Wizards of Wright

Lesson: Reaction Chemistry

(Endothermic vs. Exothermic)

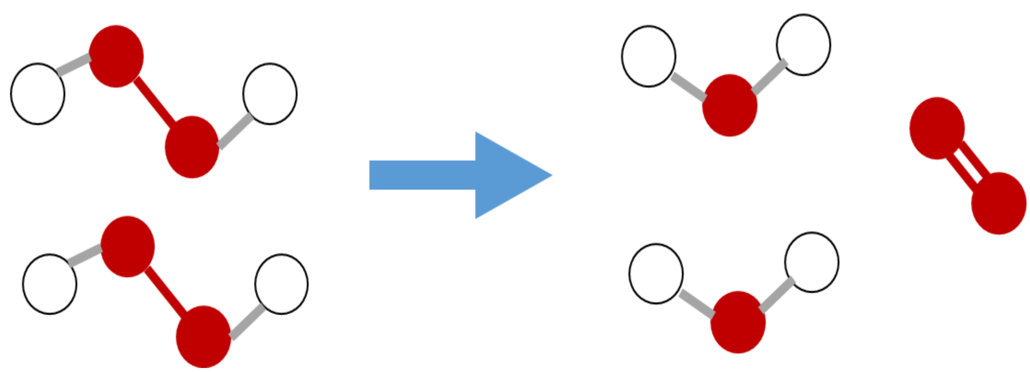
Use WOW! Lesson Intro to begin.

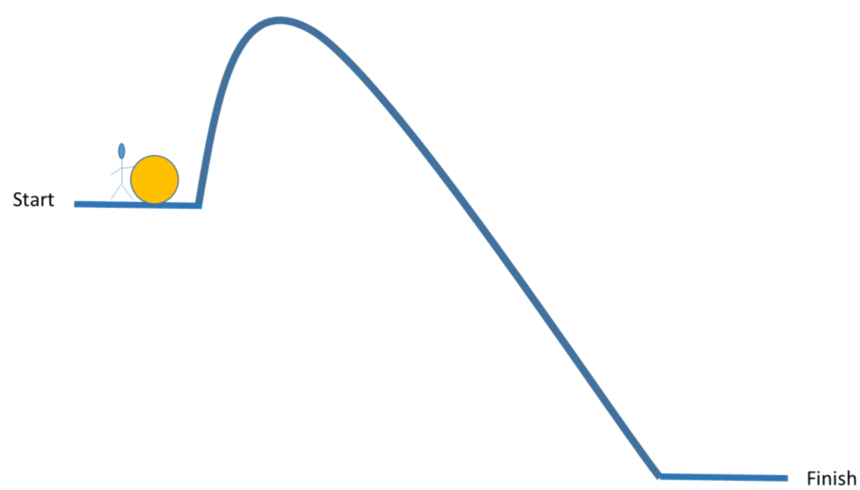
Background Info for Wizards:	Endothermic and exothermic reactions, heat energy transfer, decomposition reactions, catalyst, gas formation, work as a product of force and/or distance or pressure volume work. Idea of matter changing form. Latent heat: the heat required to convert a solid into a liquid or vapor, or a liquid into a vapor, without change of temperature. Note that temperature does not change during phase change.
Materials:	Introduction: Poster or PowerPoint Slides Guided Lesson: Poster or PowerPoint Slides Gloves and Safety glasses for Wizard Paper towels for cleanup Wizard Demonstration #1: (part A and part B) Warm water 1 packet of yeast Beaker Erlenmeyer Flasks (#1 and #2) Tray Hydrogen Peroxide (6%) Vernier: temp probe Go link Laptop Measuring spoon Dish soap Student Activity #1: 2 helpers Rolling scooter

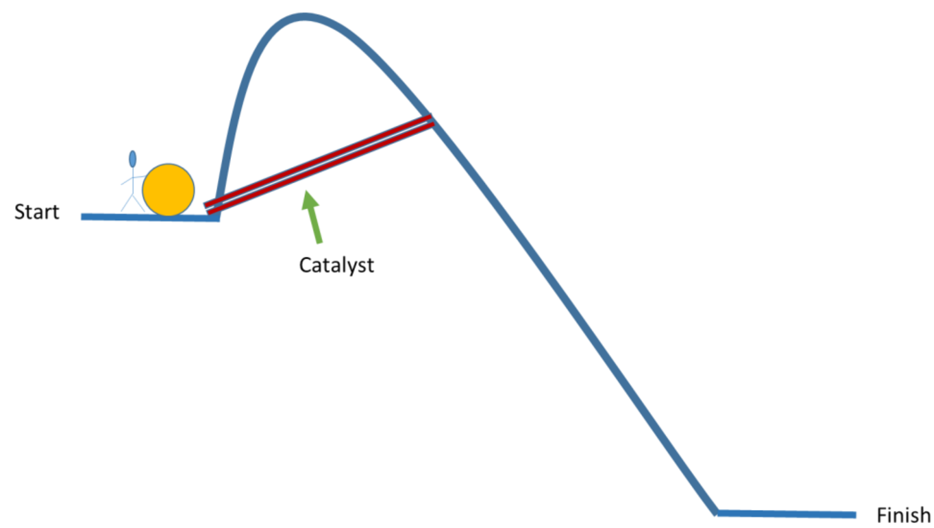
	<u>Wizard Demonstration #2</u>:
	Temperature probe
	Flask (#3)
	Measuring spoon
	Sodium Bicarbonate
	Vinegar
	Graduated cylinder
	
	<u>Wizard Demonstration #3</u>:
	Balloon filled with 1 teaspoon of Sodium Bicarbonate
	Vinegar
	Test tube
	
	<u>Student Activity #2</u>:
	Each group of 2 students receives:
	        2 effervescent tablets
	        a tray
	        a film canister
	        graduated cylinders (100 mL of water)
	Safety glasses **If a student has regular glasses on the safety glasses aren't needed

Lesson Time: ***45-60 minutes***	Introduction: 5 minutes Guided Lesson: 5 minutes Wizard Demonstration #1A: 5 minutes Student Activity #1: 5 minutes Wizard Demonstration #1B: 5 minutes Wizard Demonstration #2: 5 minutes Wizard Demonstration #3: 5 minutes Student Activity #2: 10 minutes Conclusion: 5 minutes
Learning Targets:	Students will learn the difference between endothermic and exothermic reactions. Students will learn about the role of a catalyst. Students will be introduced to the idea of pressure-volume work and how chemical reactions can be used to do work.
Introduction for Students: 5 minutes	*Use PowerPoint or poster to give an overview of today's lesson (**Slides 1-3**).* **Slide 1:** Title/ Intro to lesson **Slide 2:** Energy comes in many forms. Kinetic energy is the energy in motion and potential energy is energy that is stored. Objects, like a butterfly or bird, can have both

	at the same time! It has kinetic energy while its wings are moving in flight and then potential energy when it's in a still position soaring through the air. There is another kind of energy that we will talk about today, and that is chemical energy. Chemical energy is released when chemical bonds are broken. **Slide 3:** Molecules also have kinetic energy, they are never still. They vibrate and rotate and stretch and bend. The bonds between atoms have potential energy. Thermal energy, or heat can be used to access this chemical energy by altering the motion of breaking the bonds.
Guided Lesson: 5 minutes	*Use PowerPoint or poster to give an overview of today's lesson (**Slides 4-10**).* **Slide 4:** When we eat food, we are gathering and storing chemical energy. We "burn" the calories in our food to keep warm while it provides us the energy to run, jump, and play. **Slide 5:** Plants take energy from the sun via photosynthesis. We can then turn plants like sugar cane into ethanol fuel to drive a car! During these reactions some energy is typically lost or gained in the form of heat. We have names for reactions that either gain or lose heat energy. **Slide 6:** Let's consider a phase change, or a change from SOLID, TO LIQUID, TO A GAS. This is called an ENDOTHERMIC processes. Heat has to ENTER the system for the change to occur. **Slide 7:** If our changes move through the phases in the opposite direction, starting with a GAS then a LIQUID and then a SOLID, heat must EXIT the system. These are EXOTHERMIC processes. **Slide 8:** Both combustion, or burning, and freezing are EXOTHERMIC processes. One is a chemical change and the other is a physical change. **Slide 9:** Let's use ice as an example. Ice melts as it absorbs heat from the atmosphere around it. Have you ever wondered "where does that energy go"?

	Slide 10: Chemists can use probes and sensors to track physical and chemical changes during reactions. This is what we will do together today.
Wizard Demonstration #1A: 5 minutes	<u>**Exothermic reactions and catalysts:**</u> *Please put on gloves and safety glasses.* 1) Mix 100 ml warm water with 1 packet of yeast in a beaker, set aside. (This needs to be prepped early, but will be used in a later demonstration.) **2)** Place <u>**flask 1**</u> on the tray. And add 100 mL of hydrogen peroxide. (Measure using flask markings). **Remind students they are probably most familiar with hydrogen peroxide because they've put it on wounds/cuts.** **Slide 11:** The hydrogen peroxide immediately begins to decompose. The decomposition reaction means a single compound breaks down into two or more compounds or elements. AB → A + B $$2H_2O_2 \rightarrow 2H_2O + O_2$$  The bubbles you see when you add the H_2O_2 (hydrogen peroxide) to a cut is a sign of the decomposition. The O_2 formed is what kills the bacteria through a process called oxidation. The walls of the bacterial cell are destroyed! The rate, or speed, at which H_2O_2 (hydrogen peroxide) decomposes is just very slow. We can speed this process up using a catalyst! Let's discuss what a catalyst is.

Student Activity #1:	Catalysts and reactions:
Student Activity #1: 5 minutes	**<u>Catalysts and reactions:</u>** 1) Have student 1 sit on the floor 2) Have student 2 attempt to pull them across the room. 3) Next have student 1 sit on <u>the scooter</u> and have student 2 pull them across the room. 4) Discuss "What was different?" Explain that this is how a catalyst works. It makes the change easier, while using less energy. **Slide 12 and 13:** There is a certain amount of energy required for a reaction to occur. This is called the activation energy. It can be thought of as a barrier to a chemical reaction, or a hurdle that must be crossed. If the barrier is high, few molecules have sufficient kinetic energy to collide and cross the barrier. Reactants with energy lower than activation energy cannot pass over the barrier at all. Let's think of it this way. Imagine you are trying to push a giant boulder uphill. It would be a difficult task!  A catalyst provides a lower energy route for the reaction to occur.

	The different route allows the bond rearrangements needed to convert reactants to products to take place more easily, while using less energy. It's like using a ramp or a bridge to complete the task!  So the presence of a catalyst allows a greater amount of the starting material to pick up sufficient energy to pass over the barrier and become a product. In this way the catalyst increases the rate of a reaction. It is important to note that the catalyst does not undergo any permanent change and it is not actually used up in the reaction.
Wizard Demonstration #1B: 5 minutes	Let's go back to the experiment we started. The reaction we will show is EXOTHERMIC. Which means heat energy is put out. Some examples include: freezing, condensation, burning, and rusting. 1) We will use the beaker with 100 ml **warm water** and yeast that we previously mixed and set aside. 2) Hook up the Vernier temperature probe to the laptop, open "Logger Lite 1.9.4" 3) Place the probe into **flask 1** **(**the one with the with the hydrogen peroxide in it). Hit the "collect" button ***Make sure screen is facing students! "Since the reaction is going at a slow rate, we see very little change in the temperature. Let's add some catalyst and see what happens!" 4) **Slowly** add **50 mL of the yeast and water mixture** to ***flask 1*** a little bit at a time.

	5) Temperature should increase. 6) Allow reaction to proceed so they see the temperature increase. Hit "end." Do not save. We can make this reaction a little more dramatic… and fun. 7) Mix about a tsp of dish soap and 100 mL H_2O_2 in **<u>flask 2</u>**. 8) Pour remaining warm water and yeast to **<u>flask 2</u> quickly** and STAND back. Since a gas is being formed we can use that to do the work of making bubbles!
Wizard Demonstration #2: 5 minutes	**<u>Endothermic reactions:</u>** So far, we've seen an example of an exothermic reaction, and shown what a catalyst can do. Now, let's see an endothermic reaction. In the **exothermic** example, heat **exited**. This includes examples like burning of coal, an iron fence rusting, and making ice cubes. Now we'll give you an **endothermic** example, heat or energy will **enter** our object. This includes examples like frying an egg, sweating, and photosynthesis. **Slide 14:** 1) Wipe off the temperature probe and place it in **<u>flask 3</u>** with 1 tsp of sodium bicarbonate, which is regular baking soda. 2) Hit "collect" so the sensor begins to collect data. 3) **<u>Slowly</u>** add 50 mL of vinegar. ***Use graduated cylinder to measure.** 4) Students should observe temperature decrease. You may swirl the flask to bump the reaction. 5) Hit "end," do not save. We are also forming a gas in this reaction. The solid sodium bicarbonate reacts with the liquid vinegar (acetic acid) and produces carbon dioxide gas.
Wizard Demonstration #3: 5 minutes	**Slide 14:** The energy created from chemical reactions can be harnessed to do work. Think of a rocket ship taking off! When a phase change occurs and a gas is created we have the same number of molecules we started with, however, the new product takes up more space! We can use the volume of the gas created to do work.

	Let's look at a simple example of this! 1) Use balloon with sodium bicarb. 2) Add 25 mL of vinegar to test tube (fill to black line). 3) Fit balloon over top of test tube. 4) Lift balloon to mix and watch balloon inflate. The gas created has a larger volume than the reactants, the gas expanding creates a force that inflates the balloon. You will now do a similar reaction to propel a film canister rocket.
Student Activity #2: 10 minutes	This activity is best, if students work in pairs. Review Safety Rules with students. 1. Safety glasses must be worn. 2. Directions must be followed. 3. Students should be aware of popping items around them. **Film canister rocket:** Pass out safety glasses. Pass out trays, graduated cylinders, and film canisters. Fill each groups' graduated cylinder with 100 mL of water. Explain to students that the amount of water will be used in multiple trials. They should NOT use it all in one attempt. Here's a hint, they should end up with some water left over at the end. **Instruct students to work on the tray: This will get messy!** ***Walk the students through a dry run so they understand the procedure.*** 1) Carefully add some water to the film canister. 2) Add a tab to the canister, seal it, and IMMEDIATLY turn up-side down. 3) PLACE CANISTER ON THE TRAY. 4) Stand Back and Wait… 5) Once it has popped, the student should quickly remove the tablet from the water, so it can be used again. 6) Allow students to experiment with the amount of water added to the film canister for each trial. Each tablet should provide about 3 "pops". 7) After all directions have been given, then give each pair 2 effervescent tablets.

	Have the student help clean up their area and the trays.
Conclusion: 5 minutes	Review what was learned in each demonstration and activity. What did they learn about Endothermic and Exothermic Reactions? **Q:** What amount of water in the film canister gave the best results? **A:** Small **Q:** Why? What is actually acting as the propellant (doing the work)? **A:** Gas **Q:** Did the canister feel hotter or colder? **A:** Colder **Q:** So what type of reaction is this? **A:** Endothermic, energy from the environment is pulled in. **Q:** If the canister had felt warmer what type of reaction would it have been? **A:** Exothermic, heat energy is released. **Q:** What is a catalyst? **A:** Something that helps a reaction proceed by offering a lower energy route from reactant (starting material) to product (ending material) **Q:** Is a catalyst used up or altered? **A:** NO!

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