1 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)

.....

.....

.....

RevisionMadeSimple.com

(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 = ...

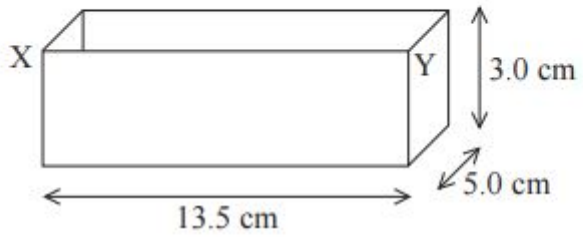
(ii) Suggest why the time calculated in (b)(i) is a minimum.

(1)

.....

.....

2 In an experiment to determine the resistivity of salt water, a plastic container is filled with salt water. Pieces of metal foil are placed inside the container, covering the ends X and Y.



A resistance meter is attached to the pieces of metal foil and used to measure the resistance of the salt water between X and Y.

resistance of salt water = 1.2 kΩ

Calculate the resistivity of the salt water.

(3)

.....

.....

.....

.....

.....

Resistivity = ...

(c) When a ray is stunning its prey, it produces a potential difference of 45 V and a current of 0.12 A in a burst of duration 5 ms. There can be up to 400 bursts in an attack.

Calculate the energy transferred by the ray in a 400 burst attack.

(2)

.....

.....

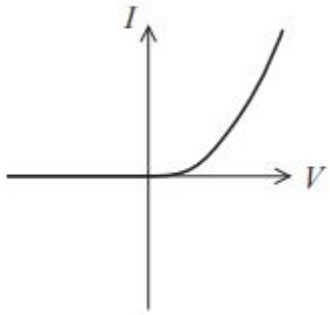
.....

.....

Energy transferred = ...

RevisionMadeSimple.com

3 The graph shows how current varies with applied potential difference for a diode.



Explain the shape of the graph.

(3)

.....

.....

.....

.....

.....

4 The photograph shows a solar charging unit consisting of a solar panel connected to three rechargeable cells.

RevisionMadeSimple.com

(a) (i) The radiation flux incident on the solar panel is 49 W m^{-2}. The area of the panel is 6.4×10^{-3} m^2.

Show that the panel receives radiation energy at a rate of about 0.3 W.

(2)

.....

.....

.....

.....

.....

(ii) The e.m.f. of the solar panel is 5.6 V.

Calculate the efficiency of the solar panel when the current is 6.8 mA.

(3)

Efficiency = ...

(b) Each rechargeable cell is marked 1.2 volts, 1500 milliamp hours.

Calculate the maximum energy that can be delivered by the three fully charged cells.

(3)

Maximum energy = ...

RevisionMadeSimple.com

(c) Assuming that the current in the solar cell remains at 6.8 mA, explain whether the three cells would be charged more quickly if connected in series or in parallel.

(2)

.....

.....

.....

.....

.....

5 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.

RevisionMadeSimple.com

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)

.....

.....

.....

RevisionMadeSimple.com

(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)

.....

.....

.....

.....

.....

.....

.....

.....

RevisionMadeSimple.com

(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)

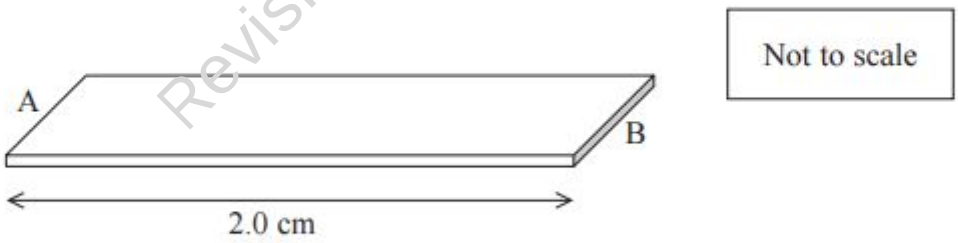
Current = ...

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

(2)

Rate = ...

6 A student investigates the resistance of the 'lead' in a pencil. A pencil is used to draw a rectangle, of length 2.0 cm and width 6.0 mm, on paper, creating a strip of unknown thickness *t*.



(a) The resistance of the strip between ends A and B is measured with an ohmmeter.

resistance = 55 000 Ω

resistivity of this pencil lead = 3.5×10^{-5} Ωm

Show that the cross-sectional area of the strip of pencil lead is about 1×10^{-11} m^2.

(2)

RevisionMadeSimple.com

(b) The pencil lead is made of a mixture of graphite and clay. This pencil has 50% graphite and 50% clay.

charge carrier density n for pure graphite is 3.5×10^{24} m^{-3}

Calculate the drift velocity for the charge carriers in the pencil lead when a potential difference of 6.0 V is applied across the strip from A to B.

Assume that the clay contributes no charge carriers.

(4)

.....

.....

.....

.....

.....

.....

Drift velocity = ...

RevisionMadeSimple.com

(c) Pencil leads are made with a hardness range from 9H (very hard) to 9B (very soft). Hard pencil leads have a higher proportion of clay.

Explain how the resistance of the strip would be affected if it were drawn with a softer pencil.

(2)

.....

.....

.....

.....

.....

.....