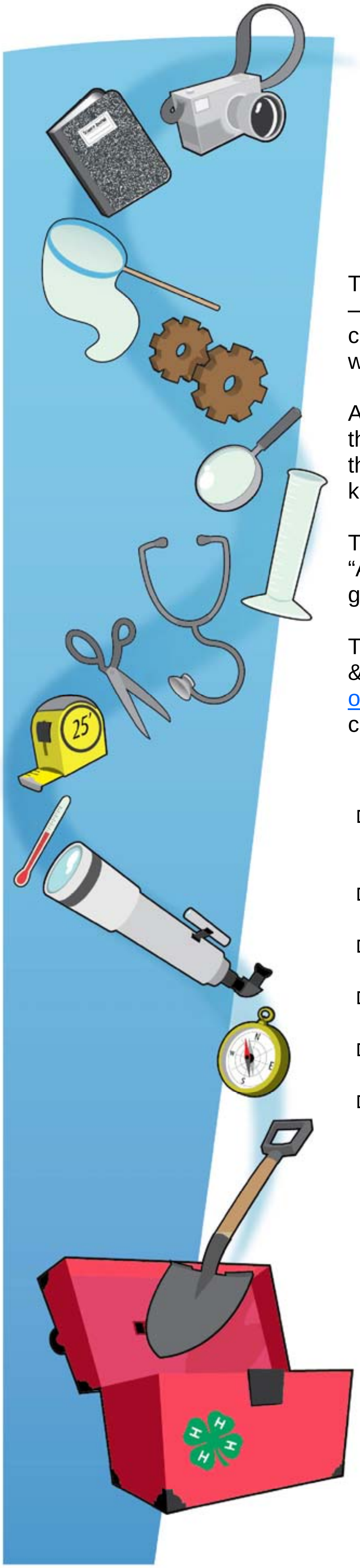
4-H Science Toolkit



Astronomy 2:
Exploring the Solar System

About the 4-H Science Toolkit Series: Exploring the Solar System

This series of activities focuses on a subject of fascination to both children and adults – our Solar System. Through the activities, children will learn what scientists have discovered about our Solar System and feel both a sense of awe and connection to our world each time they look at the sky.

All of these adventures call on students to predict what will happen, test their theories, then share their results. They'll be introduced to astronomy vocabulary, make items they can take home to expand their adventures and come home armed with enough knowledge about the night sky to share with their family.

The lessons in this unit were adapted from various NASA resources and from "Astronomy – It's Out of this World" 4-H Leader/Member Guide by Brian Rice. This guide is available online at http://www.ecommons.cornell.edu/handle/1813/3487.

To find out more about astronomy activities, visit the Cornell Center for Radiophysics & Space Research education and public outreach web site at http://astro.cornell.edu/outreach/. To find numerous resources related to astronomy and other sciences, check out the national 4-H Resource Directory at http://www.4-hdirectory.org.

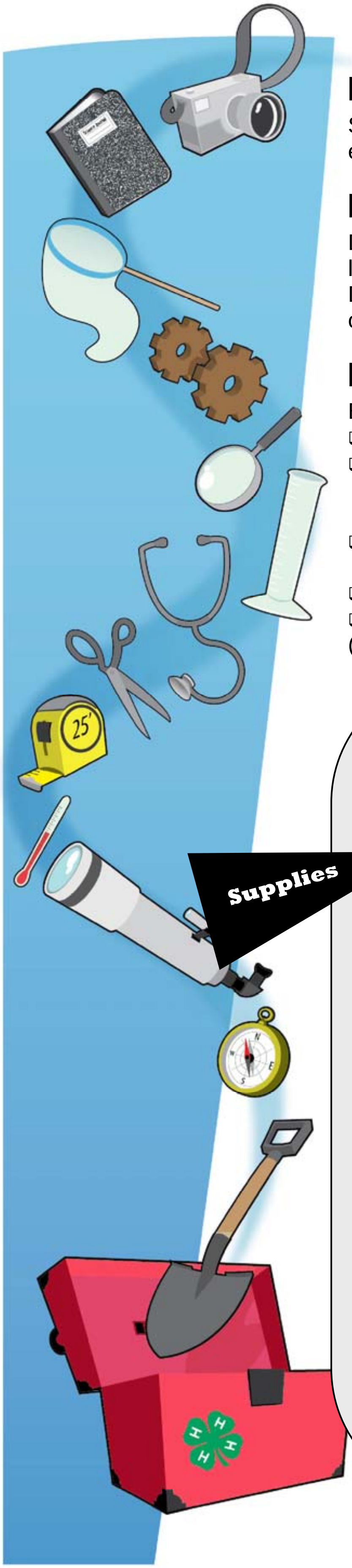
Exploring the Solar System Table of Contents

4-H Youth Development is the youth program of Cornell Cooperative Extension

Astronomy 2: Exploring the Solar System

How Big and How Far? Scale model of our solar system

Activity Series: Astronomy 2
Grade: 2nd & up
Time: 45-60 min



Main Idea

Scale models make it easier to comprehend the vast sizes and distances in our solar system.

Motivator

Did you know that Mercury, the closest planet to the Sun, is still 36 million miles away from the Sun? Earth is 93 million miles from the Sun? Don't know how far 93 million miles is? Let's find out by making a model of our solar system.

Pre-Activity Questions

Before you start the activity, ask the students:

- How many stars are in our solar system? (One, our Sun)
- How many planets are in our solar system? Can you name them in order? (Assign students a planet name and line up in order of the planets.)
- Do you know any mnemonic (memory) phrases to help remember the planets?
- Do you know the two main types or groupings of planets?
- How is Pluto now classified?

(See background resources for answers)

Activity

Supplies

- Basketball
- Grain of sand
- Two peas of different sizes
- BB
- Golf ball
- Ping pong ball
- Two gum balls
- Meter stick
- A half-mile field, football field or at least 15 feet of clear space
- Cardboard and sturdy bamboo skewers (optional, for making signs)

You could also use other objects of similar size and scale to each other.

1. This activity demonstrates the relative placement (order from the Sun) of the planets and relative size difference between them.
2. View the chart on the next page and decide which model you will do. The field model is recommended if you have the space. Or you can try both. (With the 15-foot model, size and distance are not at the same scale.)
3. Assign each of the objects to a participant.
4. Have the whole group pace out (or measure) the distance to each planet. You might want to attach the smaller objects to a piece of cardboard, attach a stick, plant the sign in the ground at each planet's location and go on to the next one. Leave the basketball Sun wherever you start.
5. Talk about each planet as you take your journey through the solar system. Ask the participants what they know.

Objectives

- To develop an understanding of the vast scale of our solar system and the order and relative sizes of the planets.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

Contributed By

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4-H Science Toolkit

Astronomy 2

How Big and How Far? Scale model of our solar system

Celestial Body	Object to Represent	Distance from Sun		
		15 foot Model	Football Field Model	Large Field (approx. 1/2 mile). Pace = ~ 3 feet
Sun	Basketball			
Mercury	Grain of sand	1.8”	1 yard	10 paces from Sun
Venus	Smaller pea	3.1”	2 yards	8 paces from Mercury
Earth	Larger pea	4.5”	3 yards	8 paces from Venus
Mars	BB	6.8”	4.5 yards	18 paces from Earth
Jupiter	Golf ball	2’ 0”	15 yards	106 paces from Mars
Saturn	Ping-pong ball	3’ 7”	26 yards	138 paces from Jupiter
Uranus	Gum ball	7’ 6”	51 yards	279 paces from Saturn
Neptune	Gum ball	11’ 4”	79 yards	315 paces from Uranus

Background information on the planets

Mercury: Solid and rocky, diameter is 38 percent the size of Earth’s; almost no atmosphere; no moons; day = 58 Earth days, year = 88 Earth days

Venus: Solid and rocky; diameter is 95 percent of Earth’s; thick atmosphere of mostly carbon dioxide 92 times Earth’s sea-level pressure; no moons; day = 243 Earth days, year = 225 Earth days (a day is longer than a year!)

Earth: You know a lot about Earth!

Mars: Solid and rocky, diameter is 53 percent of Earth’s; very thin atmosphere of mostly carbon dioxide with less than 1 percent of the air pressure on Earth; two small moons (sort of look like potatoes, probably captured asteroids); day = 24.6 Earth hours, year = 1.9 Earth years

Jupiter: Gas (mostly hydrogen and helium), liquid hydrogen, liquid metallic hydrogen, rock and metal core; the largest planet (diameter is 11 times bigger than the Earth’s); year = 11.9 Earth years, day = 9.9 Earth hours; more than 60 moons

Saturn: Gas (mostly hydrogen and helium), liquid hydrogen, liquid metallic hydrogen, methane, ammonium, and water ices; rock and metal core; diameter is 9 ½ times the Earth’s; day = about 10.6 Earth hours; year = 29.5 Earth years; more than 60 moons; spectacular ring system made of water ice particles

Uranus: Pronunciation “YOOR-a-nus”; mostly methane ice on inside, liquid hydrogen, rock and metal core; has rings; orbits the sun on its side; diameter is four times bigger than Earth’s; day = 17 Earth hours; year = 84 Earth years; has at least 27 moons, most named after Shakespearean characters

Neptune: Mostly methane ice on inside, liquid hydrogen, rock and metal core; has rings and at least 13 moons; diameter is almost four times bigger than Earth’s; day = 16 Earth hours; year = 165 Earth years

Science checkup - Questions to ask to evaluate what was learned

- ❑ Which planets are closer to the Sun than the Earth? Which are farther away?
- ❑ What are some of the things that planets are made of?
- ❑ What are the similarities and differences between planets closer to the Sun and planets farther away?

How Big and How Far? Scale model of our solar system

Extensions

For more information on the solar system, check out these and other Web sites:

- Windows to the Universe: www.windows2universe.org (search for solar system)
- Welcome to the Planets: http://pds.nasa.gov/planets/
- Modeling the Solar System: This set of activities includes a fun solar system model using fruits, vegetables, nuts and seeds (e.g. head of lettuce, cantaloupe, lemon, lime …) http://solarsystem.nasa.gov/educ/docs/modelingsolarsystem.pdf/
- Solar System Scale Model Meta Page: Links to other sites, check out the "Build a Solar System" site: http://www.vendian.org/mncharity/dir3/solarsystem/
- Pocket solar system: This activity uses adding machine tape and is a fun quick activity that gives kids something to take home. It illustrates the relative distance between planets and the order of the planets: www.astrosociety.org/education/astro/bayarea/PocketSolarSystem.pdf

Vocabulary

Scale Model: A representation or copy of an object that is proportionally larger or smaller than the actual object and helps us to understand the object or system.
Geocentric: An older theory that the Earth is the center of the universe and other objects go around it. The distinction between the solar system and the universe was not clear until modern times. Belief in this system was common in ancient Greece and China.
Heliocentric: The modern accurate system, in which the Sun is at the center of the solar system.
Asteroid Belt: A region of the solar system located roughly between the orbits of the planets Mars and Jupiter. It is occupied by large numbers of irregularly shaped rocky bodies called asteroids
Kuiper Belt: A region of icy objects beyond Neptune like the asteroid belt, but much larger, with icy bodies rather than rocky ones. Pluto is the most familiar object in the Kuiper Belt.

Background Resources

- Around the year 330 BC, Heraclides may have developed the first known model of the solar system, but his model was geocentric, meaning that the Earth — not the Sun — was at the center of the solar system. Within the following century, Aristarchus, another Greek scientist, presented an argument for a heliocentric (Sun-centered) model of the solar system. His ideas were rejected at the time and not revived until 1,800 years later by Copernicus.
- There are eight planets in our Solar System: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune
- There are several examples of memory phrases to help students remember the order of the planets, including "My very educated mother just served us noodles."
- Mercury, Venus, Earth and Mars are all rocky or "terrestrial" planets. Jupiter, Saturn, Uranus and Neptune are known as gas or "gaseous" planets.
- Since 2006, Pluto has been considered a dwarf planet. Pluto doesn't fit in either group of rocky or gas planets. Leaving Pluto out (although it is still out there!) makes distance models a little easier.

4-H Science Toolkit

Astronomy 2: Exploring the Solar System

Pop Rockets!

Activity Series:: Astronomy 2
Grade: 3-6
Time: 60 min

Main Idea

Build and launch a simple rocket using film canisters, paper, and fizzy tablets.

Motivator

NASA launches many satellites and spacecraft using rockets. The principles that make model rockets launch are exactly the same as those used in launching a spacecraft to Mars. A great deal of force needs to be generated to allow the rocket to escape Earth's gravity. We are going to design simple model rockets and discover how changes to our designs affect our launches.

Pre-Activity Questions

Before you start the activity, ask the students:

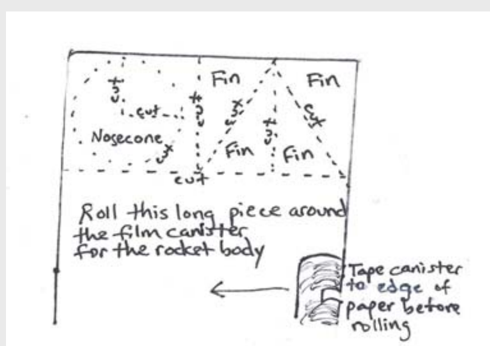
- ❑ Have you ever built and launched a model rocket?
- ❑ Have you ever seen a rocket launch on TV or in a movie?
- ❑ How does a rocket work?
- ❑ Why does it take so much fuel to launch a real rocket from Earth into space?

Activity

Supplies

- ❑ Paper or cardstock/oak tag/poster board.
- ❑ Plastic film canisters (They must have a cap that fits inside the rim. They can be purchased from online science supply stores if you can't find them.)
- ❑ Tape and scissors
- ❑ Effervescing (fizzy) antacid tablets
- ❑ Paper towels, towels or mop if indoors
- ❑ Water
- ❑ Eye protection (glasses, sun glasses, safety glasses)

Making the rocket:



1. Cut out pieces for your rocket (body, fins, cone) from the paper, cardstock or posterboard. There is no one right way - try out different types. The body can be long or short. You can try different numbers of fins or no fins at all.
2. Wrap and tape a tube of paper around the film canister. Make sure the lid end of the canister is at the bottom of the rocket body, so it can be opened.
3. Tape your fins to the body, if you want them.
4. Roll a circle with a wedge cut out into a cone and tape it to the top of the rocket. Make sure the rocket can stand upright.

Objectives

- Experiment to discover how changing variables affect a rocket launch.
- Understand the basic concepts that make a rocket launch.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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Astronomy 2
Pop Rockets!

Keep in Mind - just like a real rocket, the less mass your rocket has and the less air resistance (drag) it has, the higher it will go.

Launching the rocket:
1. Put on eye protection.
2. Turn the rocket upside down and remove the canister lid.
3. Fill the canister one-third full of water. You need to work quickly at this point!
4. Drop one-half of an antacid tablet into the canister.
5. Snap the lid on tight.
6. Stand your rocket on the floor or on a playground.
7. Stand back and wait. Your rocket will blast off! Try to watch the height it goes and compare different designs.

Science Checkup - Questions to ask to evaluate what was learned

- ❑ How did different design features (variables) affect the launches? What stayed constant (control)?
- ❑ What made the rocket launch?
- ❑ What changes would you make to your design the next time?

Extensions

- NASA Adventures in Rocket Science Educator Guide (for grades K-12). Designed for informal science leaders: http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Adventures_in_Rocket_Science.html
- NASA Rockets Educator Guide (for grades K-12). Designed for classrooms: http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Rockets.html

Vocabulary

Rocket: A vehicle, typically cylindrical, containing liquid or solid propellants, which produce hot gases or ions that are ejected rearward through a nozzle and, in doing so, creates an action force accompanied by an opposite and equal reaction force driving the vehicle forward.
Motion: Movement of an object in relation to its surroundings.
Thrust: The force from a rocket engine that propels it.
Drag: Friction forces in the atmosphere that "drag" on a rocket to slow its flight.
Mass: The amount of matter contained in an object.

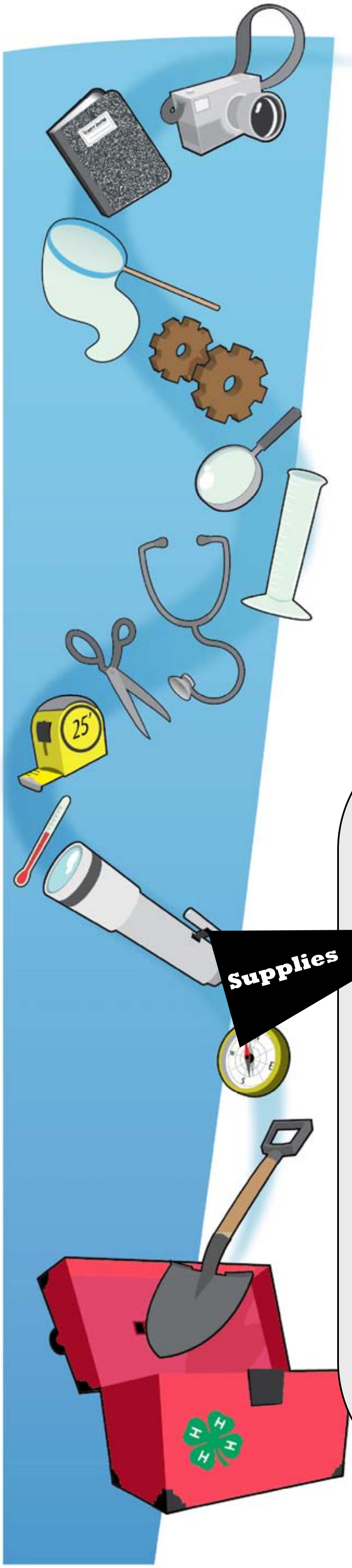
Background Resources

- The principles of all rockets are the same - Newton's Laws of Motion form the foundation for all rocket science. These laws relate force and direction to all forms of motion.
- How does the pop rocket work? When the fizzy tablet is placed in water, many little bubbles of gas escape. The bubbles go up because they weigh less than water. When the bubbles get to the surface of the water, they break open. All that gas that has escaped from the bubbles pushes on the sides of the canister and has to go somewhere! The lid pops off and the water and gas rush down and out, pushing the canister up and up, along with the rocket attached to it. This is Newton's Third Law: for every action there is an equal and opposite reaction.
- This unit is adapted from "Build a Bubble-Powered Rocket!" on the NASA Space Place site. http://spaceplace.nasa.gov/ There is another version on the LPI Explore! site in the Beyond Earth activities http://www.lpi.usra.edu/education/explore/beyondEarth/activities/rock

4-H Science Toolkit

Astronomy 2: Exploring the Solar System
Moon Landing

Activity Series:: Astronomy 2
Grade: 3-6
Time: 60 min



Main Idea

Students will design and build a spacecraft lander that will protect a marshmallow astronaut when it lands on the Moon. The junior engineers will learn to use the engineering design process.

Motivator

NASA engineers design and build many types of spacecraft. One spacecraft can take years to build because spacecraft are so complicated and engineers need to make sure everything will work right. As an engineer, you are going to design, build and test an original spacecraft lander to protect your marshmallow astronaut. Just like a real engineer, you will probably have to make changes after each test to improve your design.

Pre-Activity Questions

Before you start the activity, ask the students:

- When engineers design and build something new, do you think it always works right the first time? (no) If it doesn't work on the first try, what do they do? (modify the design and test again, over and over)
- What are some things you could do to protect an astronaut? (design a way to cushion the fall, absorb the shock, slow the spacecraft down… accept all answers)

Activity

Supplies

- Small paper or plastic cups (3-5 oz.) – 1 per lander
- Stiff paper or cardboard (approx. 4"x 5") – 1 per lander
- 3"x 5" index cards (brightly colored, if possible)
- Regular marshmallows – 1-2 per lander
- Miniature marshmallows (colored, if possible)
- Plastic straws (any type)
- Rubber bands
- Tape and scissors
- Fine string and lightweight plastic bags or Mylar for parachutes (optional)

1. Tell participants that NASA needs their help designing a spacecraft that can land on the moon without injuring the astronauts or damaging the spacecraft. Their landers need to land safely when dropped on the floor (the moon's surface). After making their first design, tell students they will test it to find ways to make it better — the design process engineers use.
2. Have students brainstorm ways to 1) design shock absorbers to soften the landing and 2) make sure the lander doesn't tip as it falls through the air. Show students how to make a spring out of an index card by folding it like an accordion. This is one method of absorbing shock — they could design other methods.

Objectives

- To use and understand the engineering design process

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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Astronomy 2
Moon Landing

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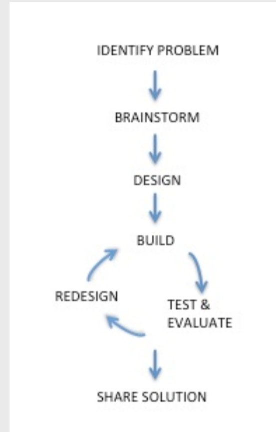
3. Build, test, evaluate, and redesign. Have students build their initial design, then test their spacecraft. Have them drop their spacecrafts from the same height and time the falls with a stopwatch to see how slowly they can make them fall. When they are ready, they may want to test a longer fall. You may or may not want to make it a competition.
4. After the first round of tests, have them meet as a group to talk about ideas for improving their spacecrafts. The design process is what is important. You could set a group goal to make all the spacecraft landers successful from a certain height and work together to achieve it. There is not one "right" design. Encourage and support everyone's efforts.



Science Checkup - Questions to ask to evaluate what was learned

- ❑ What forces affected the spacecraft lander as it fell? (It accelerated due to the force of gravity; air resistance slowed it down.)
- ❑ What changes did you make based on testing?
- ❑ Engineers' first ideas rarely work out perfectly. How does testing help improve a design?
- ❑ What did you learn from watching others test their landers?
- ❑ The moon is covered in a thick layer of fine dust. How might this be an advantage? A disadvantage?

Extensions

- This activity was adapted from the "Touchdown" activity in the "On the Moon" guide from Design Squad and NASA: Engineering Challenges for School and Afterschool Programs for Grades 3-12. http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/On_the_Moon_Guide.html
- Check out the Lunar & Planetary Institute "Explore!" activities from "To the Moon and Beyond!" and "Marvel Moon." http://www.lpi.usra.edu/education/explore/

Vocabulary

Potential and kinetic energy: When the lander hits the surface, its kinetic (motion) energy is changed into potential (stored) energy, which is stored in the shock absorbers.
Acceleration due to gravity: The lander accelerates (speeds up) as it falls due to Earth's gravitational pull.
Air resistance: Air exerts a force on the lander as it falls, slowing it down.

Background Resources

- NASA is one of the largest employers of engineers in the world. By engaging in engineering design projects, kids get an opportunity to experience engineering firsthand. When NASA engineers try to solve a problem, their initial ideas rarely work out perfectly. Like all engineers, they try different ideas, learn from mistakes and try again. The series of steps engineers use to arrive at a solution is called the "design process." The youth may want to research different types of engineers (such as aerospace, mechanical, electrical and computer).
- NASA for Students site: http://www.nasa.gov/audience/forstudents/index.html

Astronomy 2: Exploring the Solar System
Craters on the Moon

Activity Series:: Astronomy 2
Grade: 3-6
Time: 45 min

Main Idea

Impact craters form following a high velocity collision of a smaller object with a larger solar system body.

Motivator

Have you ever looked at the moon through binoculars or a telescope, or with your naked eye on a dark night? What did you see? There are countless numbers of craters formed by impacts with smaller objects that have hit the moon! We are going to model the formation of impact craters and experiment with different variables.

Pre-Activity Questions

Before you start the activity, ask the students:

- What causes craters on the moon and other solar system bodies?
- Are there impact craters on Earth? (Yes, one of the best known is Meteor Crater in Arizona.)
- Why are there more on the moon than on Earth? (Earth's surface changes over time from erosion, plate tectonics and volcanism.)

Activity

Supplies

- Sand or flour
- Chocolate cake mix or cocoa (optional)
- Plastic dishpan, foil tray with sides or cardboard box
- Objects for impactors (small rocks, ball bearings, marbles, other small hard objects)
- Measuring tape

1. Fill the tray or box with at least 3 inches of sand or flour. Then sprinkle a thin layer of cake mix (or cocoa) on top.
2. Drop objects one at a time and record data using the Crater Worksheet.
3. Can you draw conclusions based on the data? (Because of limitations to the model, conclusions may not hold true in actual cratering environments.)

Science Checkup - Questions to ask to evaluate what was learned

- What were some of the limitations to the model? (Not modeling the explosion that takes place in a high velocity impact; surface of flour or sand may be different than the real thing; objects moving too slowly; not coming from far away, etc. Accept all answers)
- What is the difference between a meteoroid, meteor and meteorite? (See background resources)
- If using cake mix of cocoa, did you see an ejecta blanket or rays form (See vocabulary for definitions)?

Objectives

- Understand what causes impact craters on solar system objects

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

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Craters on the Moon

Extensions

- Lunar & Planetary Institute Explore! Crater Creations activity. http://www.lpi.usra.edu/education/explore/LRO/activities/craterCreations/
- NASA Exploring Meteorite Mysteries Guide (for grades 5-12). http://curator.jsc.nasa.gov/outreach/expmetmys/
- Hawaii Space Grant Consortium Impact Craters activities. http://www.spacegrant.hawaii.edu/class_acts/

Vocabulary

Meteoroid: Most meteors are caused by meteoroids, which are sand- to boulder-sized particles of debris that enter Earth's atmosphere.
Meteor: The visible path in the sky that a meteoroid makes when passing through Earth's atmosphere.
Meteorite: A natural object originating in space that survives impact with Earth (or another body).
Shooting/Falling Stars: What some people call meteors, but they are not stars, so this is a confusing term.
Asteroid: Small, rocky objects in the inner solar system (primarily between Mars and Jupiter in a belt) that orbit the Sun.
Ejecta: Debris that falls in a generally circular pattern around a crater following an impact. It's normally thicker near the crater and thinner as it spreads out.
Rays: Radial streaks of fine debris thrown out during the formation of an impact crater.

Background Resources

- Impact craters form when a smaller body strikes a larger one in the solar system. They are found on all solar system objects that have surfaces. The occurrence and appearance of impact craters tell us about the history of cratering events and whether surfaces are geologically active.
- On Earth, impact craters are not easily recognized because processes — such as weathering, erosion, plate tectonics and volcanoes — change the surface over time. On the moon, there have been few changes to the surface over the last 4 billion years.
- When an object impacts a larger body, there are shock waves that occur and the material impacted is rapidly compressed, which cause a violent explosion. Since craters are caused by explosions, they are nearly always circular. The model described in this activity, therefore has limitations to accuracy, but will help the participants understand what causes impact craters.
- The root word meteor comes from the Greek meteoros, meaning "high in the air."

Worksheet 4.1

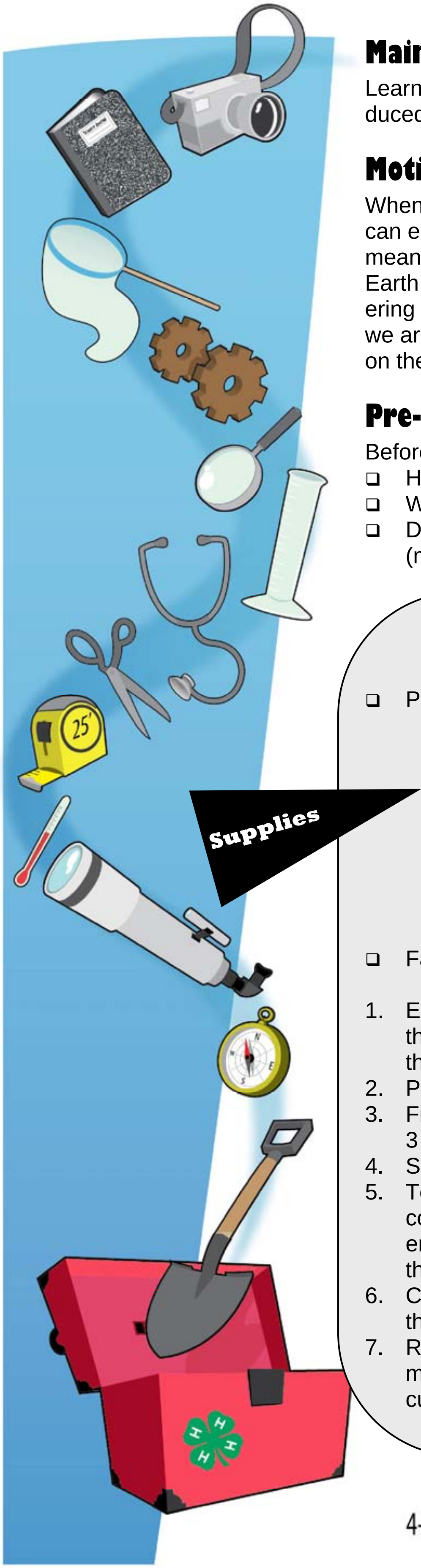
Cratering Worksheet

Object	*Object Size*	*Height Dropped*	*Speed Dropped*	*Crater Size*

4-H Science Toolkit

Astronomy 2: Exploring the Solar System
Lava Layers

Activity Series::	Astronomy 2
Grade:	3-6
Time:	60 min



Main Idea

Learn about the stratigraphy (layers) of lava flows on the Moon produced by multiple eruptions.

Motivator

When you go out on a clear dark night and look up at the Moon, you can easily see the maria (dark areas), caused by flows of lava. “Mare” means sea in Latin. There aren't volcanoes on the Moon, like on Earth and Mars. Scientists who explore rock or complicated lava layering like the layers on the Moon are studying “stratigraphy.” Today, we are going to model lava flows to learn more about how this occurs on the Moon.

Pre-Activity Questions

Before you start the activity, ask the students:

- ❑ Have you ever looked at the Moon on a clear dark night?
- ❑ What did you see? (craters, big dark spots...)
- ❑ Do you know what the dark areas are and what they are called? (mare - singular, maria - plural)

Activity

- ❑ Play dough (make or buy) - about 1 pound per group (in the same colors as food coloring if possible)
    - ❑ Cafeteria trays or cookie sheets with sides
    - ❑ 4 oz. paper cups (at least 5 per group)
    - ❑ Tablespoon and measuring cup
    - ❑ Baking soda
    - ❑ Vinegar
    - ❑ Food coloring in 4 different colors
    - ❑ Paper towels
    - ❑ Plastic knives or dental floss to cut through layers
- ❑ Fat, clear plastic straws (optional)

1. Each group needs a cup cut to a height of 2.5 cm (1 in) and put in the middle of the tray. This is the eruption source and the tray is the original land surface.
2. Place one tablespoon of baking soda in this cup.
3. Fill four 4 oz. cups (not cut down) with 1/8 cup of vinegar and add 3 drops of food coloring to each (4 different colors).
4. Set aside four balls of play dough (4 different colors).
5. To create your first eruption, pour one of the cups of vinegar-food coloring into your source cup with the baking soda and watch the eruption of "lava". Observe carefully where the "lava" went and then soak up most of the liquid with paper towel.
6. Cover the area where the lava was with your red play dough in a thin layer.
7. Repeat steps 6 and 7 with the other three vinegar-food coloring mixtures. You may need to add fresh baking soda to the source cup or spoon out excess vinegar.

Objectives

- Understand how lava flowed from eruptions on the ancient moon multiple times to create layers called maria.

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
Troubleshoot
Redesign
Optimize
Collaborate
Compare

Contributed By

Nancy Schaff, Cornell Center for Radiophysics & Space Research in the Department of Astronomy

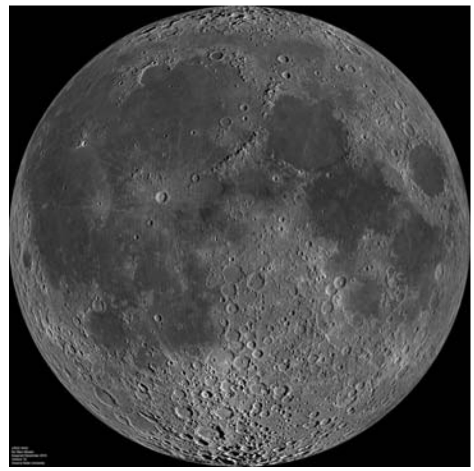
4-H Science Toolkit

Astronomy 2
Lava Layers

8. Switch places with another group and observe their lava model to see if you can determine where the youngest and oldest flows are. Make a vertical cut through an area of overlapping "lava" layers, draw a sketch of what you see in the vertical section and label youngest and oldest layers.
9. Optional - take a clear straw and take a core sample in several areas where lava layers overlap to help determine the history of the flows.

Science Checkup - Questions to ask to evaluate what was learned

- ❑ Discuss the observations that were made about how the lava behaved and what influenced the path of the lava flows.
- ❑ How do you think a scientist that studies lava flows that happened long ago determines the number of different layers and which are older and which are younger? (Remember, real lava isn't colored like play dough).



LROC WAC, No Slew Mosaic, Acquired, December 2010, Version 1b, Arizona State University

Extensions

- NASA Afterschool Mars and Earth module for grades 3-6. Scientific investigations using satellite images of Earth and Mars to compare surface features and learn about geologic processes. http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Mars_and_Earth_Educator_Guide.html
- NASA Exploring the Moon Teacher's Guide for grades 5-12: http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Exploring.the.Moon.html
- NASA Planetary Geology Teacher's Guide for grades 5-12: http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Planetary.Geology.html

Vocabulary

Maria (plural)/Mare (singular): Pronounced "mahr-ay-a" and "mahr-ay"; Large, dark, basaltic plains on the Moon, formed by ancient eruptions.
Stratigraphy: The study of rock layering.
Basalt: Igneous volcanic rock that flows out onto the surface from hot magma below. Found on Earth, the Moon, and Mars.
Impact Basin: Large impact feature more than 300 km in diameter.
Eruption Source: The place where the lava flows from and where it reaches the surface.

Background Resources

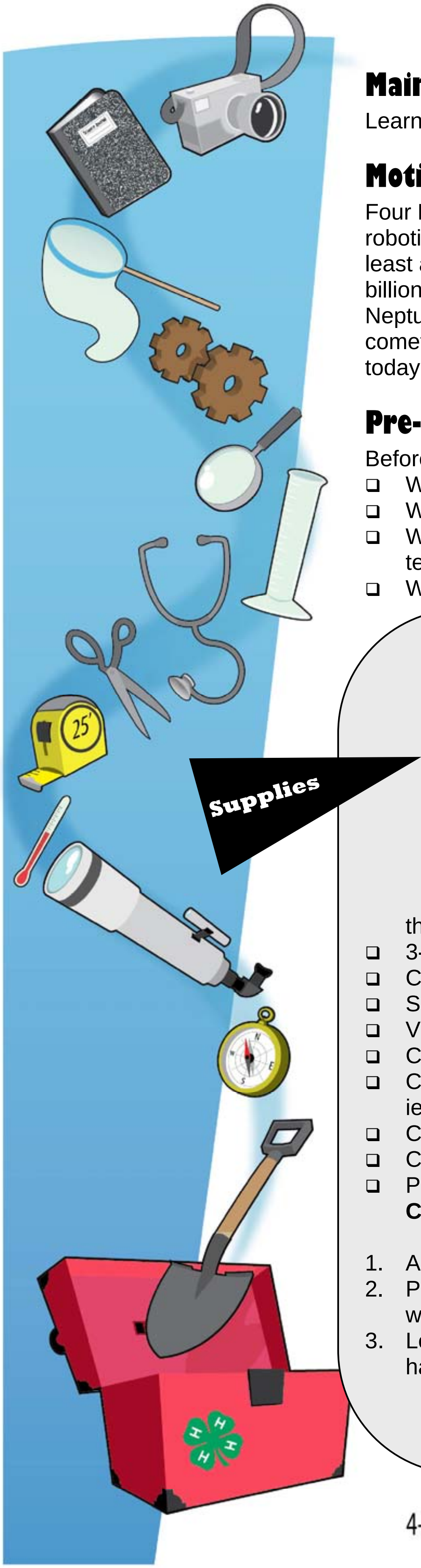
- The dark, flat maria (layers of basaltic lava flows) cover about 16% of the Moon's surface. The lava flowed long distances to flood low-lying impact basins.
- The eruption sources for most lunar lava flows are difficult to identify because they were buried by younger flows and/or eroded by meteoritic bombardment.
- Volcanism on the Moon took place 3-4 billion years ago. Because of the low gravity on the moon (1/6 of Earth's gravity), volcanic debris spreads out further. The flows must have been very fluid and the lack of water prevented explosive eruptions like we have on Earth, so the lavas flowed smoothly over the surface.

4-H Science Toolkit

Astronomy 2: Exploring the Solar System

Comet Ice Cream

Activity Series:: Astronomy 2
Grade: 3-6
Time: 60 min



Main Idea

Learn about what comets are made of by making ice cream.

Motivator

Four NASA missions visited three different comets with two different robotic spacecraft in 2004, 2005, 2010 and 2011. Comets are the least altered solid objects from the formation of the Solar System 4.6 billion years ago. They originate in the Kuiper Belt (the region beyond Neptune where Pluto lives) and the Oort Cloud (a spherical cloud of comets way beyond the Kuiper Belt). We're going to make ice cream today as a model of what comets are made of.

Pre-Activity Questions

Before you start the activity, ask the students:

- ❑ What is a comet?
- ❑ Where do they come from?
- ❑ What happens when they get closer to the Sun (closer than Jupiter's orbit)?
- ❑ What do you think they are made of?

Activity

Supplies for a group of 20. (Information in paratheses is what each ingredient represents.)

- ❑ Sturdy reclosable bags - One sandwich or quart size and one gallon size for each pair of participants
- ❑ Small cups and spoons to eat the ice cream
- ❑ Oven mitts, mittens or towels (the bags get cold!)
- ❑ Ice (enough to fill each gallon bag half full)
- ❑ Salt (2-3 containers)
- ❑ 1 gallon whole milk (2% will not work, some will be leftover, this represents water in comet)
- ❑ 3-4 cans evaporated milk or cream
- ❑ Can opener
- ❑ Sugar (organic molecules)
- ❑ Vanilla extract (organic molecules)
- ❑ Crushed chocolate sandwich cookies (dust)
- ❑ Crushed peppermint or toffee candy (minerals or new discoveries)
- ❑ Coconut flakes (CO2 and other frozen gases)
- ❑ Chopped peanuts (rocks)
- ❑ Paper and pencils for data collection

CAUTION: Be sure to check for food allergies!

1. Ask everyone to wash their hands or wear gloves.
2. Provide some background information about comets and explain what the different ingredients represent.
3. Load the gallon-size bags with 10 heaping spoonfuls of salt and half way with ice.

Objectives

- Understand what a comet is and what comets are made of

Learning Standards

(See Matrix)

Common SET Abilities 4-H projects address:

Predict
Hypothesize
Evaluate
State a Problem
Research Problem
Test
Problem Solve
Design Solutions
Develop Solutions
Measure
Collect Data
Draw/Design
Build/Construct
Use tools
Observe
Communicate
Organize
Infer
Question
Plan Investigation
Summarize
Invent
Interpret
Categorize
Model/Graph
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Comet Ice Cream

4. In the smaller bag, mix 1/3 cup evaporated milk (or cream), 2/3 cup whole milk, 5 teaspoons of sugar and a splash of vanilla (optional).
5. Each pair or team adds the other ingredients (cookies, nuts, candy, coconut) that they want in their comet and records those ingredients. Limit to 1 teaspoon of each per bag. Seal bag tightly to keep salt out!
6. Place the smaller bag inside the larger bag and seal well! Remove as much air as possible.
7. Gently roll and shake the bag, keeping it in constant motion until the ice cream gets to desired consistency. This is best done outdoors if possible or on a floor that can easily be mopped (in case of leaks). Rinse the outside of the ice cream bag before opening.
8. When ice cream is done, divide the ice cream in each bag into four portions and put into four cups.
9. Swap two cups with another team. Pretend your senses are an instrument on a spacecraft (spectrometer) taking data from a comet in space. One cup is for feeling (don't eat this one). The other cup is for (1) observing, (2) smelling, and (3) tasting. Record your data on a piece of paper.
10. Share your data with the team that made the test ice cream and see if you discovered the correct comet composition.
11. Eat your own ice cream!

Science Checkup - Questions to ask to evaluate what was learned

- How was your ice cream like a real comet?
- How was it different?
- Were you able to use your senses like a spacecraft instrument to determine the composition of the comet?

Extensions

- Older students can use "The Chemistry and Thermodynamics of Ice Cream" after this activity: http://deepimpact.umd.edu/educ/mod_ExploringComets/09_IceCream_ChemPhys.pdf
- More Comet activities and background information are available at the NASA Stardust-NExT site (recommended: "Comet-on-a-Stick" and "Cooking up a Comet"): http://stardustnext.jpl.nasa.gov/education/index.html
- NASA Solar System Comets: http://solarsystem.nasa.gov/planets/profile.cfm?Object=Comets
- Windows to the Universe Comets: http://www.windows2universe.org/comets/comets.html

Vocabulary

Comet: Small solar system body that originates in the Kuiper Belt or Oort Cloud.
Comet Nucleus: Small solid body that develops a coma and tail as it gets closer to the Sun. Irregular in shape, very dark and dirty, at least 85% ice, can be smaller than 1 km. or greater than 40 km.
Coma: Thin, fuzzy-looking temporary atmosphere that forms around the nucleus when the comet gets closer to the Sun (affect of solar wind and radiation).
Ion and Dust tails: Streams of dust and gas released from the coma.

Comet Ice Cream

Background Resources

- Scientists have learned about comet nuclei by visiting comets with robotic spacecraft (Giotto, Deep Impact, Stardust, EPOXI, Stardust-NExT, Rosetta).
- Comets are often called dirty iceballs or snowballs. The nucleus is a cold mixture of ices (water, carbon dioxide, ammonia) and other sandy/rocky materials left over from the formation of the Solar System. They also contain organic (carbon-based) molecules.