

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

Class: \_\_\_\_\_

Date: \_\_\_\_\_



Physics

High School

6 hours

## Objective

Run experiments with an ethanol fuel cell learn about chemical reactions, electricity, and renewable energy.

## Materials

- Horizon's Ethanol Fuel Cell Science Kit
- Ethanol solution
- Distilled water
- Stopwatch
- Horizon Renewable Energy Monitor (optional)

## Background



Fig. 1: This car uses ethanol instead of gasoline.

Ethanol is an excellent source of renewable energy. From biofuel resources like corn and sugar we can get a renewable source of energy that will reduce pollution and decrease dependence on fossil fuels. But before we can understand its environmental impact, we need to understand how it works as an energy source.

Ethanol is being used to power cars (Figure 1) and as a heat source for homes because it's similar to other organic compounds that can burn like gasoline or kerosene. Unlike those energy sources, though, it can also be used by a fuel cell to produce electricity. You can learn more about ethanol's characteristics by reading [Introduction to Ethanol](#).

With the right mixture of ethanol, our fuel cell will provide enough electricity to power a small motor on a fan. But it won't always produce the same amount of electricity. We can change how well the fuel cell works by changing things like how hot the fuel is or how much ethanol we mix with water.

What concentrations of ethanol are better for the fuel cell? At what temperature should it run? When scientists are building cars and machines that run on ethanol, they have to ask these kinds of questions to make sure they get the most energy out of their ethanol fuel. Now we'll use the ethanol fuel cell to explore these questions and more during this activity.

## Method

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We will be using the ethanol fuel cell to power a small fan. We will run experiments to understand more the most efficient way to make our ethanol fuel cell work.

## Procedure

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### Procedure:

As you assemble your fuel cell and run your experiments, write down any interesting observations you have in the **Observations** section below.

1. Open the purging valve on the bottom of the fuel cell by pushing it towards the back, away from the fan.
2. Make sure the tubing connecting the fuel cell, purging valve, and fuel container is secure.
3. Open the fuel container and pour the ethanol solution in, then close the lid.
4. Wait 5-10 minutes for the fuel cell to begin the chemical reaction.
5. Attach the red and black alligator clips to the fuel cell and observe what happens.
6. When you're finished, disconnect the alligator clips.

### Observations:

Write down anything interesting you observe while running the ethanol fuel cell.

**Experimentation: Concentration of Ethanol**

Will the fuel cell run better if the ethanol is more concentrated? Using the different concentrations of ethanol provided by your teacher, run the fuel cell as you did in the **Procedure** section.

Each time you run it with a different concentration, write down any observations below.

<b>Concentration</b>	<b>Observations</b>
<b>5%</b>	
<b>7%</b>	
<b>10%</b>	
<b>12%</b>	
<b>15%</b>	

What happened when you used different concentrations of ethanol in your fuel cell? *Construct an explanation* of what you observed.

**Experimentation: Temperature**

How does the fuel cell work with fuel at different temperatures? Using the heated fuel samples provided by your teacher, run the fuel cell as you did in the **Procedure** section. Record any observations below:

<b><i>Temperature (°C)</i></b>	<b><i>Observations</i></b>

Did the temperature of the fuel affect how fast the fan was spinning? *Construct an explanation* of what you observed.

## Analysis

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Make a *scientific claim* about your ethanol fuel cell. What are the conditions that would generate the most electricity from this fuel cell? To help you write a claim statement, see [Stating a Scientific Claim](#).

### Claim

What evidence can you use from your observations of the car to back up your claim? State the reasoning you used to make your claim.

### Evidence

State the reasoning you used to make your claim.

### Reasoning

Use the data you collected to *design an experiment* that you could run to test the effect of air temperature on the fuel cell. Explain the steps of your experiment here:

Does it matter if the fuel cell is attached to something other than the fan? *Design an experiment* that would test what happens when other electric machines are powered by the ethanol fuel cell. Explain the steps of your experiment here:

## Conclusion

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1. What happens if you attach the wires to the fan backwards (red to black and black to red)? *Construct an explanation* of what you observe.

2. Could you use an ethanol fuel cell to provide power to your house? *Develop an argument* to support your position using evidence you observed during this activity and defend your argument if there are different points of view in your group.

3. Describe a change you could make to the fuel cell and make a prediction of what you would expect to happen to the amount of electricity produced as a result of that change.

4. How could you test what factor has the biggest influence on the electrical output of the fuel cell?.

5. Based on your observations during this experiment, predict what would happen if you attached a fan with a larger motor to your fuel cell.

6. What types of energy are present during this experiment? How are they changed during the reaction?

## Measurement

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How much electricity is running through our circuit? To find out, we'll need to use an ammeter like the Horizon Renewable Energy Monitor to measure the amount of electric current being produced by the generator. Read [Measuring Current in a Circuit](#) for more information on how to set this up.

When your ammeter is connected to your circuit, run the ethanol fuel cell to power the fan. Use a stopwatch and measure the amount of current in the circuit at different times. If you have the Horizon Renewable Energy Monitor, you can also measure the volts. Record your data below:

<b><i>Time (min)</i></b>	<b><i>Amps (A)</i></b>	<b><i>Volts (V)</i></b>
<b><i>0</i></b>		
<b><i>2</i></b>		
<b><i>4</i></b>		
<b><i>6</i></b>		
<b><i>8</i></b>		
<b><i>10</i></b>		



Does the amount of electricity produced by the fuel cell change? *Construct an explanation* of what you observed.