Current, Charge, Potential Difference & Power

Question Paper

Level	International A Level
Subject	Physics
Exam Board	Edexcel
Topic	DC Electricity
Sub Topic	Current, Charge, Potential Difference & Power
Booklet	Question Paper

Time Allowed: **75 minutes**

Score: **/62**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 A voltmeter is used to measure the potential difference of a cell which is being used to light a bulb.

Choose the row that correctly describes the voltmeter's connection and resistance.

	Connected in	Resistance
☒ **A**	series with the cell	very low
☒ **B**	series with the cell	very high
☒ **C**	parallel with the cell	very low
☒ **D**	parallel with the cell	very high

(Total for Question 1 = 1 mark)

2 A wave has a wavelength of 24 cm. Two points on the wave are $\frac{\pi}{2}$ radians out of phase.

The distance between these two points could be

☒ **A** 3 cm

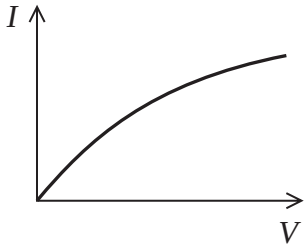
☒ **B** 12 cm

☒ **C** 30 cm

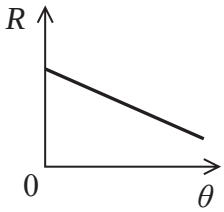
☒ **D** 36 cm

(Total for Question 2 = 1 mark)

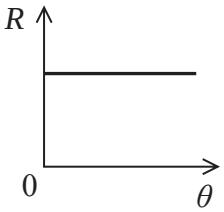
3 The graph shows the current-voltage characteristic for a filament lamp.



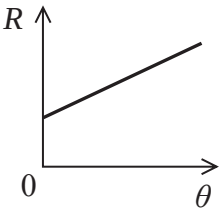
Choose the graph that best shows how the resistance R of the lamp changes with temperature θ in °C.



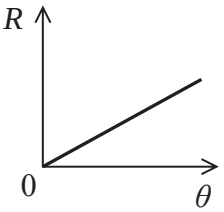
A



B



C



D

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 3 = 1 mark)

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4 A rechargeable cell is labelled 1500 mA h.

If the current is 1500 mA for 1 hour, the charge transferred is

☒ **A** 1.5 C

☒ **B** 90 C

☒ **C** 1500 C

☒ **D** 5400 C

(Total for Question 4 = 1 mark)

5 When a charge of 2.0 C passes through a light bulb, 5.0 J of energy is transferred.

What is the potential difference across the bulb?

- ☒ **A** 0.4 V
- ☒ **B** 2.5 V
- ☒ **C** 3.0 V
- ☒ **D** 10 V

(Total for Question 5 = 1 mark)

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6 A potential difference of 6 V is applied to a component to provide a current of 3 A for 2 minutes.

In this time the charge flowing through the component is

- ☒ **A** 6 C
- ☒ **B** 36 C
- ☒ **C** 360 C
- ☒ **D** 2160 C

(Total for Question 6 = 1 mark)

7 The Mars Reconnaissance Orbiter has been studying the Martian climate since 2006.

The following passage is about the Orbiter:

> This satellite is powered by two solar panels, each of area 9.5 m^2. The panels have a high efficiency of 26% at converting solar energy into electricity. In orbit around Mars each panel produces about 1500 W of power.

(a) (i) Show that, when in orbit around Mars, the power output of a single panel is about 1500 W.

radiation flux from the Sun at Mars orbit = 590 W m^{-2}

(3)

(ii) The panels are connected together to give a total output potential difference of 32 V. Show that the maximum output current is about 90 A.

(2)

(b) The solar panels are used to charge two batteries of capacity 50 ampere hours (180 kC) each.

(i) Use the current calculated in part (a)(ii) to calculate the minimum time taken to fully charge the batteries.

(2)

Minimum time = ...

(ii) Suggest why the time calculated in (b)(i) is a minimum.

(1)

(Total for Question 7 = 8 marks)

8 The e.m.f. of an alkaline cell marked 1.5 V is measured with a high resistance voltmeter and found to be 1.54 V.

Explain why the voltmeter used must have a high resistance.

(2)

(Total for Question 8 = 2 marks)

9 A student wants to determine the efficiency of a filament bulb at transferring electrical energy to light energy. She does this by measuring the thermal energy given out by the bulb.

The bulb is mounted on a piece of wood and placed upside down in water as shown in the photograph.

(a) Explain why the temperature of the filament in the bulb increases when a potential difference is applied.

(3)

(b) The bulb is switched on for 7 minutes. The current is 1.95 A and the potential difference is 11.6 V.

(i) Show that the rate of electrical energy transfer is about 20 W.

(2)

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.....

.....

.....

(ii) Show that the electrical work done is about 10 000 J.

(2)

.....

.....

.....

.....

(iii) The temperature rise of the water is measured and used to determine that the thermal energy gained by the water is 7800 J.

Calculate the efficiency of the bulb as a source of light.

(3)

.....

.....

.....

.....

Efficiency = ...

(iv) Suggest why this represents the maximum efficiency.

(1)

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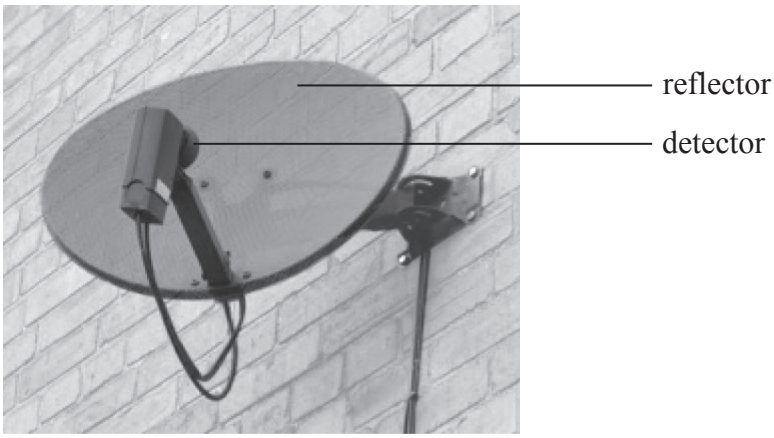
.....

.....

(Total for Question 9 = 11 marks)

10 The photograph shows a satellite television dish.



Electromagnetic radiation from a communications satellite is reflected from the reflector to the detector.

(a) The radiation used has a frequency of 12.6 GHz.

(i) Show that the wavelength of the radiation is about 2 cm.

(2)

(ii) State the region of the electromagnetic spectrum to which this radiation belongs.

(1)

(b) The radiation incident on the reflector has a radiation flux of 4.8×10^{-13} W m^{-2}.

Calculate the power of the incident radiation.

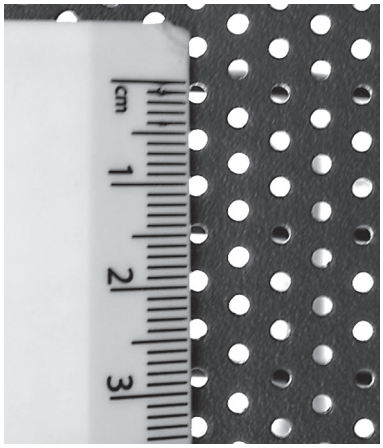
area of the reflector = 0.27 m^2

(2)

Power = ...

(c) The reflector contains many small holes.

(i) Use the photograph to estimate the diameter of the holes.



(1)

(ii) It is important that the radiation is reflected to the detector with the maximum possible power.

Use the idea of diffraction effects to explain why the radiation is reflected as if from solid metal.

(2)

(iii) Suggest a reason for having holes in the reflector, rather than using solid metal.

(1)

(Total for Question 10 = 9 marks)

11 Over 40 years ago, the Apollo astronauts placed reflectors on the surface of the Moon. These are still used by a number of observatories on Earth to monitor the distance to the Moon by reflecting pulses of laser light from them and detecting the reflected signal.

Scientists have determined that the Moon is at a distance of 363 104 km at its closest and 405 696 km at its furthest. It has also been determined that the Moon is getting about 3.8 cm further away from the Earth each year.

(a) Describe how the reflected pulses can be used to determine the distance to the Moon.

(2)

(b) An observatory sends out pulses of laser light of duration 2.0×10^{-10} s when it is determining the distance to the Moon.

(i) Calculate the pulse length.

(2)

Pulse length = ...

(ii) Discuss whether the levels of precision quoted for the distance to the Moon and its rate of increasing distance from the Earth are justified.

(2)

(iii) The round trip for the light pulses takes about 2.5 seconds. As many as 10 pulses per second may be used.

State why pulses are used rather than a continuous beam.

(1)

.....

.....

(c) Another observatory uses a higher power laser.

(i) This laser produces a pulse of duration 1.0×10^{-10} s. The energy of the pulse is 115 mJ.

Calculate the power of this laser.

(2)

.....

.....

.....

Power = ...

(ii) The wavelength of light produced by this laser is 5.32×10^{-7} m. The light is emitted from an aperture of diameter 75 cm.

Suggest, using the concept of diffraction, why such a large aperture is necessary.

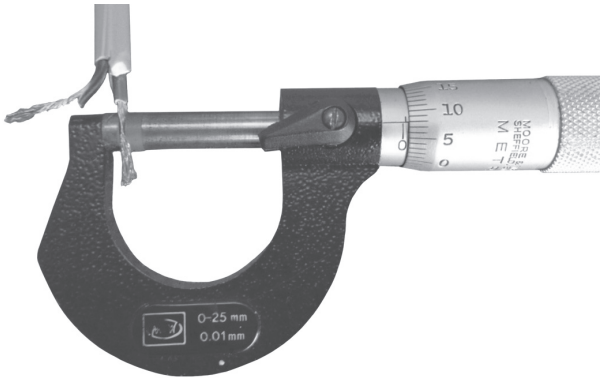
(3)

(Total for Question 11 = 12 marks)

12 A student is investigating whether the length of a mains electrical cable can be determined accurately by taking measurements of resistance using an ohmmeter and hence calculating the length.

She takes measurements of resistance and diameter for the live conductor, as shown in the photographs below. She uses these measurements to calculate the length of the cable and then compares this value with a direct measurement of length.

Resistance = 0.3 Ω



Diameter = 1.08 mm

Length = 14.500 m

(a) (i) Show that the cross-sectional area of the live conductor is about 9×10^{-7} m^2.

(1)

(ii) Calculate the length of the live conductor.

resistivity of copper = 1.68×10^{-8} Ω m

(2)

Length = ...

(iii) Comment on the accuracy of this method of determining the length of the live conductor.

(1)

(iv) The student wants to improve the determination of length.

Explain why she should improve the measurement of resistance rather than the measurement of diameter.

(3)

(v) Describe an alternative way of determining the resistance of the live conductor and how this would improve the accuracy of the resistance value obtained.

(3)

(b) The mains electrical cable is used as an extension lead for a lawnmower.

The lawnmower is labelled 1200 W, 230 V.

(i) Calculate the operating current of the lawnmower.

(2)

Current = ...

(ii) Calculate the rate at which energy is dissipated by the live conductor when it is used with the lawnmower.

(2)

Rate = ...

(Total for Question 12 = 14 marks)