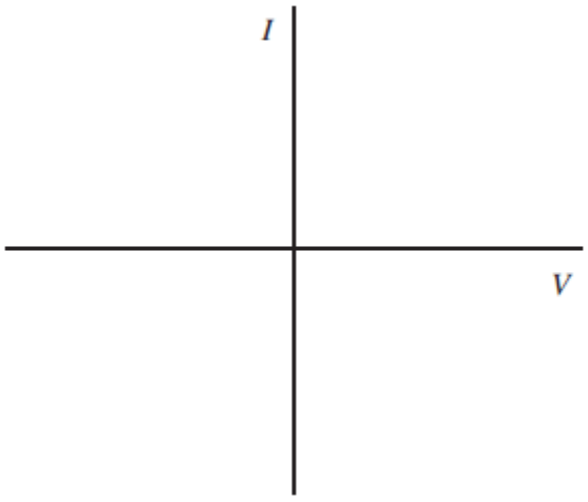
Q1.(a) Sketch, on **Figure 1**, the current−voltage (IV) characteristic for a filament lamp for currents up to its working power.

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.

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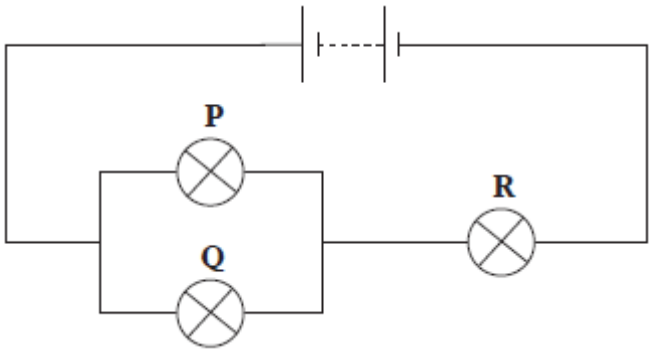
(1)

(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.

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(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.

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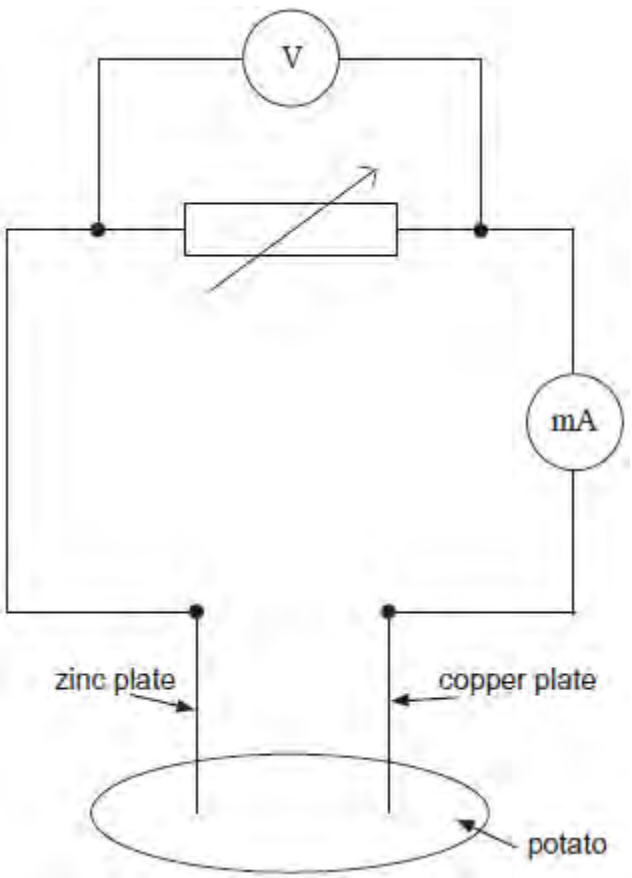
(2)
(Total 10 marks)

Q2. 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.

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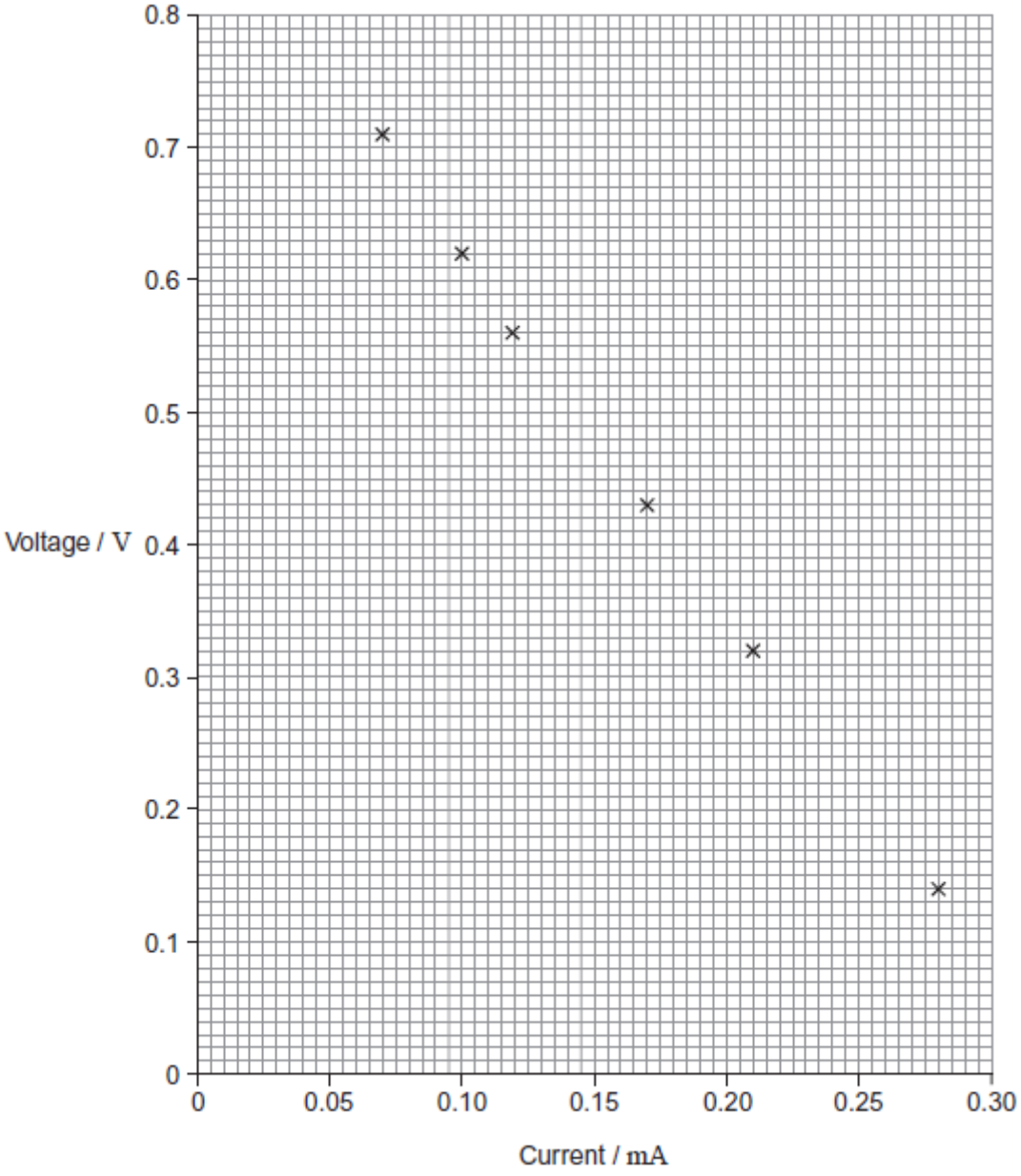
(2)

(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.

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(1)

(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.

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(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.

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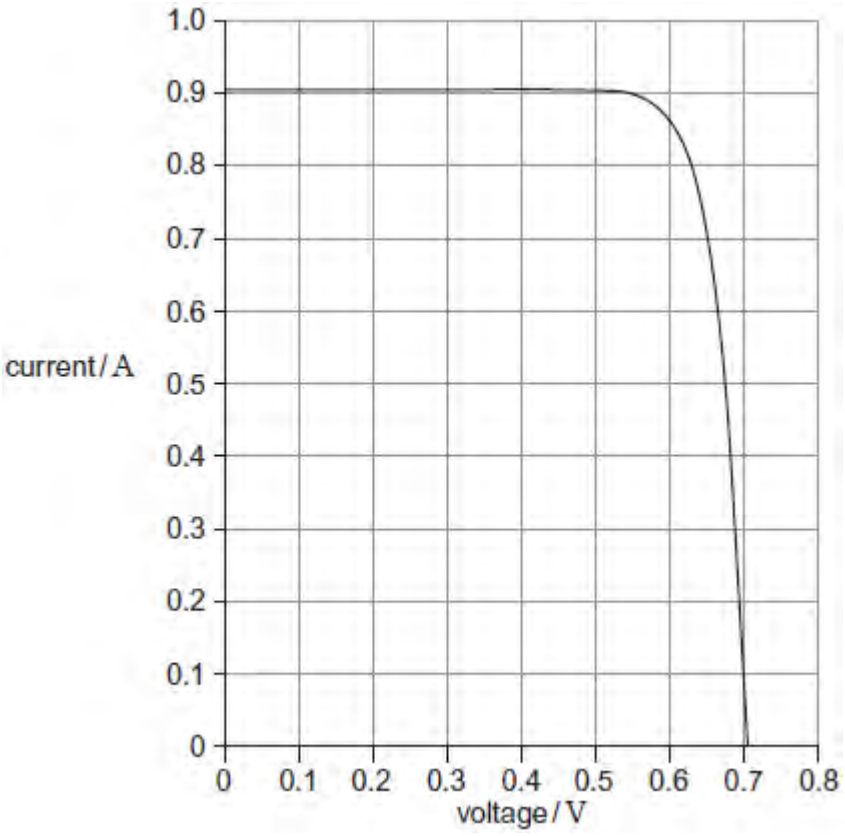
(2)
(Total 11 marks)

Q3. 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.

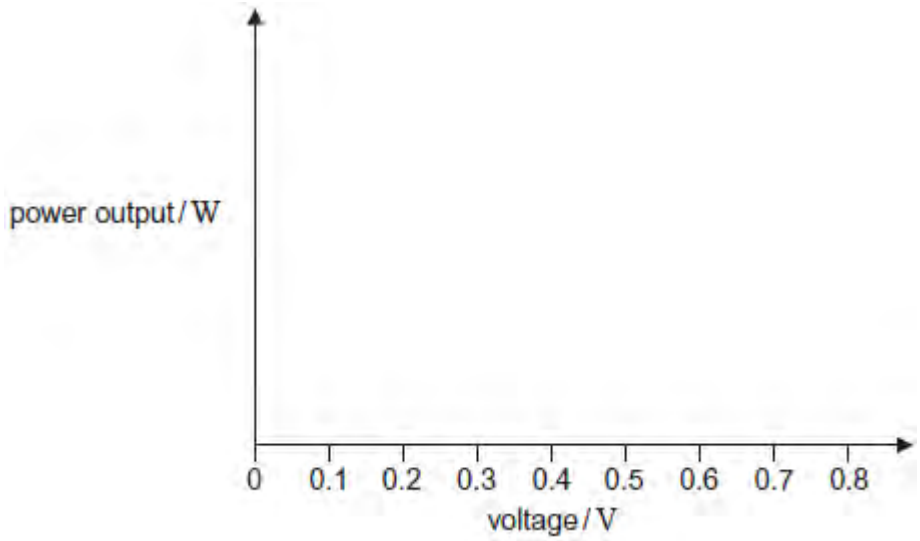


(a) (i) Using data from the graph above estimate the **maximum** power output from the solar cell.

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 0.78 Ω when delivering maximum power.

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

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(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 Ω 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.

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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:

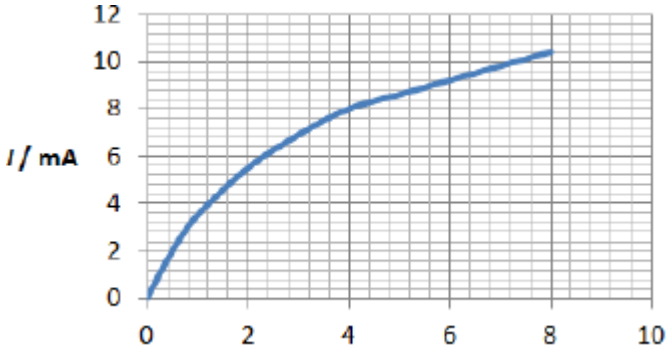
- any additional features that would be needed to ensure that the satellite's electrical systems operate continuously
- whether solar cell arrays are appropriate for space probes that travel to the edge of the solar system.

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

(6)

(Total 18 marks)

Q4. The graph shows the current–voltage (*I*–*V*) characteristics of a filament lamp.



V / V

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)

Q5. (a) Define resistance.

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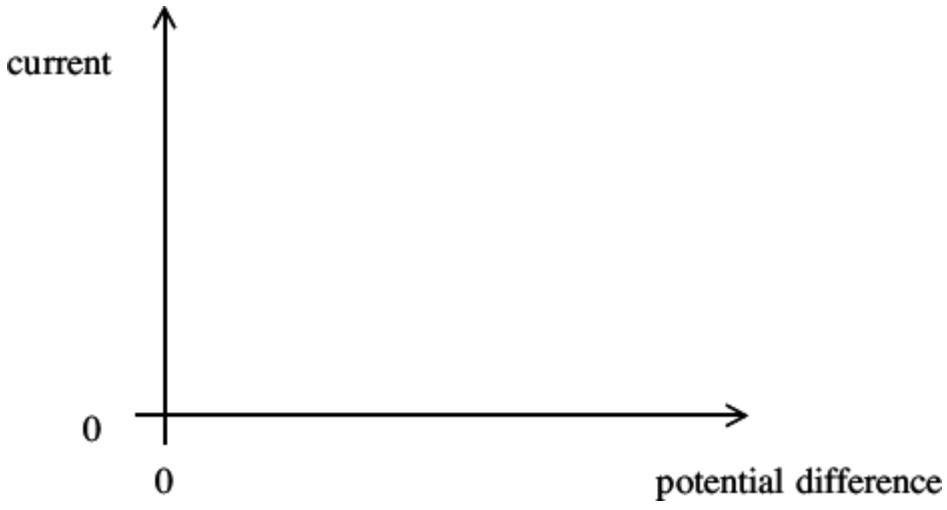
(1)

(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.

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(3)
(Total 5 marks)

Q6. (a) A semiconducting diode is an example of a *non-ohmic* component. State what is meant by a non-ohmic component.

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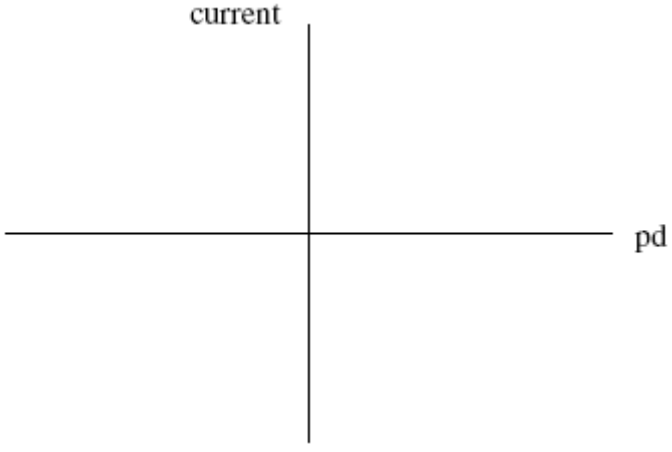
(1)

(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.

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.....

(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.

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(3)
(Total 9 marks)