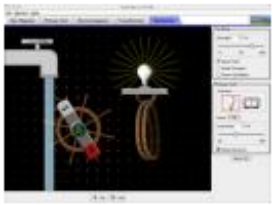
Name: _____

Generator PhET Lab rev2011

Introduction:

Why was Hoover Dam (Boulder Dam) built eighty years ago? In 1936 the generators in the dam started transmitting power to Los Angeles and later generators were brought online to power other cities, including your hometown. When high-pressure water flows through the dam's power plant, the water turns turbines in generators. A magnet in the generator spins in the generator's magnetic field. This moving-magnet-in-a-magnetic field causes electrons to move, eventually ending up in your TV, ipod, Wii, etc.



Important Formulas: $F = qv \times B$ $F_{mag} = B_{mag} I\ell$ $emf_{max} = NAB\omega$ $N_1V_2 = N_2V_1$ $P = IV$

Procedure, Part I: *PhET Simulations → Play With Sims → Electricity, Magnets, and Circuits → Generator* Run Now!

Bar Magnet | Pickup Coil | Electromagnet | Transformer | Generator

Flip Polarity
☑ See Inside Magnet
☑ Show Field
☑ Show Compass

- Begin with the "Bar Magnet." Click "See Inside" and observe the **magnetic domains** in the magnet and the field those domains create. Draw a diagram of the bar magnet in the box.
- Move the compass around the magnet. What happens as the compass moves in the magnetic field?

_____

Single magnet's field

Part II: A Moving Magnet in a Magnetic Field (Pickup Coil)

- What happens when a magnet moves through a coil in which electrons can move?

_____

- Investigate the brightness of the light (current) as the number of loops is changed, as the speed of the magnetic changes, the area of the wire coil is changed, and the polarity of the moving magnet is changed.

Changing _____ Results_____ Changing _____ Results_____

Changing _____ Results_____ Changing _____ Results_____

Part III: Creating a Magnetic Field (Electromagnet)

- Just like a changing magnetic field (from a magnet moving in a magnetic field) can cause electrons to move, moving electrons can create magnetic fields.
- Investigate how the properties of an electromagnet affect the magnetic field created.

Changing _____ Results_____ Changing _____ Results_____

Changing _____ Results_____ Changing _____ Results_____

Part IV: More Than Meets the Eye (Transformer)

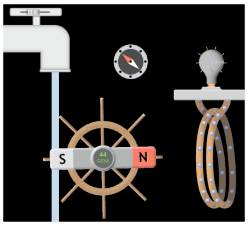
In a transformer, moving electrons in one coil create a magnetic field. When the created magnetic field interacts with a second coil, electrons can be forced to move in the second coil. Since the primary coil has four loops and the secondary coil has 1 to 3 loops, this is a *step down* transformer. Since $P = IV$ when voltage in a transformer decreases, current increases by the same amount and power in the transformer is constant.

- Investigate how the properties of a transformer's secondary coil affect the current in the secondary coil.

Changing _____ Results_____ Changing _____ Results_____

Changing _____ Results_____ Changing _____ Results_____

- Move the primary coil in and out of the secondary coil.
- Change the primary coil to AC. What happens? _____
- With a DC primary coil, move the voltage slider back and forth. What happened? _____



Part V: The Colorado River Runs Through It (Generator)

In a generator, an outside source of mechanical motion supplies the energy to move a magnet in a magnetic field. A generator works just like the moving magnet in a magnetic field (as in Part II).

- Click on Show Field and observe the moving magnetic field

Changing _____ Results_____ Changing _____ Results_____

Changing _____ Results_____ Changing _____ Results_____

Summary:

Lenz's Law states that *the induced EMF opposes the change in the magnetic field*. Imagine you were actually turning the water wheel by hand to generate current.

Would the wheel resist motion? _____

As you worked harder at moving the wheel, you would expect the light to shine _____

Explain what is happening in the simulation's generator and in Hoover Dam in terms of the law of conservation of energy.

_____

_____

Faraday's Law can be summarized with the formula: $\boxed{emf_{max} = NAB\omega}$. You investigated each of the variables that has an effect on emf (electromotive force, like potential or voltage).

List what each variable is and how it affects emf

emf = potential to drive electrons in a current

N = A = B = ω =

Finally, transformers use the **ratio** of the number of loops in the primary (input) coil to the loops in secondary (ouput) coil to determine the step, or what will happen to the voltage (emf) in the system. A transformer with 500 loops in the primary and 1000 loops in the secondary is a 2:1 step-up transformer that will double the input voltage. Is this free energy or does something have to stepped down? _____

Conclusion Calculations and Questions:

1. If the number of loops in a coil around a moving magnet doubles, the emf created *doubles / halves / remains the same*.
2. If area of a coil around a moving magnet doubles, the emf created *doubles / halves / remains the same*
3. If the speed of a moving magnet through a coil doubles, the emf created *doubles / halves / remains the same*
4. When the polarity of a moving magnet in a coil is flipped, the emf *increases / decreases / remains the same*.
5. As current increases in an electromagnet's coil, the strength of the created magnetic field *increases / decreases / remains the same*.
6. A DC electromagnet creates a *changing / constant* magnetic field and an electromagnet powered with AC creates a *changing / constant* magnetic field.
7. In a step up transformer, the emf (voltage) is stepped up and the _____ is stepped down.
8. The power output of a step up transformer is *greater than / less than / the same as* the input power of the transformer.
9. 9.0 volts are sent into a transformer with a 10-coil primary loops and a 30-coil secondary loop. The voltage leaving the secondary loop will be _____
10. The power output of a transformer is 100. W. The input voltage is 25V. What is the coil-turn ratio of the transformer if the output current is 1.0 A? _____