1. $I = Anve$. What do each of these symbols stand for? And what are their units
   - I = current in the wire (A)
   - A = cross-sectional area of wire (m^2)
   - n = number density of <u>free</u> electrons (m^{-3})
   - v = average drift speed of <u>free</u> electrons ($m\ s^{-1}$)
   - e = elementary charge (C) OR (A s)

2.

Two lamps P and Q are connected in series to a battery, as shown in Fig. 6.1.

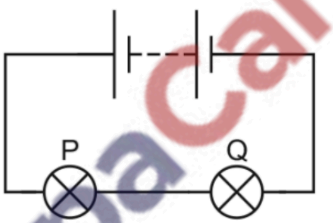


Fig. 6.1

The radius of the filament wire of lamp P is twice the radius of the filament wire of lamp Q. The filament wires are made of metals with the same value of *n*.

Calculate the ratio

$$\frac{\text{average drift speed of free electrons in filament wire of P}}{\text{average drift speed of free electrons in filament wire of Q}}.$$

Since v is inversely proportional to A,

Ratio = AQ / AP

= (pi r^2) / (pi $(2r)^2$) = 0.25

3.

The diameter of a wire XY varies linearly with distance along the wire as shown in Fig. 7.1.

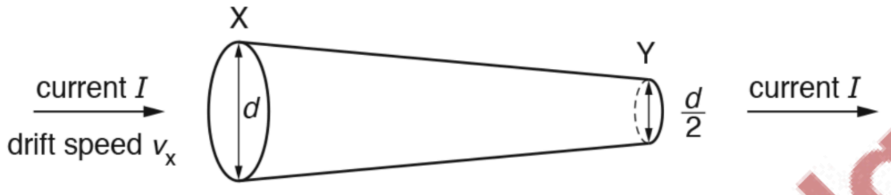
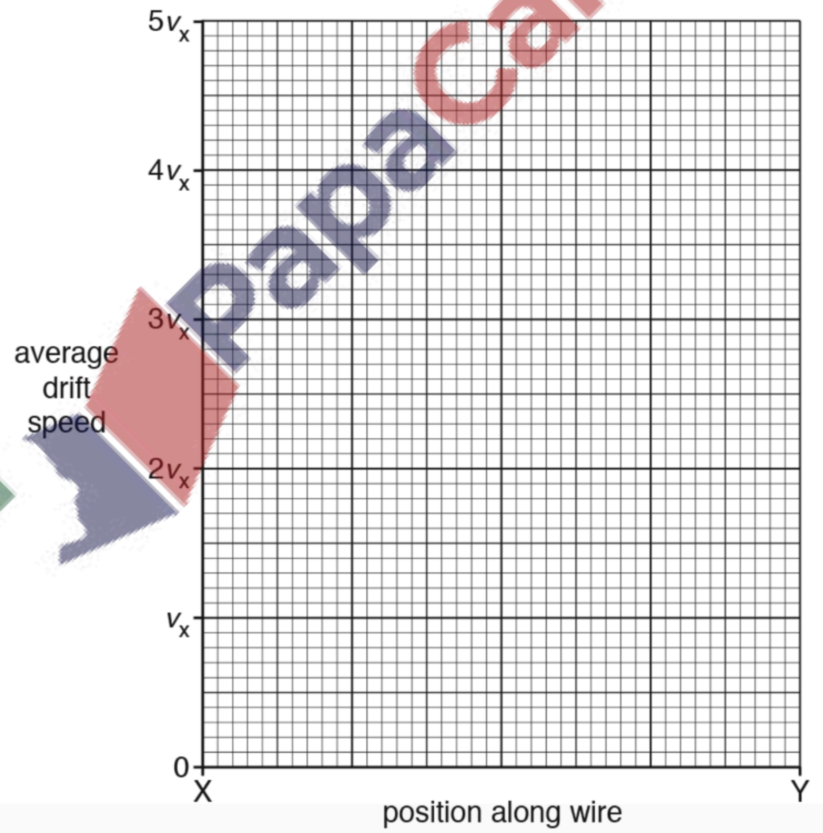


Fig. 7.1

There is a current I in the wire. At end X of the wire, the diameter is d and the average drift speed of the free electrons is v_x. At end Y of the wire, the diameter is $\frac{d}{2}$.

On Fig. 7.2, sketch a graph to show the variation of the average drift speed with position along the wire between X and Y.



line drawn between (X, v_x) and (Y, $4v_x$)

line has increasing gradient

When radius / diameter doubles, drift velocity decreases by ¼.

4. Define coulomb
   Coulomb is an ampere second.

5. Define potential difference
   $$p.d. = \frac{work\ done\ OR\ energy\ transformed\ from\ electrical\ to\ another\ forms}{charge}$$

6. Define electromotive force
   $$e.m.f\ = \frac{work\ done\ OR\ energy\ transformed\ from\ other\ forms\ to\ another\ electrical}{charge}$$

7. Define resistance
   $$resistance\ = \frac{potential\ difference}{current}$$

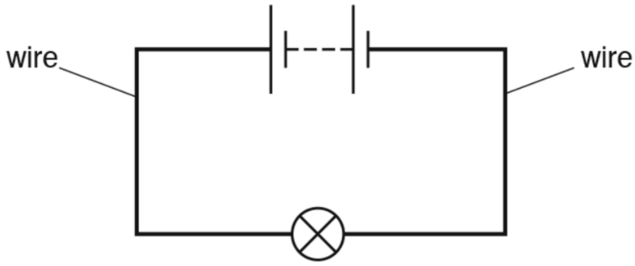
8. Define volt
   Volt is joule/coulomb

9. Define ohm
   Volt is volt/ampere

NOTE: if ans = 0.5, write 0.50!!

10.

Wires are used to connect a battery of negligible internal resistance to a lamp, as shown in Fig. 7.1.



Diameter of the connecting wires is decreased. Total length of the connecting wires and the resistivity of the metal of the connecting wires remain the same. State and explain the change, if any, that occurs to the resistance of the filament wire of the lamp.

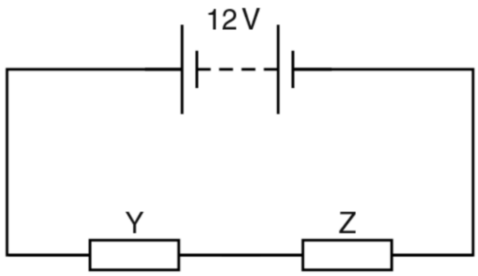
- Resistance of connecting wires increases
- This decreases current in filament wire // this decreases potential difference across filament wire
- Thus resistance of filament wire decreases

11. State what is meant by electric current
Flow of charge carriers

12. The potential difference across a filament lamp is reduced. State and explain the effect, if any, on the resistance of the filament wire in the lamp.
Temperature decreases and so resistance decreases.

13.

A 12V battery with negligible internal resistance is connected to two resistors Y and Z, as shown in Fig. 6.2.



The resistors are made from wires of the same material. The wire of Y has a diameter *d* and length *l*. The wire of Z has a diameter 2*d* and length 2*l*.

(i) Determine the ratio

$$\frac{\text{average drift speed of the charge carriers in Y}}{\text{average drift speed of the charge carriers in Z}}.$$

$$v = \frac{I}{nAe}$$

$$\therefore \text{ratio} = \frac{I}{nA_ye} \div \frac{I}{nA_ze}$$

$$= \frac{\cancel{I}}{\cancel{n}A_y\cancel{e}} \times \frac{\cancel{n}A_z\cancel{e}}{\cancel{I}} = \frac{A_z}{A_y}$$

$$= \frac{\pi(2d)^2}{\pi d^2} = \frac{4\pi d^2}{\pi d^2} = 4$$

(ii) Show that

$$\frac{\text{resistance of Y}}{\text{resistance of Z}} = 2.$$

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

$$\frac{R_y}{R_z} = \frac{\rho l_y}{A_y} \div \frac{\rho l_z}{A_z}$$

$$= \frac{\rho l_y}{A_y} \times \frac{A_z}{\rho l_z} = \frac{l_y \times A_z}{A_y \times l_z}$$

$$= \frac{\cancel{l} \times \cancel{\pi}(2d)^2}{2\cancel{l} \times \cancel{\pi} d^2} = \frac{4\cancel{d^2}}{2\cancel{d^2}} = 2$$

iii) Determine the potential difference across Y.

$$V_y = \frac{R_y}{R_y + R_z} \times 12$$

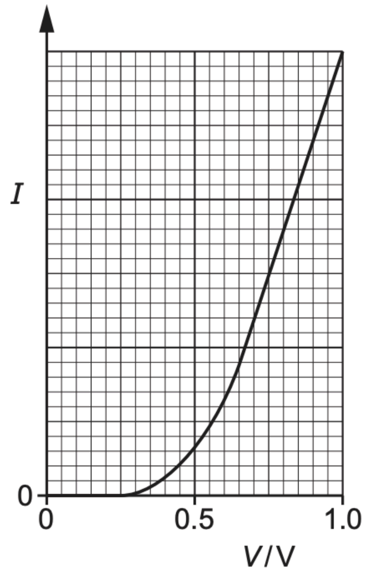
$$\therefore V_y = \frac{2}{3} \times 12 = 8V$$

NOTE: drift speed v is independent of length!!

1. Define the potential difference across a component
    - The energy transferred from electrical to other forms per unit charge.

2.

The variation with potential difference V of the current I in a semiconductor diode is shown in Fig. 6.1.



a. Use Fig. 6.1 to describe qualitatively the resistance of the diode in the range V = 0 to V = 0.25V
- Infinite resistance

b. Use Fig. 6.1 to describe qualitatively the variation, if any, in the resistance of the diode as V changes from V = 0.75V to V = 1.0V.
- Resistance decreases as V increases

NOTE: in diode, resistance cannot be constant!!. Assume this to be an upward curve, with decreasing resistance.

3.

A battery of electromotive force (e.m.f.) 9.6 V and negligible internal resistance is connected in series with two fixed resistors and a thermistor, as shown in Fig. 7.1.

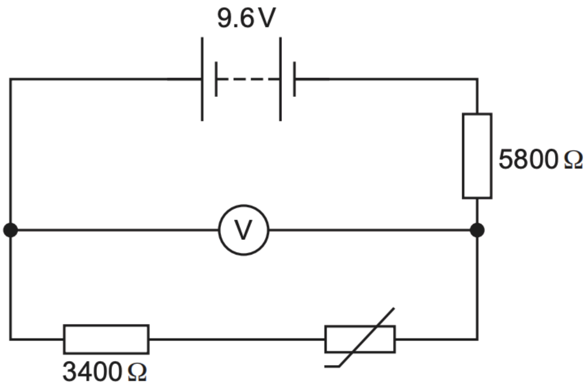


Fig. 7.1

The fixed resistors have resistances of 3400 Ω and 5800 Ω. The reading on the voltmeter in the circuit is 6.0 V.

The initial energy stored in the battery is 2.6×10^4 J.

Assume that the e.m.f. of the battery is constant.

Determine the final energy stored in the battery after a charge of 330 C has moved through it.

- E = VIt
- Q = It
- E = VQ = 9.6 x 330 = 3168
- $2.6 \times 10^4 - 3168 = 2.3 \times 10^4$

The environmental conditions change causing an increase in the resistance of the thermistor.

State whether there is a decrease, increase or no change to:

a. Temperature of the thermistor = decreases
b. Current in the thermistor = decreases
c. Potential difference across the thermistor = increases

4.

A battery is connected to two resistors X and Y, as shown in Fig. 6.1.

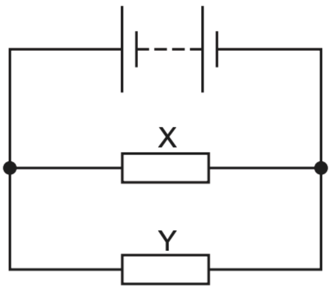


Fig. 6.1

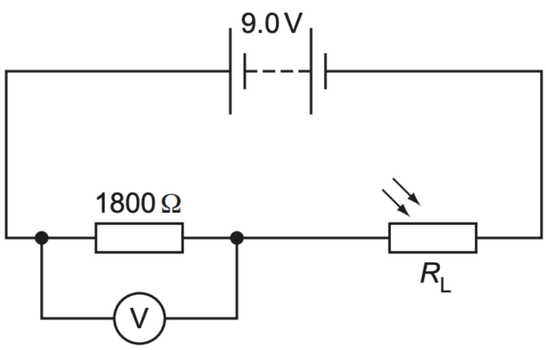
The resistance of resistor X is greater than the resistance of resistor Y.

a. State and explain which resistor dissipates more power.
- same potential difference across X and Y as in parallel
- power = V^2 / R (and $R_X > R_Y$)
- so Y dissipates more power

b. The two resistors are made of wires that have the same length. Both wires are made from metal of the same resistivity. State and explain which resistor is made of wire with the larger cross-sectional area.
- $R = \rho L / A$ (and $R_X > R_Y$)
- so Y has the larger cross-sectional area

5.

A battery of electromotive force (e.m.f.) 9.0V and negligible internal resistance is connected in series with a light-dependent resistor (LDR) and a fixed resistor of resistance 1800Ω, as shown in Fig. 6.2.



The intensity of the light illuminating the LDR increases. By reference to the current in the circuit, state and explain the change, if any, to the voltmeter reading.
- resistance of LDR (R_L) decreases
- current in the circuit increases so voltmeter reading increases

6.

Fig. 7.1 shows two resistors connected in series with a cell of electromotive force (e.m.f.) 1.50 V and internal resistance 0.28 Ω.

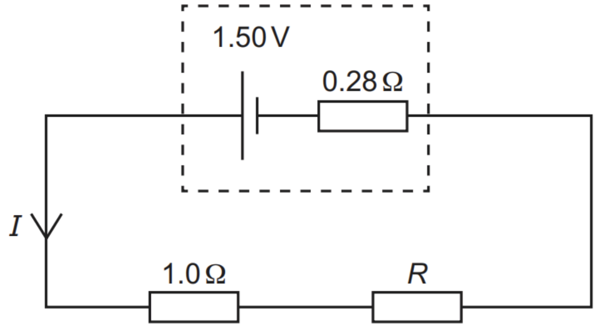


Fig. 7.1

One of the resistors has resistance 1.0 Ω. The other resistor has resistance *R*.
The terminal potential difference (p.d.) across the cell is 1.36 V.

The circuit in Fig. 7.1 is disconnected and the two resistors are reconnected to the cell, now in parallel with each other.
Explain, without calculation, whether the terminal p.d. across the cell is now less than, equal to or greater than 1.36V.

- external resistance is now smaller, so current in cell is greater OR external resistance is smaller fraction of total resistance OR internal resistance is larger fraction of total resistance
- greater p.d. across internal resistance so terminal p.d. is less

7.

A power supply, three resistors and a component X are connected in the circuit shown in Fig. 5.1.

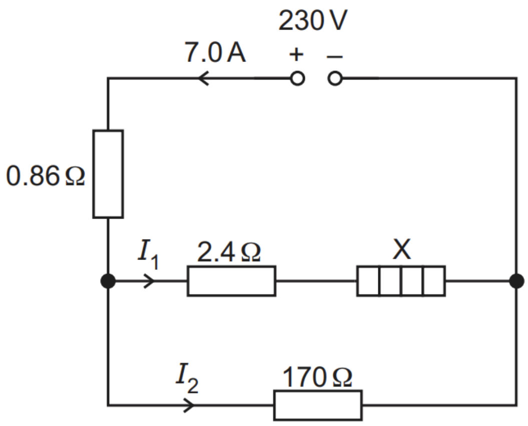


Fig. 5.1

The power supply has an electromotive force (e.m.f.) of 230 V and negligible internal resistance. The current in the power supply is 7.0 A.

P.d. across 0.86ohm resistor = 6.0V

Determine the current in I_1

I = (230 – 6.0) / 170

(= 1.3 A)

I_1 = 7.0 – 1.3

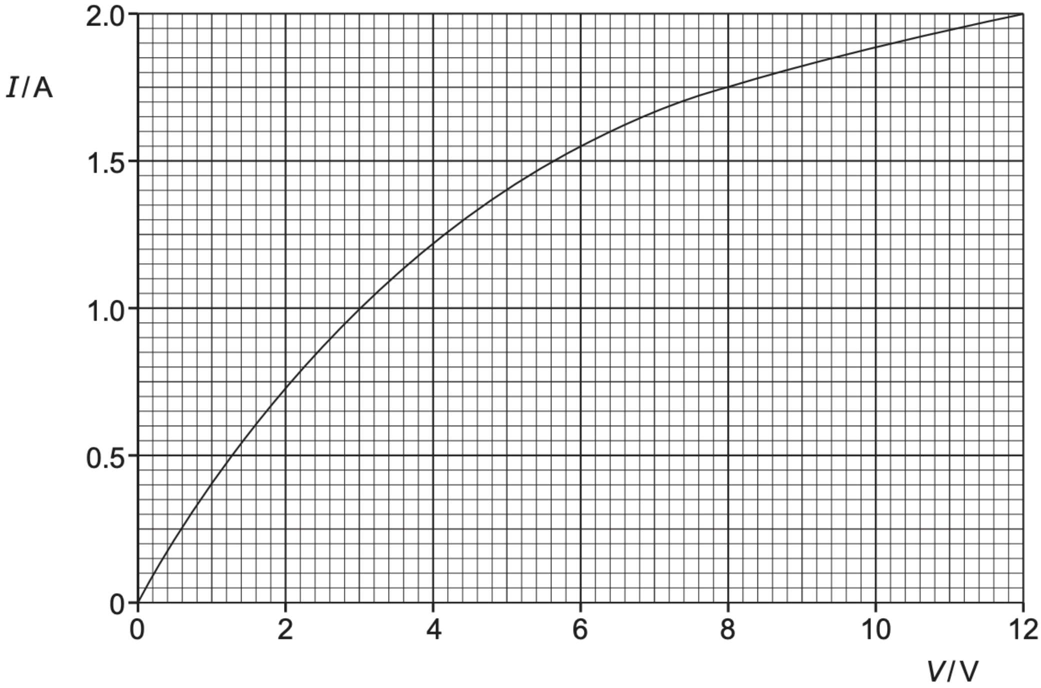
= 5.7 A

DON'T forget about the 0.86 ohm resistor!!

8. State Ohm's law
   - current through a conductor is directly proportional to potential difference across the conductor
   - provided that temperature of conductor remains constant

9.

The variation of current I with potential difference V for a filament lamp is shown in Fig. 5.1.



The resistance of the filament lamp increases with potential difference. State how Fig. 5.1 shows this.

- Ratio of V/I increases as p.d increases

10.

Fig. 5.2 shows a circuit with a battery of electromotive force (e.m.f.) 12.0 V connected to a linear potentiometer AB and two identical filament lamps P and Q.

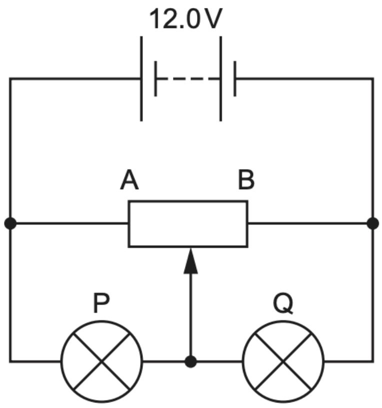


Fig. 5.2

The battery has negligible internal resistance and the lamps each have the same I–V characteristic shown in Fig. 5.1.

When the slider of the potentiometer is at its midpoint, as shown in Fig. 5.2, the current I in the battery is 1.78 A.

The slider of the potentiometer is moved to end A. State and explain the effect on the brightness of lamps P and Q

- Lamp P: p.d. across lamp decreases to zero so goes 'out'
- Lamp Q: p.d. across lamp increases to 12 V so gets brighter