1103 Period 22: DC Motors and Generators

22.1 How Do Direct Current (DC) Electric Motors Work?

1) **Spinning rotors.** In this activity, we see why the rotor of an electric motor spins.
   a) Place a permanent magnet on a plastic spinner and make the magnet spin by holding another magnet nearby. The magnets simulate a motor.
   Could you make a practical motor using only permanent magnets? Explain why or why not.
   
   b) Place a solenoid near the magnet on the spinner. Make the magnet spin by alternately connecting and disconnecting the solenoid from a 3 battery tray.
   Could you make a practical motor using electromagnets (like the solenoid) and a continuous, unchanging current? Explain why or why not.
   
   c) What are the fundamental requirements for a practical electric motor?
   
   d) What type of current is required to make a motor run? ________________

Activity 22.2: How Can You Make a Simple Motor?

2) **Building a motor:** Refer to the model on your table.
   a) Cut a 3 meter length of coated wire.
   b) Wrap the wire into a circle 3 to 4 cm in diameter, leaving about 10 cm of wire protruding from each side of the circle.
   c) Wrap each end of the wire around the loop about four times.
   d) Trim the ends of the wire so that they stick out from the loop about 2 cm.
   e) Use sandpaper to carefully scrape the red coating off of only **one side** of one of the 2 cm long wires.
   f) Scrape **all** of the coating off of the other 2 cm long wire.
   g) Place the wire circle on a paper clip support that is stapled to a wooden block.
3) **Using your motor**
   a) Use connecting wires to attach the positive end of a 3 battery tray to one side of the metal paper clip support and the negative end to the other side of the support.
   b) Hold a strong magnet near the coil of wire – either above or to one side of the coil. Start the coil spinning with your finger. The coil should continue to spin.

4) **How does the motor work?**
   a) Why must you scrape the coating off of the ends of the two wires protruding from the coil? Why do you scrape all of the insulation from one wire, but scrape insulation from only one side of one of the other wire?

   b) As the coil spins, does the current in the coil reverse or turn on and off? Why?

   c) What provides the changing magnetic field in this motor that keeps the coil spinning?

   d) All motors require two magnetic fields. What provides the second magnetic field in this motor?

   e) Group Discussion Question: What would happen to the coil’s motion if all of the insulation were scraped off of both of the protruding wires?
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Activity 22.3: How Does the St. Louis Motor Work?

5) St. Louis motor: Connect the St. Louis motor to a 3-battery tray.
   a) Does the St. Louis motor run better when the like poles (both north poles or both south poles) or the unlike poles (one north and one south pole) of its two magnets are oriented in the same direction?

   b) Remove one permanent magnet and adjust the remaining magnet until the motor runs. Does the rotor turn more rapidly using one or two permanent magnets? ______________________

   c) What makes the St. Louis motor’s rotor move?

   d) Why doesn’t the rotor turn until its poles are aligned with the opposite poles of the permanent magnets and then stop?

   e) A changing current is necessary to make a rotor spin. The St. Louis motor is connected to an unchanging direct current source. What causes a changing current in a direct current motor? ______________________
Activity 22.2: How Do Generators Work?

6) Hand-cranked generators
   a) Attach a hand-cranked generator to a small motor and turn the crank. Explain what happens inside the generator when the crank turns to create a current.

   b) List the energy conversions that take place when you crank the generator and make the motor’s shaft turn.

   c) Connect one hand-cranked generator to a second hand-cranked generator and make the second generator spin. How is a generator similar to a motor? How are they different?

7) Electric generating plants: Power plants use the same principle to generate electricity – coils of wire spinning near magnets.
   a) What form of energy spins the coils of wire in a hydroelectric generating plant?

   b) How is electricity generated in coal, oil, or natural gas generating plants?

   c) How does a nuclear power plant differ from a fossil fuel power plant?

   d) Group Discussion Question: What are the advantages and disadvantages of fossil fuel power plants? Of nuclear power plants?
Period 22 Exercises: DC Motors and Generators

Write answers to the questions below. This sheet with your answers should be turned in at the beginning of Period 23.

1. Explaining the operation of a direct current motor:

On the diagram below of a St. Louis motor, like the one seen in class, identify each part indicated by an arrow. In the space below, describe the purpose of each part.

b) ______________________

Explain the purpose of each of the motor components that you identified on the diagram.

a) ______________________

b) ______________________

c) ______________________

d) ______________________

e) ______________________

2. Understanding electricity generation:

The most commonly used fuels to generate electricity are nuclear power and fossil fuels, such as coal, natural gas, and oil. How does a nuclear plant differ from a coal-burning plant? How are these two types of plants similar?