A Level H2 Physics Tutorial 14: Current of Electricity

Syllabus :
(a) show an understanding that electric current is the rate of flow of charge

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(b) derive and use the equation I = nAvq for a current-carrying conductor, where n is the number density of charge carriers and v is the drift velocity

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1.

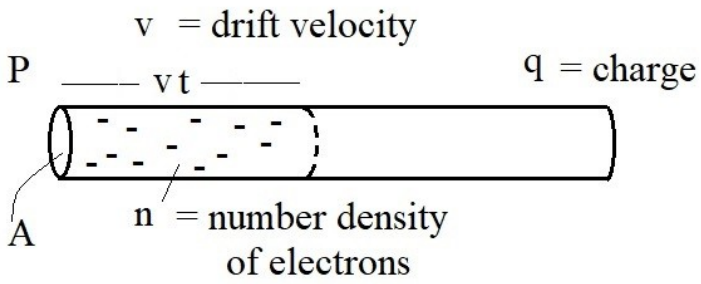

Figure 14-1

The figure shows a section of a conductor with an electric current.

The number of electrons per unit volume, n, is the electron number density. In time t, in the electrons fill a length of vt, where v is the drift velocity. A is the cross-section of the wire.

(i) In a time t, the mobile electrons fill a length vt. Write down the expression for the volume it fills.

(ii) Write down the expression for the number of electrons that crossed the start of the wire.

(iii) Write down the expression for the total charge of these electrons.

(iv) Show that the current is given by I = nAve.

(c) recall and solve problems using the equation Q = It

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2. A cell is is connected directly to a light bulb in a simple circuit. An electric current of 0.1 A flows through a light bulb. Find the amount of electric charge that flows through the bulb in 5 s.

(d) recall and solve problems using the equation $V = W/Q$

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3. For the circuit in the previous question, the cell voltage is 1.5 V. Find the work done by the cell on the bulb in 5 s.

(e) recall and solve problems using the equations $P = VI$, $P = I^2R$ and $P = V^2 / R$

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4. Find the electrical power dissipated at the bulb in the previous question.

(In English, "dissipate" means disappear. In physics, it has a similar meaning, but with the understanding that the energy is converted to other forms.)

(f) define the resistance of a circuit component as the ratio of the potential difference across the component to the current passing through it and solve problems using the equation $V = IR$

5.

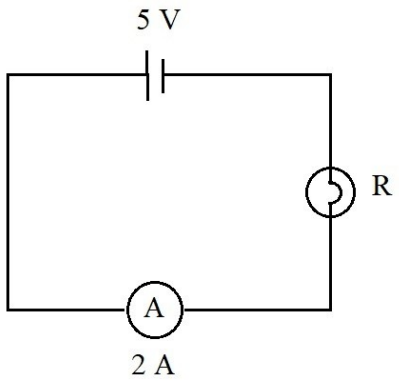

Figure 14-2

Find the resistance of the light bulb in the circuit above.

(g) sketch and explain the I–V characteristics of various electrical components such as an ohmic resistor, a semiconductor diode, a filament lamp and a negative temperature coefficient (NTC) thermistor

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6. (a) For each of the following, draw the circuit symbol and explain the I-V characteristics :

(i) ohmic resistor
(ii) semiconductor diode
(iii) filament lamp
(iv) thermistor

(b) Draw the circuit symbol a light dependent resistor (LDR). Briefly describe how it works.

(h) sketch the resistance-temperature characteristic of an NTC thermistor

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7. An NTC thermistor has a resistance the decreases as temperature goes up.

(i) Sketch a graph of voltage against current to show this behaviour.

(ii) Sketch the resistance-temperature characteristic of an NTC thermistor.

(i) recall and solve problems using the equation $R = \rho l / A$

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8. The resistance R of a wire is related to its length l and cross-sectional area A by $R = \rho l / A$, where ρ is a constant, l the length of the wire and A the cross-sectional area.

ρ is called resistivity. Its value depends on the material of the conductor. For example, the resistivity of copper is $1.68 \times 10^{-8}\ \Omega.m$

Using the formula above, find the resistance of a copper wire of length 1 m and cross-sectional area 1 cm^2.

(j) distinguish between electromotive force (e.m.f.) and potential difference (p.d.) using energy considerations

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9. A battery with e.m.f. 1.5 V is connected to a 3Ω filament light bulb. The current is 0.3 A.

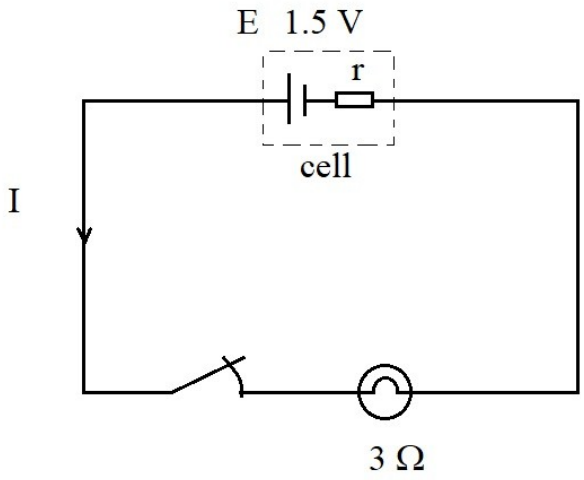

Figure 14-3

(i) Find the potential difference across the cell.

(ii) Why is the different from the cell emf ?

(iii) Find the internal resistance of the cell.

(iv) Find the power dissipated by the internal resistance.

(k) show an understanding of the effects of the internal resistance of a source of e.m.f. on the terminal potential difference and output power.

10.

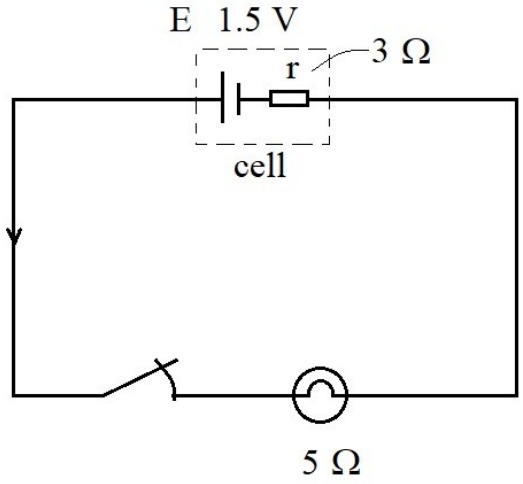

Figure 14-3

A cell has EMF E = 1.5 V and internal resistance r = 3 Ω. It is connected to a filament light bulb with a 5 Ω resistance.

Find :

(i) the terminal potential difference of the cell, and

(ii) the output power of the cell.

What would the answers be if there is no internal resistance?

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