Physics - Unit 1 – Task 3
Electricity Test

Name: SOLUTIONS **Total Marks** /58

Question 1:

Keaton and Ashlee are listening to several of Ashlee's latest CDs on a portable stereo system during lunch. The stereo system runs off four 1.50 V cells connected in series. The total resistance of the stereo when used to play music is 24.0 Ω. How much current does the stereo draw from the cells assuming that the potential difference from the four cells is added together? **[3 marks]**

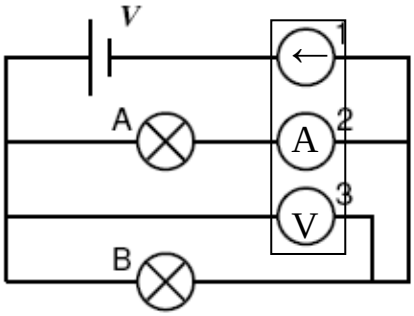
V = 4 × 1.5V (1 mark)

$I = \frac{V}{R} = \frac{4 \times 1.5}{24}$ (1 mark)

I = 0.25 Amps (1 mark)

Question 2:

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]**

← (On the line is acceptable) (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]**

2 – A (1 mark) 3 – V (1 mark)

Question 3:

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]**

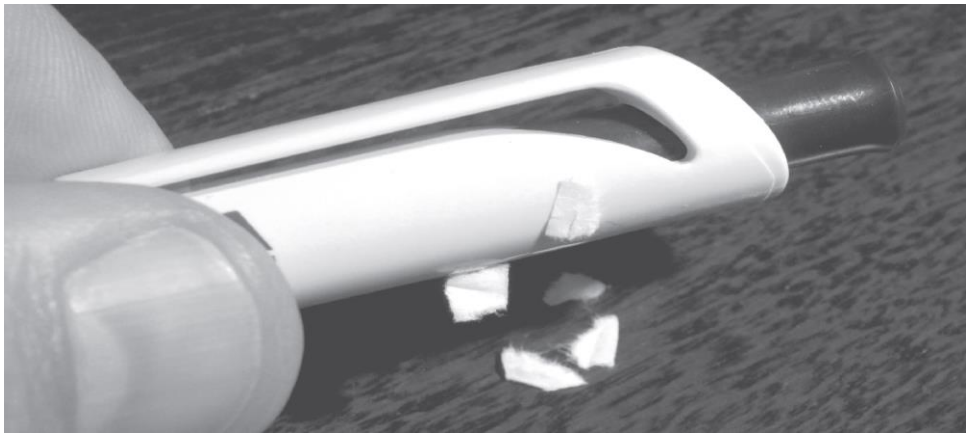
t = 2.50 × 60 × 60 s = 9.00×10^3 s (1 mark)

q = It = $2.05 \times 9.00 \times 10^3$ (1 mark)

= 1.85 × 104 C (1 mark)

Question 4:

A plastic pen, when rubbed with wool, is then seen to be able to attract small pieces of paper from a desktop. Once the paper touches the pen, the paper flies off. Explain these phenomena. **[4 marks]**



Rubbing the plastic creates a charge imbalance (adds/takes away electrons) (1 mark)

The charged pen attracts the paper (1 mark)

Upon touching the pen, the potential/charge between pen and paper equalises (1 mark)

Potentials/charges are now the same, so repel (1 mark)

Question 5:

A data logger is being used to collect data for an experiment that needs to run for 24 hours. The average current carried by the sensor system is 0.025 A and the effective sensor resistance is 20.0 kΩ. Calculate the heat energy dissipated in the system during the 24 hour period. **[3 marks]**

$t = 24 \times 60 \times 60 = 86400$ s (1 mark)

$I = 0.025$ A

$R = 20 \times 10^3\ \Omega$

$V = IR$

energy = work = VIt

$W = (0.025 \times 20 \times 10^3) \times 0.025 \times 86400$ (1 mark)

$W = 1080000$

Energy $= 1.08 \times 10^6$ J (1 mark)

Question 6:

A 75.0 W / 240 V light globe is left on for 10.0 hours, how much energy does it convert? **[3 marks]**

$P = 75.0$ W

$t = 10 \times 60 \times 60 = 36000$ (1 mark)

$V = 240$ V

$W = E = VIt$

$P = VI$

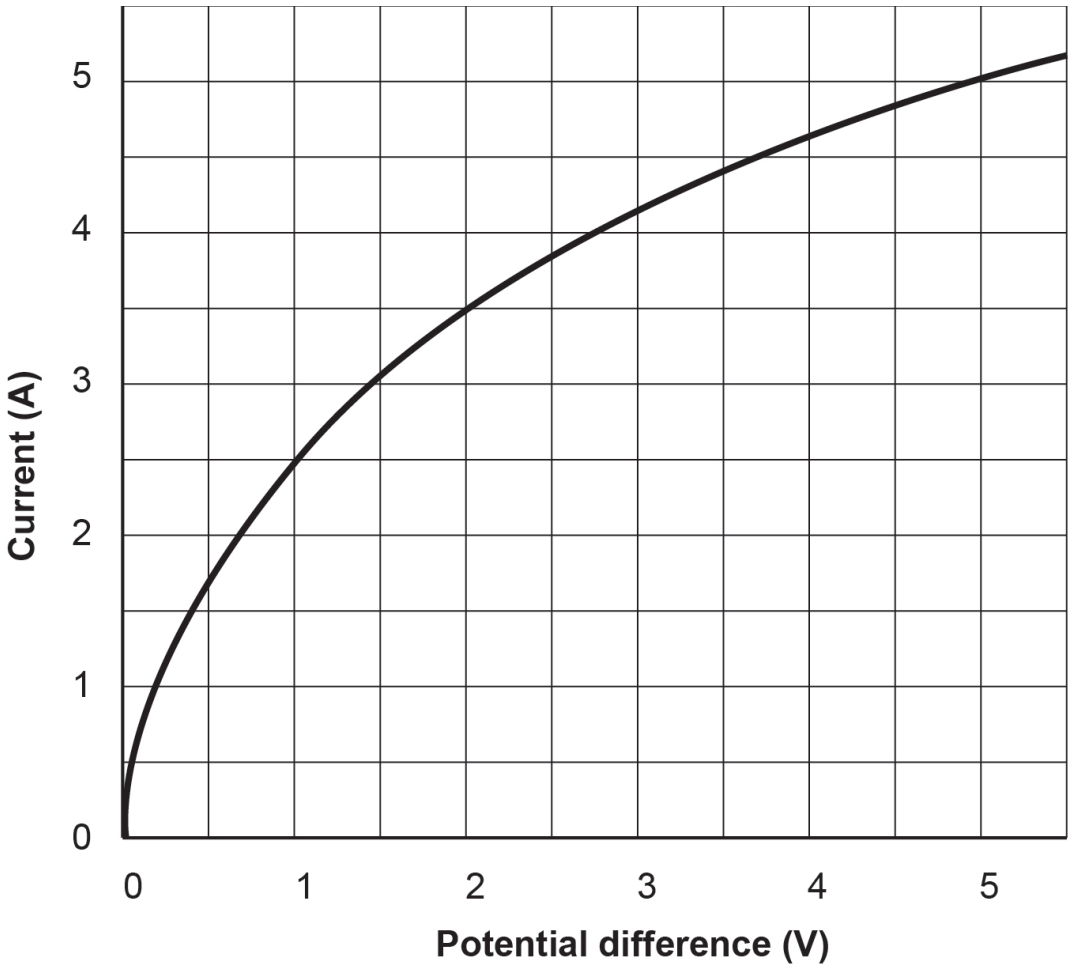
$E = Pt$

$E = 75.0 \times 36000$ (1 mark)

$E = 2.70 \times 10^6$ J (1 mark)

Question 7:

Chris is measuring the current flowing through a non-ohmic conductor as she varies the potential difference of the power source. The results are graphed below.



(a) Explain what is meant by the term 'non-ohmic'. **[2 marks]**

Does not follow Ohm's law (1 mark)
A non-ohmic conductor does not proportionally increase the current compared to potential difference (resistance is not constant) (1 mark)

(b) Determine the current when the potential difference is 1.0 V. **[1 mark]**

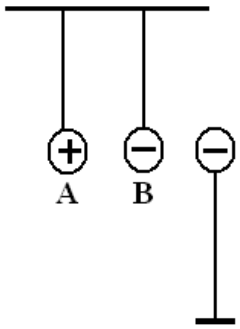
I = 2.5 A (1 mark)

Question 8:

Three charged spheres are placed near each other and held. Spheres A and B are free to move but the other sphere is in a fixed position. Once released, describe the initial motion of A and B. **[2 marks]**

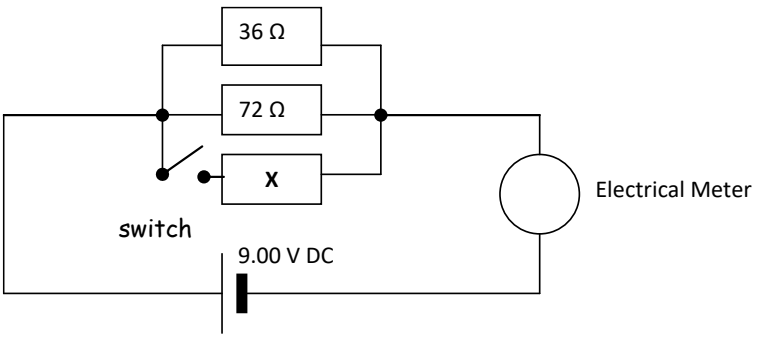
The negative (Sphere B) will move right towards the positive. (1 mark)

The positive (Sphere A) will move towards the negative (Sphere B) and probably touch. (1 mark)



Question 9:

Three resistors are connected in parallel to a 9.00 volt battery. The total resistance of the parallel group is 20.0 Ω.



a) Calculate the resistance of resistor X. **[2 marks]**

$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{20} = \frac{1}{36} + \frac{1}{72} + \frac{1}{R_3}$ (1 mark)

$\frac{1}{R_3} = \frac{1}{20} - (\frac{1}{36} + \frac{1}{72})$

$\frac{1}{R_3} = \frac{1}{120}$

$R_3 = 120\ \Omega$ (1 mark)

b) Show on the diagram where a switch could be placed in the circuit that could switch off resistor X but maintain current to the other 2 resistors. Label the switch. **[1 mark]**

Switch as above (1 mark)

c) What is the electric meter on the diagram measuring? **[1 mark]**

Total current in the circuit. (1 mark) (It is an ammeter)

Question 10:

The information contained in the picture is from a Compliance Plate found on an old microwave.

a) The label lists the input voltage, power and current. Do they agree with each other? **[2 marks]**

P = 1500 W
V = 240 V
I = 6.5 A

P = V x I
1500 = 240 x 6.5
1500 ≠ 1560 (1 mark)

No they don't (1 mark for not exactly equal)

They don't equal each other (though fluctuations in Voltage supplied and rounding to 2 sig figs, make it close enough in real life!)

b) Using the actual values (not the values on the label), calculate the resistance of microwave's internal circuitry. **[2 marks]**

V = 240 V
I = 6.5 A
R = ?

V = I x R
R = V / I
R = 240/6.5 (1 mark)
R = 36.9 Ω (1 mark)

$P = \frac{V^2}{R}$
$R = \frac{V^2}{p} = \frac{240^2}{1560}$
= 36.9 Ω

c) Compare the input power to the output power. What is the efficiency and where does the lost energy go? **[3 marks]**

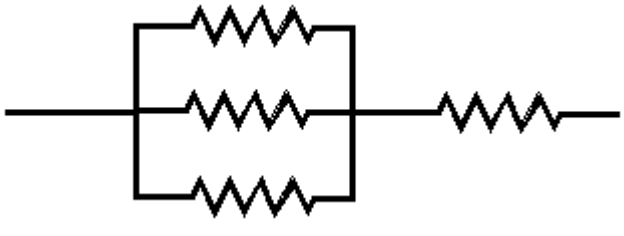
P_{in} = 1500 W
P_{out} = 750 W

Efficiency = P_{out} / P_{in} x 100%
Efficiency = 750 / 1500 x 100% (1 mark)
Efficiency = 50% (1 mark)

50% of the energy is lost as other forms, sound, light, heat. (1 mark)

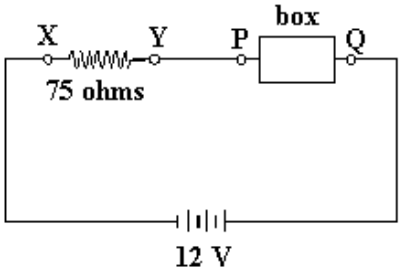
Question 11:

Tom was given four 3.00 Ω resistors. Draw a diagram below to show how he could connect the four resistors to give a total resistance of 4.00 Ω. **[2 marks]**



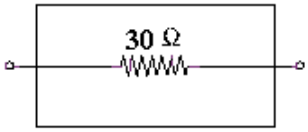
Question 12:

A student completes a circuit that includes a mystery box as shown below.

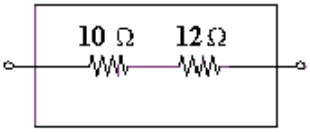


If the potential difference between X and Y is 9.0 volts, which of the following boxes (A - D) is in the circuit? **[3 marks]**

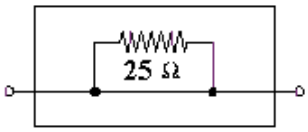
A



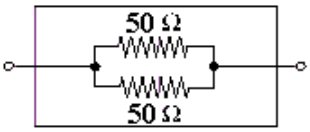
B



C



D



Answer **C**

This space has been left for any working you need to perform.

$V_T = V_{(X-Y)} + V_{(P-Q)}$

$12 = 9 + V_{(P-Q)}$

$V_{(P-Q)} = 3.0$ V

$I = \frac{V}{R} = \frac{9}{75} = 0.12$ Amps (current is the same throughout the circuit)

$R_{(P-Q)} = \frac{V}{I} = \frac{3}{0.12} = 25\ \Omega$

A = 30 Ω

B = 10 + 12 = 22 Ω

C: 25 Ω in parallel with wire (very low resistance) so R_T very low (< 25 Ω)

D: $\frac{1}{R_D} = \frac{1}{R_1} + \frac{1}{R_2} = \frac{1}{50} + \frac{1}{50} = \frac{2}{50} = \frac{1}{25}$ Hence $R_D = 25\ \Omega$

Question 13:

Two metal spheres, one of -5.00μC charge the other of +9.00μC charge, are placed 0.500 m apart from centre to centre.

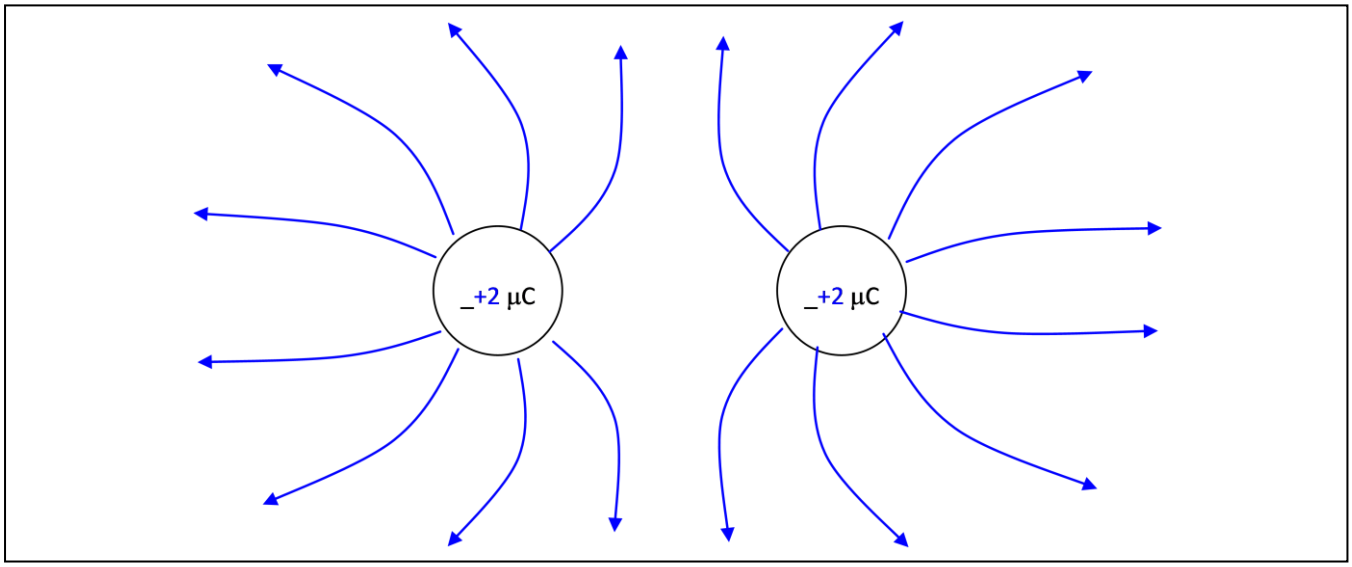
a) The two spheres are brought together in contact with each other and moved apart to 0.250 m.
   i) Explain what happens to the charges. **[3 marks]**

Unlike charges attract and these charges are trying to move towards each other so to become neutral in charge. (1 mark)

As the two spheres come into contact, the charges (electrons) quickly move across the two spheres until equally spaced and evenly distributed. (1 mark)

Any leftover charge is evenly distributed between the two spheres (-5 + 9 = 4 C left; 2 C each)

ii) Calculate the new charges of the spheres, placing the values in the correct places. Then draw the electric field lines, showing direction and interaction after the contact. **[3 marks]**



b) How does the force in situation (b) compare to the force calculated in (a)? **[1 mark]**

Circle the correct answer: GREATER EQUAL SMALLER

Question 14:

Find the resistivity of a wire that is 0.2 m in length and has a cross sectional radius of 0.0005 m and is recording a resistance of 20 Ω. **[3 marks]**

$R = \frac{\rho l}{A}$

$\rho = \frac{R A}{l}$

$A = \pi r^2 = \pi \times (0.0005)^2 = 7.85 \times 10^{-7}\ m^2$ (1 mark)

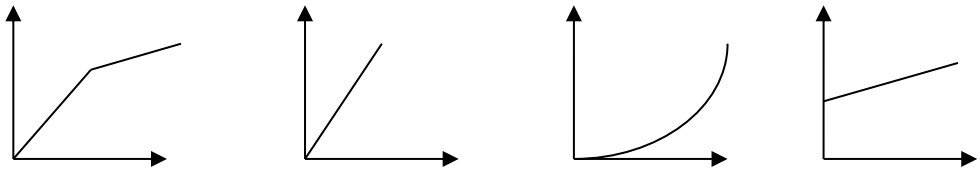
$\rho = \frac{R A}{l} = \frac{20 \times 7.85 \times 10^{-7}}{0.2} = 7.85 \times 10^{-5}\ \Omega\ m$ (1 mark and 1 mark for units)

Question 15:

Answer the following

a) Which of the following graphs best represents a non-ohmic conductor? **[1 mark]**

Answer: **C**



A B C D

b) Why did you select this graph? **[2 marks]**

For an Ohmic resistor; $V = IR$ therefore $R = \frac{V}{I}$ and as R is constant, $V \propto I$ and you produce a straight line through (0,0). (1 mark)

In non-ohmic resistors, the resistance changes as the PD increases therefore producing a curved line. (1 mark)

Only C has a curved line.

Question 16:

A 75.0 W light globe is left on for 10.0 hours.

a) How much energy does it convert? **[3 marks]**

P = 75.0 W
t = 10 x 60 x 60
t = 36000 s (1 mark)
V = 240 V

W = E = VIt
P = VI

E = Pt
E = 75.0 x 36000 (1 mark)
E = 2.70×10^6 J (1 mark)

b) What is the total cost if the electricity company charges 22.68 cents per kWh? **[3 marks]**

1 kWh = 3.6×10^6 J

N^o of units = $\frac{2.70 \times 10^6}{3.6 \times 10^6}$

= 0.75 (1 mark)

Cost = 0.75 x 22.68

= 17.01 cents