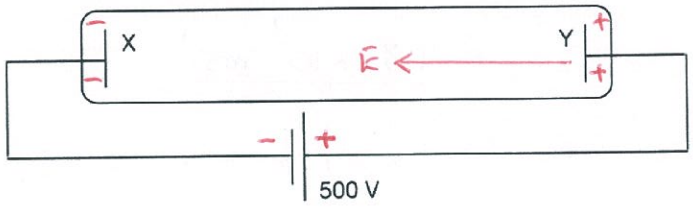
HOLY CROSS COLLEGE
Life to the Full

W-16

11 PHYSICS ATAR
TEST 4: ELECTRICITY

NAME: SOLUTIONS MARK: ___/47

1. The diagram below represents a cathode ray tube that accelerates electrons between its electrodes. Each second, 3.12×10^2 electrons move between electrodes X and Y. The accelerating voltage is 5.00×10^2 V.



(1)

(a) On the diagram, ***draw*** the direction of the electric field in the tube. Explain why you chose this direction.

- Y is a positive potential.
- Electric field comes out of the positive into the negative.
- A positively-charged particle would move away from Y.

(1).

(2)

(b) Determine the size of the current that flows.

$$I = \frac{q}{t} \quad (1)$$

$$= \frac{(3.12\times10^{2})(1.60\times10^{-19})}{1.00} \quad (1)$$

$$= 4.99\times10^{-17}\ A. \quad (1)$$

(3)

(c) Calculate the speed of the electrons as they reach the opposite electrode.

$W = Vq = \frac{1}{2}mv^2$

$\Rightarrow v = \sqrt{\frac{2Vq}{m}}$ (1)

$= \sqrt{\frac{2(5.00\times10^{2})(1.60\times10^{-19})}{(9.11\times10^{-31})}}$ (1)

$= 1.32\times10^{7}\ ms^{-1}$ (1)

(3)

(d) What is the power developed by the power source of the tube?

$P = VI$ (1)

$= (5.00\times10^{2})(4.99\times10^{-17})$ (1)

$= 2.50\times10^{-14}\ W$ (1)

(3)

2. What is the cost of running a 5.50×10^2 W refrigerator for a year if it operates an average of 8.25 hours per day and electricity costs 26.5 cents per unit?
(1.00 unit = 1.00 kWh = 3.60×10^6 J)

$Cost = P\,(kwh) \times t\,(h) \times 26.5$ (1)

$= (0.550)(8.25\times365)(26.5)$ (1)

$= \$438.90$ (1)

(3)

3. How much heat energy is dissipated by a 48.0 kΩ resistor that has a current of 0.350 A flowing through it for a time of 40.0 minutes?

$W = Q = VIt = I^2Rt$ (2)

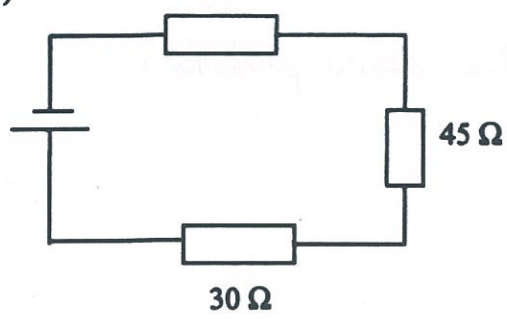
$= (0.350)^2(48.0\times10^3)(40.0\times60.0)$ (1)

$= 1.41\times10^7\ \text{J}$ (1)

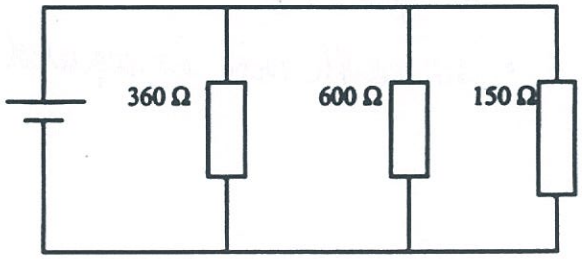
(4)

4. Determine the total resistance in each of the simple circuits shown below.

a)



b)



(a) $R_T = 15+45+30$ (1)

$= 90\ \Omega$ (1)

(b) $\frac{1}{R_T} = \frac{1}{360} + \frac{1}{600} + \frac{1}{150}$ (1)

$= 1.111\times10^{-2}$ (1)

$\Rightarrow R_T = 90\ \Omega$ (1)

(5)

5. Describe how the following act as safety features to protect people from electric shock.

(a) Fuse

- Melts due to the heat produced. (1)
- Breaks the circuit.

(b) Earth wire

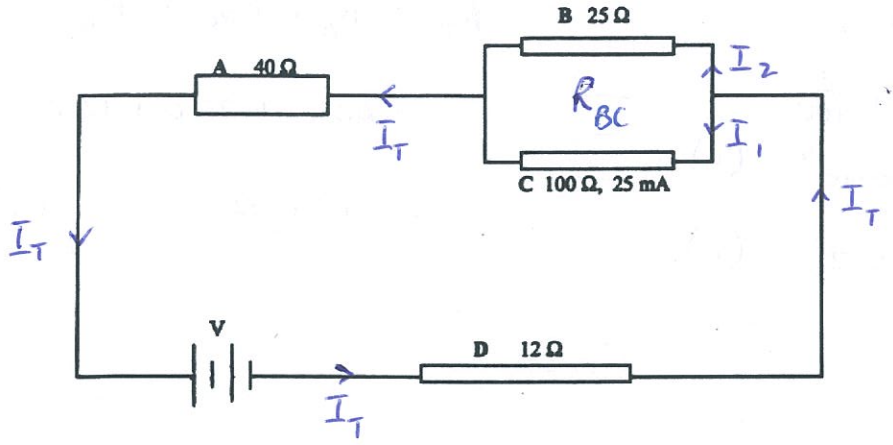
- Connected externally to a pipe ("earth").
- Allows current to flow to earth rather than a person. (1)

(c) Double insulation

- Everything electrical in the appliance is double-wrapped in plastic. (1)
- No earth wire is required - have double protection.

(3)

6. The circuit below shows a complex circuit with 25.0 mA of current flowing in the 100 Ω resistor C.



(a) Find the potential difference across resistor C.

$V_C = I_1 R$

$= (25.0 \times 10^{-3})(100)$ (1)

$= 2.50\ V$ (1)

(2)

(b) What is the current flowing in resistor B?

$V_B = V_C = I_2 R$

$\Rightarrow I_2 = \frac{2.50}{25.0}$ (1)

$= 0.100\ A$ (1)

(2)

(c) Determine the total current flowing in the circuit.

$I_T = I_1 + I_2$

$= 0.025 + 0.100$ (1)

$= 0.125\ A$ (1)

(2)

(d) What is the effective resistance of the circuit?

$$\frac{1}{R_{BC}} = \frac{1}{R_B} + \frac{1}{R_C}$$

$$= \frac{1}{25} + \frac{1}{100}$$

$$= 5.00 \times 10^{-2} \quad (1)$$

$$\Rightarrow R_{BC} = 20.0\,\Omega \quad (1)$$

$$R_T = R_A + R_{BC} + R_D$$

$$= 40.0 + 20.0 + 12.0$$

$$= \underline{72.0\,\Omega} \quad (1)$$

(3)

(e) What is the potential difference of the electricity source?

$$V = I_T R_T$$

$$= (0.125)(72.0) \quad (1)$$

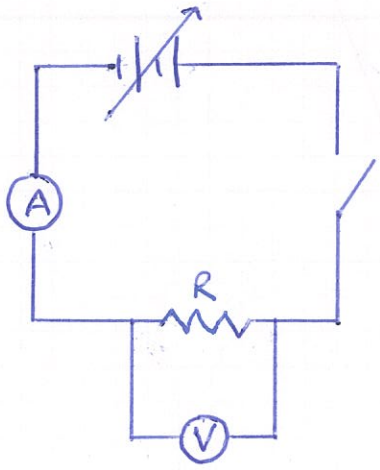
$$= \underline{9.00\ V} \quad (1)$$

(2)

7. A group of students were given the task of determining the value of an unknown ceramic resistor. Their results were as follows.

Voltage (V)	Current (A)
1.95	0.75
3.80	1.55
6.15	2.50
8.00	3.10
9.85	4.00

(a) Draw a circuit diagram to show how the students would measure the voltage and current through the resistor.



[½ mark each component] (2)

[1 mark - correct meters]

(3)

(b) Graph these results on the grid provided.

(4)

(c) Determine the gradient of the graph and hence the value of the resistance.

gradient = $\frac{(9.60-0.20)}{(4.00-0.00)}$ (2)

$= 2.35\ \Omega$ (1)

$(\pm 0.20\ \Omega)$

gradient = $\frac{\Delta V}{\Delta I} = R$

$\Rightarrow R = 2.35\ \Omega$

(3)

Labels + units - 1 mark

Scales - 1 mark

Plotting - 1 mark

Line of best fit - 1 mark