

*1 Many computers operate through an uninterruptible power supply (UPS) to protect them and the information stored on them from power surges or power cuts. A UPS will run the computer from the mains supply until it detects a problem and then the computer will run off the UPS's rechargeable battery.

A UPS is rated by the maximum power that it can provide to the computer. The unit that is used is the volt-amp (VA).

(a) Use expressions for potential difference and current to show that the volt-amp is equivalent to the watt.

(3)

(b) Each cell of the rechargeable battery has an internal resistance. An advertisement for a UPS states that, at an output power to the computer of 700 W, it can provide a continuous supply for 7 minutes.

(i) Calculate how much energy is provided in this time.

(2)

Energy =

(ii) The advertisement also states that if the output power is halved, the supply will last for 23 minutes. Without doing any calculations, explain why halving the power output more than doubles the time.

(3)

(Total for Question = 8 marks)

- 2 The planet Jupiter has a moon Io. Volcanic activity on Io releases clouds of electrons which travel at high speeds towards Jupiter. During a 15 s time period, 2.6×10^{26} electrons reach Jupiter from Io.

Calculate the current.

Current =

(Total for Question = 3 marks)

- *3 A student is asked to explain which of two filament lamps will be brighter when they are connected in parallel across a power supply. She is told that the resistance of lamp A is greater than the resistance of lamp B.

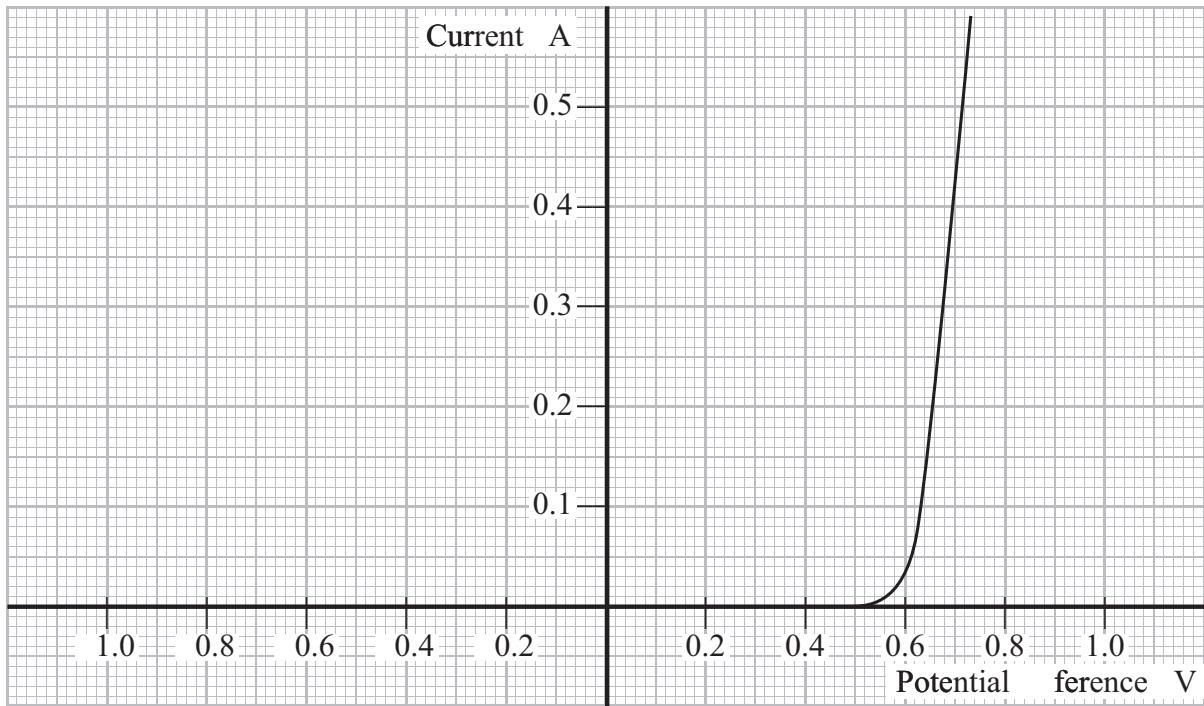
The student wrote the following explanation that contains some mistakes:

"The current is the same in both lamps. Because lamp A has a higher resistance, it is harder for the electrons to move through this lamp so they will lose more energy. Lamp A will therefore be brighter than lamp B."

Write a correct explanation.

(Total for Question = 5 marks)

4 The graph shows the current potential difference characteristic for an electrical component.



(a) State the name of the component. (1)

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(b) State the resistance of the component when the potential difference is 0.7 V. (1)

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(c) Calculate the resistance of the component when the potential difference is + 0.7 V. (2)

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Resistance

(d) State a practical use for this component. (1)

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(Total for Question 5 marks)

5 If certain crystals are subjected to a mechanical stress, a potential difference is generated across them. This is called the piezoelectric effect. These crystals can be produced as very thin films.

Below is a photograph of a T-shirt with a built-in phone charger, which is being tested at a music festival. The white rectangle is a piezoelectric film.



(a) By considering how a sound wave travels through the air, explain how sound can cause a piezoelectric film to generate a potential difference.

(4)

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(b) Explain why the crystals used in the T-shirt need to be in the form of a large, thin film.

(3)

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(c) When the T-shirt is used at a music festival the sound levels are sufficient to generate about 20 kJ over ten hours. This is enough to charge one phone.

Calculate the electrical power output.

(3)

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Power output

(d) Give **one** advantage and **one** disadvantage of this charger compared with a conventional charger.

(2)

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(Total for Question 12 marks)

6 The photograph shows a solar panel being used to produce electricity.



The solar panel has an efficiency of 15%. The average radiation flux falling on the panel is 210 W m^{-2} .

Assuming that this radiation falls normally on the panel, calculate the area of the panel that would provide an average power output of 500 W.

(3)

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Area

(Total for Question 3 marks)

7 Energy is a very important concept in physics. Energy is usually measured in joules, but may be measured in electronvolts (eV) or kilowatt-hours (kW h).

(a) In an X-ray tube an electron is accelerated across a potential difference of 100 000 V. The electron gains 100 000 eV of kinetic energy.

Calculate this energy in joules.

(2)

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100 000 eV J

(b) A 1000 W domestic heater dissipates 8 kW h of energy when used for 8 hours.

Calculate the energy dissipated in joules.

(2)

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8 kW h J

(c) Suggest why, in the above cases, the electronvolt and the kilowatt-hour are more convenient units than the joule.

(2)

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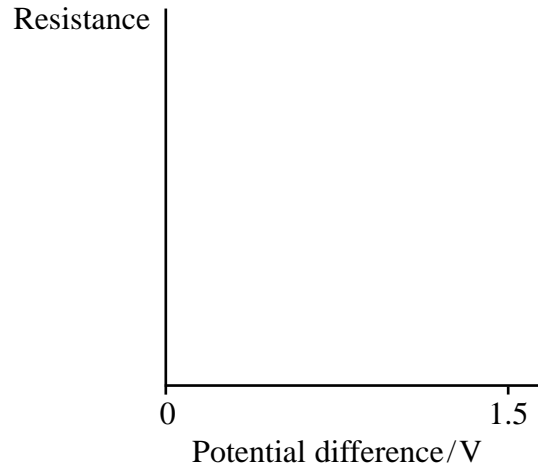
(Total for Question 6 marks)

8 (a) State Ohm's law.

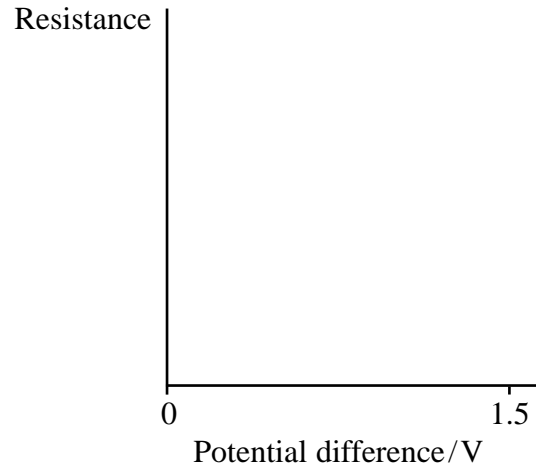
(2)

(b) Using the axes below sketch graphs to show how resistance varies with potential difference for a fixed resistor and a 1.5 V filament lamp.

(3)



FIXED RESISTOR



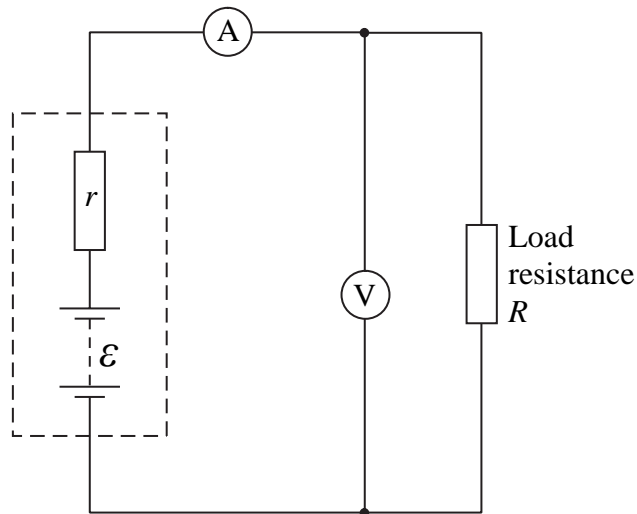
FILAMENT LAMP

(c) The filament of a lamp is made of metal. Explain why the lamp does not demonstrate Ohm's law.

(2)

(Total for Question = 7 marks)

- 9 A student uses a battery of e.m.f. and internal resistance r to investigate how the power delivered to a load R by a battery, varies with the resistance of the load. The following circuit is used.



The student uses a spreadsheet to model the behaviour of the circuit.

	A	B	C	D	E	F
1	Load resistance / Ω	E.m.f. / V	Internal resistance / Ω	Current / A	P.d. across load / V	Power in load / W
2	0.00	6.00	0.800	7.50	0.00	0.0
3	0.40	6.00	0.800	5.00	2.00	10.0
4	0.80	6.00	0.800	3.75	3.00	11.3
5	1.20	6.00	0.800	3.00	3.60	10.8
6	1.60	6.00	0.800	2.50	4.00	10.0
7	2.00	6.00	0.800	2.14	4.29	
8	2.40	6.00	0.800	1.88	4.50	8.4

(a) (i) The formula to calculate the value of cell D8 is

$$=B8/(A8+C8)$$

Show why this is the correct formula.

(1)

(ii) Write the formula to calculate the value of cell E4.

(1)

(iii) Calculate the value for cell F7.

(1)

(b) Explain why the p.d. across the load increases as the current decreases.

(3)

(c) (i) Describe how the power delivered to the load varies for load resistances in the range used.

(2)

(ii) A battery of e.m.f. 12 V and internal resistance 1.6Ω is now used with the same range of load resistances. Describe how the power delivered to the load resistance will now vary.

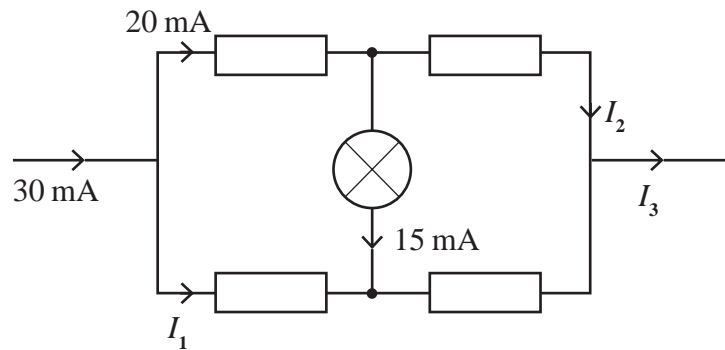
(2)

(Total for Question = 10 marks)

10 (a) What is the coulomb in base units?

(1)

(b) The diagram shows part of an electrical circuit.



Determine the magnitudes of the currents I_1 , I_2 and I_3 .

(3)

$I_1 =$

$I_2 =$

$I_3 =$

(Total for Question = 4 marks)