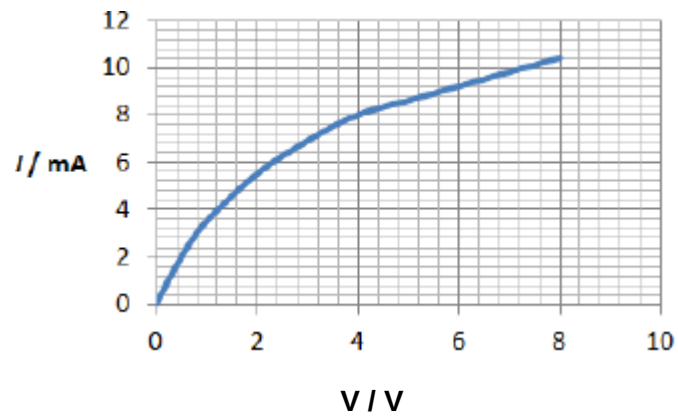


1

The graph shows the current–voltage (I – V) characteristics of a filament lamp.



What is the resistance of the filament when the potential difference (pd) across it is 4.0 V?

A 500 Ω ☐

B 1700 Ω ☐

C 2000 Ω ☐

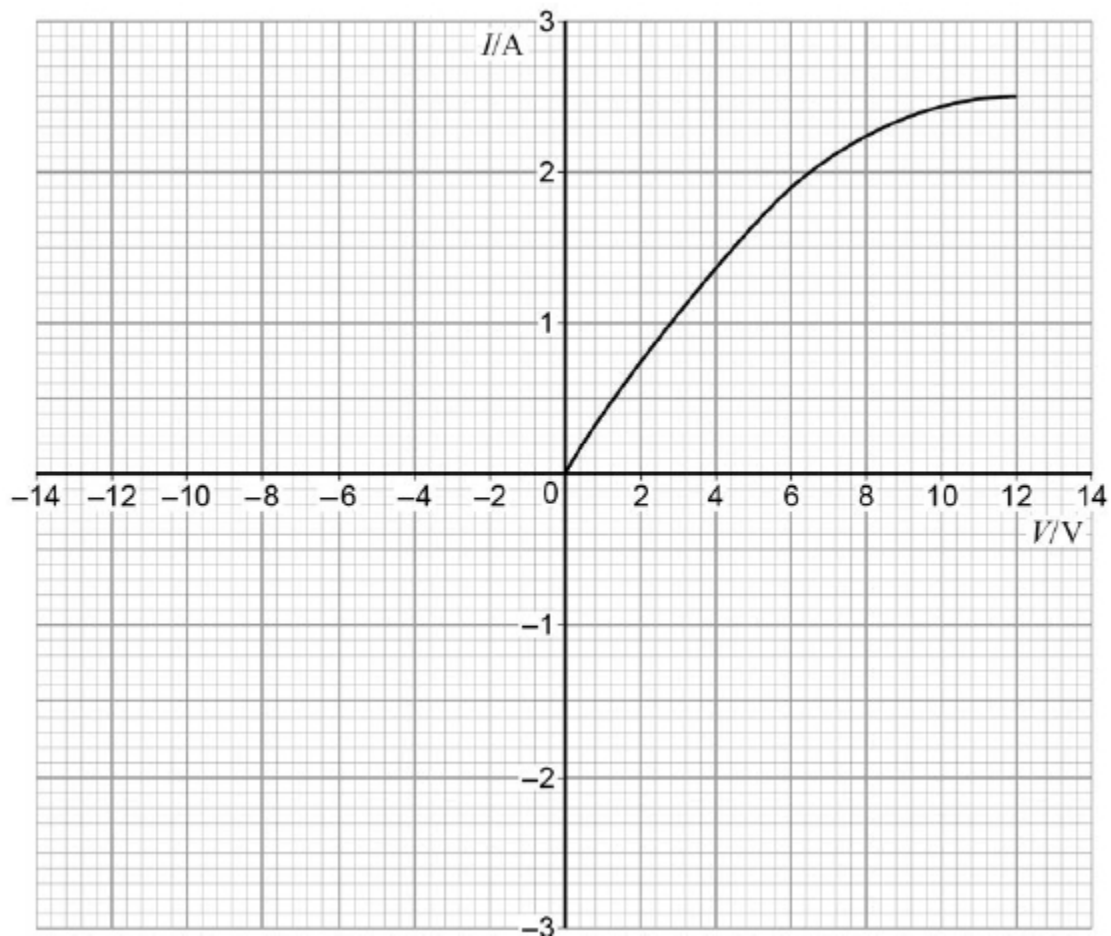
D 6000 Ω ☐

(Total 1 mark)

2

Figure 1 shows the current–voltage (I – V) characteristic of the lamp used in a car headlight up to its working voltage.

Figure 1



- (a) Draw on **Figure 1** the characteristic that would be obtained with the connections to the supply reversed.

(2)

- (b) Lamps are marked with their working voltage and the power used at this voltage. For example, a lamp for use in a torch may be marked 2.5 V 0.3 W.

Deduce the marking on the lamp for the car headlight.

lamp marking = _____ V _____ W

(2)

- (c) Determine the resistance of the lamp when the potential difference (pd) across it is half the working voltage.

resistance _____ Ω

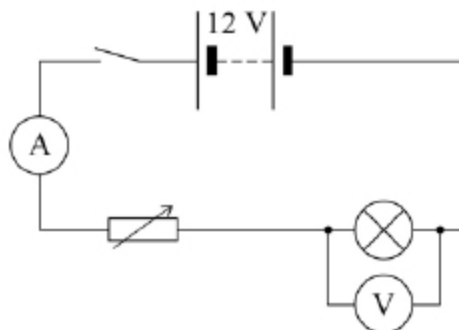
(1)

- (d) Explain, without further calculation, how the resistance of the lamp varies as the voltage across it is increased from zero to its working voltage.

(3)

- (e) A student suggests that the circuit shown in **Figure 2** is suitable for collecting data to draw the I - V characteristic of the lamp up to its working voltage. The maximum resistance of the variable resistor is $6.0\ \Omega$ and the internal resistance of the power supply is $2.0\ \Omega$. The resistance of the ammeter is negligible.

Figure 2



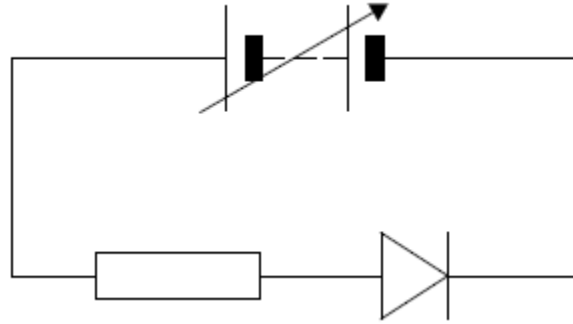
Discuss the limitations of this circuit when used to collect the data for the characteristic.

(2)

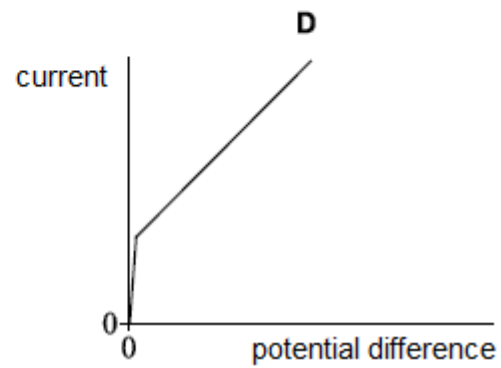
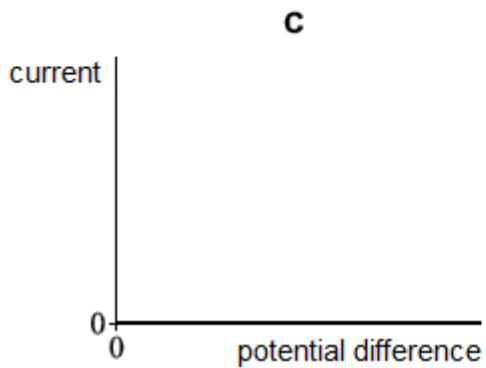
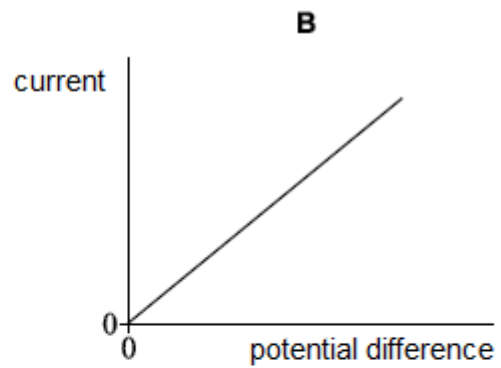
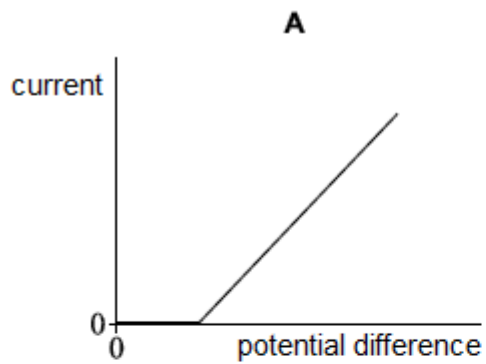
(Total 10 marks)

3

A resistor and diode are connected in series with a variable power supply as shown in the diagram.



Which best shows the characteristic for the combination of the resistor and diode?



A

☐

B

☐

C

☐

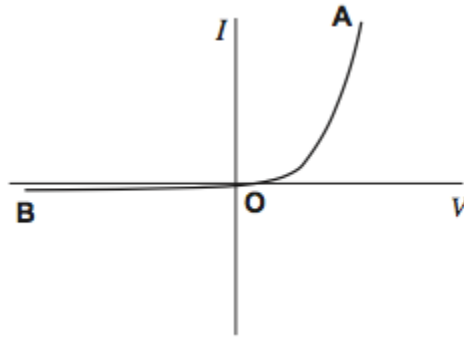
D

☐

(Total 1 mark)

4

- (a) The graph shows the current–voltage (I – V) characteristic curve for a semiconductor diode.



In order to produce this characteristic a student is given suitable equipment including an ammeter and a voltmeter.

- (i) Draw a labelled circuit diagram of the apparatus that the student could use to obtain the part of the characteristic from **O** to **A**.

(2)

- (ii) Describe how the student could use the circuit in part (a)(i) to obtain sufficient measurements to draw the part of the characteristic from **O** to **A**. Your account should include:

- details of how different readings of I and V are obtained
- a consideration of safety precautions when using the diode
- a discussion of the range and number of measurements that need to be taken
- a discussion of the advantages of using a data logger to obtain the measurements.

The quality of your written communication will be assessed in your answer.

(6)

- (iii) Suggest how the circuit you drew in part (a)(i) could be modified to obtain the characteristic from **O** to **B**.

(1)

(b) The student wants to find out how the resistance of the diode changes between **O** and **A**.

(i) Describe how the student could use the characteristic to determine how the resistance varies as the potential difference (pd) between **O** and **A** increases.

(2)

(ii) State how you would expect the resistance of the diode to vary as the pd increases.

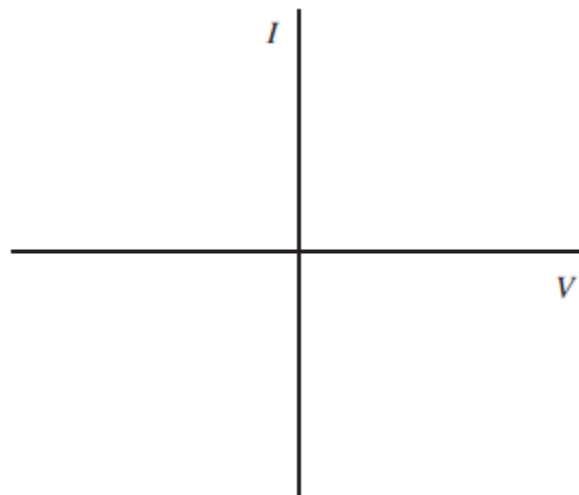
(1)

(Total 12 marks)

5

(a) Sketch, on **Figure 1**, the current–voltage (I – V) characteristic for a filament lamp for currents up to its working power.

Figure 1



(2)

- (b) (i) State what happens to the resistance of the filament lamp as the current increases.

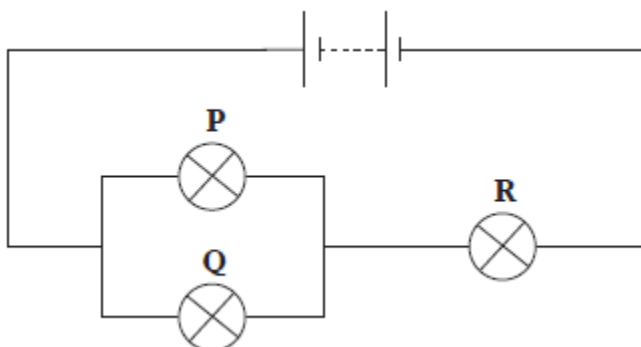
(1)

- (ii) State and explain whether a filament lamp is an ohmic or non-ohmic conductor up to its working power.

(1)

- (c) Three identical filament lamps, **P**, **Q** and **R** are connected in the circuit shown in **Figure 2**.

Figure 2.



The filament in lamp **Q** melts so that it no longer conducts. Explain why lamp **P** becomes brighter and lamp **R** becomes dimmer.

(2)

- (d) A filament lamp, **X**, is rated at 60 W 230 V. Another type of lamp, **Y**, described as 'energy saving' has the same light intensity output but is rated at 11 W 230 V.
- (i) Calculate the electrical energy converted by each lamp if both are on for 4 hours a day for a period of 30 days.

electrical energy converted by **X** = _____ J

electrical energy converted by **Y** = _____ J

(2)

- (ii) Suggest why the two lamps can have different power ratings but have the same light intensity output.

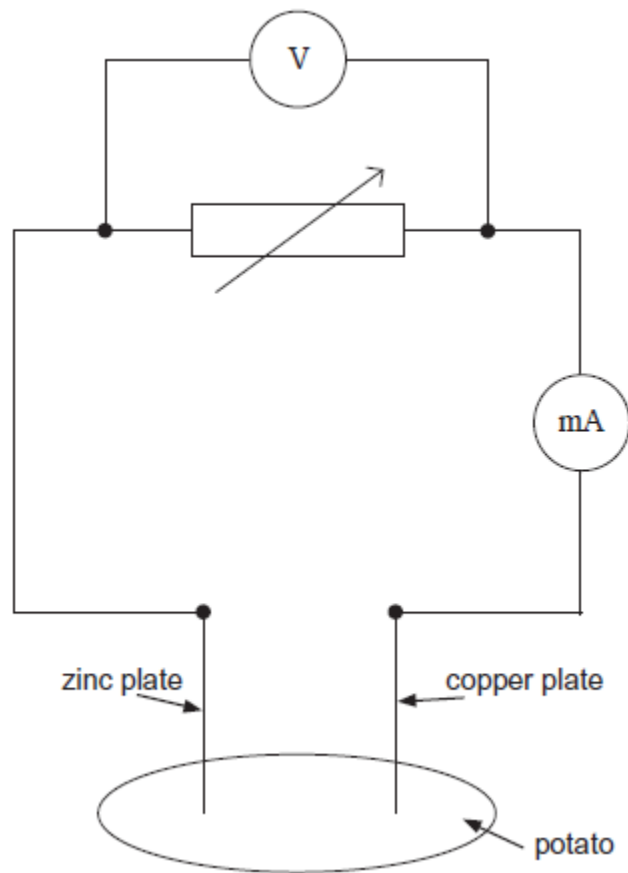
(2)

(Total 10 marks)

6

A 'potato cell' is formed by inserting a copper plate and a zinc plate into a potato. The circuit shown in **Figure 1** is used in an investigation to determine the electromotive force and internal resistance of the potato cell.

Figure 1

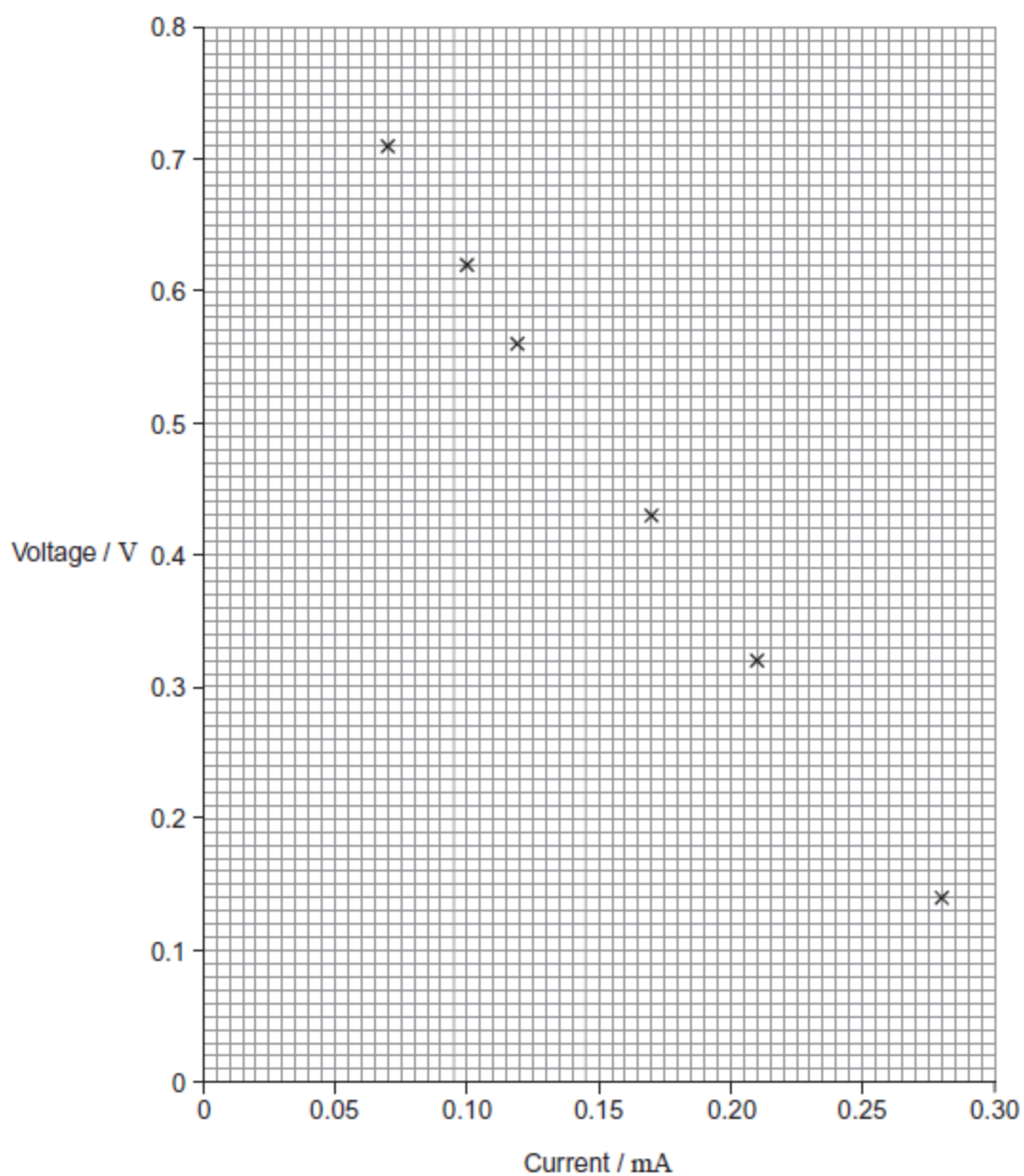


(a) State what is meant by electromotive force.

(2)

- (b) The plotted points on **Figure 2** show the data for current and voltage that were obtained in the investigation.

Figure 2



- (i) Suggest what was done to obtain the data for the plotted points.

- (ii) The electromotive force (emf) of the potato cell is 0.89 V. Explain why the voltages plotted on **Figure 2** are always less than this and why the difference between the emf and the plotted voltage becomes larger with increasing current.

(3)

- (iii) Use **Figure 2** to determine the internal resistance of the potato cell.

internal resistance = _____ Ω

(3)

- (c) A student decides to use two potato cells in series as a power supply for a light emitting diode (LED). In order for the LED to work as required, it needs a voltage of at least 1.6 V and a current of 20 mA.

Explain whether the LED will work as required.

(2)

(Total 11 marks)

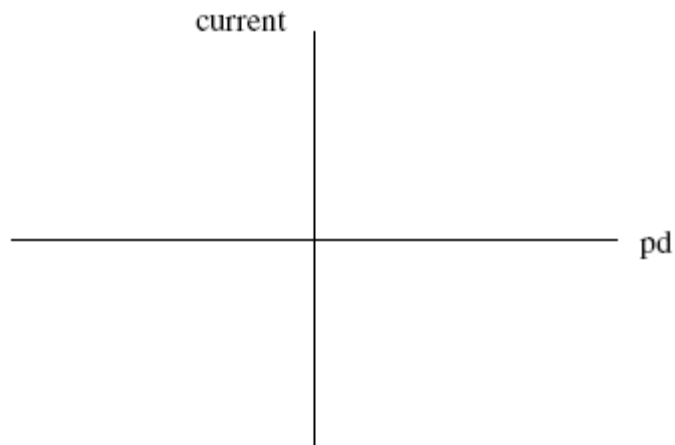
7

- (a) A semiconducting diode is an example of a *non-ohmic* component. State what is meant by a non-ohmic component.

(1)

- (b) A filament lamp is also an example of a non-ohmic component.

- (i) Sketch on the axes below the current-voltage characteristic for a filament lamp.



(2)

- (ii) State, with reference to the current-voltage characteristic you have drawn, how the resistance of the lamp changes as the pd across its terminals changes.

(1)

- (c) A filament lamp has a power rating of 36 W when there is a pd across its terminals of 12V.

- (i) Calculate the resistance of the filament when the pd across its terminals is 12V.

answer = _____ Ω

(2)

- (ii) A student predicts that if the pd across the bulb is reduced to 6.0 V the power rating of the bulb would be 9.0 W. State and explain how in practice the power rating will be slightly different from this value.

(3)

(Total 9 marks)

8

- (a) Define resistance.

(1)

- (b) (i) Sketch onto the axes below a graph of the variation of current with potential difference for a filament lamp.



(1)

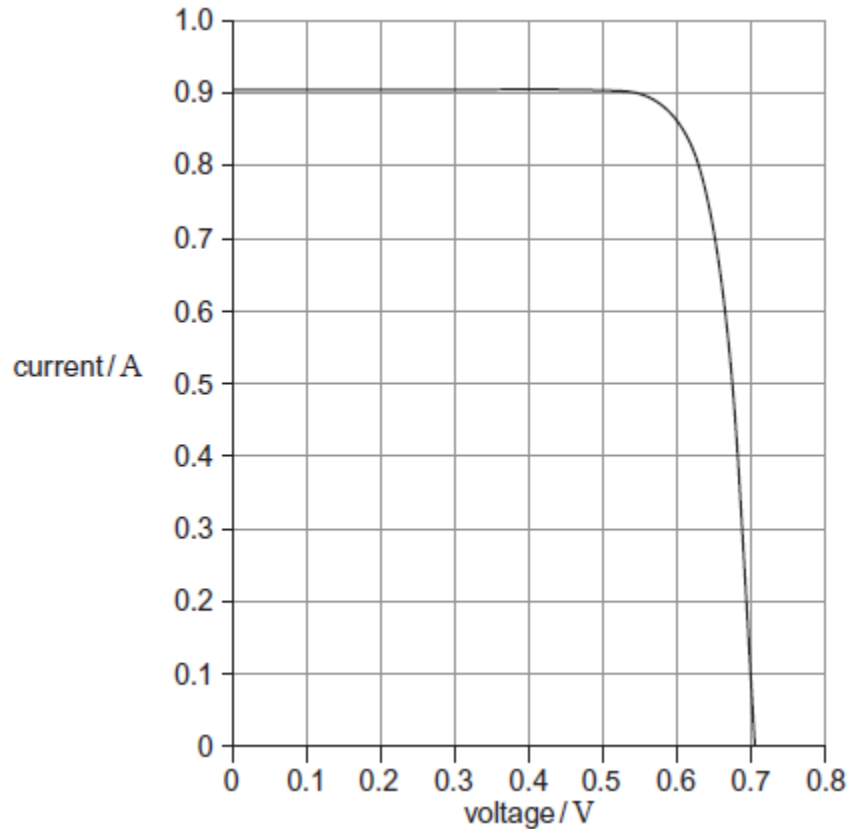
- (ii) State and explain, in terms of electron flow, how the resistance of the filament lamp changes as the current in the lamp increases.

(3)

(Total 5 marks)

9

The graph shows the current–voltage characteristic of the output from a solar cell when light of intensity 450 W m^{-2} is incident on it.

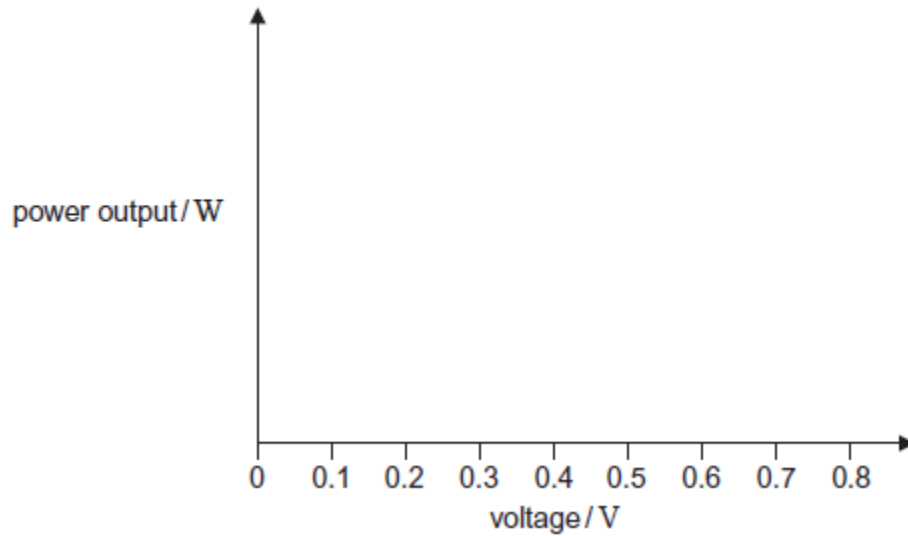


- (a) (i) Using data from the graph above estimate the **maximum** power output from the solar cell.

maximum power _____ W

(2)

- (ii) Sketch, on the axes below, a graph to show how the power output varies with voltage for this solar cell for the same incident light intensity.



(2)

- (iii) When the light intensity is 450 W m^{-2} the cell has an efficiency of 0.15 at the maximum power.

Calculate the area of the solar cell.

area _____ m^2

(3)

- (b) A manufacturer has a supply of solar cells that each have an electromotive force (emf) of 0.70 V and an internal resistance of 0.78Ω when delivering maximum power.

- (i) Explain what is meant by an emf of 0.70 V.

(1)

- (ii) The manufacturer uses a number of these solar cells in an array to make a power supply that has an emf of 14 V and an internal resistance of $3.9\ \Omega$ when delivering maximum power.

Describe and explain the arrangement of cells the manufacturer has to use in this array. Go on to calculate the number of cells the manufacturer needs to make the power supply.

number of cells _____

(4)

- (c) Communications satellites use solar cells to generate electrical power. Discuss why solar cells are appropriate for this task.

Your answer should refer to:

- any additional features that would be needed to ensure that the satellite's electrical systems operate continuously
- whether solar cell arrays are appropriate for space probes that travel to the edge of the solar system.

The quality of your written communication will be assessed in your answer.

(6)

(Total 18 marks)

10

A student wishes to collect data so he can plot the I - V curve for a semiconductor diode.

- (a) (i) Draw a suitable diagram of the circuit that would enable the student to collect this data.

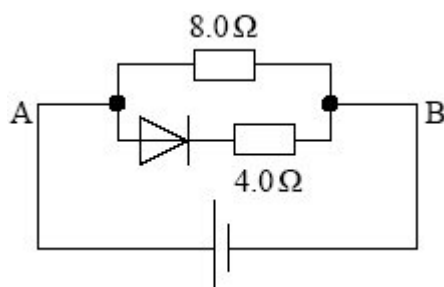
(3)

- (ii) Describe the procedure the student would follow in order to obtain an I - V curve for the semiconductor diode.

The quality of your written communication will be assessed in this question.

(6)

- (b) The diagram below shows an arrangement of a semiconducting diode and two resistors.



A 12.0 V battery is connected with its positive terminal to A and negative terminal to B.

- (i) Calculate the current in the $8.0\ \Omega$ resistor

answer _____ A

(2)

- (ii) Calculate the current in the $4.0\ \Omega$ resistor if the p.d. across the diode, when in forward bias, is 0.65 V expressing your answer to an appropriate number of significant figures.

answer _____ A

(3)

(Total 14 marks)

11

- (a) On the axes in **Figure 1** draw $I - V$ characteristics for **two** components, A and B, both of which obey Ohm's law. Component B has a lower resistance than component A. Label your characteristics clearly as A and B.

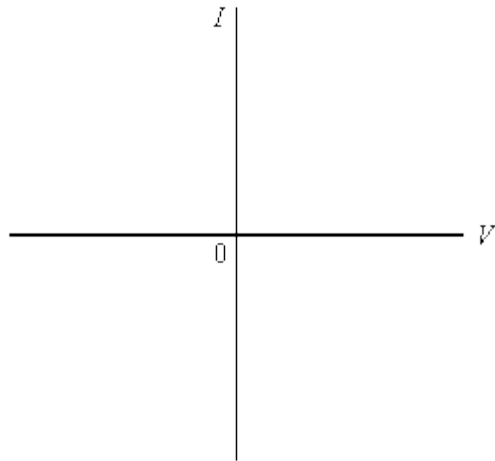


Figure 1

(2)

- (b) On the axes in **Figure 2** draw the $I - V$ characteristic for a silicon semiconductor diode, giving any relevant voltage values.

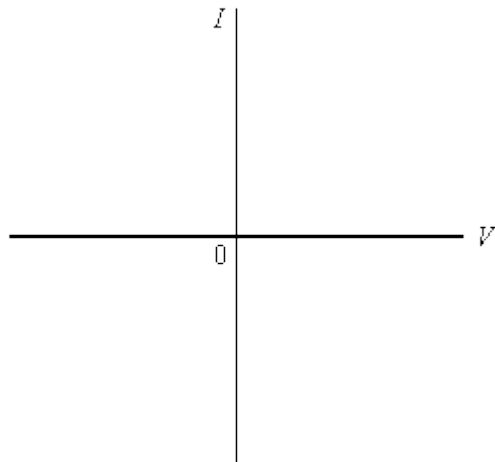


Figure 2

(3)

- (c) **Figure 3** shows the $I - V$ characteristic of a filament lamp. Explain the shape of this characteristic.

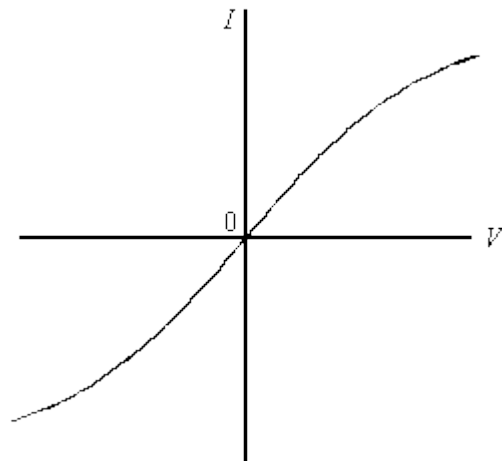


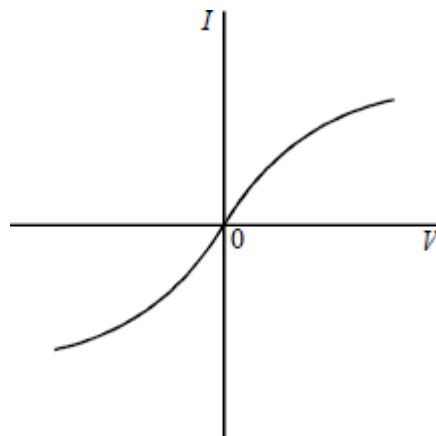
Figure 3

(4)

(Total 9 marks)

12

- (a) The characteristic shown below is that of a filament lamp.



Explain why, as the voltage is increased either positively or negatively from zero, the characteristic has the form shown in the figure.

(5)

- (b) At a certain point on the characteristic, the power developed in the lamp is 20 W and the current is 90 mA. Calculate the resistance of the filament at this point on the characteristic.

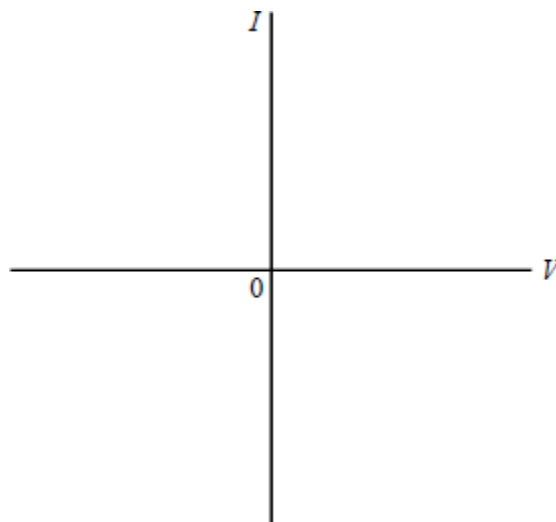
(2)

(Total 7 marks)

13

- (a) Using the axes below, sketch the characteristic of a silicon semiconductor diode for forward bias and reverse bias.

Indicate approximate values on the voltage axis.



(4)

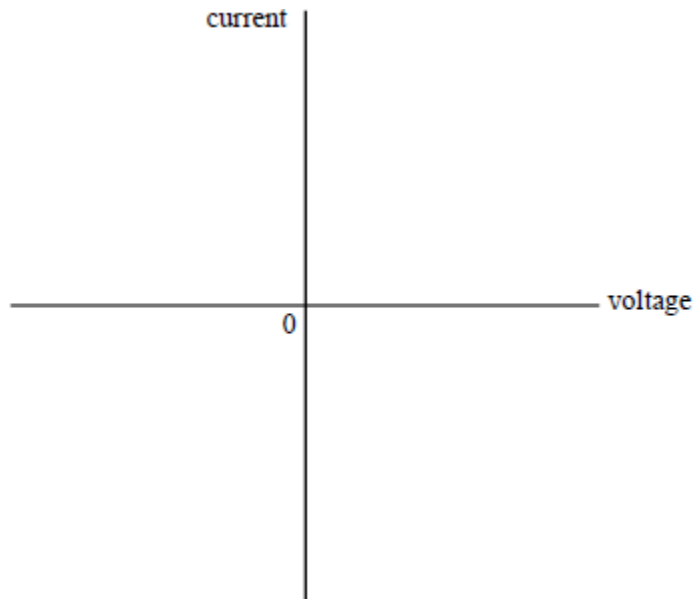
- (b) Describe, with reference to the characteristic you have drawn, how the resistance of the diode changes with the voltage across the diode.

(3)

(Total 7 marks)

14

- (a) Draw, on the axes below, the current/voltage characteristic for a filament lamp. Do **not** insert any values for current or voltage.



(3)

- (b) Explain why the characteristic has the shape you have drawn.

(3)

- (c) The current/voltage characteristic of a filament lamp is to be determined using a datalogger, the data then being fed into a computer to give a visual display of the characteristic. Draw the circuit diagram required for such an experiment and state what is varied so as to produce a range of values.

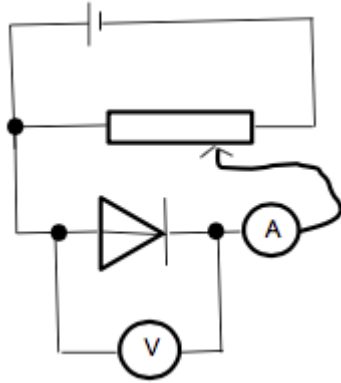
(5)

(Total 11 marks)

1	A	[1]
2	(a) correct general shape ✓ accurate plotting to within $\frac{1}{2}$ square ✓ (b) 12 (V) ✓, 30 (W) ✓ (c) $R = \left(\frac{6}{1.9} \right) = 3.2 (\Omega)$ ✓ (d) Resistance increases ✓ Temperature increases ✓ More collisions / interaction of electrons with lattice ions ✓ <i>Condone ‘atoms’, ‘molecule’.</i> <i>Do not allow electron–electron collisions.</i> (e) Can attain neither maximum nor minimum voltage ✓ Explanation of either maximum OR minimum ✓	2 2 1 3 2 [10]
3	A	[1]

4

(a) (i)



correct diode bias for variable supply, must have some attempt to vary pd ✓

Condone variable resistor (condone missing arrow) don't allow thermistor symbol

correct symbols and positions for voltmeter, ammeter:

voltmeter in parallel with diode only

ammeter in series with diode ✓

Allow mA symbol instead of A symbol for ammeter

Allow symbols for diode without line through triangle and / or with a circle

Diode symbol must consist of a triangle and a straight line at nose perpendicular to wiring in circuit.

allow voltmeter across ammeter and diode



2

- (ii) **The candidate's writing should be legible and the spelling, punctuation and grammar should be sufficiently accurate for the meaning to be clear.**

The candidate's answer will be assessed holistically. The answer will be assigned to one of three levels according to the following criteria.

High Level (Good to excellent): 5 or 6 marks

The information conveyed by the answer is clearly organised, logical and coherent, using appropriate specialist vocabulary correctly. The form and style of writing is appropriate to answer the question.

Candidate explains how to obtain sufficient values of I and V. They mention the need to limit the current through the diode and give an indication of the range and frequency of measurements. They discuss an advantage of using a data logger. Voltage does not exceed 1.0V, diode is forward biased

Intermediate Level (Modest to adequate): 3 or 4 marks

The information conveyed by the answer may be less well organised and not fully coherent. There is less use of specialist vocabulary, or specialist vocabulary may be used incorrectly. The form and style of writing is less appropriate.

Candidate explains how to obtain sufficient values of I and V. Includes mention of diode is forward biased or suitable voltage for switch on mentioned or advantage of data logger

Low Level (Poor to limited): 1 or 2 marks

The information conveyed by the answer is poorly organised and may not be relevant or coherent. There is little correct use of specialist vocabulary. The form and style of writing may be only partly appropriate.

vary p_d obtain several readings of I and V

or an advantage of using data logger

or forward biased

low level safety may include switch off / avoid overheating type arguments / don't touch

The explanation expected in a competent answer should include a coherent selection of the following points concerning the physical principles involved and their consequences in this case.

means of controlling p_d across diode

indication of range and frequency of measurement

mention of limiting current to avoid damage to diode

a consideration of the advantages of a datalogger e.g. many readings, computer display of results

use of potential divider instead of series resistor

All signs of quality that could lift mark

Lower band

vary p_d obtain several readings of I and V

or an advantage of using data logger or low level safety and action to minimise risk

Middle band

vary p_d and obtain several readings of I and V , at least 6 different values **including** an advantage of using data logger or mention of forward bias or mention of switch on voltage (0.6V) or safety

Top Band

Mention of how to vary p_d (seen in viable circuit) obtain several readings of I and V , at least 6 different values (range given where maximum value of p_d does not exceed 1.0V)

mention of limiting current through diode using protective resistor

consider advantage of data logger

mention forward bias

must include potentiometer for 6 marks

must have voltage as independent, no current led arguments in Top band

Data logger advantages:

Not more accurate

Not removes human error

6

- (iii) reverse connections to the power supply / battery / cell / reverse diode ✓
not switch wires around (need clear link to reversing connections at supply's terminals)

1

- (b) (i) divide V by I for a reading from graph **or** uses $R = V/I$ for a reading from graph ✓

Treat gradient = $\frac{1}{R}$ as TO

repeat for different values of V and I ✓

Must score 1st mark to achieve 2nd

2

- (ii) (Resistance) decreases ✓

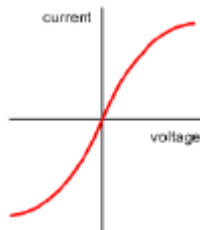
Or resistance starts off very high and then becomes much lower

1

[12]

5

(a)



✓ ✓

first mark for linear at origin and decreasing gradient in either quadrant (linear region can be very small)

second mark for symmetry plus no dip at end or extended horizontal section at end

straight line scores zero

2

- (b) (i) resistance (of filament lamp) increases ✓

1

- (ii) filament lamp is a non-ohmic conductor as current is not (directly) proportional to voltage / resistance is not constant ✓

proportionality can be shown using graph

1

- (c) either

circuit / total resistance increases ✓

(hence) current decreases and pd / voltage across R decreases ✓

OR

resistance of PQ combination increases ✓

(hence) greater share of pd / voltage across lamp P ✓

implication that current is different in different parts of series circuits

scores 0

implication that new total current is greater scores zero

voltage flowing loses second mark

2

- (d) (i) (use of $\text{energy} = VIt$)
 (energy converted by X = $60 \times 120 \times 3600 = 2.59 \times 10^7 \text{ J}$ ✓
 (energy converted by Y = $11 \times 120 \times 3600 = 4.75 \times 10^6 \text{ J}$ ✓
Accept answers to 1 sig. fig.

2

- (ii) in lamps energy is wasted as heat / thermal energy ✓
 specific lamp considered e.g. in lamp, X / filament lamp more energy is wasted
 OR in X / filament lamp less energy is converted to light / luminosity ✓

2

[10]

6

- (a) emf is the work done / energy transferred by a voltage source / battery / cell ✓ per unit charge ✓
 OR
 electrical energy transferred / converted / delivered / produced ✓
 per unit charge ✓
 OR
 pd across terminals when no current flowing / open circuit ✓ ✓
not in battery
accept word equation OR symbol equation with symbols defined if done then must explain energy / work in equation for first mark

2

- (b) (i) by altering the (variable) resistor ✓

1

- (ii) reference to correct internal resistance ✓
e.g. resistance of potato (cell)
 terminal pd = emf – pd across internal resistance / lost volts ✓
 pd / lost volts increases as current increases OR as (variable) resistance decreases greater proportion / share of emf across internal resistance ✓
accept voltage for pd

3

- (iii) draws best fit straight line and attempts to use gradient ✓
 uses triangle with base at least 6 cm ✓
 value in range 2600 – 2800 (Ω) ✓

3

stand-alone last mark

- (c) total emf is above 1.6 V ✓
 but will not work as current not high enough / less than 20 mA ✓

2

[11]

7	(a)	a non-ohmic conductor does not have a constant resistance (1)		1
	(b)	(i)	curve of decreasing gradient with increasing V (1) attempt to make graph symmetric in two opposite quadrants (1)	2
		(ii)	resistance increases as pd increases/current increases (1)	1
	(c)	(i)	(use of $P = V^2/R$) $36 = 144/R$ (1) $R = 4.0 \text{ } (\Omega)$ (1)	2
		(ii)	reference to temperature change (1) (resulting in) a lower resistance (1) (hence) power rating would be greater (1)	3

[9]

8	(a)	ratio of voltage (across component) to current (through component) or $R = V/I$ with terms defined and R as subject	B1	1
	(b)	(i)	correct curve	1
		(ii)	resistance increases / increase in resistivity	1
			energy transfer increases lattice vibration / temperature rise increases lattice vibration / electron collisions increases lattice vibration	1
			more frequent collisions/ ions now a larger target for electrons	3

[5]

9

- (a) (i) Use of $P = VI$ with pair of valid coordinates from graph

C1

0.52 (W)

Allow 1sf if within 0.49 to 0.52

A1

2

- (ii) Correct general shape

M1

Linear rise between 0.0 – 0.5 V and falls to zero at 0.71 V

A1

2

- (iii) Use of $\text{efficiency} = \frac{\text{useful power out}}{\text{total power in}}$

C1

Use of $I = \frac{P}{A}$

C1

Their (i) / 67.5 (m²) (7.7 × 10⁻³ if correct)

A1

3

- (b) (i) 0.7 J of work done (by cell) per 1 C of charge (when moved round circuit)
OR
(Terminal) pd across (solar) cell with no load / current is 0.7 V
Not "per unit charge"

B1

1

- (ii) 20 cells in series (to produce 14 V)

B1

Series arrangement has internal resistance of 15.6Ω

B1

Cells in parallel (needed to reduce total internal resistance of array)

B1

80 cells / 4 parallel sets of 20 cells in series

B1

4

- (c) The marking scheme for this question includes an overall assessment for the quality of written communication (QWC). There are no discrete marks for the assessment of QWC but the candidate's QWC in this answer will be one of the criteria used to assign a level and award the marks for this question.

Descriptor – an answer will be expected to meet most of the criteria in the level descriptor.

Level 3 – good

- claims supported by an appropriate range of evidence;
- good use of information or ideas about physics, going beyond those given in the question;
- argument is well structured with minimal repetition or irrelevant points;
- accurate and clear expression of ideas with only minor errors of grammar, punctuation and spelling.

Level 2 – modest

- claims partly supported by evidence;
- good use of information or ideas about physics given in the question but limited beyond this;
- the argument shows some attempt at structure;
- the ideas are expressed with reasonable clarity but with a few errors of grammar, punctuation and spelling.

Level 1 – limited

- valid points but not clearly linked to an argument structure;
- limited use of information about physics;
- unstructured;
- errors in spelling, punctuation and grammar or lack of fluency.

Level 0

- incorrect, inappropriate or no response.

Some points:

Use on communication satellite:

Continuous supply of energy from Sun

No need for fuel (for power purposes)

Large area of solar cells not needed (but possible)

Low mass

Can be unfolded (after launch)

No environmental hazard

Reliable/no moving parts

Continuous operation:

Arrays need to track sun (to maximise absorption)

Shielding required as can be damaged by meteors or cosmic rays

Need storage system (rechargeable batteries / capacitors) for back up (if in shadow)

Limit use of energy-intensive operations

Use on space probe:

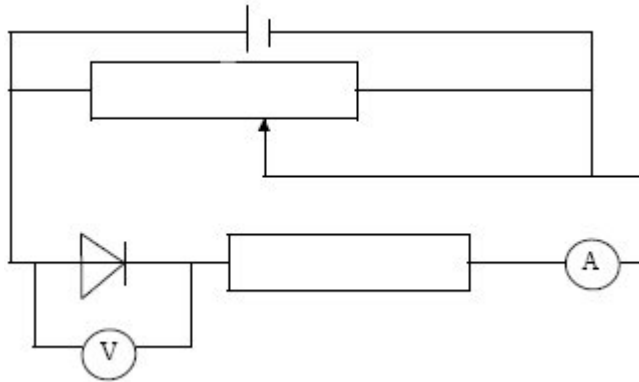
Light intensity / energy too low at large distance

Intensity falls as inverse-square

Area of array would be too large

10

(a) (i)



suitable variable input (variable power supply or variable resistor) **(1)**

protective resistor **and** diode **forward** biased **(1)**

correct current **and** pd measuring devices **(1)**

- (ii) the mark scheme for this part of the question includes an overall assessment for the Quality of Written Communication

QWC	descriptor	mark range
good-excellent	Uses accurately appropriate grammar, spelling, punctuation and legibility. Uses the most appropriate form and style of writing to give an explanation or to present an argument in a well structured piece of extended writing. [May include bullet points and/or formulae or equations]. Answer refers to at least 5 of the relevant points listed below.	5-6
modest-adequate	Only a few errors. Some structure to answer, style acceptable, arguments or explanations partially supported by evidence or examples. Answer refers to at least 3 of the relevant points listed below.	3-4
poor-limited	Several significant errors. Answer lacking structure, arguments not supported by evidence and contains limited information. Answer refers to no more than 2 of the relevant points.	1-2
incorrect, inappropriate or no response	No answer at all or answer refers to unrelated, incorrect or inappropriate physics.	0

The explanation expected in a competent answer should include a coherent selection of the following physics ideas.

connect circuit up **(1)**

measure current (I) and pd/voltage (V) **(1)**

vary resistance/voltage **(1)**

obtain a range of results **(1)**

reverse connections to power supply (and repeat) **(1)**

plot a graph (of pd against current) **(1)**

mention of significance of 0.6V **or** disconnect between readings **or** change range on meters when doing reverse bias **(1)**

- (b) (i) (use of $I = V/R$)

$$I = 12/8 \text{ (1)} = 1.5\text{A (1)}$$

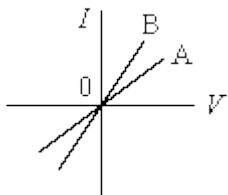
(ii) $I = (12 - 0.65 \text{ (1)})/4 = 2.8 \text{ A (1) sig figs (1)}$

5

[14]

11

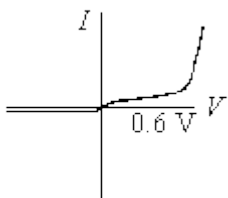
- (a)



straight line in both quadrants,
through origin for A and B (1)
greater gradient for B (1)

2

- (b)



characteristic to show:
positive current increasing slowly and then rapidly (1)
at $\approx 0.6\text{V}$ (1)
negative current either zero or just $< \text{zero}$ (1)

3

- (c) as voltage increases, current increases (1)
current heats filament (1)
therefore resistance increases (1)
correct argument to explain curvature (1)
mirror image in negative quadrant (1)

max 4

[9]

12

- (a) Ohm's law obeyed (or straight line graph) initially (1)
at a given voltage) current heats filament (to certain temperature) (1)
resistance constant at that temperature (1)
increase in voltage gives increase in current (1)
temperature of filament increases and resistance increases (1)
rate of increase of current less than if resistance was constant (1)
negative voltage and current produces same effect (1)

5

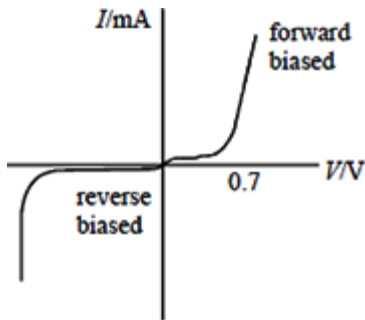
- (b) $P = I^2 R$ (1)
 $20 = (90 \times 10^{-3})^2 R$ and $R = 2.5 \times 10^3 \Omega$ (1) (2470 Ω)

2

[7]

13

(a)



forward bias:

zero current rising gradually (1)

sharp increase at ≈ 0.7 V (1)

reverse bias:

zero or slightly less than zero current (1)

sharp negative increase at breakdown (1)

breakdown value >50 V indicated (1)

4

- (b) forward bias: high resistance (initially gives small current) (1)
 at ≈ 0.7 V, resistance decreases rapidly (current increases) (1)

reverse bias: high resistance (gives $\approx$ zero or slightly negative current) (1)

at breakdown, resistance $\approx$ zero (and very large current) (1)

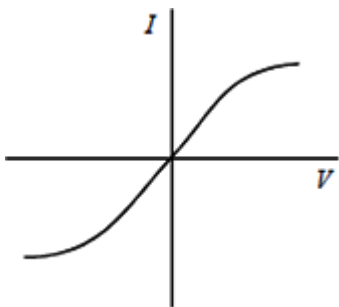
3

The Quality of Written Communication marks are awarded for the quality of answers to this question.

[7]

14

(a)



correct curve in positive quadrant (1)

correct curve in negative quadrant (1)

passing through origin (1)

(3)

- (b) the current heats the filament **(1)**
(temperature rises) resistance increases **(1)**
pd. and current do not increase proportionally **(1)**
some reference to mirror image in negative quadrant **(1)**

The Quality of Written Communication marks were awarded primarily for the quality of answers to this part

(max 3)

- (c) diagram to show:
battery, variable resistance (or variable supply) and filament **(1)**
current sensor in series circuit **(1)**
voltage sensor across filament **(1)**
the two sensor boxes connected to datalogger **(1)**

method:

- variable resistor or variable supply altered
[or choose recording interval] **(1)**
thus changing both V and I **(1)**

The Quality of Written Communication marks were awarded primarily for the quality of answers to this part

(max 5)

[11]