Electricity

Goals

- Generate an electric current
- Add electric charge to a capacitor
- Create an electric current using a capacitor

Background

More than any other technological advance, electricity has shaped our modern world. Nearly everything you do in an average day, from turning on a light in the morning, to driving to school or work, to listening to music or watching movies, would be impossible without electricity.

Electricity is actually nothing more than the movement of electrons, the tiny subatomic particles that orbit the nucleus of every atom at almost the speed of light. When large numbers of electrons move in one direction, we call that an electric current. But if large numbers of electrons don't move, but instead pile up in one place, we say that we've built up an electric charge.

If you've ever felt your hairs stand on end from static electricity, you've felt an electric charge building up on your skin. When you get an electric shock from touching metal or another person, that charge moves and turns into a short-lived electric current.

Electricity can move in two ways. It can proceed in a single direction around a circuit, or it can move back and forth many times a second, never moving any one electron far from its origin but transmitting electric energy over long distances.

Alternating current(AC), the movement of electrons back and forth in a circuit, is very useful for generating and transporting electricity. The current that comes out of a wall socket anywhere in the world is an alternating current. But direct current (DC), where electricity travels in one direction, is used in nearly all of our electronic devices such as computers, phones, or tablets.

A capacitor is a perfect tool for exploring electricity because it is capable of storing electric charge, which it will then gradually release as electric current. Capacitors do this by stopping electric current from passing through them. When a current is applied to a capacitor, through a generator or battery, the current is forced to build up in the capacitor instead of flowing through it, as the current would do with a lightbulb, motor, or other electrical device.

All that built-up current sits in the capacitor as electric charge, which can then be released as an electric current in the reverse direction if the capacitor is hooked up to an electric circuit.

During this activity, we will use a hand-crank generator to build up electric charge on a supercapacitor (a capacitor with the ability to hold a large amount of electric charge) and we will use that charge to run a small motor.

Procedure

1. Look at the super capacitor. It's the long cylinder with one red and one black plug on one end. What wires do you think you should attach to it?

2. Once you've got wires attached to the super capacitor, you'll connect the other end of those wires to the

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potentiometer (po-ten-ti-OM-et-er). That's the dial with red, yellow,

3. and green sections. Where do you think you'll attach the red and black wires? Will it matter which plugs you use?

4. The potentiometer will tell you when you've filled the super capacitor with energy, but you'll need the hand-crank generator to do that. Looking at the generator, how do you think you should attach it to the potentiometer?

5. If you've got your generator hooked up to the potentiometer, turn the hand-crank in a clockwise direction to transfer power to the super capacitor. (WARNING: Do not spin it in a counter-clockwise direction or you will damage the super capacitor!) What do you observe as you spin the hand-crank?

6. As you fill the super capacitor, you'll notice the dial on the potentiometer moving. How will you know when it's full?

7. When you've filled the super capacitor, disconnect the potentiometer from the super capacitor and connect the fan to the super capacitor using the red and black wires. The fan should start moving as soon as it's connected.

Observations

Experimentation

1. Does the capacitor hold the same amount of charge each time you fill it? Use a stopwatch to measure the amount of time the motor runs each time you connect it to the supercapacitor. Record your results below:

Trial:	Time (sec):	Observations:
1		
2		
3		
4		

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2. Will the capacitor keep its charge when disconnected, or does it lose charge over time? After charging the capacitor, wait before hooking it up to the motor and record what happens:

Trial:	Idle Time (sec):	Motor Time (sec):	Observations:
1			
2			
3			
4			

Measurement

For this section, you will need a multimeter or the Horizon Renewable Energy Monitor. For an introduction to using a multimeter, click here.

1. Record the highest current in Amps and highest voltage in Volts produced while the capacitor is powering the motor. Record your answers below:

Current: _____________ A

Voltage: ___________ V

2. Voltage is equal to the current in amps multiplied by the resistance in ohms (V = IR), so according to your data what is the resistance of the motor in ohms?

Resistance: ____________ Ω

3. Capacitance (C) is measured in farads. Look closely at your capacitor and you'll find that it lists its capacitance. Record it below:

Capacitance: ____________ F

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4. Since C = q/V where q is the charge and V is the voltage, how many coulombs of charge does your capacitor hold?

Charge: ______________ C

5. One coulomb of charge is equal to approximately 6.242×1018 electrons. How many electrons are stored in your capacitor?

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Analysis

1. Make a scientific claim about what you observed while running your capacitor.

2. What evidence do you have to back up your scientific claim?

3. What reasoning did you use to support your claim?

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4. Design an experiment that could test the relationship between the size of the capacitor and the current it produces when discharging. Describe your experiment below:

Conclusions

1. Why did the fan eventually stop moving? Construct an explanation of what you observed using what you know about electricity.

2. Could a capacitor be a useful source of electricity for an electric car? Why or why not?

3. Based on your observations, does the capacitor lose its charge over time?

4. Based on your observations, does the capacitor lose its charge over time?

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