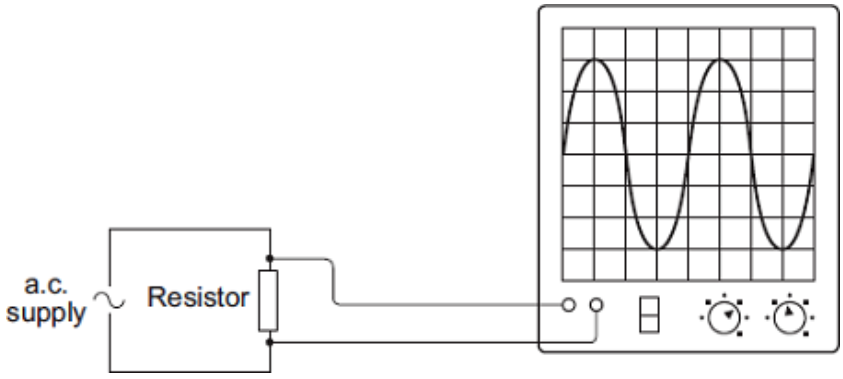
.....

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.

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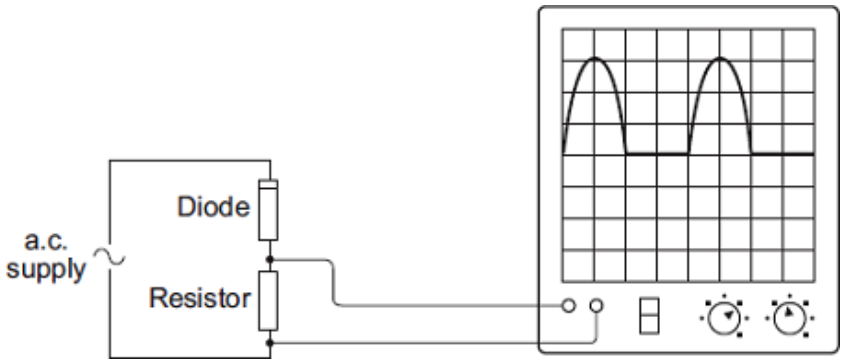
Frequency = ... hertz

(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?

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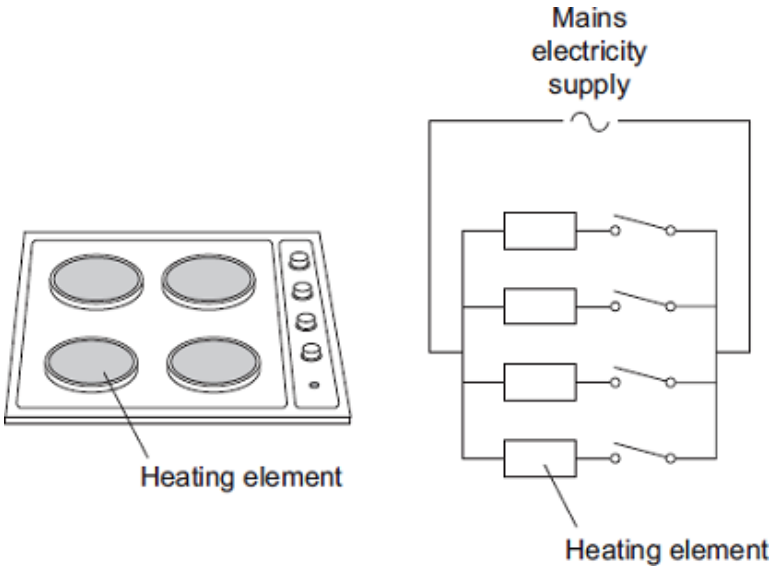
(2)

(Total 12 marks)

Q24. 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?

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(2)

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

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(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?

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(2)
(Total 10 marks)