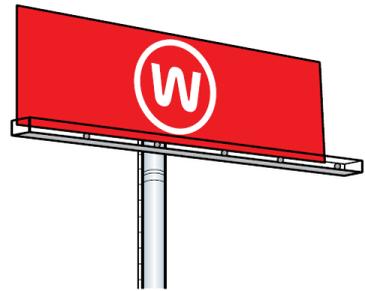


## CHAPTER III : ELECTRICITY

### Formative Practice 3.1 [Current and Potential Difference]

1. Define current and potential difference.
2. What is an electric field?
3. Figure 3.11 shows an electronic advertisement board. The current flowing is  $4.0 \times 10^{-2}$  A. What is the number of electrons flowing in the circuit when it remains switched on for 3 hours? 



**Figure 3.11**

4. A bulb labelled 3.0 V, 0.2 A was lit for 1 hour. Calculate:
  - (a) the electric charge
  - (b) the energy generated
5. An electric charge of 900 C flows through a metallic conductor in 10 minutes. Calculate the current.

Formative Practice 3.2 [Resistance]

1. List the factors that affect the resistance of a wire.

1.	
2.	
3.	
4.	

2. Calculate the total resistance of a coil of copper wire with a length of 50.0 m and a cross-sectional area of 2.5 mm<sup>2</sup>, given that the resistivity of copper at a temperature of 20°C is  $1.72 \times 10^{-8} \Omega \text{ m}$ . 🧠

Formative Practice 3.3 [Electromotive Force (e.m.f) and Internal Resistance]

1. What is meant by electromotive force, e.m.f.?

2. State the difference between e.m.f. and potential difference.

E.M.F	Potential Difference

3. What is the effect of internal resistance on current in a complete circuit?

4. If you are supplied with two dry cells, what type of arrangement can reduce the effective internal resistance of the dry cells?

Formative Practice 3.4 [Electrical Energy and Power]

1. The output power of a battery is 80 W. Determine the electrical energy that is supplied by the battery in:
  - (a) 10 seconds
  - (b) 2 hours
  
2. If the cost of electricity is 30 sen per unit, calculate the cost of using:
  - (a) 600 W LED television for 8 hours
  - (b) 1 kW vacuum cleaner for half an hour

## Summative Practice Electricity

1. Figure 1 shows a filament lamp. Why does a coiled filament produce a brighter light?

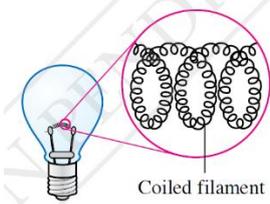


Figure 1

2. Figure 2 shows a circuit with three bulbs, X, Y and Z with a resistance of  $3\ \Omega$  each.

- (a) If switches  $S_1$ ,  $S_2$  and  $S_3$  are closed, calculate:
- the effective resistance in the circuit
  - the current indicated by the ammeter
  - the potential difference across bulb X

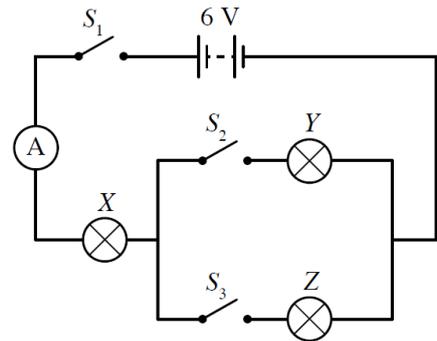


Figure 2

- (b) Compare the brightness of light bulbs X, Y and Z when switches  $S_1$ ,  $S_2$  and  $S_3$  are closed.

- (c) If only switches  $S_1$  and  $S_2$  are closed, calculate:
- the effective resistance in the circuit
  - the current indicated by the ammeter
  - the potential difference across bulb X

- (d) Compare the brightness of light bulbs X, Y and Z when only switches  $S_1$  and  $S_2$  are closed.

3. An experiment is conducted to study the relationship between electromotive force,  $\mathcal{E}$  and internal resistance,  $r$  of a dry cell. The electrical circuit for the experiment is shown in Figure 3. The voltmeter readings,  $V$  and the corresponding ammeter readings,  $I$  are as shown in Table 1.

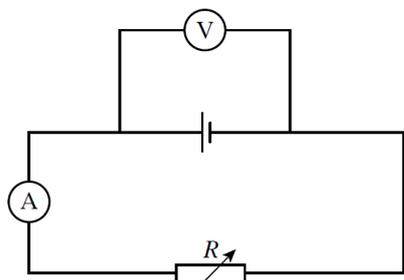


Figure 3

Table 1

$V / \text{V}$	$I / \text{A}$
1.40	0.2
1.35	0.4
1.25	0.6
1.15	0.8
1.10	1.0

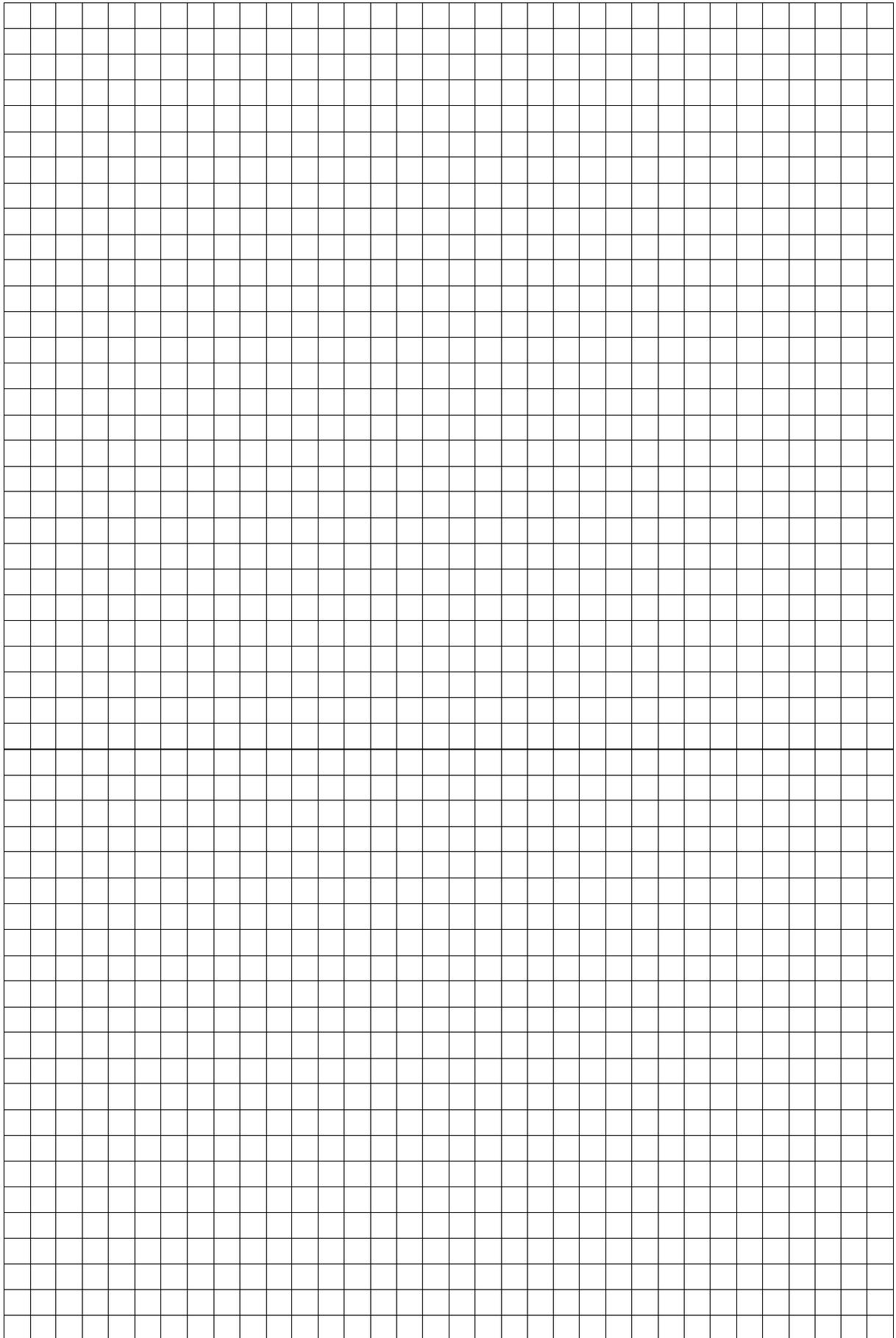
- (a) What is meant by electromotive force? (b) Based on the data in Table 1, plot a graph of  $V$  against  $I$ .

- (c) Based on the graph plotted, answer the following questions:
- What happens to  $V$  when  $I$  increases?
  - Determine the value of the potential difference,  $V$  when the current,  $I = 0.0 \text{ A}$ .  
Show on the graph how you determine the value of  $V$ .
  - Name the physical quantity that represents the value in 3(c)(ii).

- (d) The internal resistance,  $r$  of the dry cell is given by  $r = -m$ , where  $m$  is the gradient of the graph. Calculate  $r$ .

- (e) State two precautions that need to be taken in this experiment.

Graph Paper Soalan 3b Abe



4. Figure 4 shows a circuit that is used to investigate the relationship between resistance,  $R$  and length of wire,  $l$  for two different wire conductors with the same diameter, that is 0.508 mm. Figure 5 shows the graph of resistance against length of wire.

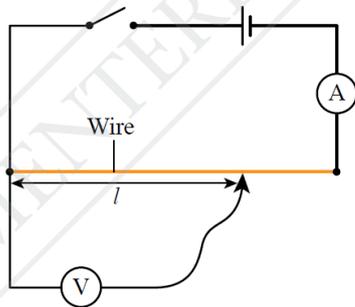


Figure 4

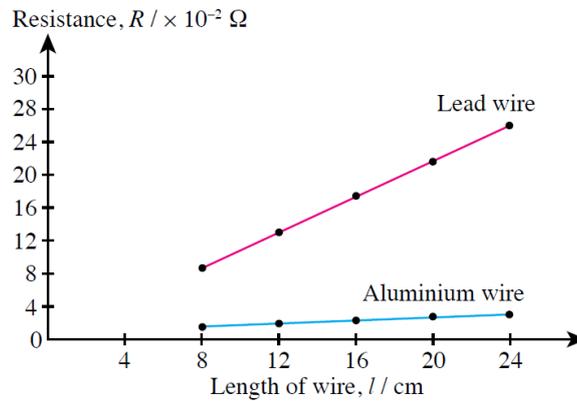


Figure 5

(a) What is meant by resistivity?

(b) Based on the graph in Figure 5, compare: 🍄

- (i) the gradients of the graph
- (ii) their resistivities.

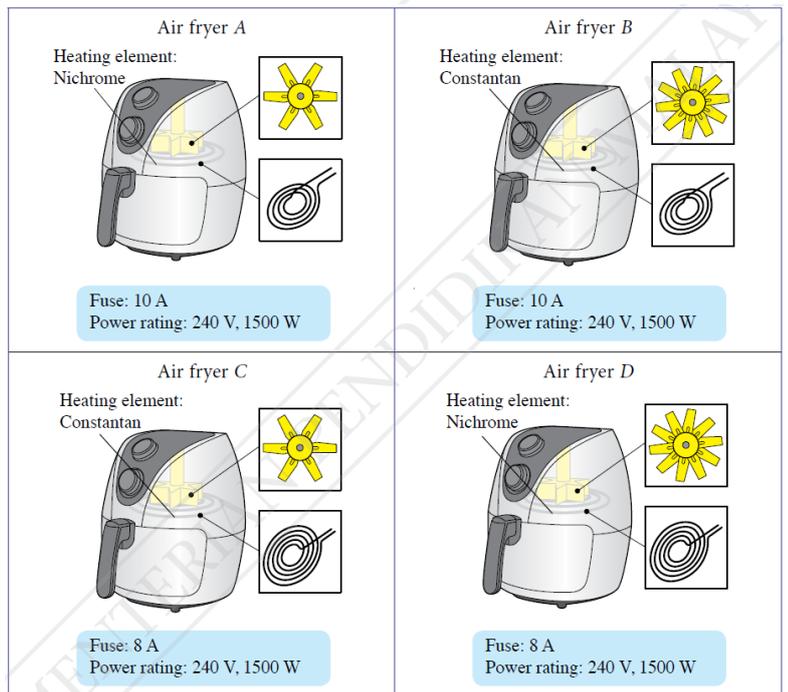
(c) Based on your answer in 4(b), state the relationship between the gradient of the graph and the resistivity of the conductor. 🍄

5. Figure 6 shows four types of air fryers A, B, C and D with different specifications. Study the specifications of the four air fryers based on the following aspects:

- heating element
- coil turns of the heating element
- number of fan blades
- suitability of fuse

(a) What is the function of a fuse in an air fryer?

(b) What is meant by 240 V, 1500 W on the label of the air fryers?



(c) Discuss the specifications of the four air fryers to cook food quickly and safely. 🍷

		Explanation

(d) Determine the most suitable air fryer. Give your reasons. 🍷

6. Your mother has just renovated her kitchen with a modern concept. As a final touch, she asked you to buy an electric stove that can heat up food quickly and save electricity. Table 2 shows several electric stoves with its heating element features.

**Table 2**

Type of electric stove	Metal resistivity at 20°C, $\rho / 10^{-6} \Omega \text{ cm}$	Thermal conductivity	Melting point / °C	Oxidation rate
P	1.7	Low	1 084	High
Q	2.7	High	660	Low
R	6.9	High	1 452	Low
S	20.6	Low	327	High

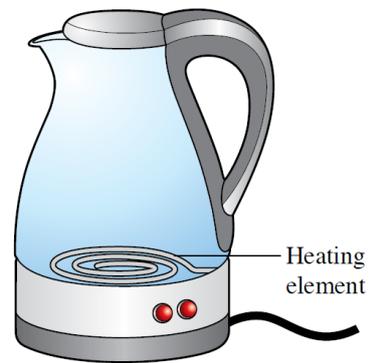
- (a) Discuss the suitability of the four types of electric stoves based on the features given. 🌸


- (b) Determine the most suitable electric stove. Give your reasons. 🌸

7. Figure 7 shows a heating element in an electric kettle. You are required to modify the heating element so that it is portable and can boil water faster and safer.

Explain the modifications based on the following aspects: 

- number of coil turns of the heating element
- density of the heating element
- diameter of the heating wire
- type of material used as the heating element



*Figure 7*

Aspect	Characteristic	Explanation
Number Of Coil Turns Of The Heating Element		
Density Of The Heating Element		
Diameter Of The Heating Wire		
Type Of Material Used As The Heating Element		

**Formative Practice 3.1**

- A current is the rate of flow of charge in a conductor.  
The potential difference is the work done to move one coulomb of charge between two points.
- An electric field is the region around a charged particle where any electric charge in the region will experience an electric force.
- Current,  $I = 4.0 \times 10^{-2}$  A  
Time,  $t = 3$  h  
 $= 3 \times 60 \times 60$   
 $= 10\,800$  s  
 $Q = ne$  and  $It = ne$   
 $4.0 \times 10^{-2}(10\,800) = n(1.6 \times 10^{-19})$   
Number of electrons,  $n = 2.7 \times 10^{21}$  electron
- (a) Time,  $t = 1 \times 3\,600$   
 $= 3\,600$  s  
Current,  $I = 0.2$  A  
Charge flow,  $Q = It$   
 $= 0.2 \times 3\,600$   
 $= 720$  C  
(b) Potential difference,  $V = 3.0$  V  
Charge flow,  $Q = 720$  C  
Energy,  $E = VQ$   
 $= 3.0 \times 720$   
 $= 2\,160$  J
- Charge flow,  $Q = 900$  C  
Time,  $t = 10$  min  
 $= 10 \times 60$   
 $= 600$  s  
Current,  $I = \frac{Q}{t}$   
 $= \frac{900}{600}$   
 $= 1.5$  A

**Formative Practice 3.4**

- (a) Power,  $P = 80$  W  
Time,  $t = 10$  s  
Electrical energy,  $E = Pt$   
 $= 80(10)$   
 $= 800$  J  
(b) Power,  $P = 80$  W  
Time,  $t = 2$  h  
 $= 2 \times 60 \times 60$   
 $= 7\,200$  s  
Electrical energy,  $E = Pt$   
 $= 80(7\,200)$   
 $= 576$  kJ
- (a) Power,  $P = 600$  W  
Time,  $t = 8$  h  
Energy used  $= 0.6$  kW  $\times 8$  h  
 $= 4.8$  kWh  
Unit cost = RM0.30  
Cost of energy used  $= 4.8 \times 0.30$   
 $=$  RM1.44  
(b) Power,  $P = 1$  kW  
Time,  $t = 0.5$  h  
Energy used  $= 1$  kW  $\times 0.5$  h  
 $= 0.5$  kWh  
Unit cost = RM0.30  
Cost of energy used  $= 0.5 \times 0.30$   
 $=$  RM0.15

**Formative Practice 3.2**

- Wire length, cross-sectional area of wire, resistivity and temperature.
- Wire length,  $l = 50.0$  m  
Cross-sectional area,  $A = 2.5$  mm<sup>2</sup>  
 $= 2.5 \times 10^{-3} \times 10^{-3}$  m<sup>2</sup>  
 $= 2.5 \times 10^{-6}$  m<sup>2</sup>  
Resistivity of copper,  $\rho = 1.72 \times 10^{-8}$   $\Omega$  m  
 $R = \frac{\rho l}{A}$   
 $= \frac{(1.72 \times 10^{-8})50}{2.5 \times 10^{-6}}$   
 $= 0.344$   $\Omega$

**Formative Practice 3.3**

- The electromotive force, e.m.f. is the energy transferred or work done by a source of electrical energy to move one coulomb of charge in a complete circuit.
- The electromotive force, e.m.f. is the work done by a source of electrical energy to move one coulomb of charge in a complete circuit and its value is measured when the switch is open (open circuit) while potential difference is the work done to move one coulomb of charge between two points in the external circuit and its value is measured when the switch is closed (closed circuit).
- The magnitude of the current is smaller.
- The dry cells are connected in parallel.

## Summative Practice

- The filament lamps require high resistance to produce light.
  - The coiled filament causes the wire length to increase.
  - The resistance is directly proportional to the length of the wire.
  - The longer the filament wire, the higher the resistance.
  - The higher the resistance, the brighter the lamp.
- Resistance,  $\frac{1}{R} = \frac{1}{3} + \frac{1}{3}$
    - Current,  $I = 1.33 \text{ A}$
    - Resistance,  $R = 3 \ \Omega$
    - Potential difference,  $V = IR$

$$\begin{aligned}
 &= \frac{2}{3} \\
 R &= \frac{3}{2} \\
 &= 1.5 \ \Omega
 \end{aligned}$$

$$\begin{aligned}
 \text{Effective resistance, } R &= 3 + 1.5 \\
 &= 4.5 \ \Omega
 \end{aligned}$$

- Potential difference,  $V = 6 \text{ V}$
  - Effective resistance,  $R = 4.5 \ \Omega$

$$\begin{aligned}
 \text{Current, } I &= \frac{V}{R} \\
 &= \frac{6}{4.5} \\
 &= 1.33 \text{ A}
 \end{aligned}$$

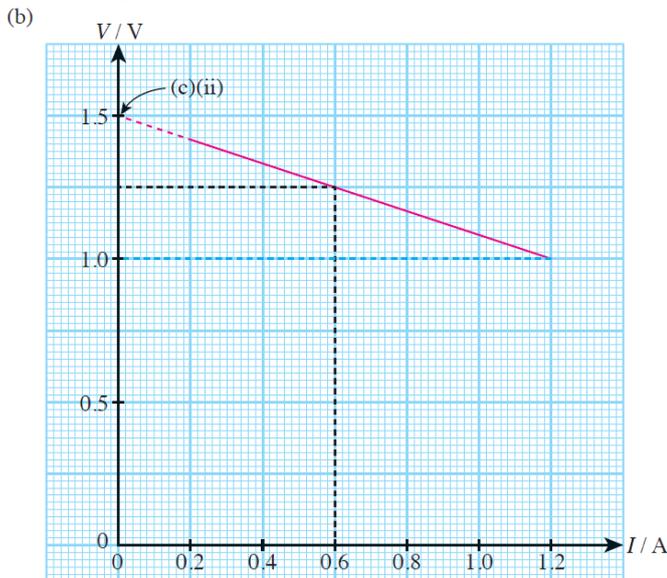
- Bulb X is the brightest compared to bulb Y and bulb Z. Bulb Y and bulb Z have the same brightness.

- Effective resistance,  $R = 3 + 3$
  - Potential difference,  $V = 6 \text{ V}$
  - Effective resistance,  $R = 6 \ \Omega$

$$\begin{aligned}
 \text{Current, } I &= \frac{V}{R} \\
 &= \frac{6}{6} \\
 &= 1.0 \text{ A}
 \end{aligned}$$

- Bulb X and bulb Y glow with equal brightness. Bulb Z does not light up.

- The electromotive force, e.m.f. is the energy transferred or work done by a source of electrical energy to move one coulomb of charge in a complete circuit.



- $V$  decreases linearly with  $I$
  - From the graph above,  $V = 1.5 \text{ V}$
  - Electromotive force, e.m.f.

$$\begin{aligned}
 \text{Gradient, } m &= \frac{1.0 - 1.5}{1.2 - 0} \\
 &= -0.417 \ \Omega
 \end{aligned}$$

$$\begin{aligned}
 \text{Internal resistance, } r &= -m \\
 &= -(-0.417) \\
 &= 0.417 \ \Omega
 \end{aligned}$$

- Make sure the connecting wires are tightly connected.
  - Avoid parallax errors when taking ammeter and voltmeter readings.

- The resistivity of a conductor,  $\rho$  is a measure of a conductor's ability to oppose the flow of electric current.
  - The gradient of the lead wire graph is greater.
    - The resistivity of the lead wire is greater.
  - The greater the gradient of the graph, the greater the resistivity of the conductor.
  - The gradient of the graph is directly proportional to the resistivity of the conductor.

- The most suitable type of electric stove to be used must have four characteristics of the heater as follows:

- Metal resistivity at  $20^\circ \text{ C}$  is high. Therefore, does not need a long wire to obtain the resistance required to make the stove heat up quickly.
  - High thermal conductivity. Therefore, the stove will heat up quickly.
  - High melting point. Therefore, it can withstand heat and the heater will not melt at high temperatures.
  - Low oxidation rate. Therefore, it does not rust easily and is more durable.
- The type  $R$  of electric stove is the most suitable for use due to its high metal resistivity, high thermal conductivity, high melting point and low oxidation rate.

- The fuse melts when the current exceeds the value of the fuse current, thereby disconnecting the circuit.
  - A total of  $1500 \text{ J}$  of electrical energy is consumed per second when connected to a  $240 \text{ V}$  power supply.

Feature	Explanation
The heating element is nichrome	Nichrome has high resistivity
The heating wire has many turns of coil	It produces a high resistance
There are many fan blades	More hot air can be spread
A suitable fuse must have a current specification that is slightly higher than the current that goes into the air fryer	The current flowing through the air fryer is $6.25 \text{ A}$ . Hence an $8 \text{ A}$ fuse is suitable for use

Feature	Explanation
The heating wire has many turns of coil	Long wire, the resistance is high
Low density heating element material	Light
Small diameter of the heating wire	High resistance
The heating element is nichrome	High resistivity