Q1.(a) The power P dissipated in a resistor of resistance R is measured for a range of values of the potential difference V across it. The results are shown in the table below.

V / V	V^2 / V^2	P / W
1.00	1.0	0.21
1.71	2.9	0.58
2.25		1.01
2.67		1.43
3.00	9.0	1.80
3.27	10.7	2.18
3.50	12.3	2.43

(i) Complete the table above.

(1)

(ii) Complete the graph below by plotting the two remaining points and draw a best fit straight line.

(2)

(iii) Determine the gradient of the graph.

gradient = ...

(3)

(iv) Use the gradient of the graph to obtain a value for R.

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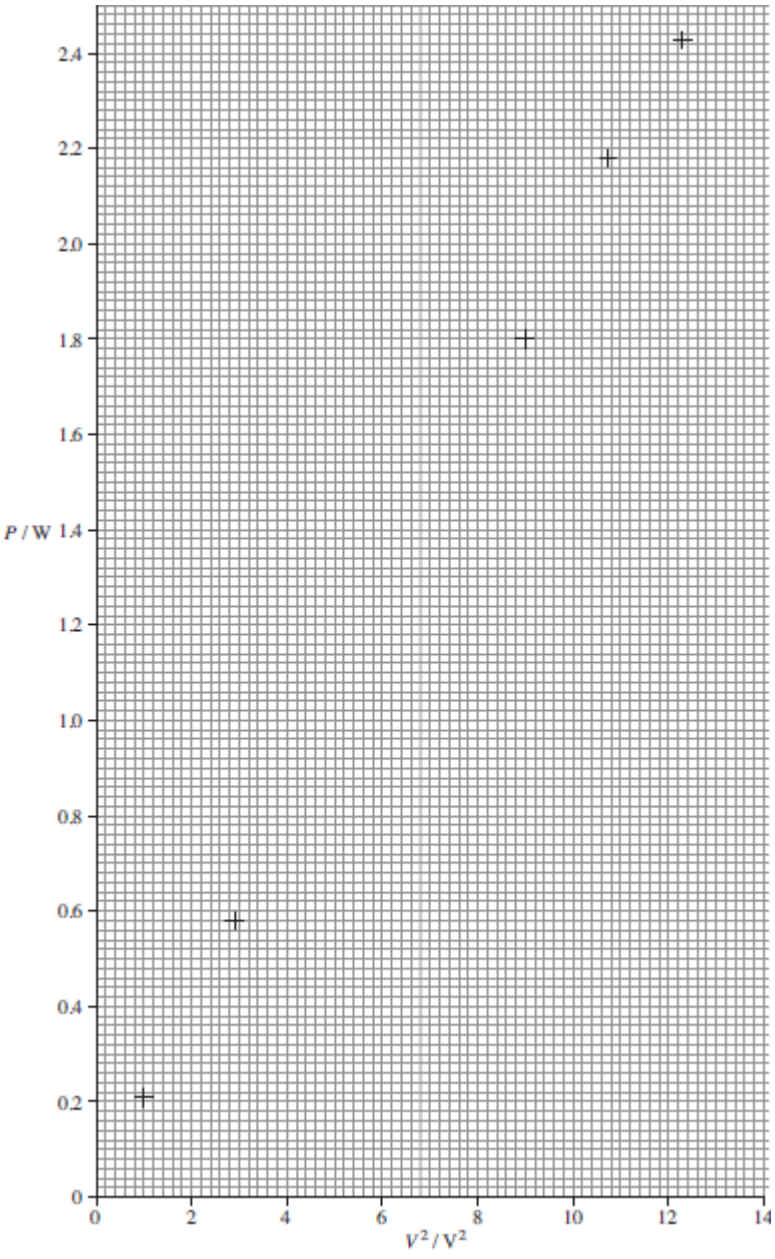
R = ...



(1)

(b) The following questions are based on the data in the table above.

(i) Determine the value of R when V = 3.50 V.

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R = ... Ω

(1)

(ii) The uncertainty in V is ± 0.01 V. The uncertainty in P is ± 0.05 W.

Calculate the percentage uncertainty in the value of R calculated in part (1).

percentage uncertainty = ... %

(3)

(iii) Hence calculate the uncertainty in the value of R.

uncertainty = ...

(1)

(iv) State and explain whether the value of R you calculated in part (1) is consistent with the value of R you determined from the gradient in part (a)(iv).

(2)

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(Total 14 marks)

Q2.(a) (i) Describe how you would make a direct measurement of the emf ε of a cell, stating the type of meter you would use.

.....

.....

(1)

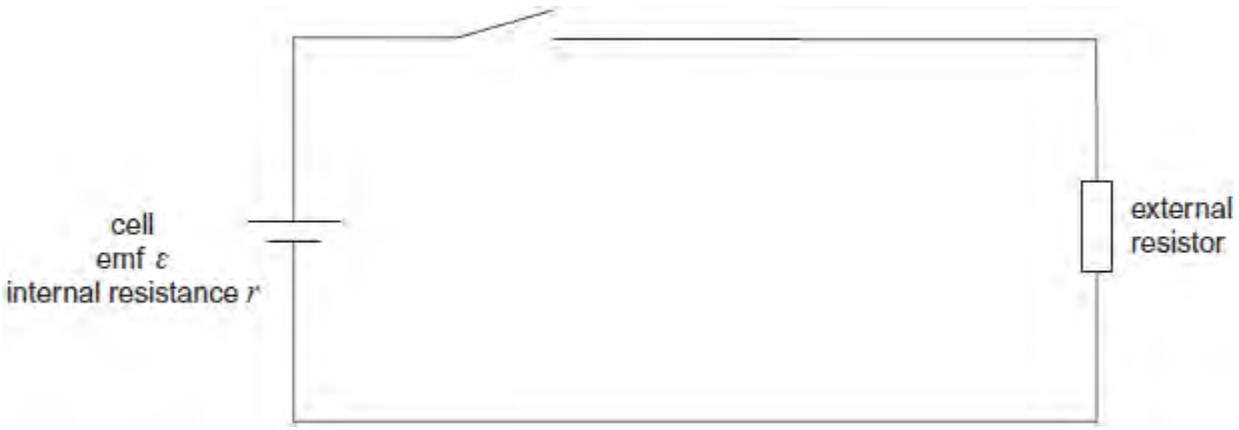
(ii) Explain why this meter must have a very high resistance.

.....

.....

(1)

(b) A student is provided with the circuit shown in the diagram below.



The student wishes to determine the efficiency of this circuit.

In this circuit, useful power is dissipated in the external resistor. The total power input is the power produced by the battery.

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$$\text{Efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

The efficiency can be determined using two readings from a voltmeter.

(i) Show that the efficiency = $\frac{V}{\varepsilon}$ where ε is the emf of the cell

and V is the potential difference across the external resistor.

(1)

(ii) Add a voltmeter to the diagram and explain how you would use this new circuit to take readings of ε and V.

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(2)

(c) Describe how you would obtain a set of readings to investigate the relationship between efficiency and the resistance of the external resistor. State any precautions you would take to ensure your readings were reliable.

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(2)

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(d) State and explain how you would expect the efficiency to vary as the value of R is increased.

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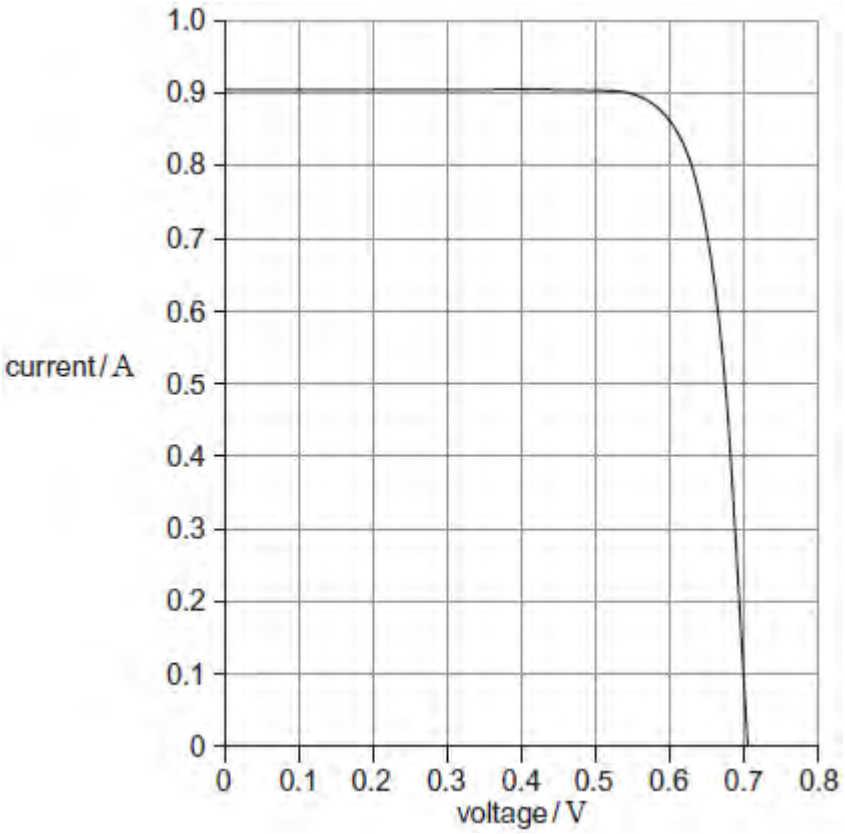
(2)
(Total 9 marks)

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.



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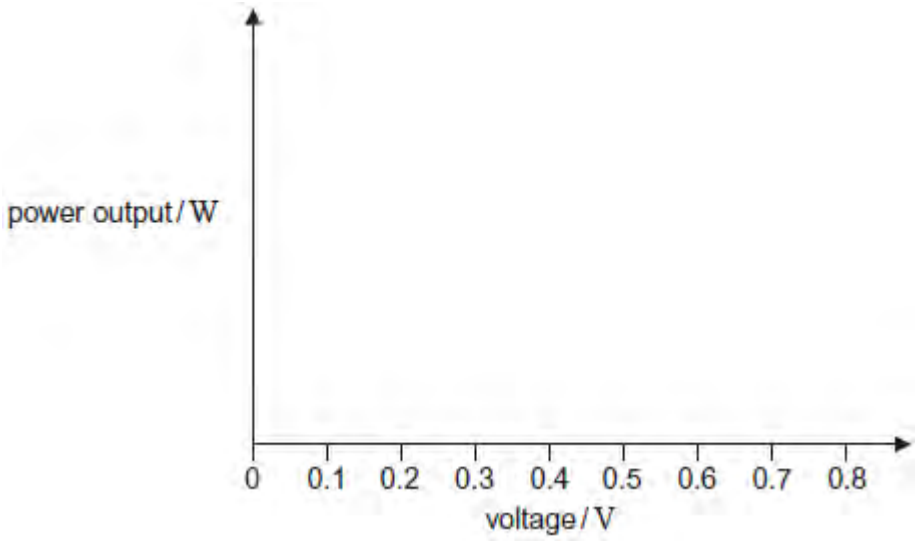
(a) (i) Using data from the graph above estimate the **maximum** power output from the solar cell.

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

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(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.

.....

.....

(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)

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