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Bruce Museum at Home
STEAM Activities for Children

Lesson #10: ***Reaction Action***
Week of May 25, 2020

This week's STEAM at Home lesson is a continuation of last week's introduction to basic chemistry. Learners have the opportunity to experiment with two varieties soda bottle rockets, focusing on the differences between chemically created and physically created energy. The experiments this week do not use difficult-to-source materials, but they are messy and physical projects that require specific materials. Please plan accordingly before beginning any of these projects with your learner.

Learners will use their science journals to predict, record, and explore their experiments. If your learner hasn't made a science journal, instructions can be found here, or if they have a notebook or other paper they prefer to use, that's fine.

In order of appearance, this lesson contains: a materials list for *Reaction Action* and a simple art activity, instructions for *Reaction Action*, ways to add on to the activity, open-ended question ideas, and NGSS Performance Expectations. A list of chemistry vocabulary words is available as a separate document, and can be found here.

A tip for adults: *Liquids and solids are about to go flying. These experiments* ***must*** *be done outdoors in a fairly open area. You and your learner should take appropriate precautions, and depending on your learner's age, you may need to launch their rockets for them. Please take appropriate precautions and wear protective eye gear.*

Materials for experiment:

Chemical Rocket: empty plastic 1 or 2 liter bottles, measuring spoons, a full bottle of white vinegar, baking soda (make sure you use baking soda, not baking powder), paper towels, rubber bands, corks, duct tape, sticks, pencils or skewers for a rocket stand, science journal, pens or pencils.

Physical Rocket: empty plastic 1 or 2 liter bottles, bicycle pump with inflation needle, rubber bands, corks, duct tape, sticks, pencils or skewers for a rocket stand, science journal, pens or pencils.

Materials for art project: thick paper, scissors, magic markers, crayons or colored pencils, clear tape, glue.

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Let's Get Building!

Chemically Powered Rocket

The chemical reaction between baking soda and vinegar creates carbon dioxide gas. Carbon dioxide gas will build up inside the chemically powered rocket and (eventually) blast it off into the air.

- Show your learner the materials for the chemically powered rocket.
    - In their science journals, learners will create a design for their rocket using the materials available.

After your learner is done creating a design for their rocket, follow the steps below for an effective build.

- Turn the empty bottle (without cap) upside down. On three sides of the bottle (think the legs of a peace sign), attach the pencils (or whatever you are using), so that the rocket will be able to stand with the opening of the bottle at least an inch above the ground.
    - There are other ways to create a stand for your rocket, but they involve more materials.
    - Make sure that your bottle can stand strong on its legs.
- Make a packet that holds two or three tablespoons of baking soda using a paper towel (substitute tissue or newspaper as available), a little bit of tape or rubber bands.
    - Make sure the baking soda is firmly folded into the paper towel- no leaks!
    - Make sure your baking soda packet will fit into the mouth of your bottle.
- Test out your cork: does it fit snugly in the mouth of your bottle?
    - If your cork does not fit, try other corks or trim/add onto your cork using materials available to you.
- Go outside (taking your rocket, baking soda packet, cork, and vinegar with you), and find an open area to launch your rocket.
    - If you want to do more than one experiment, or if you think it may not work initially (and it may not), bring extra vinegar, paper towels, and baking soda with you.
    - Ask your learner to write down what they think will happen when you start the chemical reaction in the rocket.
- Find a safe outdoor location and fill your rocket about ½ way with vinegar.
- Very quickly place the packet of baking soda inside the soda bottle rocket and seal the mouth of the bottle with your cork.
- Place the rocket on the ground of its base and move away quickly!
    - As soon as the vinegar soaks through the baking soda packet, or the baking soda begins to leak out, the chemical reaction will start.

- Carbon dioxide will build up in your rocket until, POP, the cork flies out and the rocket flies away.
- The rocket will, of course, come crashing back down once the pressure is relieved, so watch out, below!

Physically Powered Rocket

- Start by creating a similar base for this rocket as you did for the chemically powered rocket.
- Drill or poke a hole all the way through a cork so that the needle attachment of a bike pump can fit through the cork.
  - Adult help may be needed for this step of the project.
  - Secure the needle using tape so that it is tight inside the cork.
- Fill your soda bottle rocket ⅓ of the way up with water.
  - If the area you are going to has running water, no need to pre-fill your bottle.
  - If the area you are going to does not have running water, and you'd like to shoot your rocket more than once, bring extra water with you.
- Go outside and find a nice open spot to launch your rocket.
  - If your soda bottle rocket is not ⅓ full with water, fill it.
- Stick the cork that has the bicycle pump pin inside firmly into the mouth of the bottle and attach the bike pump.
- Don't make the mistake we did and make the soda bottle rocket's legs too short for the bike pump to fit underneath the rocket.
  - If you did make this mistake, find something sturdy to prop your rocket against so that it faces up, and away from you.
- Start pumping the bike pump!
  - You should see the water in the bottle bubbling as air is forced into it.
- When the pressure is strong enough, BANG! The cork will pop out, and your bottle will go flying!

Learners should use their science journals to note what worked, what didn't work, and how many attempts they made. Use the questions below as prompts to extend the experience.

- Did your rockets work?
  - Why?
  - Why not?
- What could you change to have a bigger explosion?
  - Chemical explosion questions
    - How much baking soda did you use?
    - Did the baking soda leak before you put it in the soda bottle rocket?
    - How much vinegar did you use?
    - Did the vinegar leak before the explosion?
  - Physical explosion questions
    - How much water was in your bottle?

        - How much air did you pump in with your bike pump?
    - General Questions
        - How big was your bottle?
        - Was your cork airtight?
- Was there a difference between the physical and chemical explosion?
    - What was that difference?
        - Did they look different?
        - Which explosion was bigger?
        - Which explosion was more exciting?
    - Which type of energy generation, physical or chemical, has more waste products?

Decorate Your Rocket

As you can see in the picture on the right, we decorated two of our three rockets and left one plain, just to show how different they look with a bit of decoration!

For the nose cone and fins, use a large piece of construction paper. Cut the piece of paper in half and use one half to make a cone. Tape the cone to the top of the rocket (the bottom of the bottle); this will be your nose cone. Use the rest of the paper to make triangular fins and other decorations for your rocket. Use a marker to write a message or your rocket's name on the side.

We added some cut-out figures from a previous project; take your decorations in your own direction. Just remember that they will get wet when you shoot off your rocket!

NGSS Performance Expectations

2-PS1-2 Matter and Its Interactions: Analyze data obtained from testing different materials to determine which materials have the properties that are best suited for an intended purpose.*

5-PS1-4 Matter and Its Interactions: Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

5-PS1-3 Matter and Its Interactions: Make observations and measurements to identify materials based on their properties.

MS-PS-1-2 Matter and its Interactions: Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.