

## Electrical Potential

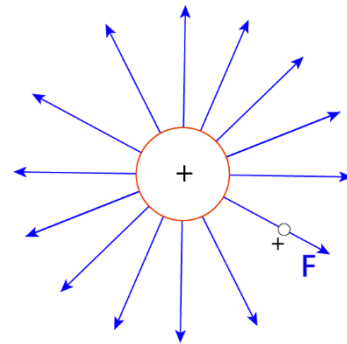
(Form of potential energy)

Recall we created potential energy in mechanics by moving a mass  $m$  against gravity to a height  $h$  to put  $m$  on bookshelf. It has potential energy because if it falls it gains kinetic energy or can do work.

Can do the same by separating charges which then have potential (volts) to do work if allowed

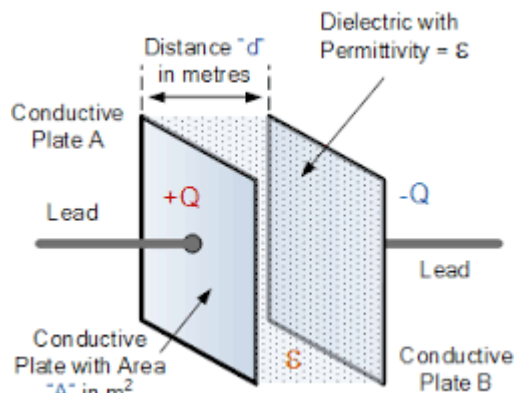
Force field, blue lines with arrows, represent forces  $F$  on test charge  $T$  at a point in space.

Move a distance  $d$  do work  $Fd = \text{potential energy}$ . Energy difference or voltage difference across distance  $d$ . If release test charge it moves back and gains kinetic energy..

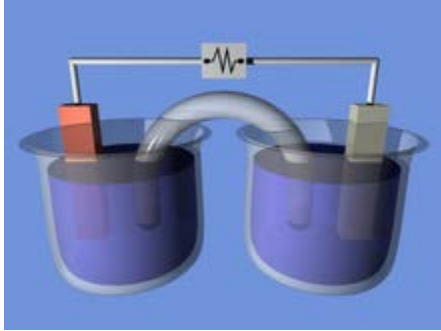


## Capacitors

Store electrical energy.



## Voltage (Electrical energy) Sources



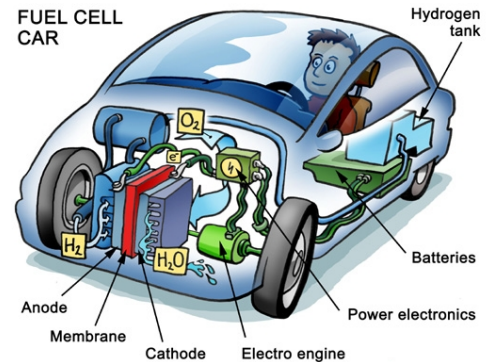
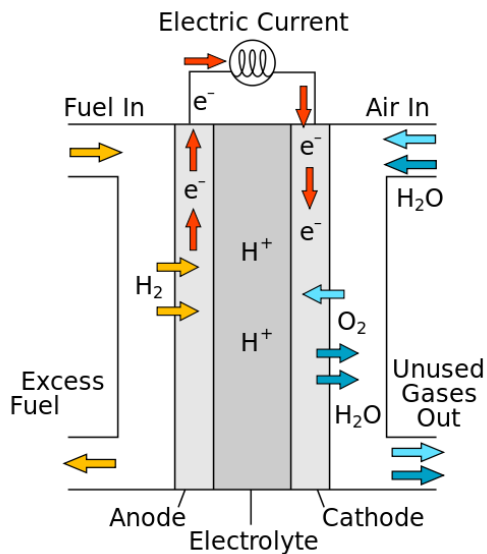
Electrochemical cell (battery)

[https://en.wikipedia.org/wiki/Electrochemical\\_cell](https://en.wikipedia.org/wiki/Electrochemical_cell)

Batteries are electrochemical cells that use chemical reactions to produce voltages  $V$  that can drive electrical currents  $I$  (flow of electrons) through a load (resistance  $R$ ).

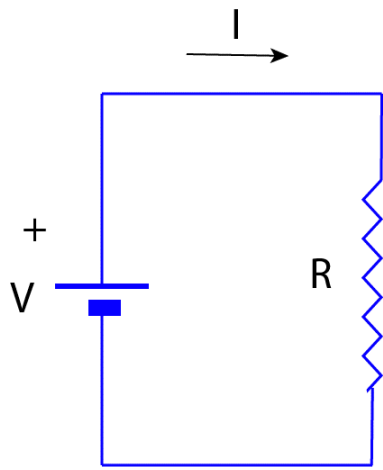
## Fuel cell (future)

Use **continuous** source of fuel (hydrogen) and air (or oxygen). First used in space applications by NASA but now more widespread (submarines, remote locations, buses...).



Images courtesy Wikipedia

([https://en.wikipedia.org/wiki/Fuel\\_cell#/media/File:Fuelcell.jpg](https://en.wikipedia.org/wiki/Fuel_cell#/media/File:Fuelcell.jpg))



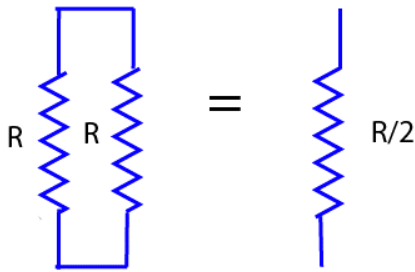
**Ohm's law:**  $V = IR$  V volts, I amperes, R in ohms

$$V = IR$$

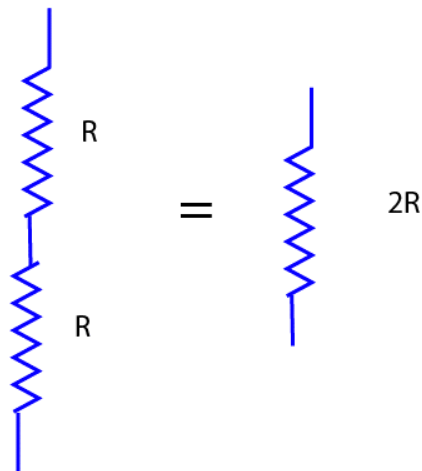
A 12 voltage source applied to 6 ohms gives a current  $I = 2$  amps.



Georg Ohm (1789-1854). By <http://stat.case.edu/~pillar/genealogy/ohm.gif>, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=1840459>



Resistance in parallel  
Inverses add  $1/R = 1/R_1 + 1/R_2$



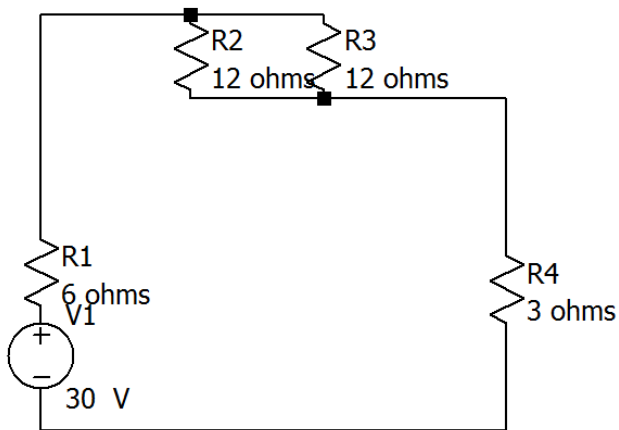
Resistances in series  
Resistances add  
 $R = R_1 + R_2$

**Exercises:**

**Find**

**(a) Current through R1**

**(b) Current through R2**



**Let I be current through R1 and R4.**

**R2 and R3 combine to make 6 ohms. Total resistance around loop = 15 ohms**

$$I = 30/15 = 2 \text{ amps}$$

## Homework (Due Tuesday October 23 at 3PM).

Do either (1) or (2) below

- (1) Write a one page essay on the contributions of either  
(a) **Charles-Augustin de Coulomb**, or (b) **Georg Ohm**.  
**(1 page 12 pt font single spaced)**

- (2) Solve the circuit below by finding the current (amperes) for an 18 volt fuel source if each resistance is 6 ohms.

