Physics ATAR - Year 11

Electrical Physics Unit Test 2018

Mark: / 64

= %

Name: Solutions

Time Allowed: 50 minutes

Notes to Students:

- You must include **all** working to be awarded full marks for a question.
- Marks will be deducted for incorrect or absent units and answers stated to an incorrect number of significant figures.
- **No** graphics calculators are permitted – scientific calculators only.

Question 1 **(18 marks)**

A simple series circuit is composed of six 1.50 V cells connected in series to an ammeter, an open switch, a light globe and a variable resistor.

(a) In the space below draw the circuit diagram that would represent this simple series circuit.
(4 marks)

The circuit could be drawn in a number of ways.

21/2 marks (1/2 for each correct symbol)

1 All components connect correctly in series

1/2 mark drawn neatly using a ruler

(b) State the EMF of this circuit.
(1 mark)

6 x 1.50 = 9.00V

(c) When the switch is closed, a total of 2.50 x 10^{19} electrons flow through the ammeter in a time of 5.00 seconds. Calculate the current reading on the ammeter.
(3 marks)

q = I t so I = n_eq/t 1

I = (2.50 x 10^{19} x 1.60 x 10^{19}) / 5.00 1

I = 0.800 A 1

(d) On your diagram use an arrow to indicate the direction of electron current.
(1 mark)

Electron current goes from negative to positive

(e) When the current is flowing, determine the total resistance of this circuit.
(3 marks)

V = I R so R= V/I 1

R = 9.00/0.800 1

R = 11.3 Ω 1

(f) If the variable resistor used has its resistance **increased,** explain what happens to:

(i) the current

(2 mark)

- the current will decrease
- as I is inversely proportional to R

(ii) the brightness of the globe

(2 mark)

- The brightness of the globe will decrease
- current is decreased delivering less electrical potential energy to be converted to light

(iii) the EMF of the circuit

(2 mark)

- The EMF of the circuit is produced by the six 1.50 V cells
- and is not affected by the resistance in the circuit

Question 2 **(5 marks)**

This question is related to the concepts of potential difference, work done, electric potential energy and energy transformations.

(a) Explain why the voltage measured across a component in a circuit is referred to as the "potential difference".

(2 marks)

• Potential difference is defined as the **electrical potential** energy that can be **transferred/work done**
• as **charge** flows from **one side of a component to the other**

(b) In an experiment, students measured a current of 4.35 A flowing through a resistor that has a measured potential difference of 9.42 V across it. Calculate the work done per minute as the current passes through the resistor.

(3 marks)

I = 4.35 A, V = 9.42 V, t = 60 s

q = It and W_d = qV therefore W_d = VIt (1)

q = 9.42 x 4.35 x 60 (1)

= 2.46 x 10^3 J (1)

or use E = VIt as 4.35 x 9.42 x 60 = = 2.46 x 10^3 J

Question 3 **(11 marks)**

A house uses outdoor floodlights for security. Each floodlight is rated at 7.50 x10^2 W. A voltage of 250.0 V is supplied across their terminals.

(a) Calculate the current one floodlight would draw when it is on.

(2 marks)

$P = V I$
$I = (7.50 \times 10^2)/250$
$I = 3.00$ A

(b) The house has a number of floodlights connected to the same circuit that switch on automatically when activated by individual sensors. Explain the type of circuit that would be used such that each light could operate independently of the others.

(3 marks)

* The circuit used would be a parallel circuit
- that enables each floodlight to use the same operating voltage, current and thus power
- and will continue to function should something go wrong with any of the other floodlights

(c) Determine the number of floodlights that could be activated at one time if they are all connected to a fuse that is rated at 15.0 A.

(3 marks)

- Each floodlight draws 3.00 A.
- A 15.0 A fuse will allow 15.0/3.00
- 5 floodlights to activate at any one instance

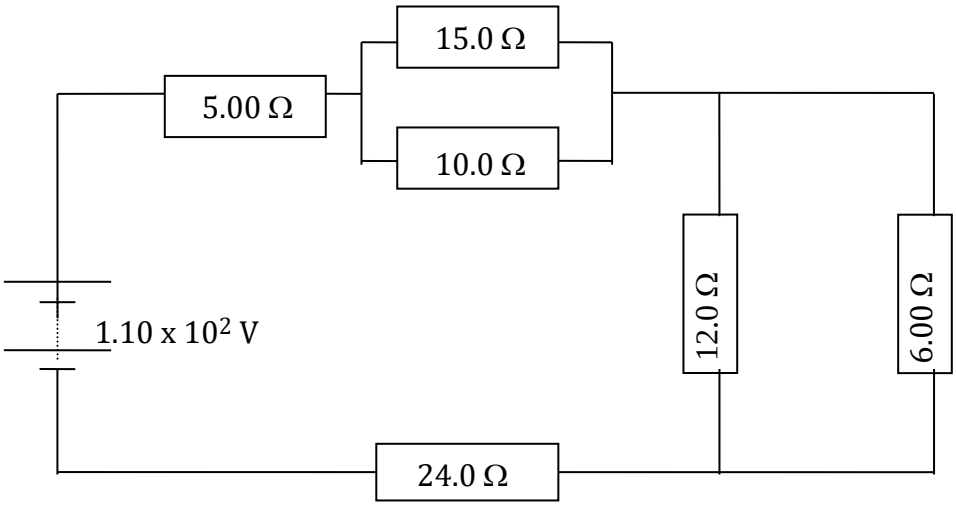
(d) Explain the purpose of the fuse.

(3 marks)

- The fuse is a safety device to protect against **thermal hazards**
- that will **melt/break** to create an **open circuit** if the current passing through the circuit it is connected to
- **exceeds** a determined current

Question 4 **(9 marks)**

Consider the circuit below.



(a) Calculate the total resistance of the circuit.

(3 marks)

$1/R_1 = 1/15.0 + 1/10.0$ $R_{E1} = 6.00\ \Omega$ (1) $1/R_{E2} = 1/12 + 1/6$ $R_2 = 4.00\ \Omega$ (1)

$R_T = 5.0\ \Omega + 6.0\ \Omega + 4.0\ \Omega + 24.0\ \Omega$ $= 39.0\ \Omega$ (1)

(b) Calculate the current flowing from the battery.

(2 marks)

$I = \varepsilon/R_T$ (1) $= 110\ V/39.0\ \Omega$ $= 2.82\ A$ (1)

(c) Calculate the potential difference across the 12.0 Ω resistor.

(2 marks)

$V = I\ R_{E2}$ (1) $= 2.82\ A \times 4.0\ \Omega$ $= 11.28 = 11.3\ V$ (1)

(d) Calculate the current flowing through the 6.00 Ω resistor.

(2 marks)

$I = V/R$ (1) $11.3V/6.0\Omega = 1.88\ A$ (1) or $I = 2/3 \times 2.82\ A = 1.88\ A$

Question 5 **(6 marks)**

A 5.00 m piece of an unknown wire is being used in an experiment. When connected to a 10.0 V battery in a simple circuit it is found to allow a current of 2.50 A to pass through it. A student using a micrometer, measures the diameter of the wire as 1.00 mm. Determine the resistivity of the wire used in the experiment.

$V = IR$ (1) so $R = 10.0/2.50 = 4.00\ \Omega$ (1)

$A = \pi r^2$ (1) $A = \pi\left(\frac{1.00 \times 10^{-3}}{2}\right)^2 = 7.85 \times 10^{-7}\ m^2$ (1)

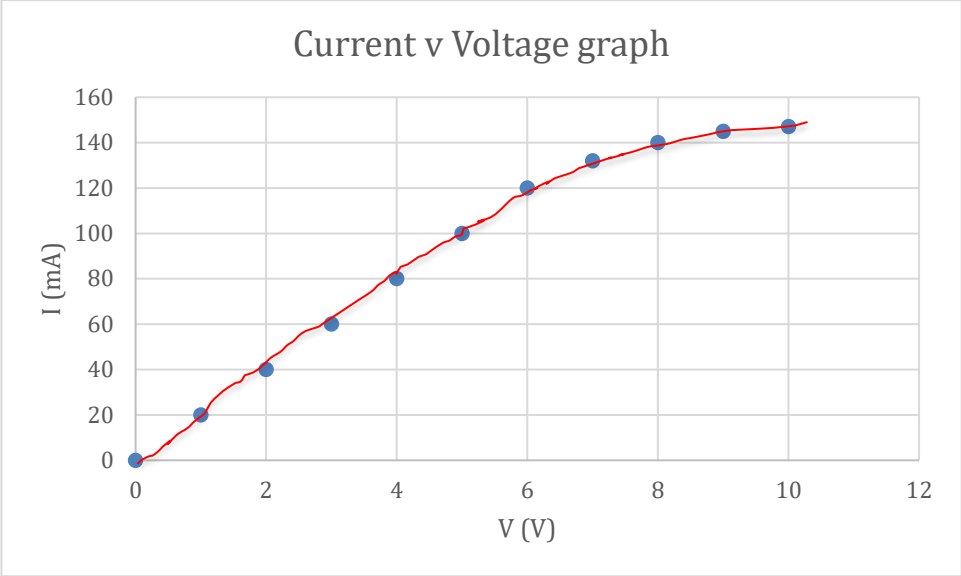
$R = \frac{\rho L}{A}$ so $\rho = \frac{R\,A}{L}$

$\rho = \frac{4.00 \times 7.85 \times 10^{-7}\ A}{5.00}$ (1)

$\rho = 6.28 \times 10^{-7}\ \Omega m$ (1)

Question 6 **(10 marks)**

A voltage source is connected across a filament light bulb and the current is measured for different voltages. The graph is shown below.



(a) . Draw a line of best fit for the data shown in the graph above.

(1 mark)

(b) State the range of voltages where the light bulb is behaving as an ohmic conductor.

(1 mark)

Range: 0 V - 6 V

(c) Use the graph above to calculate the average resistance of the light bulb when it is behaving as an ohmic conductor.

(3 marks)

1

V = IR R = V/I or calculate the gradient of the line

1

R = 6.0/120x10^{-3} A

1

R = 50.0 Ω

(d) Calculate the resistance of the filament light bulb when the voltage is at 8.00 V.

(2 marks)

V = IR R = V/I

R = 8.00/140x10^{-3} = 57.1 Ω

(e) Explain and account for the difference in values for parts c) and d).

(3 marks)

- as the current increases there is more energy converted to heat, increasing the temperature of the filament
- as temperature is proportional to the mean kinetic energy of particles
- the increased movement of particles impeding the flow of charge, thus increasing electrical resistance

Question 7 **(5 marks)**

A typical household in City Beach uses a reverse cycle air-conditioner for a 22.0 day period heat wave during summer to keep their house cool. The main living area uses a 2250 W air conditioner that is left on for 14.0 hours every day over the 22.0 day period. Every night 2 other smaller air conditioners are switched on to cool 2 bedrooms: a 1.10×10^3 W unit is switched on for 8.00 hours every night to cool the master bedroom, and a 8.50×10^2 W unit is switched on for 10.0 hours every second night to cool another bedroom. If the cost of electricity is 23.3c per unit, calculate the cost of running the air conditioners for the 22.0 day period.

Energy usage =

2.25 kW x 22 x 14 = 693 kWh (1)

1.10 kW x 22 x 8 = 193.6 kWh (1)

0.85 x 22/2 x 10 = 93.5 kWh (1)

Total = 693 +193.6 + 93.5 = 980 kWh (3 sig fig due to d.p. addition rule) (1)

Cost = 980 x \$0.233 = \$228 (3 sig fig) (1)

END OF TEST