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Physics

2019

Year 12: Semester 1

Electromagnetism experiment

Total time: 75 mins

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Simulator report (40%):

Conclusion/questions (60%):

Combined result:

**Generator PhET Lab** Total(29)

**Introduction:**

The Hoover Dam (Boulder Dam) was built eighty years ago in the U.S during the great depression. 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:**     

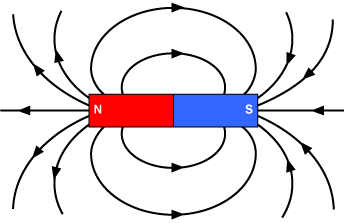
**Procedure, Part I:** *PhET Simulations 🡪 Play With Sims 🡪 Electricity, Magnets, and Circuits 🡪 Generator* 



* 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? (1 marks)

Compass rotates so that opposite ‘colours/poles’ face each other. North on the compass attracted to the south pole and visa versa

Single magnet’s field (1 marks)



**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?

(1 mark)

The electrons move (current generated) which operates the light

* 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. (4 marks)

Changing **Loops (increase)** Results **Brightness(increase** Changing: **Speed (increase)** Results **Brightness(increase**

Changing **Area (increase)** Results **Brightness (slight increase)** Changing **Polarity** Results **No change**

**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. (4 marks)

Changing **Loops (increase)** Results **Stronger** Changing **current (increase)** Results **Increase**

Changing **EMF increase** Results**Stronger** Changing **AC Current** Results: **Field continually changes in direction**

**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  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. (4 marks)

Changing **Area (increase)** Results **(slight increase)** Changing **Voltage increase** Results **increase**

Changing **Speed increase** Results **increase** Changing **Loops increase** Results **increase**

* Move the primary coil in and out of the secondary coil.
* Change the primary coil to AC. What happens? (1 mark)

**A current is induces in the secondary coil**

* With a DC primary coil, move the voltage slider back and forth. What happened? (1 mark)

**A current was induced when the voltage changed**

**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 (4 mark)

Changing **Water speed (increase)** Results **increase** Changing **Magnetic strength increase** Results **increase**

Changing **Loops (increase)** Results **change in current** Changing **Area (increase)** Results **change in current**

**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. (2 marks)

Would the wheel resist motion? \_\_\_\_ **yes** \_\_\_\_\_

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

Explain what is happening in the simulation’s generator and in Hoover Dam in terms of the law of conservation of energy. (2 marks)

**Water –applied torque – wheel turns a magnet that creates a changing magnetic field that induces a current.**

**The current creates a magnetic field that opposes the motion of the wheel (hence conservation of energy). The wheel continues to turn as kinetic energy of the water is converted to kinetic energy of the wheel.**

Faraday’s Law can be summarized with the formula: . 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 (4 marks)

N = **Number of loops: More loops =greater EMF** A = **Area of coil. Greater area=greater EMF**

B = **Magnetic flux density. Higher flux density=greater EMF** ω = **frequency. Higher=greater EMF**

**Conclusion: Calculations and Questions: ( 20 marks)**

1. 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? Explain: (2 marks)

The higher EMF results in a lower current. The lower current is proportional to the higher emf, in this case the current will be half the original.

1. If the number of loops in a coil around a moving magnet doubles, the emf created ***doubles /*** *halves / remains the same*.

(1 marks)

1. If area of a coil around a moving magnet doubles, the emf created ***doubles /*** *halves / remains the same* (1 marks)
2. If the speed of a moving magnet through a coil doubles, the emf created ***doubles /*** *halves / remains the same* (1 marks)
3. When the polarity of a moving magnet in a coil is flipped, the emf *increases / decreases /* ***remains the same*.** (1 marks)
4. As current increases in an electromagnet’s coil, the strength of the created magnetic field ***increases*** */ decreases / remains the same*. (1 marks)
5. A DC electromagnet creates a *changing /* ***constant*** magnetic field and an electromagnet powered with AC creates a ***changing*** */ constant* magnetic field. (2 marks)
6. In a step up transformer, the emf (voltage) is stepped up and the \_**Current**\_\_ is stepped down. (1 marks)
7. The power output of a step up transformer is *greater than / less than /* ***the same as*** the input power of the transformer.

(1 marks)

1. 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 (1 marks)

**27V**

1. 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? (1 marks)

**1:4stepup**

1. A train is travelling with a constant velocity of 80 Km/hr in an area were the vertical component of the Earth’s magnetic fields is 36 µT. (3 marks)
   1. What is the size of the emf induced across each 10.m long axle? ( 2 marks)

**Emf = lVB = = 8 V**

* 1. If the train is travelling in a south westerly direction, describe the forece acting on an electron in this axle: ( 1)

**The electron is being pulled by the Earth’s magnetic field but also pulled south westerly by the train’s EMF from the tracks.**

1. A physics student inserted the north pole of a bar magnet into a coil that was connected to a galvanometer, and noticed that the galvanometer needle moved to one side. When she withdrew the magnet from the could she noticed te needle moved to the opposite side of the galvanometer. Explain these observations with the help of a diagram. (4 marks)

**Diagram 1 (Magnetic with North moving towards coil and electron flow counterclockwise) - 1 mark**

**Diagram 2 (Magnetic with North moving away from coil and electron flow counterclockwise) - 1 mark**

**Lenz’s and Faradays law explaining that induced current produces a magnetic field opposing the changing magnetic field. – 2 Marks**