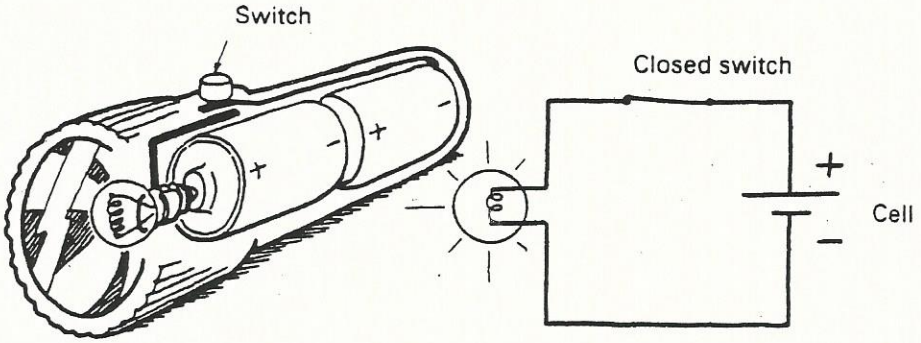
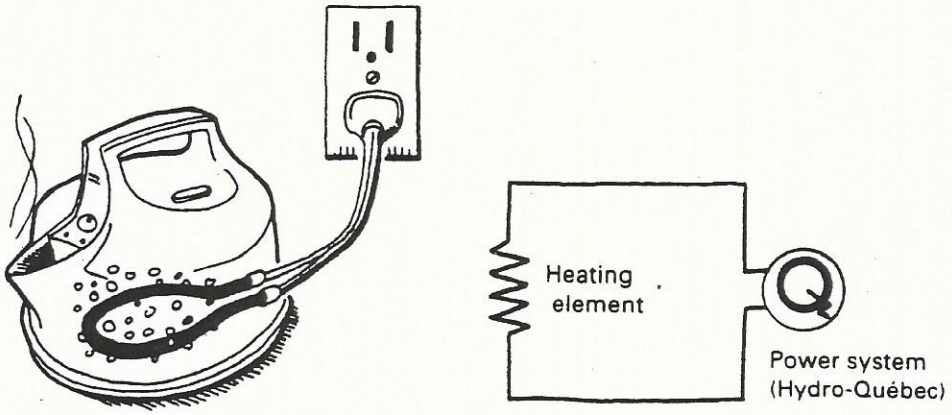
Simple Circuits

circuit: an uninterrupted series of components (e.g. cell/battery/switch/light bulb, etc.) connected by means of conductors (wires).

Examples of simple circuits



a) A flashlight circuit: the light goes on when the circuit is closed.

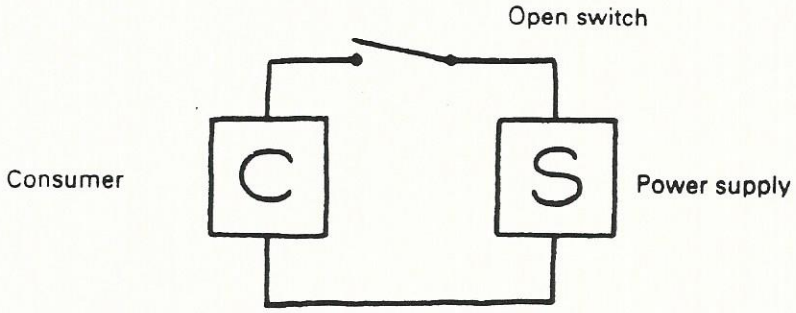


b) A kettle circuit: the kettle heats up when the circuit is closed.

simple circuit: includes a power supply (e.g. battery or AC source), wires, and some device that uses electricity (e.g. light bulb).

closed circuit: one in which there is no break; current can therefore flow through.

open circuit: one in which there is a break; current cannot flow through if the circuit is open. e.g. if the switch is open then the circuit is open and current cannot flow.



General diagram of a simple circuit: the current cannot flow when the switch is open.

circuit components: refer to any of the devices that may be connected in a circuit.

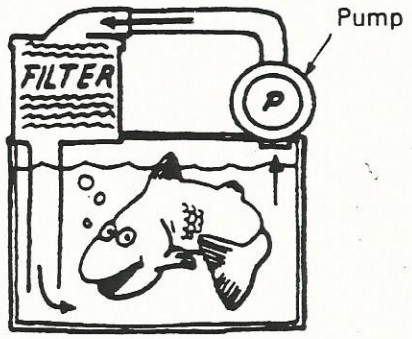
Conventional symbols used in circuit diagrams

Symbol	Circuit component
	Cell
	Battery
	Bulb
	Open switch
	Closed switch
	Resistor (element that consumes electricity)
	Fuse

Comparing a Hydraulic Circuit with an Electric Circuit

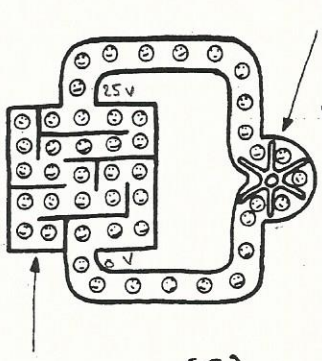
The components of an electric circuit, that is, the power supply, the conductors and the consumers, each play a specific role. This comparison will enable you to discover the roles and properties of the various components.

Comparing a hydraulic circuit with an electric circuit



(A) fig

a) The hydraulic circuit in an aquarium: the pump forces the water through the pipes and the filter.



(B) fig

b) Electric circuit: the cell (pump for charges) forces the charges through the wires and the light bulb (labyrinth).

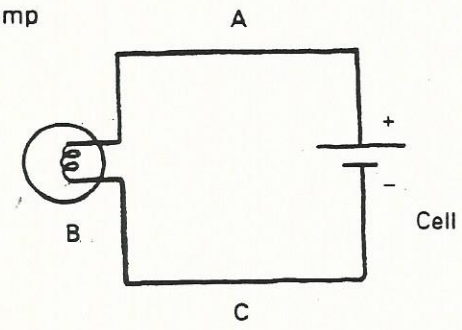


Fig (C)

c) An electric circuit diagram

In the hydraulic circuit in Figure (A) , the pump forces the water through the pipes and the filter. The number of litres of water that leave the pump every minute is called the "flow." For example, a pump that discharges two litres of water per minute produces a flow that is twice as great as a pump that discharges one litre of water per minute. The amount of water entering the pump is always equal to the amount leaving it. The flow is the same at any given point in the circuit, whether in the pump, the pipes or the filter. The water flows at a steady rate.

Several factors can influence flow. For each of the situations described below, indicate whether you think the flow will increase, decrease or stay the same.

a) The transparent pipes are replaced with opaque pipes of the same size.

stay the same

b) The filter is replaced with a thicker one.

decrease

c) The filter and its support are moved to another corner of the aquarium.

stay the same

d) After some time, the filter gets dirty.

decrease

e) The pump is replaced with a more powerful one.

increase

Conclusion: The flow in the hydraulic circuit depends on . . .

the strength of the pump and the thickness and cleanliness of the filter

In an electric circuit, charged particles or charges are displaced instead of a liquid. They are easier to imagine with the help of Figure (B) The cell "pumps" the charges through the conductors and the light bulb filament.

f) Referring to the information above, complete the following table, indicating which components of an electric circuit (e.g. light bulb, conductors, cell) correspond to the components of the aquarium circuit.

Components of the aquarium circuit	**Components of the electric circuit**
PUMP	Cell / Battery
FILTER	Resistor
PIPES	Wires (conductors)

Like the pump, which forces the water through the pipes and the filter, the cell forces the charges through the conductors and the light bulb.

In electricity, the flow of charges (number of charges per second) is called the **current**. It is the same at any point in the circuit. Observers at points A, B or C in Figure(C) will see the same number of charges go by each second. Charges flow at a steady rate.

In an electric circuit, the light bulb is characterized by its resistance and the cell by its electromotive force (emf), that is, the number of **volts** written on its shell. For example, a 1.5-V cell (1.5 volts) has an emf of 1.5 V.

g) Continue with the comparison by completing the following table, indicating which characteristics of an electric circuit (i.e. current, electromotive force of the cell, resistance of the light bulb) correspond to those of the aquarium circuit.

Characteristics of the aquarium circuit	**Characteristics of the electric circuit**
'FORCE*' OF THE PUMP	Voltage of the Power Source (V)
THICKNESS\CLEANLINESS OF FILTER	Resistance of the Resistor (R)
FLOW RATE OF WATER	Current (I)

* The word "force" here is used in its general sense and not in the more restrictive sense used in physics, which is why it is in quotation marks.

Several factors can influence the flow of charges, or the electric current.

What happens to the electric current if:

h) we replace the 1.5-V cell with a 6.0-V battery (greater emf)?

increases

i) we replace the light bulb with one with a smaller resistance?

increases

j) we replace a red wire with a black wire?

no change

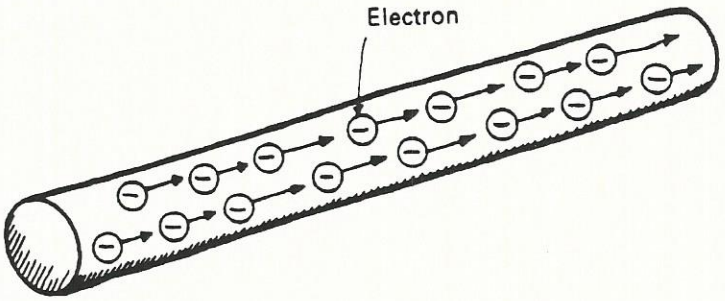
Conclusion: Current intensity depends on . . .

the resistance of the resistor and the voltage of the power source

More on Current

- Current is the flow of moving electrons (charge) through a conductor (e.g. wire)

Part of a conductor with a current flowing through it



An electric current is the result of moving negative particles known as electrons.

- Electrons are represented by $\bar{e}$, and their charge (which is negative) is expressed using the unit C (Coulombs). The symbol for charge is Q.

  e.g. the charge of $1\bar{e} = 1.6\text{x}10^{-19}$ C therefore, for $1\ \bar{e}$ $Q = 1.6\text{x}10^{-19}$ C

- How many electrons are needed to make up a charge of 1C ?

$$\frac{1\bar{e}}{1.6\text{x}10\text{-}19\text{C}} = 6.25 \text{ x } 10^{18}\ \bar{e} \text{ or } 6\ 250\ 000\ 000\ 000\ 000\ 000\ \bar{e}$$

- This many drops of water would fill Lac Saint-Jean 10 times.

- This many electrons, though, would still be much too small to see since individual electrons are <u>so</u> tiny.

- Many coulombs per second can pass through a circuit.

Recall analogy:

$$\text{Flow of water} = \frac{\text{volume of } H_2O}{\text{time}} = \frac{\#\text{ mL}}{\text{m}}$$

$$\text{Likewise, Current} = \text{I} = \text{flow of charges} = \frac{Q}{t} = \frac{\#C}{s} \leftarrow \text{units}$$

$$\uparrow \text{symbols}$$