**Pre-Class Assignmets, Simulations & Hands on:**

**1: (Basics of Static Electricity)**

*(Review class schedule and discuss expectations for the use of pre-class ‘on-line’ class materials.)*

Learn about the fundamentals of the atom, the simplified Bohr model of atomic theory and how this became the basis for modern electrical theory.

We will explore the effects of static electricity with balloons, charged combs and paper.

**Note:** This class will also cover the expectations for students to review the on-line material assignments before coming to each future class.

**Pre-Class Assignment:**

**Open Khan Academy:** [**https://www.khanacademy.org/**](https://www.khanacademy.org/)

**Search for:** *Triboelectric effect and charge*(12 Minutes)

**Search for:** *Elements and atoms* (13 Minutes)

**Search for:** *The history of atomic chemistry* (9 Minutes)

**Search for:** *Introduction to the atom*(29 Minutes)

**Search for:** *Coulomb's Law* (12 Minutes)

**Simulation(s):**

[**https://phet.colorado.edu/en/simulation/build-an-atom**](https://phet.colorado.edu/en/simulation/build-an-atom)

**https://phet.colorado.edu/en/simulation/legacy/charges-and-fields**

[**https://phet.colorado.edu/en/simulation/john-travoltage**](https://phet.colorado.edu/en/simulation/john-travoltage)

**Hands On:**

Experiments with charged Balloons, combs & paper slips!

* Positive and Negative Charge,
* Attraction and Repulsion

**2: (Direct Current and Batteries, Circuits & Components)**

Atomic numbers and valance and how they relate to the periodic table of elements will lead us to discover why a battery causes electric current and why current always must flow in a complete circuit (Kirchhoff’s 1st law).

Each student should bring one Dime and one Penny to class. With these we will all be able to ‘taste’ electricity on a very small scale. We will also ‘build’ a simple battery using a common lemon as the driving force.

**Pre-Class Assignment:**

**Open Khan Academy:** [**https://www.khanacademy.org/**](https://www.khanacademy.org/)

**Search for:** *Crash Course Chemistry****,*** (then)*The nucleus*(10 Minutes)

**Search for:** *Crash Course Chemistry****,*** (then)*The electron*(14 Minutes)

**Search for:** *Conductors and Insulators* (13 Minutes)

**Search for:** *Introduction to circuits and Ohm's law* (12 Minutes)

**Search for:** *Resistors in series* (11 Minutes)

**(How to use your Breadboard)**

**YouTube:** [**https://www.youtube.com/watch?v=6WReFkfrUIk**](https://www.youtube.com/watch?v=6WReFkfrUIk)(How to use a breadboard)

**YouTube:** [**https://www.youtube.com/watch?v=6Maq5IyHSuc**](https://www.youtube.com/watch?v=6Maq5IyHSuc)(Components)

**Simulation(s):**

[**https://phet.colorado.edu/en/simulation/ohms-law**](https://phet.colorado.edu/en/simulation/ohms-law)

[**http://everycircuit.com/**](http://everycircuit.com/)

[**https://www.youtube.com/watch?v=vcXZylSj9DI**](https://www.youtube.com/watch?v=vcXZylSj9DI)

**Hands On:**

* ‘Taste’ electricity: Dime and Penny
* Lemon Battery (*Instructors bring lemon, wires & DVM*)
* 1st Circuit with battery, resistor and LED.
* Measure voltage drops around a circuit with multiple resistors.

**3: (Permanent Magnetics and magnetic fields)**

Magnetics, magnetic attraction and repulsion and magnetic fields will be our topics for tonight’s exploration. We will also watch a magnetic ‘fall’ slowly through a metal tube.

**Pre-Class Assignment:**

**Open Khan Academy:** [**https://www.khanacademy.org/**](https://www.khanacademy.org/)

**Search for:** *Introduction to magnetism*(11 Minutes)

**Search for:** *Resistors in series*(11 Minutes)

**Simulation(s):**

[**https://phet.colorado.edu/en/simulation/magnet-and-compass**](https://phet.colorado.edu/en/simulation/magnet-and-compass)

**LTSpice:** [**http://www.linear.com/designtools/software/**](http://www.linear.com/designtools/software/)

**Hands On:**

* Magnetic attraction & repulsion.
* Magnetic poles.
* The earth’s magnetic field.

**4: (Electromagnetics and magnetic forces)**

We will make a wire move without touching it using DC current and a magnetic field.

We will also talk about magnetic force and how a simple solenoid functions.

**Pre-Class Assignment:**

**Open Khan Academy:** [**https://www.khanacademy.org/**](https://www.khanacademy.org/)

**Search for:** *Magnetic field created by a current carrying wire*(9 Minutes)

**Search for:** *Induced current in a wire*(12 Minutes)

**Search for:** *Build your own motor*(7 Minutes)

**Search for:** *Resistors in Parallel*(11 Minutes)

**Simulation(s):**

[**https://phet.colorado.edu/en/simulation/magnets-and-electromagnets**](https://phet.colorado.edu/en/simulation/magnets-and-electromagnets)

[**https://phet.colorado.edu/en/simulation/faradays-law**](https://phet.colorado.edu/en/simulation/faradays-law)

**Hands On:**

* Magnetic ‘induction’.
* Build a simple electric motor.
  + - Wind a simple electromagnet with air and iron cores and watch them at work.

**5: (Frequency, Alternative Current and Electrical Safety)**

The relationship between time, frequency, electricity and electromagnetic fields will be our topics for tonight. We will explore the effects electric current at different frequencies has on inductors and capacitors.

We will discuss Electric Safety and AC current. Why is electric safety so important and the need for proper grounding, fuses, circuit breakers and why too much current can cause overheating problems.

**Pre-Class Assignment:**

**Open Khan Academy:** [**https://www.khanacademy.org/**](https://www.khanacademy.org/)

**Search for:** *Introduction to waves*(13 Minutes)

**Search for:** *Capacitors and capacitance*(6 Minutes)

**Search for:** *Ideal circuit elements*(6Minutes)

**YouTube:** *EEVblog #486 - Does Current Flow Through A Capacitor?* (17 Minutes)

**Simulation(s):**

[**https://phet.colorado.edu/sims/wave-on-a-string/wave-on-a-string\_en.html**](https://phet.colorado.edu/sims/wave-on-a-string/wave-on-a-string_en.html)

**Hands On:**

Heating of batteries with accidental short circuits.

Electrical Safety & Fuses, Safety grounding,

Romex Wiring - Circuit Breakers and overheating.

AC Current through a Capacitor

AC Current through an Inductor

**6: (Frequency and Wavelength)**

We will demonstrate linear and transverse waves, determine wavelengths for waves on water, sound in air and light in free space.

**Pre-Class Assignment:**

**Open Khan Academy:** [**https://www.khanacademy.org/**](https://www.khanacademy.org/)

**Search for:** *Amplitude, period, frequency and wavelength of periodic waves*(14Minutes)

**Search for (and read):** *Real-world circuit elements.*

**YouTube**: Inductor basics - What is an inductor? <https://www.youtube.com/watch?v=NgwXkUt3XxQ>

**YouTube**: What is an oscillator? <https://www.youtube.com/watch?v=aJAZHPqEUKU>

**Simulation(s):**

[**https://phet.colorado.edu/en/simulation/wave-on-a-string**](https://phet.colorado.edu/en/simulation/wave-on-a-string)

**Hands On:**

Waves in materials (rope wave demonstration)

Waves in motion (Slinky demonstration: Transverse & Longitudinal waves.)

Calculating wavelengths from frequencies.

**7: (Radio Frequency and Crystal radios)**

Tonight we will talk about radio frequency (RF) circuits and ‘Crystal’ radios. We will discuss how a simple Diode can demodulate pulling an audio signal out of an RF signal and let us ‘hear’ the radio.

Teams of 4 to 5 will build simple diode radio’s.

**Pre-Class Assignment:**

**Open Khan Academy:** [**https://www.khanacademy.org/**](https://www.khanacademy.org/)

**Search for:** *Electromagnetic waves and the electromagnetic spectrum*(11 Minutes)

**Search for:** Capacitors and capacitance *spectrum*(6 Minutes)

**Search for:** *Diode* (11 Minutes)

**Simulation(s):**

[**http://everycircuit.com/**](http://everycircuit.com/)(use AC source & Diode + Resistor)

**Hands On:**

Build Diode Radio’s, use portable speaker system to demonstrate.

**8: (Resonance and resonant circuits)**

We will talk about current frequency and how coils and capacitors can create ‘resonant’ circuits. The teams will build simple tuning capacitors to augment their Diode radio and allow it to be tuned to ‘select’ different stations.

**Pre-Class Assignment:**

**Open Khan Academy:** [**https://www.khanacademy.org/**](https://www.khanacademy.org/)

**Search for:** *Circuit elements (*

**YouTube:** *EEVblog #486 - Does Current Flow Through A Capacitor?* (17 Minutes)

**YouTube**: Resonance Experiment: [*https://www.youtube.com/watch?v=JDnNmLkQ3Bc*](https://www.youtube.com/watch?v=JDnNmLkQ3Bc) *(*

**YouTube**: *Singing plates - Standing Waves on Chladni plates* [*https://www.youtube.com/watch?v=wYoxOJDrZzw*](https://www.youtube.com/watch?v=wYoxOJDrZzw) *(4 Minutes)*

**YouTube**: *Resonance Circuits: LC Inductor-Capacitor:* [*https://www.youtube.com/watch?v=Mq-PF1vo9QA*](https://www.youtube.com/watch?v=Mq-PF1vo9QA) *(7 Minutes)*

**YouTube**: *Physics Videos by Eugene Khutoryansky:* [*https://www.youtube.com/user/EugeneKhutoryansky/videos*](https://www.youtube.com/user/EugeneKhutoryansky/videos)

*(As you find time, try to review as many of these that talk about electrical things as you can.)*

**Simulation(s):**

[**http://everycircuit.com/**](http://everycircuit.com/)(use Variable AC source & Capacitor + Inductor)

Vary the AC source frequency and watch what happens in the circuit!

**Hands On:**

Adding a home built tuning capacitor for your Diode radio.

**9: (Digital Logic Circuits & Computer Interface)**

We will talk about current frequency and how coils and capacitors can create ‘resonant’ circuits. The teams will build simple tuning capacitors to augment their Diode radio and allow it to be tuned to ‘select’ different stations.

**Pre-Class Assignment:**

**YouTube:** [*https://www.youtube.com/watch?v=95kv5BF2Z9E*](https://www.youtube.com/watch?v=95kv5BF2Z9E)(47 Minutes)

**Simulation(s):**

**n/a**

**Hands On:**

Using the LapTop audio board as a computer input/output system.

**10: (Radio Astronomy)**

Astronomers from the Math-Hulbert Observatory at Lake Angelus, MI will talk to us about radio astronomy, and we may assemble a simple radio astronomy ‘whistler’ receiver and listen to the earth’s magnetic field ‘talk’ to us.

**Pre-Class Assignment:**

**YouTube:** *Radio Astronomy in Five Minutes*(4 Minutes)

**Simulation(s):**

**N/A**

**Hands On:**

Build a ‘Whistler’ receiver.

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**Planed schedule for each class:**

**Before each class:** **Students and instructors review an on-line tutorial(s) covering the basic skills required as background for each topic, (Details are listed with each class.)**

**Class Timing:**

* 6:30: Instructors arrive, setup and prepare for class.
* 6:45: Students arrive and register with librarian representative.
* 7:00: In-Class discussion with a quick review of the ‘on-line’ tutorial topics to answer any immediate questions.
* 7:15: Class discussion of the scheduled topics and demonstrations.
* 7:30: “Hands on” experimentation by students to demonstrate the results of putting the tutorial information into practice.
* 8:15: Clean up and store any experimental materials
* 8:30: Class discussion to review how the experiments related to the pre-class tutorial information.
* 8:45: Class dismissed
* 8:45: Instructors pack up equipment, clean room, depart.

Pre-Class Assignment Example:

**Pre-Class Assignment:**

**Open Khan Academy:** [**https://www.khanacademy.org/**](https://www.khanacademy.org/)

**Search for:** *Crash Course Chemistry****,*** (then)*The nucleus*(10 Minutes)