# Motor Cause Lab

Investigate how electrical changes affect a toy motor

**PS.3.e** "Plan and carry out investigations to determine the relationships between magnetism and electrical charge in common devices."

NAME _____ DATE _____

## 1 READ AND MARK

Read it twice

**YOUR JOB** Underline what the class changes in each test, circle what it measures, and number the details it keeps the same. These marks will help you judge which changes caused the motor's response.

### What Makes the Motor Turn?

1. A small battery-powered toy car uses a geared motor to turn its wheels. Inside the motor, electric charges move through wire coils near permanent magnets. Magnetic forces on the current-carrying coils turn a shaft. A gear train slows the output so its turns are easy to count. To investigate cause and effect, a class connects a motor rated for three volts to either one or two 1.5-volt batteries in series. They put a bright mark on the output shaft and count complete turns for ten seconds. They use the same motor, gear train, and counting time for every trial.

2. First, the class tests the battery setups twice, keeping the battery orientation the same. With one battery, the shaft makes 14 turns, then 15 turns, in ten seconds. With two batteries, it makes 25 turns, then 24 turns, in ten seconds. Two batteries provide a greater voltage, which can drive more current through the motor's coils. In these trials, the higher-voltage setup produces more turns in the same time. The class cannot use these results to claim that every motor will speed up by the same amount. Motors, loads, and battery conditions can differ.

3. Next, the class uses one battery again but swaps the two connections to the motor. The shaft turns the opposite way. Swapping connections reverses the direction of current through the motor, so the magnetic force on its coils reverses direction. For a fair direction test, the students keep the same battery, motor, gears, and ten-second interval. They repeat each setup to check whether the direction stays consistent. They disconnect the batteries between trials so the motor does not run unattended. Their observations link moving electric charge to magnetic forces in a familiar device, rather than treating electricity and magnetism as unrelated effects.

## 2 ANSWER WITH EVIDENCE

Use the passage

1. In the first test, what does the class change, what does it measure, and what does it keep the same to make the comparison fair?

2. Use both sets of turn counts to explain what happened when the class used two batteries instead of one. What can the class conclude about this motor?

3. When the class swapped the motor connections, what changed about the shaft's motion? Explain how moving electric charge and magnetism caused that change.

4. Suppose the class counted turns for ten seconds with one battery but twenty seconds with two. Why would that weaken its test of the batteries' effect, and how should it fix the plan?

## 3 YOUR TURN

Your own words

In a model of a battery-powered doorbell, current flows through wire wrapped around an iron bolt, which pulls a metal striker. Plan a test of whether changing the number of wire turns affects how strongly the bolt attracts metal: state what you would change, what you would measure, what you would keep the same, and how the results could show a cause-and-effect relationship.

# Motor Cause Lab



## PART 1 · READ AND MARK

Underline what the class changes in each test, circle what it measures, and number the details it keeps the same. These marks will help you judge which changes caused the motor's response. Accept any marking that follows this job and points at the right text.

## PART 2 · ANSWERS

| # | QUESTION | ANSWER |
|---|---|---|
| 1 | In the first test, what does the class change, what does it measure, and what does it keep the same to make the comparison fair? | **The class changes the number of batteries and measures shaft turns in ten seconds. It keeps the motor, gear train, counting time, and battery orientation the same.** |
| 2 | Use both sets of turn counts to explain what happened when the class used two batteries instead of one. What can the class conclude about this motor? | **With one battery, the shaft made 14 and 15 turns; with two, it made 25 and 24 turns in the same time. For this motor under these conditions, the higher-voltage setup produced more turns.** |
| 3 | When the class swapped the motor connections, what changed about the shaft's motion? Explain how moving electric charge and magnetism caused that change. | **The shaft turned the opposite way. Swapping the connections reversed current through the coils, which reversed the direction of the magnetic force on them.** |
| 4 | Suppose the class counted turns for ten seconds with one battery but twenty seconds with two. Why would that weaken its test of the batteries' effect, and how should it fix the plan? | **Counting for different lengths of time could change the turn totals even without a change in speed. The class should count for the same ten-second interval in both setups.** |

## PART 3 · YOUR TURN (SAMPLE ANSWER)

I would wrap 20 turns of wire around the bolt, then test it again with 40 turns. I would measure how many identical paper clips the bolt lifts each time the circuit is briefly closed. I would keep the same bolt, battery, wire type, clips, and test time, and repeat each setup. If the counts differ consistently, the results would show that changing the coil turns affected the bolt's magnetic pull under these conditions.

Accept other measurable ways to compare magnetic pull if students change only the number of wire turns and identify appropriate controls. A prediction is not required; the plan must explain how observations would support a conclusion.