

Your Science Department

2. Electricity Mastery Booklet

(Physics Paper 1)

Name : _____

Teacher : _____

Date Given : _____

These booklets are a consolidation of your learning. They should be used in the following way – You should attempt the questions WITHOUT looking at the answers. Then mark your questions with **red pen** and add any missing marks you missed. You should then present the completed document to your teacher to show WITHIN TWO weeks of receiving the booklet.

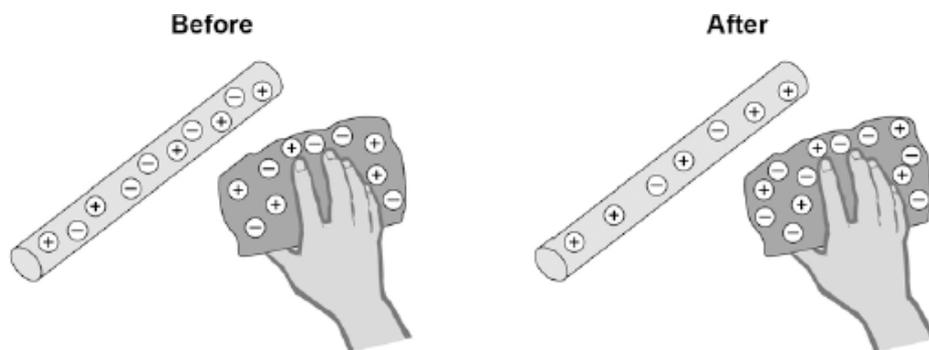
THIS WILL IMPROVE YOUR GRADES...!!

Q1.

A student rubs an acetate rod with a cloth.

Figure 1 shows the charges on the acetate rod and cloth before and after rubbing.

Figure 1



- (a) Explain how rubbing an acetate rod with a cloth causes the rod and cloth to become charged.

(4)

- (b) After charging them, the student moves the acetate rod and the cloth closer together.

Which statement is correct?

Tick **one** box.

There is no force between the acetate rod and the cloth.

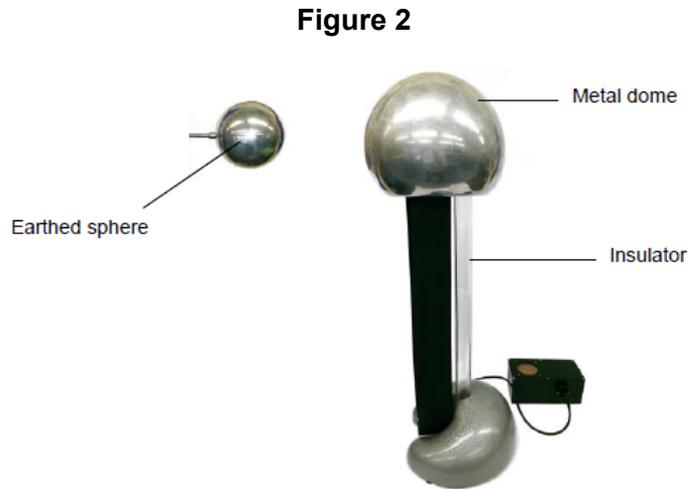
There is a force of attraction between the acetate rod and the cloth.

There is a force of repulsion between the acetate rod and the cloth.

Give a reason for your answer.

(2)

- (c) **Figure 2** shows a Van de Graaff generator, which is used to generate static electricity.



The longer the Van de Graaff generator is switched on, the more charge is stored on the metal dome. Use an answer from the box to complete the sentence.

decrease	increase	stay the same
-----------------	-----------------	----------------------

The amount of charge on the metal dome is increased, which causes the potential difference between the metal dome and the earthed sphere to _____.

(1)

- (d) When the potential difference between the Van de Graaff generator and the earthed sphere is 60 kV, a spark jumps between the metal dome and the earthed sphere.

The spark transfers 0.000025 coulombs of charge to the earthed sphere.

The equation which links charge, energy and potential difference is:

$$\text{energy transferred} = \text{charge} \times \text{potential difference}$$

Calculate the energy transferred by the spark.

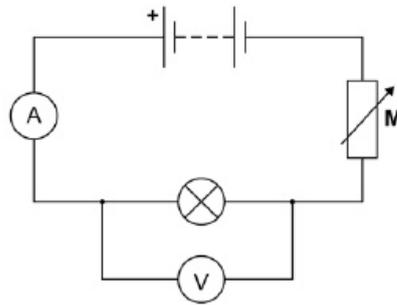
Energy transferred = _____ J

(2)

(Total 9 marks)

Q2.

The diagram shows the circuit used to obtain the data needed to plot the current-potential difference graph for a filament lamp.



(a) Why is component **M** included in the circuit?

Tick **one** box.

To keep the current constant.

To keep the potential difference constant.

To vary the current.

(1)

(b) Why does the resistance of the lamp increase as the potential difference across the lamp increases?

(1)

(c) The potential difference across the lamp is 12.0 V

Calculate the energy transferred by the lamp when 8.5 C of charge flows through the lamp.

Use the equation:

$$\text{energy transferred} = \text{charge flow} \times \text{potential difference}$$

Energy transferred = _____ J

(2)

- (d) The table gives data about two types of lamp that householders may use in their homes.

Type of lamp	Energy efficiency	Mean lifetime in hours
Halogen	10%	2000
LED	90%	36000

Both types of lamp produce the same amount of light.

Describe the environmental advantages of using the LED lamp compared with the halogen lamp.

(2)
(Total 6 marks)

Q3.

An electrician is replacing an old electric shower with a new one.

The inside of the old shower is shown in the figure below.



© Michael Priest

- (a) The electrician should **not** change the shower unless he switches off the mains electricity supply.

Explain why.

(2)

- (b) The new shower has a power output of 10 690 W when it is connected to the 230 V mains electricity supply.

The equation which links current, potential difference and power is:

$$\text{current} = \frac{\text{power}}{\text{potential difference}}$$

Calculate the current passing through the new shower.

Give your answer to two significant figures.

Current = _____ A

(4)

- (c) The new shower has a higher power rating than the old shower.

How does the power of the new shower affect the cost of using the shower?

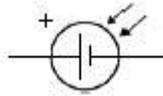
Give a reason for your answer.

(2)

(Total 8 marks)

Q4.

Solar cells produce electricity using light from the Sun.



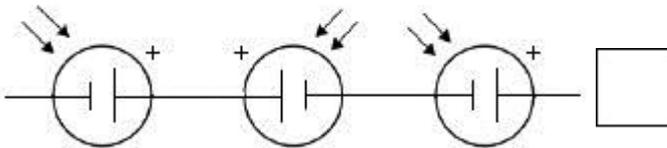
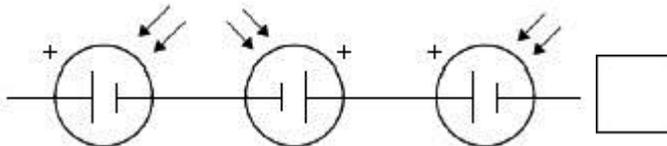
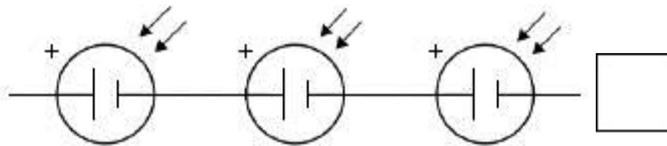
The symbol for a solar cell is:

A householder has three solar cells.

Each solar cell has an output potential difference of 0.70 V

(a) Which arrangement of three solar cells will give a potential difference of 2.10 V?

Tick **one** box.



(1)

(b) A solar cell has a resistance of 2.5 Ω when the output potential difference is 0.70 V

Calculate the current through the solar cell.

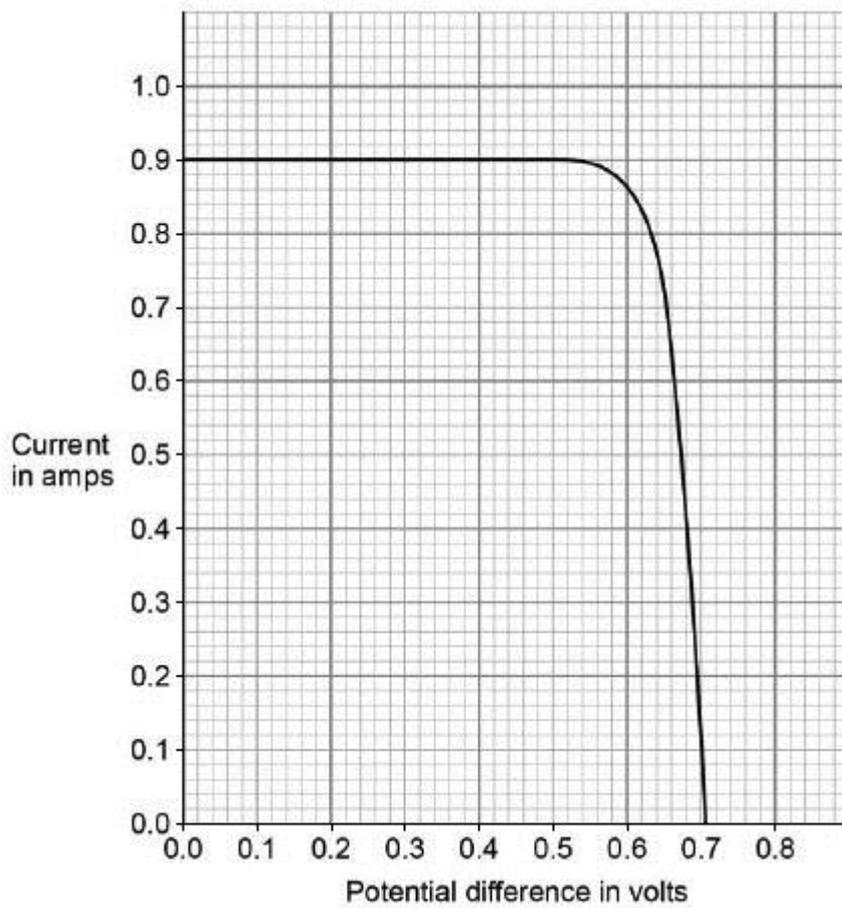
Use the equation:

$$\text{current} = \frac{\text{potential difference}}{\text{resistance}}$$

Current = _____ A

(2)

The graph below shows a graph of current against potential difference for a different type of solar cell.



(c) The power output of the solar cell is calculated using the equation.

$$\text{power} = \text{current} \times \text{potential difference}$$

Which value of potential difference on the graph above gives the maximum power output of the solar cell?

Tick **one** box.

0.1 V

0.3 V

0.6 V

0.7 V

Give the reason for your answer.

(2)

- (d) Write down the equation that links efficiency, total power input and useful power output.

(1)

- (e) The total power input to the solar cell is 2.4 W when the efficiency is 0.20

Calculate the useful power output of the solar cell.

Useful power output = _____ W

(3)

(Total 9 marks)

Q5.

Many electrical appliances are connected to the mains supply using a three-core cable and a three-pin plug.

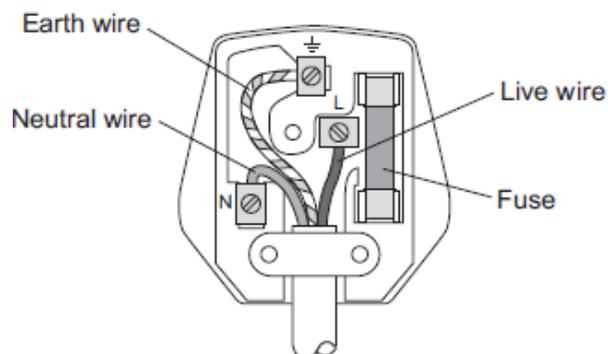
- (a) Use the correct answer from the box to complete the sentence.

charge	energy	power
--------	--------	-------

Electric current is the rate of flow of _____ .

(1)

- (b) The diagram shows a three-pin plug connected to a three-core cable.



- (i) The three wires of the three-core cable have different coloured coverings.

State the colour of the covering of the neutral wire.

(1)

(ii) Which **two** parts of the plug shown above protect the wiring of a circuit?

Tick (✓) **two** boxes.

	Tick (✓)
Earth wire	
Fuse	
Live wire	
Neutral wire	

(2)

(c) Some electrical appliances are connected to the mains supply using a two-core cable and a three-pin plug. Appliances that are double insulated do not require all three wires.

(i) What does 'double insulated' mean?

(1)

(ii) State which of the three wires is **not** required.

(1)

(d) (i) An electrical appliance is connected to a 20 V supply.

The current in the appliance is 3 A.

Calculate the power of the appliance.

Power = _____ W

(2)

(ii) Another electrical appliance is connected to a 20 V supply.

The appliance transfers 300 J of energy.

Calculate the charge.

Give the unit.

Charge = _____

Unit _____

(3)

(Total 11 marks)

Q6.

A student finds some information about energy-saving light bulbs.

(a) A 30W light bulb uses 600J of electrical energy in a certain period of time. In that time, it produces 450 J of light energy. The rest of the energy is wasted.

(i) Calculate the energy wasted by the light bulb in this period of time.

Wasted energy = _____ J

(1)

(ii) What happens to the energy wasted by the light bulb?

(1)

(iii) Calculate the efficiency of this light bulb.

Efficiency = _____

(2)

(iv) Calculate the period of time, in seconds, during which the 600 J is provided to the 30 W light bulb.

Time = _____ s

(2)

- (b) A company that makes light bulbs provides information about some of their products.

The table shows some of this information.

	Power in watts	Lifetime in hours	Cost of bulb in £
Filament bulb	60	1250	2.00
LED bulb	12	50 000	16.00

- (i) Suggest why it is important to confirm this information independently.

(1)

- (ii) A homeowner is thinking about replacing his filament bulbs with LED bulbs.

A 12 W LED bulb gives the same light output as a 60 W filament bulb.

Suggest reasons why the homeowner is likely to choose LED bulbs.

Use the information given in the table.

(2)

- (iii) State **one** factor, other than efficiency, that is important when considering the choice of a bulb for lighting in the home.

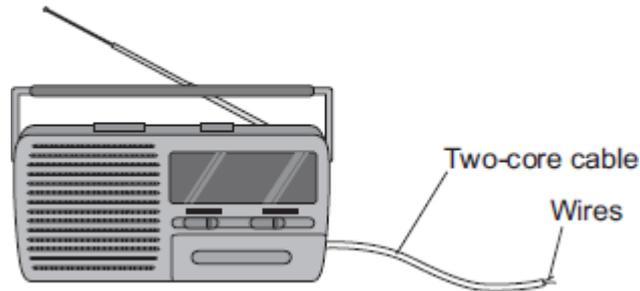
(1)

(Total 10 marks)

Q7.

Figure 1 shows a radio. The radio can be powered by connecting the two-core cable to the mains electricity supply.

Figure 1



- (a) (i) What must be fitted to the cable before it can be connected to the mains electricity supply?

(1)

- (ii) There are only two wires inside the cable.
What are the names of the two wires inside the cable?

Tick (✓) **one** box.

- | | |
|-------------------|--------------------------|
| Earth and live | <input type="checkbox"/> |
| Earth and neutral | <input type="checkbox"/> |
| Live and neutral | <input type="checkbox"/> |

(1)

- (iii) Use the correct answer from the box to complete the sentence.

double	extra	fully
---------------	--------------	--------------

It is safe to connect the radio to the mains electricity supply using a two-core cable because the radio is _____ insulated.

(1)

(b) The radio can also be powered by a battery.

What type of current does a battery supply?

Tick (✓) **one** box.

Alternating current (a.c.) only

Direct current (d.c.) only

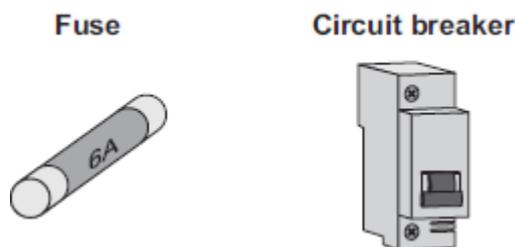
Both a.c. and d.c.

(1)

(c) **Figure 2** shows a fuse and a circuit breaker.

Fuses and circuit breakers are able to disconnect and switch off circuits.

Figure 2



(i) Use the correct answer from the box to complete the sentence.

earth	live	neutral
-------	------	---------

A fuse or a circuit breaker is connected to the _____ wire in a circuit.

(1)

(ii) What happens to cause a fuse or circuit breaker to disconnect a circuit?

(1)

- (iii) Suggest **two** advantages of using a circuit breaker to disconnect a circuit compared with using a fuse.

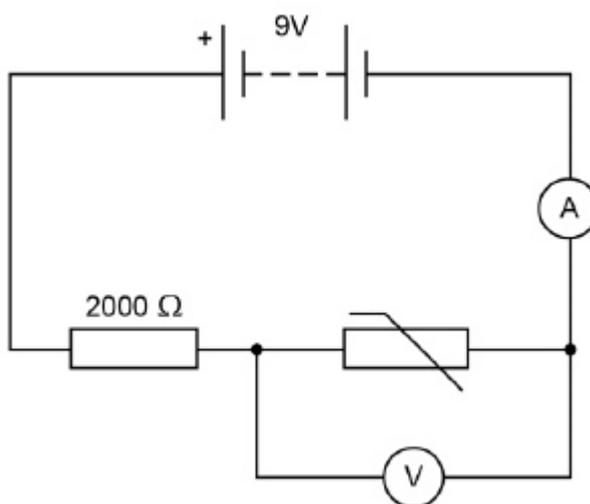
1. _____

2. _____

(2)
(Total 8 marks)

Q8.

The diagram shows a temperature sensing circuit used to control a heating system in a house.



- (a) What quantity does the ammeter measure?

(1)

- (b) The current in the circuit is 3.5 mA when the potential difference across the thermistor is 4.2 V

Calculate the resistance of the thermistor.

Resistance = _____ Ω

(3)

- (c) Calculate the charge that flows through the thermistor in 5 minutes when the current is 3.5 mA.

Charge = _____ C

(3)

- (d) Explain why the potential difference across the thermistor changes as the temperature in the house decreases.

(2)

- (e) The circuit shown in the diagram can be modified to turn lights on and off by replacing the thermistor with a Light Dependent Resistor (LDR).

Draw the circuit symbol for an LDR in the space below.

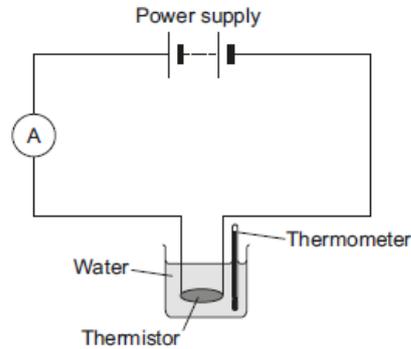
(1)

(Total 10 marks)

Q9.

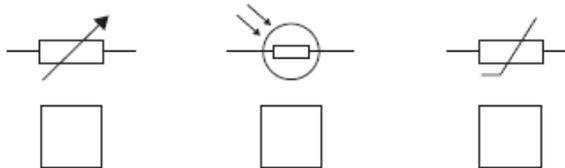
Figure 1 shows the apparatus used to investigate how the current through a thermistor depends on the temperature of the thermistor.

Figure 1



(a) Which **one** of the following is the correct circuit symbol for a thermistor?

Tick (✓) **one** box.

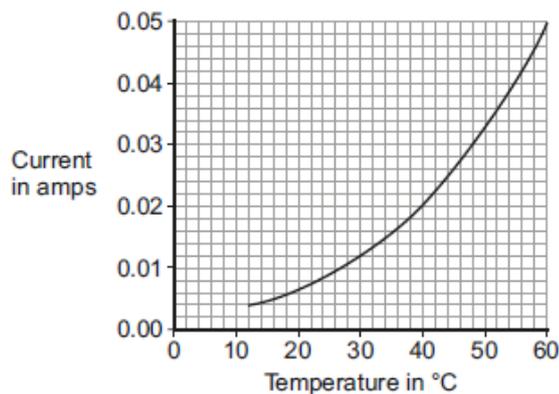


(1)

(b) To get a range of results, hot water at 60 °C was poured into the beaker. The temperature of the water and current through the thermistor were then recorded as the water cooled.

The results of the investigation are shown in **Figure 2**.

Figure 2



(i) Suggest **one** way the investigation could have been changed to give a wider range of temperatures.

(1)

- (ii) Describe how the current through the thermistor depends on the temperature of the thermistor.

(1)

- (iii) Use **Figure 2** to determine the current through the thermistor at 40 °C.

Current at 40 °C = _____ A

(1)

- (iv) At 40 °C the thermistor has a resistance of 250 Ω.

Use your answer to part (iii) and the resistance of the thermistor to calculate the potential difference across the thermistor.

Potential difference = _____ V

(2)

- (v) The potential difference across the thermistor stays the same all through the investigation.

What conclusion can be made from the results in **Figure 2** about the resistance of the thermistor as the temperature of the thermistor **decreases**?

Tick (✓) **one** box.

the resistance increases

the resistance does not change

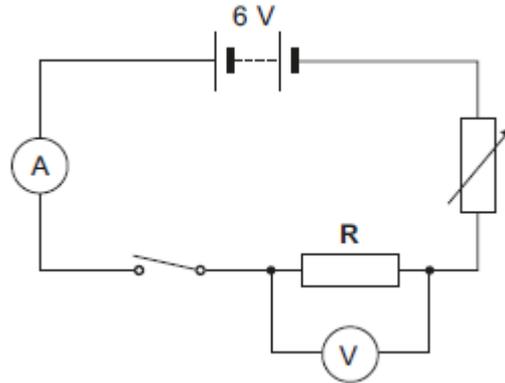
the resistance decreases

(1)

(Total 7 marks)

Q10.

The diagram shows an electrical circuit.



- (a) The 6 V battery shown in the diagram is made up of a number of identical 1.5 V cells.

Calculate the minimum number of cells needed to make the battery.

Number of cells = _____

(1)

- (b) The switch in the diagram is shown in the open position. Closing the switch completes the circuit.

Charge flows through the completed circuit and a reading is shown on both the ammeter and the voltmeter.

- (i) In 10 seconds, 20 coulombs of charge flows through the circuit.

Calculate the current reading shown on the ammeter.

Current = _____ A

(2)

- (ii) For 20 coulombs of charge to flow through the resistor R, 100 joules of work must be done.

Calculate the potential difference reading given by the voltmeter.

Potential difference = _____ V

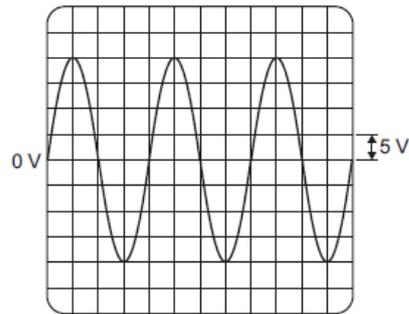
(2)

(Total 5 marks)

Q11.

- (a) **Figure 1** shows the oscilloscope trace an alternating current (a.c.) electricity supply produces.

Figure 1



One vertical division on the oscilloscope screen represents 5 volts.

Calculate the peak potential difference of the electricity supply.

Peak potential difference = _____ V

(1)

- (b) Use the correct answer from the box to complete the sentence.

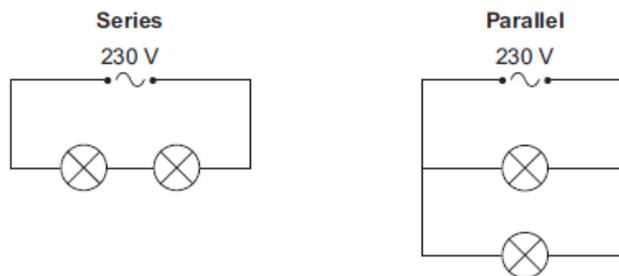
40	50	60
-----------	-----------	-----------

In the UK, the frequency of the a.c. mains electricity supply is _____ hertz.

(1)

- (c) **Figure 2** shows how two lamps may be connected in series or in parallel to the 230 volt mains electricity supply.

Figure 2



- (i) Calculate the potential difference across each lamp when the lamps are connected in **series**.

The lamps are identical.

Potential difference when in series = _____ V

(1)

- (ii) What is the potential difference across each lamp when the lamps are connected in **parallel**?

Tick (✓) **one** box.

115 V 230 V 460 V

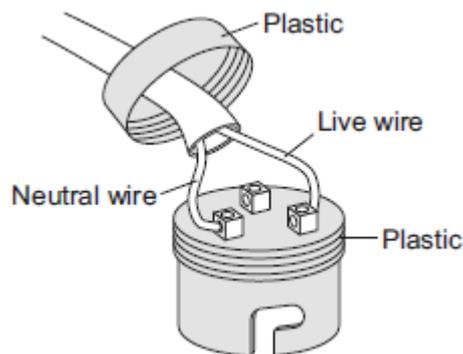
(1)

- (iii) Give **one** advantage of connecting the lamps in parallel instead of in series.

(1)

- (d) **Figure 3** shows the light fitting used to connect a filament light bulb to the mains electricity supply.

Figure 3



The light fitting does **not** have an earth wire connected.

Explain why the light fitting is safe to use.

(2)

- (e) A fuse can be used to protect an electrical circuit.

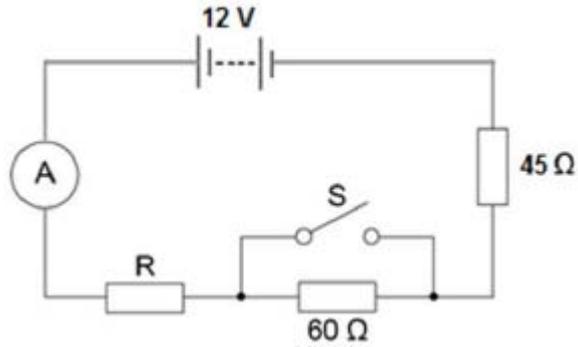
Name a different device that can also be used to protect an electrical circuit.

(1)

(Total 8 marks)

Q12.

A student set up the electrical circuit shown in the figure below.



- (a) The ammeter displays a reading of 0.10 A.

Calculate the potential difference across the 45 Ω resistor.

Potential difference = _____ V

(2)

- (b) Calculate the resistance of the resistor labelled **R**.

Resistance = _____ Ω

(3)

- (c) State what happens to the total resistance of the circuit and the current through the circuit when switch **S** is closed.

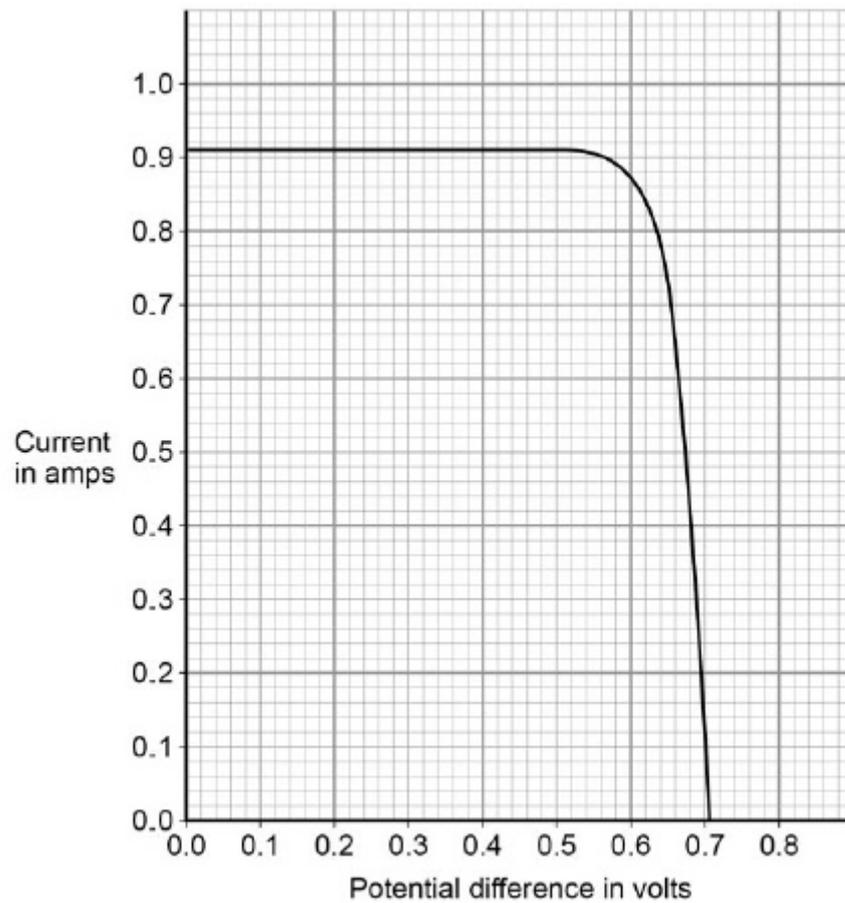
(2)

(Total 7 marks)

Q13.

Figure 1 shows a graph of current against potential difference for a solar cell when light of intensity 450 W/m^2 is incident on it.

Figure 1



- (a) Determine the power output of the solar cell when the potential difference is 0.5 V

Use data from **Figure 1**.

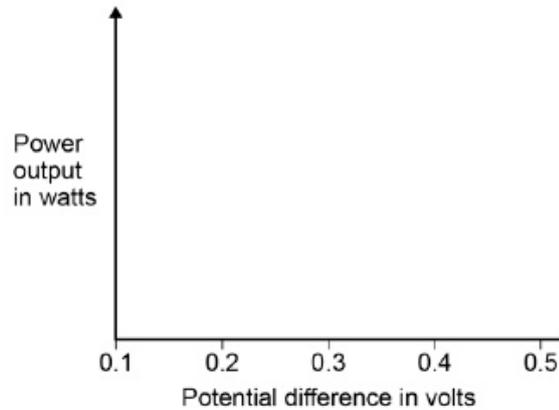
Power = _____ W

(3)

- (b) Draw a sketch graph on **Figure 2** to show how the power output of the solar cell varies with potential difference between 0.1 V and 0.5 V

No values need to be included on the vertical axis.

Figure 2



(2)

- (c) The maximum power output of this solar cell is 0.52 W

When the light intensity is 450 W/m^2 the cell has an efficiency of 0.15 at the maximum power output.

Calculate the area of the solar cell.

Area = _____ m^2

(4)

- (d) A householder has four solar cells.

Each of the solar cells has a resistance of 0.78Ω

Explain how the solar cells should be connected so that the total resistance is as low as possible.

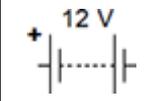
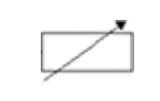
(2)

(Total 11 marks)

Q14.

A student wants to investigate how the current through a filament lamp affects its resistance.

- (a) Use the circuit symbols in the boxes to draw a circuit diagram that she could use.

12 V battery	variable resistor	filament lamp	voltmeter	ammeter
				

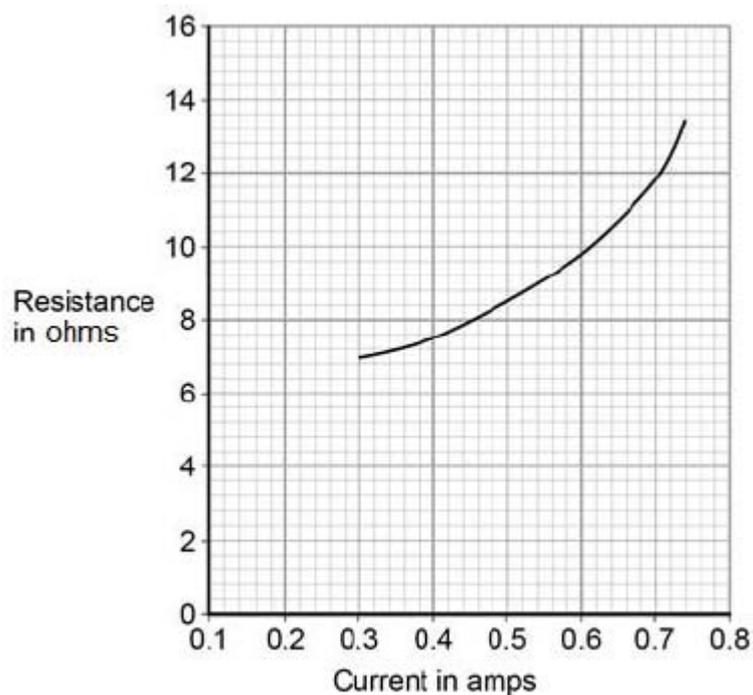
(2)

- (b) Describe how the student could use her circuit to investigate how the current through a filament lamp affects its resistance.

(4)

- (c) The student's results are shown in **Figure 1**.

Figure 1



Describe how the resistance of the filament lamp changes as the current through it increases.

(1)

- (d) Use **Figure 1** to estimate the resistance of the filament lamp when a current of 0.10 A passes through the lamp.

Resistance = _____ Ω

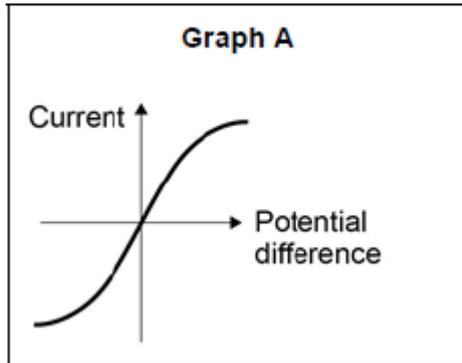
(1)

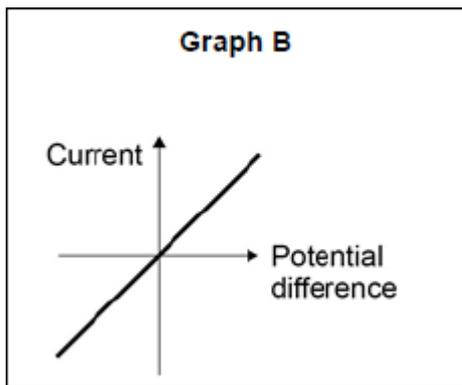
(e) The current-potential difference graphs of three components are shown in **Figure 2**.

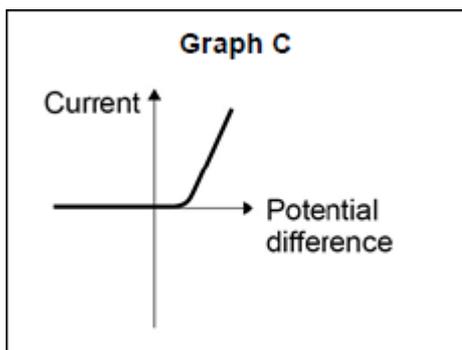
Use answers from the box to identify each component.

diode	filament lamp	light dependent resistor
resistor at constant temperature		thermistor

Figure 2







(3)

(Total 11 marks)

Mark schemes

Q1.

(a) **Level 2 (3–4 marks):**

A detailed and coherent explanation is provided. The student makes logical links between clearly identified, relevant points.

Level 1 (1–2 marks):

Simple statements are made, but not precisely. The logic is unclear.

0 marks:

No relevant content

Indicative content

- friction (between cloth and rod) causes
- electrons (to) move
- from the acetate rod **or** to the cloth
- (net) charge on cloth is now negative
- (net) charge on rod is now positive

4

(b) there is a force of attraction between the acetate rod and the cloth

(reason)

1

unlike charges attract

or

negative charges attract positive charges

1

(c) increase

1

(d) $0.000025 \times 60\,000$

1

1.5 (J)

1

accept 1.5 (J) with no working shown for 2 marks

[9]

Q2.

(a) to vary the current.

1

(b) the temperature of the filament increases

allow the filament heats up

1

(c) $E = 12 \times 8.5$

1

$$E = 102 \text{ (J)}$$

an answer of 102 (J) scores 2 marks

1

(d) (LED lamp)

longer lifetime (per lamp)

1

wastes less energy

or

lower input energy (for same light energy output)

1

[6]

Q3.

(a) he may receive an electric shock

or

he may be electrocuted

1

if he touches the live wire

1

(b) $10\,690 = I \times 230$

1

$$I = 10\,690 / 230$$

1

$$46.478(260) \text{ (A)}$$

1

$$46$$

1

allow 46 (A) with no working shown for 4 marks

(c) cost is higher

1

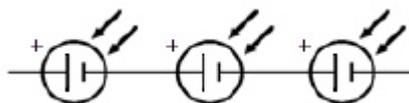
more energy is used (per second)

1

[8]

Q4.

(a)



1

(b)

$$\text{current} = \frac{0.70}{2.5}$$

	current = 0.28 (A)	1
	<i>an answer of 0.28 (A) scores 2 marks</i>	
		1
(c)	0.60 (V)	1
	product of potential difference and current gives highest value	
		1
(d)	$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$	1
(e)	$0.20 = \frac{\text{useful power output}}{2.4}$	1
	useful power output = 0.20 × 2.4	
		1
	useful power output = 0.48 (W)	
	<i>an answer of 0.48 (W) scores 3 marks</i>	
		1

[9]

Q5.

(a)	charge	1
(b)	(i) blue	1
	(ii) earth wire	1
	fuse	1
(c)	(i) case is non-metal / non-conducting / plastic / insulator <i>must refer to case / outside of appliance</i> <i>do not accept plastic coating / covering</i>	1
	(ii) earth (wire)	1
(d)	(i) 60 (W)	
	<i>P = 3 × 20 gains 1 mark</i>	
	<i>provided no subsequent step shown</i>	
		2
	(ii) 15	
	<i>300 = 20 × Q</i>	

or
 $20 = 300 / Q$ gains 1 mark

2

C / coulombs
must clearly be upper case C accept J / V or As

1

[11]

Q6.

(a) (i) 150

1

(ii) transferred to the surroundings by heating
reference to sound negates mark

1

(iii) 0.75
450 / 600 gains 1 mark
accept 75% for 2 marks
maximum of 1 mark awarded if a unit is given

2

(iv) 20 (s)
correct answer with or without working gains 2 marks
correct substitution of 600 / 30 gains 1 mark

2

(b) (i) to avoid bias

1

(ii) use less power and last longer

1

1 LED costs £16, 40 filament bulbs cost £80

or

filament costs (5 times) more in energy consumption

1

(iii) any **one** from:

- availability of bulbs
- colour output
- temperature of bulb surface

1

[10]

Q7.

(a) (i) (3-pin) plug
*do **not** accept plug socket*

1

(ii) live and neutral

- (iii) double 1
- (b) direct current (d.c.) only 1
- (c) (i) live 1
- (ii) too great a current flows
accept a surge of current
accept too great a power
accept an electrical fault
*do **not** accept voltage / energy / electricity too high* 1
- (iii) can be reset
accept does not need replacing 1
- (disconnects circuit) faster
cheaper is insufficient
does not melt is insufficient
quicker to fix / replace is insufficient 1

[8]

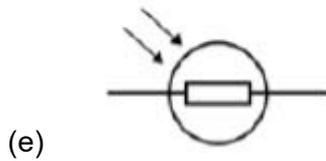
Q8.

- (a) current 1
- (b) $4.2 = 3.5 \times 10^{-3} \times R$ 1
- $R = 4.2 / 3.5 \times 10^{-3}$ 1
- $R = 1200 (\Omega)$
an answer of 1200 (Ω) scores 3 marks
an answer of 1.2 scores 2 marks 1
- (c) conversion from minutes to seconds (300 s) 1
- $Q = 0.0035 \times (5 \times 60)$ 1
- $Q = 1.05 \text{ C}$
an answer of 1.05 (C) scores 3 marks
an answer of 17.5 scores 1 mark
an answer of 1050 or 0.0175 scores 2 marks 1
- (d) (potential difference) increases

(because thermistor) resistance increases
2nd mark dependent on scoring 1st mark

1

1



1

[10]

Q9.

(a) last box ticked



1

(b) (i) use hotter water (than 60 °C)
accept use boiling water
accept use water at any stated temperature above 60 °C

or
add ice cubes

accept add water at any stated temperature below 12 °C
use different temperatures is insufficient

1

(ii) the current increases as the temperature increases

1

(iii) 0.02 (A)

1

(iv) 5 (V)

or
their (b)(iii) \times 250 correctly calculated
allow 1 mark for correct substitution ie $V = 0.02 \times 250$

or
 $V = \text{their (b)(iii)} \times 250$

2

(v) the resistance increases

1

[7]

Q10.

(a) 4

1

(b) (i) 2

allow 1 mark for correct substitution ie

$$I = \frac{100}{20}$$

provided no subsequent step

2

(ii) 5

allow 1 mark for correct substitution ie

$$V = \frac{100}{20}$$

provided no subsequent step

2

[5]

Q11.

(a) 20

1

(b) 50

1

(c) (i) 115

1

(ii) 230

1

(iii) if one goes out the other still works
or
brighter

accept power (output) is greater

can be switched on/off independently is insufficient

1

(d) the outside/casing is plastic

there is plastic around the wires is insufficient

it is plastic is insufficient

1

and plastic is an insulator

an answer the light fitting is double insulated gains both marks

1

(e) (residual current) circuit breaker

accept RCCB

accept RCBO

accept RCCD

accept RCB

accept miniature circuit breaker / MCB

trip switch is insufficient

breaker is insufficient

do not accept earth wire

Q12.

(a) $V = 0.10 \times 45$

1

4.5 (V)

1

(b) $R = 12 / 0.10$

1

total resistance = 120 (Ω)

1

$R = 120 - 105 = 15$ (Ω)

1

(c) (total) resistance decreases

1

(so) current increases

1

[7]

Q13.

(a) current at 0.5 V = 0.91 (A)

1

$P = 0.91 \times 0.5$

1

$P = 0.455$ (W)

an answer of 0.455 (W) scores 3 marks

1

(b) straight line with positive gradient

allow for 1 mark a straight line that passes through (0.1, 0)

1

positive y-axis intercept

ignore any values on y-axis

1

(c) $0.15 = \frac{0.52}{\text{total } P}$

1

total P = 3.47 (W)

1

area = $\frac{3.47}{450}$

1

area = 7.7×10^{-3} (m^2)

*an answer of $7.7 \times 10^{-3} \text{ (m}^2\text{)}$ scores 4 marks
allow use of student's calculated incorrect total power for last
2 marking points*

1

- (d) connect the solar cells in parallel

1

(so that) the current has multiple paths it can take

or

the total resistance is less than the resistance of one solar cell

1

[11]

Q14.

- (a) battery, lamp and ammeter connected in series with variable resistor

1

voltmeter in parallel with (filament) lamp

1

- (b) **Level 2 (3–4 marks):**

A detailed and coherent description of a plan covering all the major steps is provided.

The steps are set out in a logical manner that could be followed by another person to obtain valid results.

Level 1 (1–2 marks):

Simple statements relating to relevant apparatus or steps are made but they may not be in a logical order. The plan would not allow another person to obtain valid results.

0 marks:

No relevant content

Indicative content

- ammeter used to measure current
- voltmeter used to measure potential difference
- resistance of variable resistor altered to change current in circuit **or** change potential difference (across filament lamp)
- resistance (of filament lamp) calculated **or** $R=V / I$ statement
- resistance calculated for a large enough range of different currents that would allow a valid conclusion about the relationship to be made

4

- (c) (as current increases) resistance increases (at an increasing rate)

1

- (d) any value between 6.3 and 6.9 (Ω)

1

- (e) **A:** Filament lamp

1

B: Resistor at constant temperature

1

C: Diode

1

[11]