Unit 1-electricity

1.1 Electric current

Learning Objectives:

a) define electric current as the flow of charge carriers.

b)) solve problems using $Q = It$. (Where Q=Ne, N is the number of electrons)

c) define the coulomb.

d) derive and use, for a current-carrying conductor, the expression $I = Anve$, where n is the number density of charge carriers.

e) solve problems involving the mean drift velocity of charge carriers.

Useful links

- Electric Current

https://www.youtube.com/watch?v=9OchTQ4Qfik

https://www.youtube.com/watch?v=rkgf0T7RWZY

- Relation between current and drift velocity

https://www.youtube.com/watch?v=5HFRs8X4gU0

Past GED Questions

1. An electric current of (5A) is equivalent to:

- ☐ 5 J/C
- ☐ 5 V/C
- ☐ 5 C/sec
- ☐ 5 C/sec
- ☐ 5 W/sec

2. One Ampere is equal to:

- ☐ C^2. s
- ☐ C.s
- ☐ C/s
- ☐ s/C^2
- ☐ C/s

3. what is meant by saying that the electrical current equals (5A)? (1 mark)

The amount of charge of 5 coulombs that passes a point within 1 seconds.

5 Coulombs of charge is passing through a conductor in one second

4. A wire carries a steady current of (2A). How many electrons passes through the wire in (2s)? (2 marks)

$\because Q = It$ — $\frac{1}{2}$

$\therefore Q = 2 \times 2$

$= 4C$ — $\frac{1}{2}$

$\because n = \frac{Q}{q}$

$\therefore n = \frac{4}{1.6 \times 10^{-19}}$ — $\frac{1}{2}$

$= 2.5 \times 10^{19}$ — $\frac{1}{2}$

5. The rate of flow of electric charges through a conductor is called:

- ⬭ electric current
- ⬭ electric power
- ⬭ potential difference
- ⬭ ohmic resistance

⬭ electric current

6. What is the definition of an electric current in an electrical circuit?

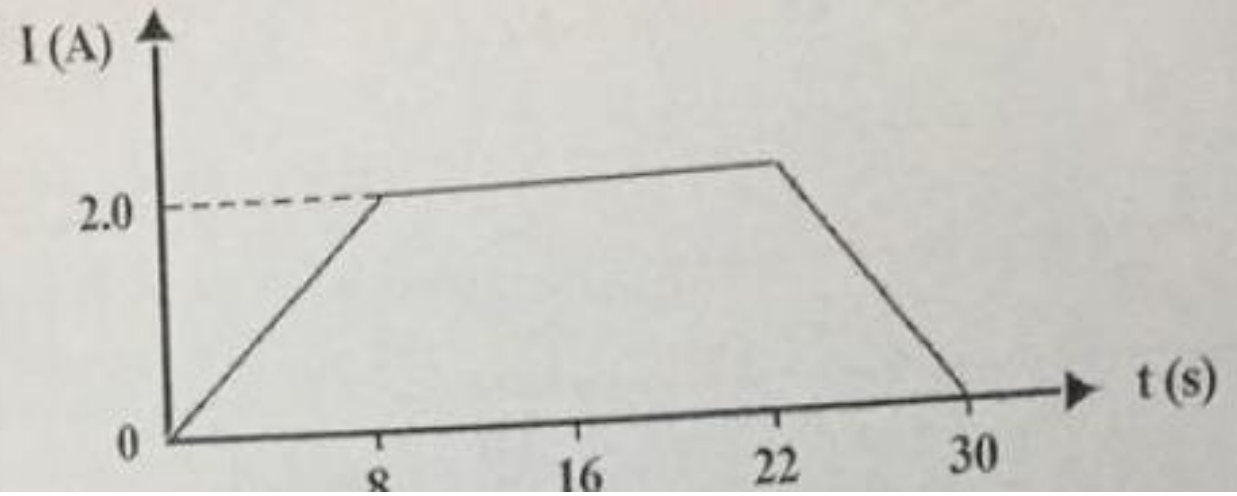
- ☐ The flow rate of positive ions.
- ☐ The flow rate of free electrons.
- ☐ The flow rate of free positive charges.
- ☐ The flow rate of both positive and negative particles.

7.

- ☐ The flow rate of free electrons.

8.

The variation of current through a point with time is shown in the figure below.



Calculate the charge that flows through the point from (8 s) to (30 s). [2 marks]

The charge flow = the area under the graph.

From 8s to 22s,
the area = $2\times(22-8) = 2\times14 = 28$ C ($\frac{1}{2}$)
From 22s to 30s,
the area = $\frac{1}{2}\times8\times2 = 8$ C ($\frac{1}{2}$)
$\therefore$ Total area = $8+28 = 36$ C (1)

9. "The flow of electric charge carriers through a point in (1 s) in which there is a constant current of (1 A)" is defined as:

- ☐ Watt
- ☐ Ohm
- ☐ Volt
- ☐ Coulomb
- ☐ Coulomb

10. A Copper wire has a radius of (4.85×10^{-4} m) carries a current of (1 A). If the Copper wire contains (8.4×10^{28} free electrons/m^3), the electron drift velocity is approximately:

- ☐ 1×10^{-23} m/s
- ☐ 1×10^{-4} m/s
- ☐ 1×10^{3} m/s
- ☐ 1×10^{8} m/s

11. If the wire carrying this current is (0.5 mm) in radius, what is the drift velocity of the electrons at (t = 15 s), assuming that the number of electrons per (m^3) is (1×10^{28}). [2 marks]

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

$$A = \pi r^2 = \pi(0.5\times10^{-3})^2 = 7.85\times10^{-7}$$

$$v = \frac{2}{1\times10^{28}\times7.85\times10^{-7}\times1.6\times10^{-19}}$$

$$= 1.59\times10^{-3}\ \text{m/s}$$

12. A wire carries a current of 2.0 amperes for 1.0 hour.

How many electrons pass a point in the wire in this time?

A 1.2×10^{-15}

B 7.2×10^{3}

C 1.3×10^{19}

D 4.5×10^{22}

13. **D** 4.5×10^{22}

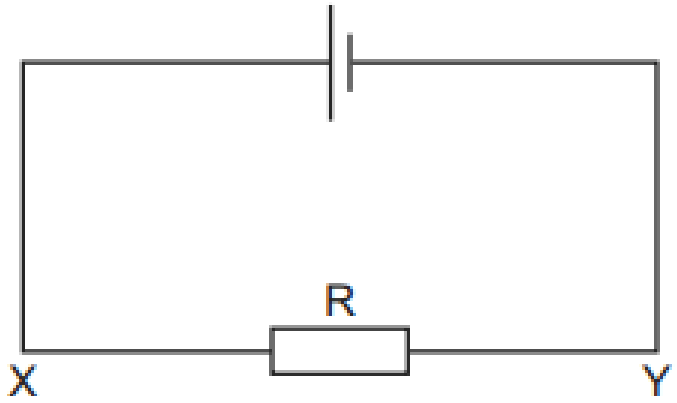
The current in a resistor is 8.0 mA.

What charge flows through the resistor in 0.020 s?

A 0.16 mC **B** 1.6 mC **C** 4.0 mC **D** 0.40 C

A 0.16 mC

14. The current in the circuit is 4.8 A.



What is the rate of flow and the direction of flow of electrons through the resistor R?

A $3.0 \times 10^{19}\,s^{-1}$ in direction X to Y

B $6.0 \times 10^{18}\,s^{-1}$ in direction X to Y

C $3.0 \times 10^{19}\,s^{-1}$ in direction Y to X

D $6.0 \times 10^{18}\,s^{-1}$ in direction Y to X

C $3.0 \times 10^{19}\,s^{-1}$ in direction Y to X

- 15. Estimate the average drift speed of conduction electrons in a copper wire of cross section area 2.5 X 10^{-7} m2 carrying a current of 2.7A. Assume the density of conduction electrons to be 9 x 10^{28} m3.

Ans : 7.5 x10-4 m/s

- Textbook questions

Now it's your turn

1 Calculate the current when a charge of 240 C passes a point in a circuit in a time of 2 minutes.

2 In a silver-plating experiment, 9.65×10^4 C of charge is needed to deposit a certain mass of silver. Calculate the time taken to deposit this mass of silver when the current is 0.20 A.

3 The current in a wire is 200 mA. Calculate:
   (a) the charge which passes a point in the wire in 5 minutes,
   (b) the number of electrons needed to carry this charge (electron charge $e = -1.6 \times 10^{-19}$ C).

Now it's your turn

4 The average drift speed in a metal wire is 6.5×10^{-4} m s^{-1} when the current is 0.80 A. The diameter of the wire is 0.50 mm. Calculate the number of 'free' electrons per unit volume in the wire.

1 2.0 A

2 4.8×10^5 s

3 **(a)** 60 C

(b) 3.8×10^{20}

4 3.9×10^{28} m^{-3}