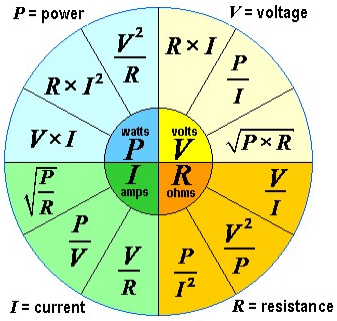
Class 04
Ohm's Law



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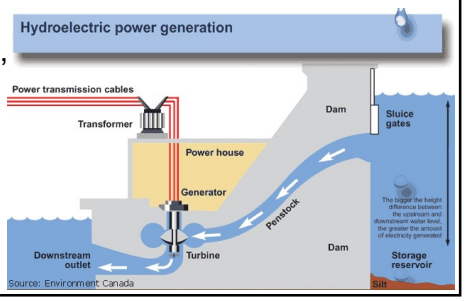
- Electrical Units of Measure
  - Gravitational Potential
    - The work done by mass in the presence of an gravitational field.
    - Derived Units – Joules per kilogram, J / kg
    - AKA gravitational force,, pressure differential

"A joule per kilogram is defined as a difference of energy causing one kilogram of mass to do one joule of work"

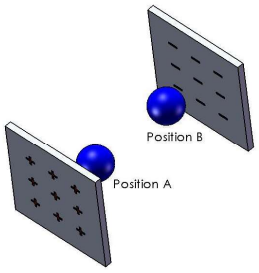
Hydraulic Analogy

What happened to the pressure?



- Electrical Units of Measure
  - Electric Potential
    - The work done by a charged particle in the presence of an electrical field.
    - Derived Units – Volt (E,V) (Joules per Coulomb)
    - AKA electro-motive force, voltage, potential differential

"A volt is defined as a difference of potential causing one coulomb of current to do one joule of work"



Electric potential energy is the amount of work required to move a charged particle from position B to position A.

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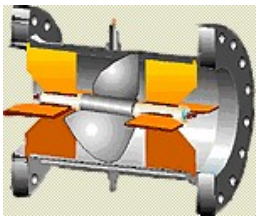
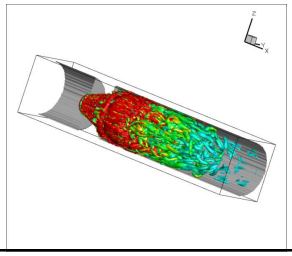
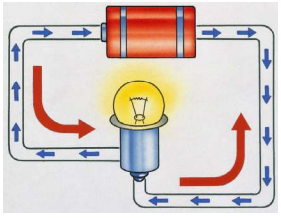
- Electrical Units of Measure
  - Hydraulic Flow
    - The mass per unit time that passes a point in a closed system
    - Requires pressure potential, free molecules & flow path
  - Derived Unit – kilogram per second

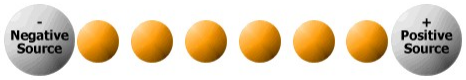
Hydraulic Analogy





- Electrical Units of Measure
  - Electric Current
    - The charge per unit time that passes a point in a circuit
    - Requires electric potential, free electrons & current path
  - Derived Unit – Ampere (I) = 1 Coulomb per second (6.25 x 10^{18} electrons per second)





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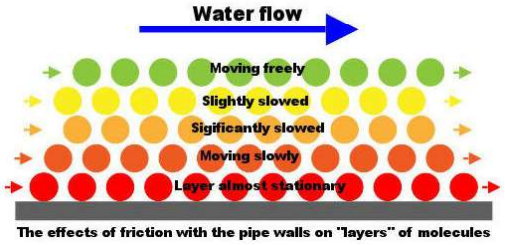
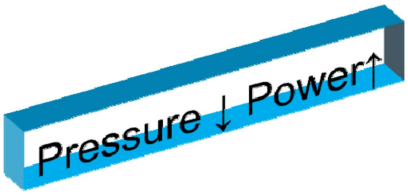
- Electrical Units of Measure
  - Losses
    - Opposition to hydraulic flow
  - Derived Unit – Head Feet (ft hd)

Hydraulic Analogy

Frictional Losses (Bad)

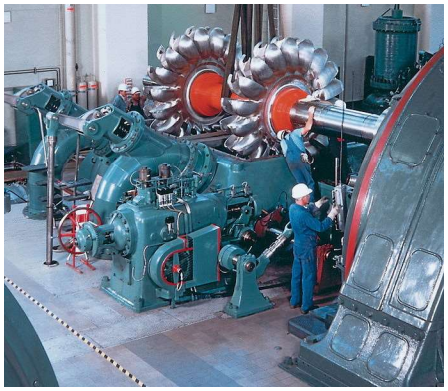


- Electrical Units of Measure
  - Losses
    - Opposition to hydraulic flow
  - Derived Unit – Head Feet (ft hd)



Hydraulic Analogy

Engineered Losses (Good)



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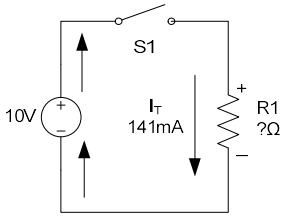
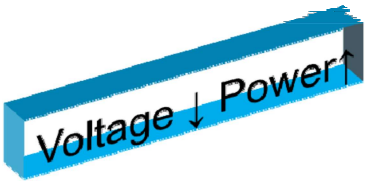
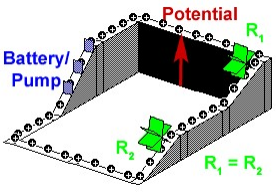
- Electrical Units of Measure
  - Resistance
    - Opposition to charge flow
    - From Ohm's Law V = I R
  - Derived Unit – Ohm Ω (R) Volt / Current

$$R = \frac{E}{I}$$



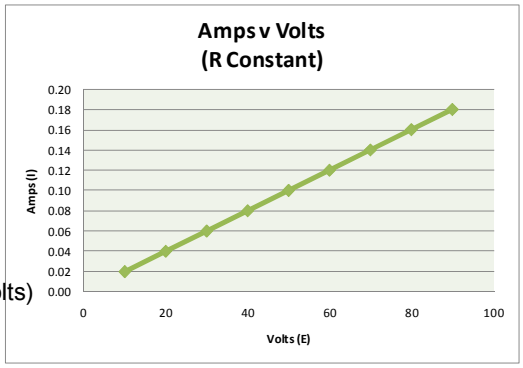




What happened to the potential?

- Ohm's Law
  - Current in a circuit is directly proportional to the applied voltage

$$I = \frac{E}{R}$$



If voltage increases
current must increase

Where
E = potential difference (Volts)
I = current (Amperes)
R = resistance (Ohms)

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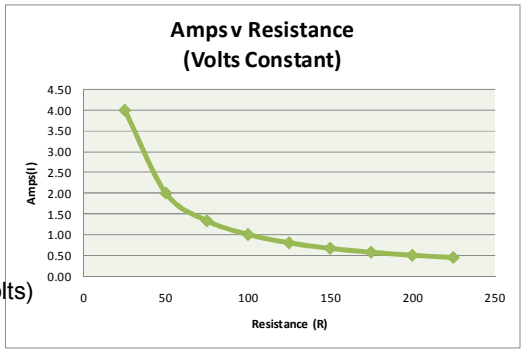
- Ohm's Law
  - Current in a circuit is inversely proportional to the circuit resistance

$$I = \frac{E}{R}$$



If resistance increases
current must decrease

Where
E = potential difference (Volts)
I = current (Amperes)
R = resistance (Ohms)

- Ohm's Law
  - Three Forms

$$I = \frac{E}{R} \qquad E = IR \qquad R = \frac{E}{I}$$

Where
E = potential difference (Volts)
I = current (Amperes)
R = resistance (Ohms)

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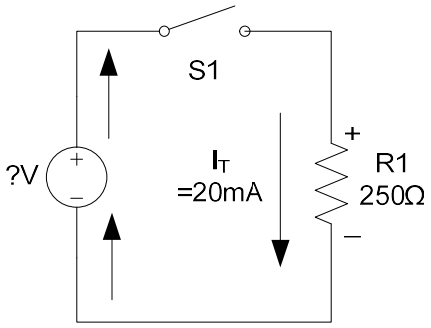
- Ohm's Law
  - Examples
    - **E = ?**
    - R = 250Ω
    - I = 20mA

$$E = IR \qquad I = \frac{E}{R} \qquad R = \frac{E}{I}$$

$$E = IR = 20mA \times 250\Omega = 5.000V$$

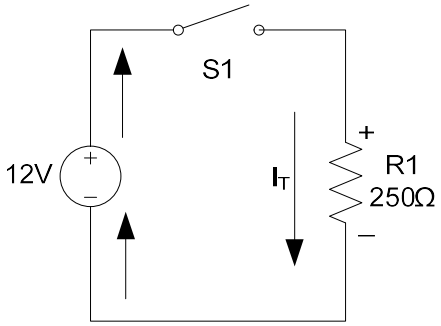


Where
E = potential difference (Volts)
I = current (Amperes)
R = resistance (Ohms)

- Ohm's Law
  - Examples
    - E = 12V
    - R = 250Ω
    - **I = ?**

$$E = IR \qquad I = \frac{E}{R} \qquad R = \frac{E}{I}$$

$$I = \frac{12V}{250\Omega} = 48mA$$



Where
E = potential difference (Volts)
I = current (Amperes)
R = resistance (Ohms)

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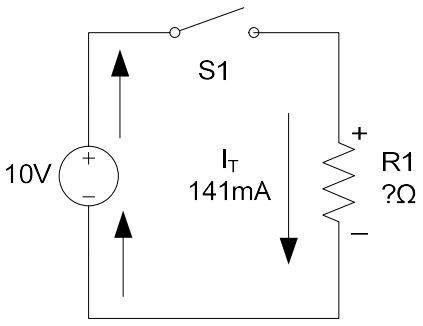
- Ohm's Law
  - Examples
    - E = 10V
    - **R = ?Ω**
    - I = 141mA

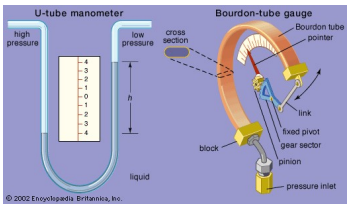
$$E = IR \qquad I = \frac{E}{R} \qquad R = \frac{E}{I}$$

$$R = \frac{E}{I} = \frac{10V}{141mA} = 70.92\Omega$$

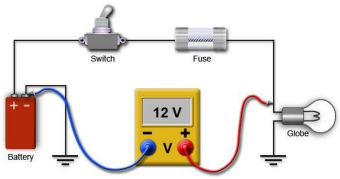


Where
E = potential difference (Volts)
I = current (Amperes)
R = resistance (Ohms)

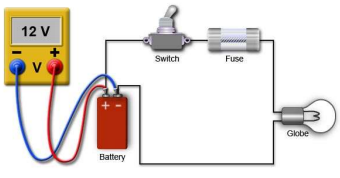
- Ohm's Law
  - Voltage measurements (hydraulic analogy)
    - Pressure is the potential energy difference between ***two*** system points of interest.
      - Gage pressure – system pressure referenced to atmospheric pressure (≈ 14.7 PSI)
      - Absolute pressure – system pressure referenced to zero pressure



- Ohm's Law
  - Voltage measurements
    - Voltage is the potential energy difference between ***two*** circuit points of interest.
      - Ground referenced – circuit voltage referenced to earth ground (always 0 volts)
      - Differential – circuit voltage referenced to another circuit point

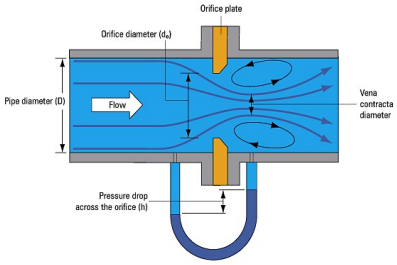


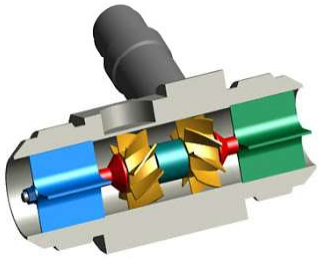
Ground Referenced



Differential

- Ohm's Law
  - Current measurements (hydraulic analogy)
    - Flow rate is amount of liquid flowing through a ***single*** flow path per unit time
      - Mass flow – the mass per second (kg/sec)
      - Volumetric flow – the volume per second (gallon/min)





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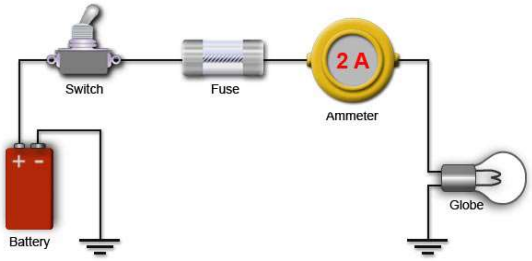
- Ohm's Law
  - Current measurements
    - Current is number of electrons per second flowing through a ***single*** conductor per unit time



Lab 04 – Ohm's Law Validation

Learning Objectives

- Construct a simple circuit with source, load, control and conductors
- Measure electrical values using a digital voltmeter
- Use Ohm's Law to validate field measurements

		Points Possible
Documentation	Quality of documentation (neatness, clarity, spelling, grammar)	**10**
	Power supply characterization	**5**
	Resistor R1, R2 & R3 values recorded	**5**
	V_S & V_L values recorded	**5**
	Data Tables 1, 2 & 3 completed & accurate	**15**
	Conclusions complete and accurate	**15**
	Total	**55**