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Exploring Electric Motors Worksheet

Activity 1: Beakman Electric Motor Design Challenge

1. **Ask:** How can you design a Beakman motor to achieve the most consistent coil spin?

2. **Research:** How does a Beakman Motor work? Watch this video of a simple electric motor to find out! (https://www.youtube.com/watch?v=it_Z7NdKgmY&list=PL1B2B0F87955817C8; 2:17 minutes).

   Write down your observations of the motor's components and how the wire coil moves when connected to the battery.

3. **Imagine:** Brainstorm 4–5 ideas for how changing the wire gauge or number of coil wraps might help you achieve the most consistent coil spin. Sketch your ideas below.

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4. **Plan:** Select one design variable to investigate:
    a. Wire gauge (e.g., 20-, 22-, or 24-gauge)
    b. Number of coil wraps (e.g., 5, 10, or 15 wraps)

    Plan three motor designs by changing your selected variable while keeping the other design features as consistent as possible. Why did you select this design variable? Predict which of your three designs will produce the most consistent coil spin and explain why. Then sketch your three designs below.

5. **Create:**
    a. **Make the coil:** Wrap your selected gauge of wire around a cylinder, such as a glue stick or marker, for your chosen number of wraps to form a circle.
    b. **Secure the wire ends:** Keep about 2 inches of straight wire on both sides. Loop each end lightly around the coil at opposite ends and thread the end through the loop to hold it together.
    c. **Remove wire insulation (important):** Use sandpaper to lightly scrape off the red coating on the straight ends of the wire. Scrape all the way around one wire end, and scrape only one side of the other wire end.
    d. **Build the coil stand:** Slide one end of each of the two large paper clips upward to create a loop in the middle of each paper clip (this loop will support the wire coil). Use electrical tape or a wide rubber band to hold two paper clips upright on opposite sides of the D-cell battery. To avoid creating a short circuit, DO NOT touch the paper clips together once attached to the battery!
    e. **Set the coil:** Rest the coil ends in the paper clip loops. Check that the paper clip supports are straight and the wire is level and can spin freely. Reshape the wire coil if necessary.
    f. **Add the magnet and test the design:** Place the magnet on the battery off to the side between the two paper clips. Gently push the coil to help it start spinning. If the wire coil does not spin, check that the wire insulation is fully removed on one side and only half-removed on the other, adjust the magnet placement, and slightly tilt the motor setup forward or backward. To avoid a short circuit, DO NOT place the magnet so it connects with the paper clips attached to the battery leads.
    g. **Turn the motor off:** Remove the wire coil from the motor stand to turn off the motor and conserve the battery. Use care when removing neodymium magnets from the battery to avoid pinched fingers.

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6. **Test:** Test your motor design and record the results in the data table below.
   Classify the coil's performance as constant coil spin (continues spinning without assistance), intermittent coil spin (spins but stops or requires additional pushes), or no coil spin (does not continue spinning after the initial push).

Beakman's Electric Motor Design #1	Beakman's Electric Motor Design #2	Beakman's Electric Motor Design #3
Gauge of wire:	Gauge of wire:	Gauge of wire:
Number of coil wire wraps:	Number of coil wire wraps:	Number of coil wire wraps:
Results (constant coil spin, intermittent coil spin, no coil spin):	Results (constant coil spin, intermittent coil spin, no coil spin):	Results (constant coil spin, intermittent coil spin, no coil spin):

7. **Reflection Questions:**
   a. How did changing your selected design variable (wire gauge or number of coil wraps) affect the consistency of the coil spin? Use evidence from your test results to support your answer.

   b. What other factors may have affected the performance of your motor?

   c. Which of your three motor designs performed best? What 2–3 modifications would you make to improve that design and achieve more consistent coil spin?

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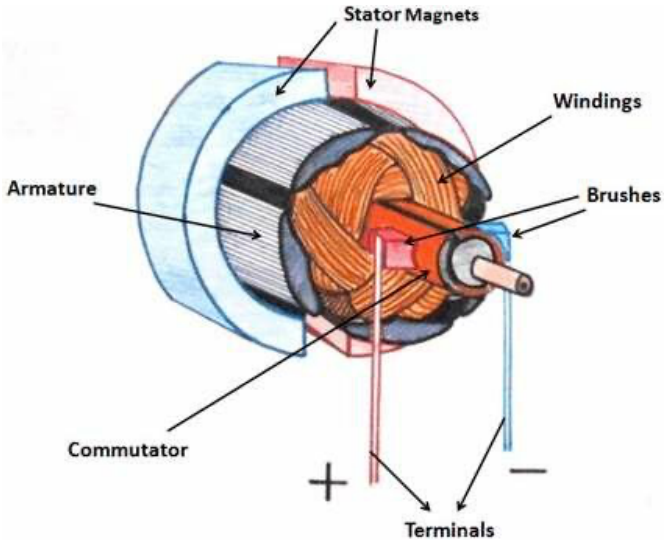
Activity 2: Dissect a DC Motor



Watch and Learn

1. Watch this video on how DC motors work: https://www.youtube.com/watch?v=1AaUK6pT_cE (4:49 minutes).

2. Answer the following questions based on the video:
   a. What is the stator? Does it act as a permanent magnet or an electromagnet?

   b. What is the armature (rotor)? Does it act as a permanent magnet or an electromagnet?

   c. What is the commutator, and what is its purpose in an electric motor?

   d. What are the brushes, and what role do they play?

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Disassemble and Investigate

3. You will now investigate the inside of a DC motor to determine how its components work together to produce rotation.
    a. **Mark the case.** Draw a small alignment line across the seam between the motor case and back cap. This mark will help with correctly aligning the components if the motor is reassembled.
    b. **Remove the gear.** If a gear is attached to the motor shaft, carefully remove it using a small screwdriver.
    c. **Bend back the tabs.** Locate the metal tabs securing the back cap to the motor case and carefully bend the tabs straight using your fingers or a small screwdriver.
    d. **Open the motor case.** Carefully pull the back cap away from the motor body. If necessary, gently pry it open with a small screwdriver.
    e. **Remove the armature.** Carefully slide the armature (rotor) out of the motor case.
    f. **Using the DC motor diagram,** identify as many motor parts as possible. Your motor may not include all parts shown, but aim to identify the armature (rotor), brushes, commutator, stator, and terminals.

Reflection Question

4. These small motors do not include a cooling fan. Why do you think a cooling fan is not needed?

Electric Motors and EVs

5. Watch this video to learn more about how electric motors move electric vehicles: https://www.youtube.com/watch?v=nMqt9isT00M (9:15 minutes).

6. Identify connections between the motors you investigated and the electric vehicle motor shown in the video. Discuss how both use interactions between electricity and magnetic fields to produce mechanical motion.