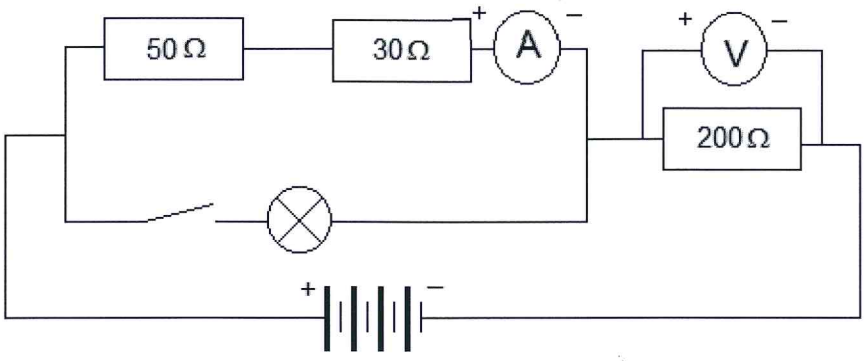
Solution 5.2 & 5.3 Year 11

Answer 1

(5 marks)

To the circuit diagram below, add:

- an ammeter to measure the current through the 50 Ω resistor, indicating which connection is positive and which is negative
- a voltmeter to measure the potential difference across the 200 Ω resistor, indicating which connection is positive and which is negative
- a switch to allow the lamp to be turned on and off without switching the rest of the circuit on or off.



Description	Marks
Ammeter and voltmeter correctly placed, polarities correct	1–4
Switch correctly placed	1
Total	**5**

Answer 2

(4 marks)

(a) Calculate the current, in amperes, between the cloud and the ground. (2 marks)

Description	Marks
$q = 1.50 \times 10^{20} \times 1.6 \times 10^{-19}$ $= 24$ C	1
$I = q/t$ $= 24 / 0.200$ $I = 120$	1
Total	**2**

(b) If the potential difference between the storm cloud and the Earth was 7.00×10^8 V, calculate the energy, in joules, that was released by the lightning during the strike. (2 marks)

Description	Marks
$E = P \times t$ $= VIt$ $= 7.00 \times 10^8 \times 120 \times 0.2$	1
$E = 1.68 \times 10^{10}$	1
Total	**2**

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Answer 3

(5 marks)

A beam of electrons in the electron gun of a cathode ray tube is accelerated from rest through a potential difference of 80 kV.

(a) How much energy in joules does each of these electrons gain in being accelerated in this field? (2 marks)

Description	Marks
$E = qV = 1.60 \times 10^{-19} \times 8.0 \times 10^{4}$	1
$= 1.28 \times 10^{-14}$ J	1
	Total 2

(b) If the energy gained by each electron is all kinetic, what velocity will an electron have after undergoing this acceleration? (3 marks)

Description	Marks
$0.5mv^2 = 1.28 \times 10^{-14}$	1
$v^2 = 1.28 \times 10^{-14}/(0.5 \times 9.11 \times 10^{-31})$ $= 2.81 \times 10^{16}$	1
$v = 1.68 \times 10^{8}$ m s^{-1}	1
	Total 3

Answer 4

(4 marks)

(a) Circle the correct response. (1 mark)

When the lamps are turned on,

Lamp A is brighter than Lamp B. | the lamps are the same brightness. | Lamp B is brighter than Lamp A.

Description	Marks
Lamp A is brighter than Lamp B	1
Total	**1**

(b) Explain your answer to Part (a) with reference to Ohm's Law. (3 marks)

Description	Marks
The long extension cord will have a resistance and so Lamp B is effectively in series with a non-zero resistor so total resistance greater.	1
V = IR with the same V, if R is increased then I decreases	1
As current determines the brightness of the lamp, lower current means Lamp B is dimmer. Students may also discuss power	1
Total	**3**

Solution 5.2 & 5.3

Year 11

Answer 5

(6 marks)

A power pack for a laptop computer delivers 19.5 V with a current of 2.05 A. It is connected to the computer to recharge the battery for 2.50 hours.

(a) How much charge flows from the power pack to the battery in that time? (3 marks)

Description	Marks
$t = 2.50 \times 60 \times 60\ s = 9.00 \times 10^3\ s$	1
$Q = It = 2.05 \times 9.00 \times 10^3$	1
$= 1.85 \times 10^4\ C$	1
	Total 3

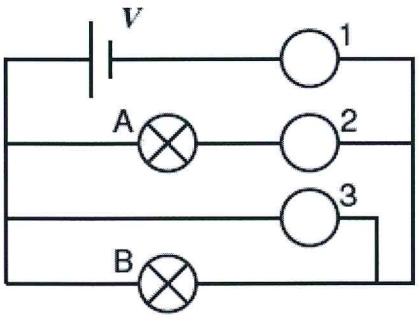
(b) How much work is done in moving this charge? (3 marks)

Description	Marks
Work = qV	1
$= 1.85 \times 10^4 \times 19.5$	1
$= 3.61 \times 10^5\ J$	1
	Total 3

Answer 6

(3 marks)

A lighting circuit diagram includes a cell and two globes A and B as shown below.



(a) Indicate in circle 1 the direction of the conventional current through this point. (1 mark)

(b) In circles 2 and 3, place a V or A to indicate if a voltmeter or ammeter would be most appropriate to complete the circuit diagram. (2 marks)

Description	Marks
(a) ← (On the line is acceptable)	1
(b) 2 – A	1
3 – V	1
	Total 3

Solution 5·2 & 5·3 Year 11

Answer 7

(5 marks)

The average power supplied by an adult's heart for circuiting blood is about 1.5 watts.

(a) How much work does an adult human heart do in one hour? (2 marks)

(b) If this amount of work is used to lift a 50.0 kg object with a constant velocity, what is the theoretical maximum height to which the object can be raised? Use an energy value of 5000 J if you were unable to determine an answer for (a). (3 marks)

Description	Marks
(a) $W = P \times t = 1.5 \times 60 \times 60$	1
$= 5400$ J	1
(b) $W = mgh$; $h = W / mg$	1
$= 5400 / (50 \times 9.8)$	1
$= 11$ m	1
	Total 5

Answer 8

(16 marks)

(a) The unit mAh is a common unit referring to the amount of stored charge that is available, where 1mAh (one milliamp hour) is equal to 3.6 coulombs. Show by appropriate calculation(s), that 1mAh = 3.6 C (3 marks)

Description	Marks
1A = 1000 milliamps	1
1 hour = $60 \times 60 = 3600$ s	1
$I = q/t$; $q = I \times t = 1/1000 \times 3600 = 3.6$ C	1
Total	**3**

(b) Fill in the first two columns of the table for the three power sources using information from the photographs. Then calculate the stored charge and enter the value in the third column. The first row has been completed for you. (4 marks)

Photograph	Potential Difference (V)	mAh	Stored Charge (C)
A	1.2	2450	8820
B	**3.7**	**1050**	**3780**
C	**3.7**	**760**	**2736**

Description	Marks
copying values from photographs	1–2
1 mark for each calculation	1–2
Total	**4**

(c) Calculate the work that can be done by the AA rechargeable cell in Photograph A, assuming all of the charge could be released at the given potential difference of 1.2 V.
(2 marks)

Description	Marks
$W = qV = 8820 \times 1.2$	1
=10 584 J (10.6 kJ)	1
Total	**2**

(d) Determine whether the following statements are true or false. (3 marks)

Description	Marks
F,F,F	1–3
Total	**3**

(e) The cell in Photograph A completely discharges in one hour (3600 s) when connected to a circuit. Calculate the resistance of the circuit. Assume the potential difference of the cell remains constant during this time. (4 marks)

Description	Marks
$I = q/t = 8820/3600$	1
= 2.45 A	1
$R = V/I = 1.2/2.45$	1
= 0.490 Ω	1
Total	**4**