Dynamic charges - Current

- A current is a net flow of charge from one region to another - it is another way to move energy!
- In a conductor the charges free to move are electrons. They jiggle about very quickly, and randomly
- When a voltage (really an electric field) is applied, there is a superimposed systematic motion of the electrons moving at the ‘drift velocity’ - by convention, from + to -. 

Current

- The figure shows current carriers (considered positive) flowing through a current with cross-section area $A$ .
- We define the current through $A$ as the net charge (in Coulombs) flowing through the area per unit time
- The unit of current is the ampere
  - 1 A = 1 C/s
  - usually measured with an ammeter

Potential difference - voltage

- when energy gain or loss occurs between two points in a circuit then there is a potential difference (a “voltage”) between the two points - measured in volts (symbol V) using a voltmeter.
- A loss of electrical energy from the circuit occurs in devices such as a light bulb or a ‘resistor’.
- A gain in energy occurs in devices such as a battery

Resistance

- Most devices ‘resist’ the flow of current - they have resistance (measured in Ohms - Ω).
- The relation between voltage (in V), current (in A) and resistance (in Ω) is: $V = IR$
- Power is the rate at which energy is used (e.g. in heating a resistor or lighting a globe) - i.e. energy/time
  - $P = VI$ or $P = IV/R$ or $P = V^2/R$ in J/s = Watts

Batteries and emf

- A battery provides electrical energy.
- something which provides electrical energy has an emf (electromotive force - not a good name)
- The emf of the battery originates from the chemical reaction that goes on inside the battery.
- In colloquial terms, a battery has a nominal “voltage” (actually an emf) - commonly 1.5 V

Models of current flow - which one?

Lamps same brightness - current is NOT “used up”
Lamps progressively dimmer - current is “used up”
How does a torch work?

- Use the switch to complete the circuit

Batteries in Series and Parallel

- Batteries in series - the current must flow through all 3
  - voltages add, current is the same
  - Why? To get higher voltage

- Batteries in parallel - the current has a choice
  - currents add, voltages are the same
  - Why? To get more current

Resistors in Series and Parallel

Resistors
- in series
  \[ R_{\text{total}} = R_1 + R_2 + \ldots \]
- in parallel
  \[ \frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots \]

The Electric Eel

- each 0.15 V, 0.25 Ω
- 1250 Ω
- 8.93 Ω
- -0.93 A
- -800 Ω

Individual rows - ~6 mA