9 Electricity – Part 1

Name: _____ Class: _____ Date: _____

Vocabulary

Write each word three times.

English	**Write it 3 times** (English)		
charge			
Electric current			
Potential difference			
power			
Resistance			
Ohm's law			
resistivity			

Recall

At IGCSE you built circuits. Bring this with you:

- Current is the flow of electricity; you used $V = IR$.
- You compared series and parallel circuits.

At AS we define current and voltage from **charge** and energy, and add resistivity.

New ideas

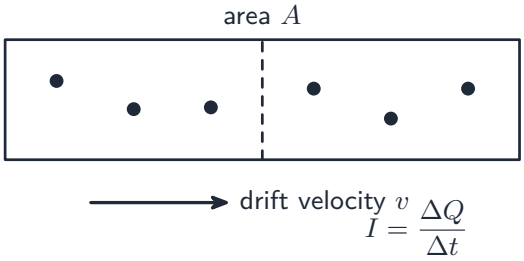
1 Current is the flow of charge

Electric current is the rate at which charge flows:

$$I = \frac{Q}{t},$$

where Q is charge in coulombs (C), t is time, and I is in amperes (A).

Worked example. If 60 C of charge flows in 20 s: $I = \dfrac{60}{20} = 3.0$ A.



2 Potential difference and power

Potential difference (voltage) is the energy given to each unit of charge: $V = \dfrac{W}{Q}$.

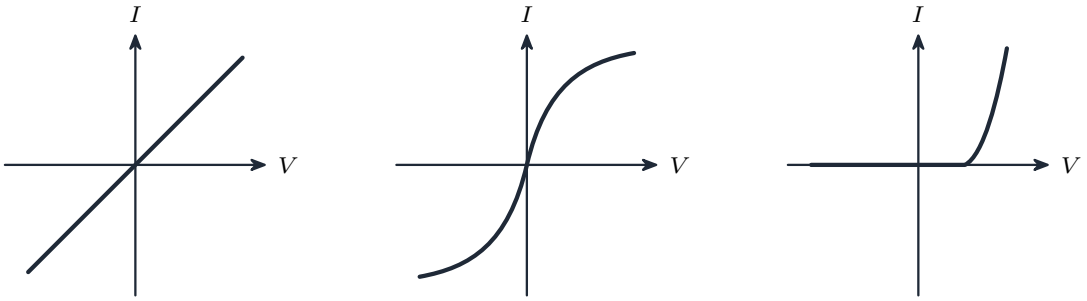
Electrical **power** is

$$P = VI = I^2R = \frac{V^2}{R}.$$

Worked example. A bulb at 12 V carrying 2.0 A: $P = VI = 12 \times 2.0 = 24$ W.

3 Resistance and resistivity

Resistance is $R = \dfrac{V}{I}$. **Ohm's law** says that for a metal at constant temperature the current is proportional to the voltage.

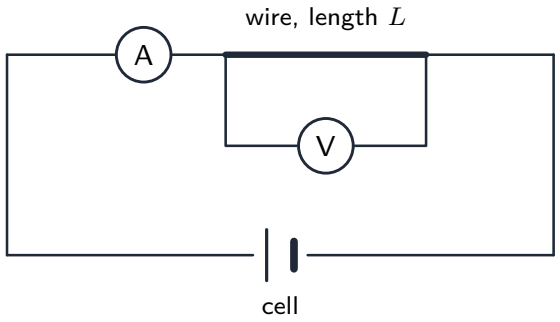


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A wire's resistance depends on the material through its **resistivity** ρ:

$$R = \frac{\rho L}{A},$$

where L is length and A is cross-sectional area.



Worked example. A 2.0 m copper wire of area 1.0×10^{-6} m^2 ($\rho = 1.7 \times 10^{-8}\ \Omega\,\text{m}$): $R = \dfrac{\rho L}{A} = \dfrac{(1.7 \times 10^{-8})(2.0)}{1.0 \times 10^{-6}} = 3.4 \times 10^{-2}\ \Omega$.

Watch out: resistivity ρ is a property of the *material* (fixed for copper); resistance R also depends on the wire's length and thickness.

Practice

9.1 A charge of 45 C flows through a lamp in 15 s. Find the current. [2]

9.2 A resistor has 6.0 V across it and a current of 0.50 A. Find its resistance. [2]

9.3 A heater works at 230 V and draws 4.0 A. Find its power. [2]

9.4 A 5.0 Ω resistor carries a current of 2.0 A. Find the power dissipated using $P = I^2R$. [2]

9.5 A wire has resistivity $1.7 \times 10^{-8}\ \Omega\,\text{m}$, length 2.0 m and area $5.0 \times 10^{-7}\ \text{m}^2$. Find its resistance. [2]

9.6 Two wires are of the same material and length, but one is twice as thick. Explain which has the lower resistance. [2]

9.7 Challenge. A wire is stretched to twice its length; its volume stays the same, so its cross-sectional area halves. State the factor by which its resistance changes. [2]

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