INDUSTRIAL ELECTRICITY

TODAY'S TOPICS:

Introduction (cont)

Scientific Notation

DUE Mon 1/13 11:00am

HOMEWORK 1

- **Reading quizzes 1 & 2**
- **Worksheet 1**

QUESTIONS??

Scantron

- Use for reading quizzes only
- Don't staple
- Erase thoroughly
- Turn in only the scantron

Website

- Schedule
- Class documents

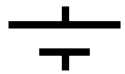
Labs

- Meet in Mechatronics Lab
- Bring a copy of the lab with you
- BYOMIYW

ELECTRIC CIRCUITS

Primary components needed to make an electrical circuit:

Power (Voltage) Source **FORCE**

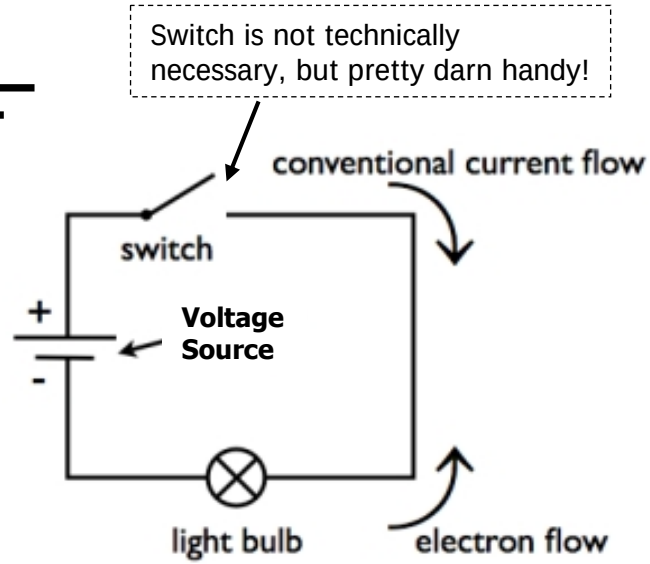
- Schematic Symbol: (varies, here is one) 
- Electrical Symbol: **E**
- Unit of Measure: (Volt) **V**

Connecting Wires (Current) **FLOW**

- Schematic Symbol: None
- Electrical Symbol: **I**
- Unit of Measure: (Ampere) **A**

Load (Resistance) **FRICTION**

- Schematic Symbol: (varies , here is one) 
- Electrical Symbol: **R**
- Unit of Measure: (Ohm) **Ω**



Mathematical Relationship

Ohm's Law

$I = E/R$

MULTIMETERS

ANALOG METERS (VOM)

DIGITAL METERS (DMM)

At the minimum, these meters measure:

VOLTS (V), OHMS (Ω), and AMPS (A)

(Plus some other "stuff")

Conductors

Conductor: Substance that readily allows its electrons to move.

[Easy to ionize]

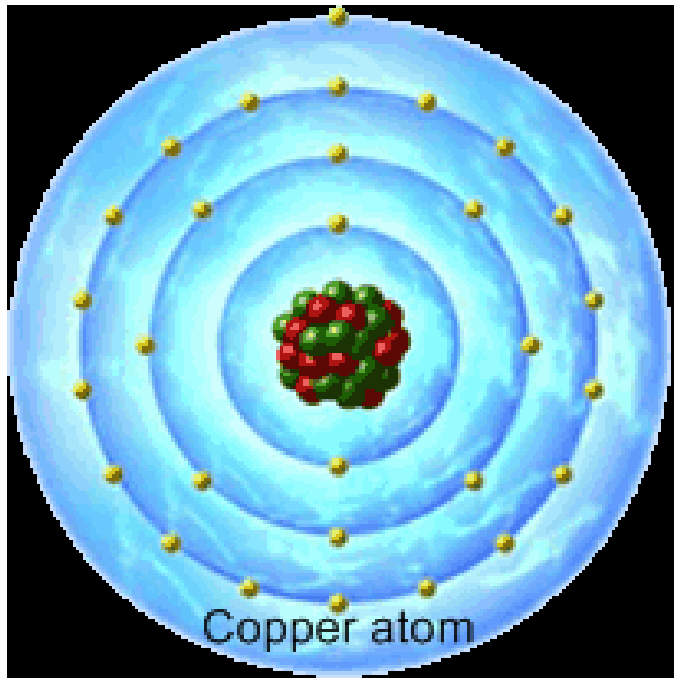
Examples:

Aluminum

Copper

Zinc

Steel



Current: **The movement of charge through a substance.**

Insulators

Insulator: A substance that does not freely allow its electrons to move.

[Hard to ionize]

EXAMPLES:

Glass

Air

Wood

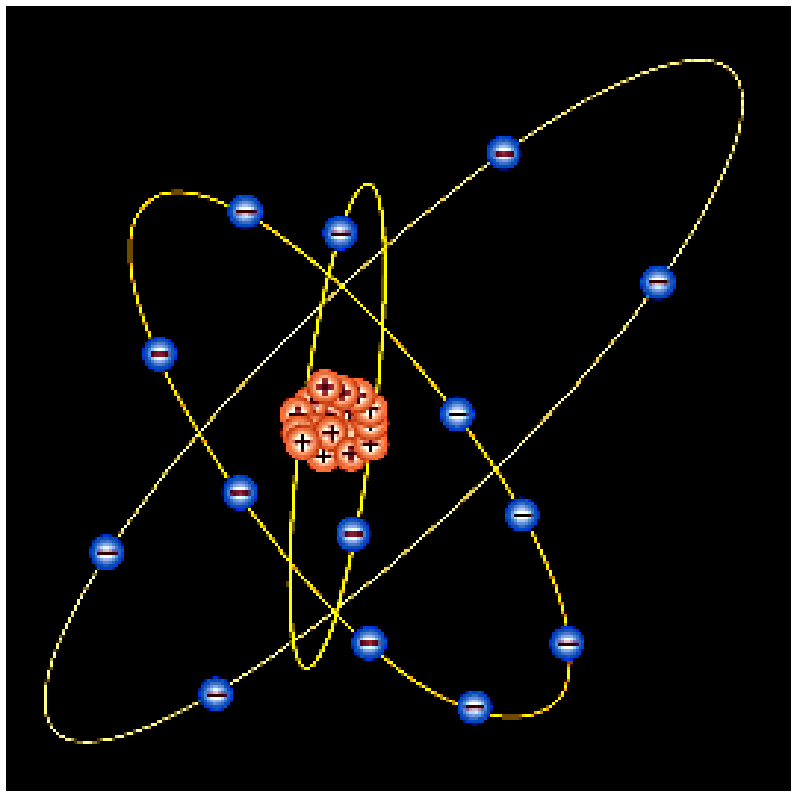
Silicon

Resistance: The opposition to the movement of electrons.

Semiconductors

Semiconductor: A substance that will, with a little coaxing, allow its electrons to move.

EXAMPLES:
Germanium
Selenium
Carbon
Silicon



Quantities & Definitions

- Coulomb: Unit of charge
  - 6.24×10^{18} electrons = 1 coulomb (C)
- Current: Rate that charge moves

  [flowrate of electrons] $I = q/t$ (A)
- Voltage – The force that provides the "push" to move the electrons
- Resistance: Opposition to flow of current

  For wires: $R = \rho * L/A$ (Ω)

ELECTRIC CIRCUITS

Primary components needed to make an electrical circuit:

Power (Voltage) Source **FORCE**

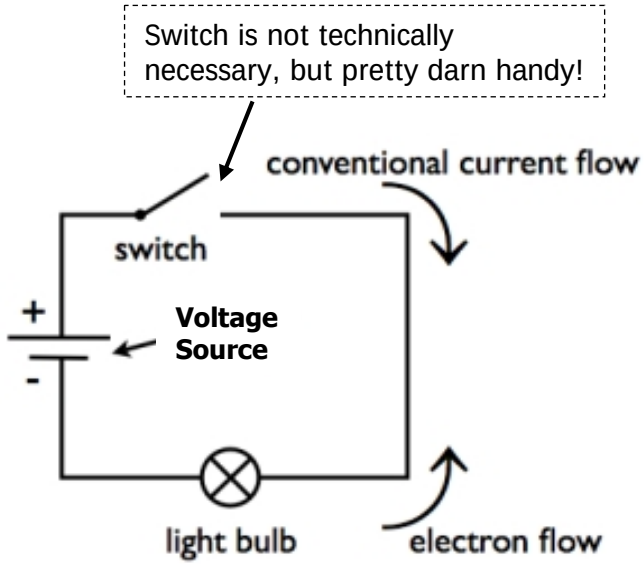
- Schematic Symbol
- Electrical Symbol **E**
- Unit of Measure (Volt) **V**

Connecting Wires (Current) **FLOW**

- Schematic Symbol
- Electrical Symbol **I**
- Unit of Measure (Ampere) **A**

Load (Resistance) **FRICTION**

- Schematic Symbol
- Electrical Symbol **R**
- Unit of Measure (Ohm) **Ω**



Mathematical Relationship

Ohm's Law

$I = E/R$

Scientific Notation

- **Scientific notation is a way of expressing really large or really small numbers in a more compact (concise) way.**

$$6{,}240{,}000{,}000{,}000{,}000{,}000 = 6.24 \times 10^{18}$$

$$0.00000000000000000000000000000911 = 9.11 \times 10^{-31}$$

- **It is often used in "scientific" calculations where standard numbers would be too cumbersome to work with.**

POSITIVE EXPONENTS REPRESENT "LARGE" NUMBERS

NEGATIVE EXPONENTS REPRESENT "SMALL" NUMBERS

METRIC PREFIXES & SYMBOLS

Multiple	Metric Prefix	Abbrev
10^{24}	yotta	Y
10^{21}	zetta	Z
10^{18}	exa	E
10^{15}	peta	P
10^{12}	**tera**	**T**
10^{9}	**giga**	**G**
10^{6}	**mega**	**M**
10^{3}	**kilo**	**k**
10^{2}	hecto	h
10^{1}	deka	da

Multiple	Metric Prefix	Abbrev
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	**milli**	**m**
10^{-6}	**micro**	**μ**
10^{-9}	**nano**	**n**
10^{-12}	**pico**	**p**
10^{-15}	femto	f
10^{-18}	atto	a
10^{-21}	zepto	z
10^{-24}	yocto	y

Blue indicates favored powers/prefixes/abbreviations used in electricity and electronics. USE ONLY THOSE WHEN COMPLETING WORK FOR THIS CLASS

Scientific Notation consists of two parts:

- A number between 1 and 9.99… (represented by the '#' symbol below)
- A power of 10 (represented by the 'n' below)

$$\# \times 10^{n}$$

For example, the mass of an proton is:

0.000000000000000000000000167kg

Or, in scientific notation:

9.11×10^{-31}kg

POSITIVE EXPONENTS REPRESENT "LARGE" NUMBERS

NEGATIVE EXPONENTS REPRESENT "SMALL" NUMBERS

To change Standard Form to Scientific Notation…

1. Place the decimal point so that there is one non-zero digit to the left of the decimal point.

2. Count the number of decimal places the decimal point has "moved" from the original number. This will be the exponent on the 10.

3. Compare the two numbers

   If you have made the number smaller, then compensate by "tacking on" a positive exponent.

   If you have made the number larger, then compensate by "tacking on" a negative exponent.

Example

One kilowatt-hour is equivalent to:

3600000 Joules

Move the decimal between the 3 and the 6

$3.60X10^{??}$

Count the number of places the decimal was moved

6

Is the number smaller or larger than the original?

Smaller

Compensate by multiplying by a small number, i.e., use negative exponent.

$3.60 \text{ X } 10^{6}$ Joules

POSITIVE EXPONENTS REPRESENT "LARGE" NUMBERS

NEGATIVE EXPONENTS REPRESENT "SMALL" NUMBERS

Example

Given: 289,800,000

Write: $2.898 \times 10^{??}$

- The decimal was moved 8 places, so the exponent will be 8.
- The “new number” is smaller, so we need the exponent to be positive.

Answer: **2.898×10^{8}**

Example

Given: 0.000567

Write: 5.67 X $10^{??}$

- The decimal was moved 4 places, so the exponent will be 4.
- The “new number” is larger, so we need the exponent to be negative.

Answer: **5.67×10^{-4}**

To change Scientific Notation to Standard Form…

- Move the decimal point to the right for positive exponent. Remember, positive exponents mean big numbers

- Move the decimal point to the left for negative exponent. Remember, negative exponents mean small numbers, NOT negative numbers

(Use zeros to fill in places.)

Example

Given: 5.093×10^6

- The exponent tells you to move the decimal six places.
- The **positive exponent** tells you to move it to the **right**.

Answer: **5,093,000**

Example

- Given: 1.976×10^{-4}

- The exponent tells you to move the decimal four places.
- The **negative exponent** tells you to move it to the **left**.

- Answer: **0.0001976**

Examples: Express in Scientific Notation

1. 5800 5.8×10^{3}

2. 450,000 4.5×10^{5}

3. 86,000,000,000 8.6×10^{10}

4. 0.000508 5.08×10^{-4}

5. 0.000360 3.60×10^{-4}

6. 850000 mA 8.5×10^{2}A

Examples: Express in Standard Notation

1. 6.3×10^{3}	6,300
2. 9.723×10^{9}	9,723,000,000
3. 5.8×10^{1}	58
4. 4.75×10^{-4}	0.000475
5. 3.56×10^{-7}	0.000000356
6. 6.3×10^{-1}	0.63

Challenge Problem

The width of a human hair is 100μm. The diameter of an electron is 1 fm.

How many electrons would fit within the width of a human hair?

NOTE: No calculator needed!

$\mu = 10^{-6}$ f = 10^{-15}

The **MOST IMPORTANT** use of electricity:

TIME TRAVEL !!!

END