KaPow!

Grade Level: Middle school

Student Objectives

- Demonstrate how transfer occurs from potential to kinetic energy through a chemical reaction (combustion)
- Describe the key part of a chemical reaction (reactants, reaction and products)
- Identify how a reaction occurs within an engine to move a race car and identify the key elements of that reaction
- Conduct a science experiment and run at least 5 trials to determine what combination produced the longest distance traveled

Materials List

- Reaction worksheet (download)
- Plastic cardboard (like election sign) or very sturdy cardboard (from a box)
- Bottle (20 oz or larger)
- Bottle cap
- Drill with bits or hammer with 6-penny nail
- Measuring spoons or teaspoon
- Measuring cup or paper cup
- Baking soda
- Vinegar
- Lemon juice
- Lime juice
- Measuring tape
- Duct tape
- Wheels (such as old CDs, DVDs, bottle caps, cat food cans, etc.)
- Large straws
- Wooden dowel, bamboo skewers or sticks
- Towel

NASCAR HALL OF FAME CHARLOTTE

Discovery Phase

Using the internet or your notes from school, research and review material to prepare you for the experiment and answer the following questions

1. What is energy?
2. What are the two primary states of energy?
3. How does energy function? Can it be created?
4. What is chemical energy?
5. Name two items where chemical energy is used in your home.
6. How does a car work? What part of a car transforms energy?
7. What are the two reactants we need to add to the car's engine to start a reaction? What is the stimulus added to cause the reaction?
8. What is one of the products created after the reaction takes place?

In Real Life: NASCAR Connection

Just like a personal car, the engine of a race car is the powerhouse of work. The engine contains many different forms of energy that need to work together to transfer the energy to the rear axle and propel the car forward.

The two reactants (fuel and air) we add to the engine can impact how the engine will perform and impact the speed and velocity of the race car. Engineers and car chiefs (the person responsible for building the race car) collaborate to have the best car possible to win a race. NASCAR mandates and control the fuel (what its chemical composition is), but the teams work with their engine company to determine other factors, such as how much air is added.

Air chemistry can change based on where in the country a race is happening or what time of day the race is occurring. Even what the predicted weather conditions are can affect it. Think about what the air feels like in winter versus the summer. It may be more dense in the summer with more water vapor. This is compared to the winter when it can be drier. If you live in a desert area, the air may be drier than if you live by the ocean. The chemistry of the air will impact how the reaction will occur and the effectiveness of the energy to keep the car moving at top speed.

The stimulus for us that causes the two reactants (air and fuel) to ignite is a spark plug. The spark plug gives off an electric pulse whichh ignites the air and fuel causing the chemical reaction of combustion to occur. Once this happens, the reaction triggers the other part of the car's engine into motion and converts that chemical energy into many other types of energy.

The primary goal is to take that energy and direct as much as possible to the rear end or axels of the car through the drivetrain. It is the rear axles of the car that provide the motion for the car to move forward.

Car chiefs, crew chief and engineers need to ensure the engine - or the heart of the car - is performing at its best. They have to calculate through tests and data reviews what the best ratios of reactants will ensure the car to move. Before the race can start, engines are tuned or adjusted for peak performance.

A driver needs to understand how an engine sounds and be able to communicate information about the engine's performance to the team. This is for the team to know if they are getting the maximum results from the engine. Engines can fail if they do not perform correctly, and then the team is out of the race. On race day, you have one car, one engine and one shot to win; there are no do overs.

Let's Experiment: Your Turn

Objective: Build a car that will move on its own through a chemical reaction
Goal: Get the car to travel the furthest distance within five trials
Variables: Change the amount of liquid and/or solids (baking soda) that you use (remember to record your changes in order to make an informed decision)
For Fun: Have a family member or sibling record your car in motion (then share the videos with us!)
Engineer/Build Your Car:

1. Use the plastic board or heavy cardboard as your base or chassis of your car.
2. Tape the straws or plastic tubes (such as a pen) on to the base. That will serve as the bushing or device that will hold your axle.
3. Use the wooden sticks or bamboo skewers as your axels. Your makeshift wheels attach to the axel; the axel turns the wheels; wheels are bolted on to a car and do not turn by themselves. Be sure your axel spins your tires. The base of the car should not be able to roll.
4. Add your engine. Tightly secure the bottle (with no holes in bottle) to the top of the board.
5. Drill or add a hole to the cap. Size of the hole might be a factor to think about for your experiment (larger hole vs. smaller hole.)
6. Your car is complete.

Experiment:

1. Ensure you have your data sheet or notebook ready to record your information from each of the trials.
2. Determine how much of only one of the three liquids (vinegar, lemon or lime juice) you will use. (Hint: You'll need at least 5 oz to start.) Record your measured amount.
3. Add the liquid to the bottle.
4. Measure the amount of baking soda with a teaspoon or tablespoon. Place this in a flexible cup such as a small paper cup from your bathroom or in a napkin. Record the amount of baking soda you selected. (Hint: Start with a teaspoon.)
5. Go outside. You need to complete the remainder of the experiment trial outside.
6. Read the rest of the instruction fully before completing.
7. Tip the car/bottle at an angle of about 45 degrees. Do not hold it straight up and down - vertically.
8. Remove the cap.
9. With the bottle at an angle, add the baking soda slowing. Try not to have the liquid and baking soda touch.
10. Re-cap the bottle.
11. Kneel or squat down to be close to the ground so you are prepared to release the car. Remember to stand to one side of the bottle and not behind where the cap with hole is.
12. Place your thumb over the hole in the cap and shake the bottle.
13. Feel the pressure build. Place the car on the ground with all four wheels down and release your thumb. The car should move forward.
14. Measure the distance traveled and record the data.
15. Dump out the liquid and rinse with water.
16. Repeat and change a variable such as the amount of liquid, amount of baking soda or type of liquid used. (HINT: Out of the three acids (liquids), the one you use in grade school may not be the best reactant for distance.)

Results:

1. What were the reactants in this experiment?
2. What caused the two reactants to react?
3. What do you think the product created was?
4. Which combination worked the best?

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Additional Resources

Energy: https://www.youtube.com/watch?v=IqV5L66EP2E
Chemical energy: https://www.youtube.com/watch?v=_77fcVFw6co
Chemical reaction: https://www.youtube.com/watch?v=5iowJs6MryI
Car chemistry: https://www.youtube.com/watch?v=e9vfMrjitXw
Website: https://www.eschooltoday.com/energy/kinds-of-energy/what-is-chemical-energy.html

Definition from science.jrank.org

Combustion reactions are those where oxygen combines with another compound to form water and carbon dioxide. The equations for these reactions usually designate that the reaction is exothermic (heat producing). Synthesis reactions occur when two or more simple compounds combine to form a more complicated compound. Decomposition reactions reflect the reversal of synthesis reactions (e.g., reactions where complex molecules are broken down into simpler molecules). The electrolysis of water to make oxygen and hydrogen is an excellent example of a decomposition reaction.
Learn more here: https://science.jrank.org/pages/1389/Chemical-Reactions.html