Astronomy Activities - Overview

Purpose

School groups (mostly ages 10-11) will be visiting Lakeside for a full day of space-themed activities

Our role

We are providing one of three sessions (the others are drama – exploring weightlessness, and art – constructing a lunar base). After an introductory session in the theatre, the school groups will rotate between these three activities (two AM, one PM). Lakeside staff will move groups between sessions.

Where

We are based in the Visual Arts Studio, upstairs in Lakeside Arts Centre (above the Box Office).

Leaders

Each session should have a nominated leader (normally June, Arianna, Meghan…) who should be responsible for keeping time. The leader should also assume responsibility for the Moon Rocks on loan from STFC. **Treat the Moon Rocks as you would a gold-plated, diamond-studded laptop** (ie don't leave them unattended). The Moon Rocks will be secured each day at the leader should be responsible for bringing them to the first morning session and bringing them back at the end of the day.

Our activities

In each session (75 minutes):

- welcome group into the "Space Lab" in character: they are "space cadets" in training and we are "space scientists".
- help them into labcoats provided (need to be collected at the end).
- leader should divde the group into 3 subgroups, and rotate as follows (approx 20 minutes each):
  - A: Gravity (main room)
  - B: Lunar Surface (small room)
  - C: Rockets: outside (weather permitting, otherwise big room)

Activity A – Gravity/Mass/Weight

Aims:

In this activity, the children should:

- learn that gravity is a force that pulls two objects together
- observe that objects of the same mass fall at the same speed (in the absence of air resistance)
- understand the the Moon does not have an atmosphere
- learn that the gravitational force on the Moon is 1/6 that of Earth

Activities [20 min]:

- Discuss the idea of gravity: what is it? What keeps us on the Earth? What happens when we go into space – do we "escape" gravity?
- Challenge the children to predict what happens when two objects of different masses are dropped at the same time – will they hit the ground at the same moment? Why or why not?
- Demonstrate using the vacuum pump with the feather and the coin (or similar) – with air resistance (see Appendix for instructions on operating the vacuum pump)
- Ask again what will happen if you take the air out & repeat demonstration with a vacuum. Does this go against their intuition?
- Discuss what it would be like on the Moon – does the Moon have an atmosphere? What is the force of gravity there compared to Earth, and why?
- show the video clips of astronauts moving on the Moon [?]
- Have the students explore the effects of lower gravity. Rolling out the long paper on the floor, have them each see how far they can jump, then translate that distance x 6 to see how much further they could jump on the Moon.

Materials

- vacuum tube and test objects
- laptop with Moon videos
- long paper roll, measuring tape, markers

Activity B – Lunar Surface and Slime Making

Aims

In this activity, the children should:

- learn about the characteristics of the lunar surface
- understand how craters are formed
- select an appropriate landing site
- understand how shadows help us interpret a 3D photo in 2D
- have fun mixing up slime

Activities

I. Introducing the lunar surface [5 min]

- introduce the posters of the Moon's surface. Note the differences between the craters (bombardment origin) and the seas (volcanic origin, or lava flows).
- Ask what they think rocks from the Moon would be like. How did we get them?
- Allow them to explore the Moon rock samples, using the microscopes if desired.

II. Picking an appropriate landing site [5 min]

- Ask them to look at photos of the Moon's surface. What would make a good landing site? Where would they land a mission, and why?
- Discuss the idea of shadows, light (where is the illumination coming from in this photo), and how we learn about 3D shapes from a 2D photo.
    - have students put on gloves
    - using the dark slime provided have them try to recreate one of the craters on the photographs until the shadows match

III. Making slime [10 min]

- remind them they are laboratory scientists and should be listen carefully and to follow instructions. **Make sure they have gloves and safety glasses on.**
- each child receives a Styrofoam cup. Demonstrator pours ~1 cm of Borax **[hazard]**.
- each child may add **one or two** drops of food colouring, and a **small** amount of glitter.
- Demonstrator pours PVA into the cup while the child carefully stirs. Continue until desired consistency reached.
- At this point the children may kneed, mold and play with the "slime" using their hands.
- At the end of session, each child may take their slime home by placing it in a Ziploc bags with advisory labels attached. Remiind them that the food colouring will stain their clothes and hands.
- **for more details, see extended lesson plan at end**

Note: if time runs out before reaching Part III, allow them to take a pre-prepared bag of slime home. Make up replacement bags after the session.

Materials

- Moon rocks & microscopes
- pre-made slime (or Playdoh)
- Styrofoam cup, pre-prepared PVA and Borax solutions, stirrer, latex gloves
- Ziploc bags and labels

Activity C – Rocket Launching

Aims

In this activity, the children should:

- learn about how spacecraft are launched
- learn about rocket propulsion and Newton's 3rd law (action – reaction)
- explore what characteristics make a good rocket
- have fun launching their own rockets

Activities [20 min]

Option A: wet weather

- Discuss how we launch spacecraft and how rockets work
- Explain that they will now have an opportunity to make their own rocket, and have them predict what aspects of a rocket will make it most successful:
    - Does the shape of the balloon affect how far (or fast) the rocket travels?
    - Does the length of the straw affect how far (or fast) the rocket travels?
    - Does the angle of the string affect how far (or fast) the rocket travels?
    - Does adding fins or other modifications make the rocket go further?
- Have each child construct a balloon rocket out of the materials of their choice.
- Lauch each balloon on the string and see which one travels furthest!

Option B: dry weather

- Weather permitting, take the children outside and set up the stomp rockets.
- Discuss how the rockets work
- Let each child make superficial modifications to each rocket using art materials (fins, etc)
- Let each child launch a rocket, and record how long the rocket stays airborne

Note: at the end of the day we will award a prize to the group whose rocket has travelled furthest/longest so please pass this information on to the day's leader.

Materials:

Wet:
- string
- balloons
- drinking straws
- clothespegs
- scissors
- tape
- art materials

Dry:
- Stomp Rockets
- stopwatch
- art materials

Appendix A: Moon Facts

National Geographic News
July 16, 2004

• How did the moon form? According to the "giant impact" theory, the young **Earth had no moon.** At some point in Earth's early history, a rogue planet, larger than Mars, struck the Earth in a great, glancing blow. Instantly, most of the rogue body and a sizable chunk of Earth were vaporized. The cloud rose to above 13,700 miles (22,000 kilometers) altitude, where it condensed into innumerable solid particles that orbited the Earth as they aggregated into ever **larger moonlets, which eventually combined** to form the moon.

• By measuring the ages of lunar rocks, we know that the moon is about 4.6 billion years old, or **about the same age** as Earth.

• The distance between the Earth and its moon averages about 238,900 miles (384,000 kilometers). The diameter of the moon is 2,160 miles (3,476 kilometers). The moon's mass—the **amount of material** that makes up the moon—is **about one-eightieth of the Earth's** mass.

• Because the force of gravity at the surface of an object is the result of the object's mass and size, the surface **gravity of the moon is only one-sixth** that of the Earth. The force gravity exerts on a person determines the person's weight. Even though your mass would be the same on Earth and the moon, if you weigh 132 pounds (60 kilograms) on Earth, you would weight about 22 pounds (10 kilograms) on the moon.

• The rotation of the moon—the time it takes to spin once around on its own axis—takes the same amount of time as the moon takes to complete one orbit of the Earth, about 27.3 days. This means the moon's rotation is **synchronized in a way that causes the moon to show the same face** to the Earth at all times. One hemisphere always faces us, while the other always faces away. The lunar far side (aka the dark side) has been photographed only from spacecraft.

• The **shape of the moon** appears to change in a repeating cycle when viewed from the Earth because the amount of illuminated moon we see varies, depending on the moon's position in relation to the Earth and the sun. We see the full moon when the sun is directly behind us, illuminating a full hemisphere of the moon when it is directly in front of us. The new moon, when the moon is darkened, occurs when the moon is almost directly between Earth and the sun—the sun's light illuminates only the far side of the moon (the side we can't see from Earth).

• The **moon orbits the Earth** at an average speed of 2,300 miles an hour (3,700 kilometers an hour).

• The moon's **gravitational pull on the Earth** is the main cause of the rise and fall of ocean tides. The moon's gravitational pull causes two bulges of water on the Earth's oceans—one where ocean waters face the moon and the pull is strongest and one where ocean waters face away from the moon and the pull is weakest. Both bulges cause high tides. These are high tides. As the Earth rotates, the bulges move around it, one always facing the moon, the other directly opposite. The combined forces of gravity, the Earth's rotation, and other factors usually cause two high tides and two low tides each day.

• The **airless lunar surface bakes** in the sun at up to 243 degrees Fahrenheit (117 degrees Celsius) for two weeks at a time (the lunar day lasts about a month). Then, for an equal period, the same spot is in the dark. The dark side cools to about -272 degrees Fahrenheit (-169 degrees Celsius).

• The rocks and soil brought back by Apollo missions are **extremely dry**; the moon has no indigenous water. However, the moon is bombarded by water-laden comets and meteoroids. Most of this water is lost to space, but some is trapped in permanently shadowed areas near both poles of the moon.

• To the unaided eye, the bright lunar highlands and the dark maria (Latin for "seas") make up the **"man in the moon."** A telescope shows that they consist of a great variety of round impact features—scars left by objects that struck the moon long ago. The largest scars are the impact basins, ranging up to about 1,500 miles (2,500 kilometers) across. The basins were **flooded with lava** some time after the titanic collisions that formed them. The dark lava flows are what the eye discerns as maria.

• On the moon there are **no mountains like the Himalaya,** produced by one tectonic plate bumping into another. There is no continental drift on the moon. Everywhere, the moon is sheathed by rocky rubble created by constant bombardment by meteoroids, asteroids, and comets.

• No cheese has ever been found on the moon.

Adapted from the National Geographic Atlas of the World (Seventh Edition) *and* Exploring Your World: The Adventure of Geography, *both published by the National Geographic Society.*

Appendix B: Operating the Vacuum Pump

From Boris:

- plug in the vaccum pump
- plug in the hose to the cylinder
- open valve to cylinder (!!!)
- switch on the pump (or the socket)
- after 10-20 seconds, the pressure should be low enough (you can see on the scale)
- close valve (!!!) BEFORE you switch off the pump
- you CAN unplug the hose if you want to
- turn the cylinder around: the feather and lead should now BOTH drop at the same speed.
- After use, just open the valve to let air back in. You can see that on the scale and you should hear it. If not, close the valve, unplug the hose and ry again.

I think for storage over night, we should let air in for sure, during the day,... possibly also, doesn't make much sense to leave it, really.

If the feather sticks to the top, there is moisture in the cylinder, in this case, open the cylinder (no vacuum first ;-)) and let it dry over night. Or change object to another feather.

Appendix C: Notes on SLIME...

http://www.msm.cam.ac.uk/SeeK/slime.htm

AIM:
To introduce polymers and cross-linking within polymers by making slime which demonstrates both liquid-like and solid-like behaviour - the property known as viscoelasticity.

CURRICULUM LINK:
KS1: Sc3 Materials and their Properties, Changing Materials 2(a)
KS2: Sc3 Materials and their Properties, Grouping and Classifying Materials. 1(e) KS2: Sc3 Materials and their Properties, Changing Materials 2(a) and (f) Introduction to KS3: Sc3 Materials and their Properties, Changing Materials - Chemical Reactions. 2 (h)

TIME:
30-45 minutes

MATERIALS REQUIRED:
Per group/pair/child (as appropriate):
1 plastic disposable cup containing 20 ml of borax solution* (borax – or hydrated sodium borate– can be bought as powder from chemists/supermarkets, it is a cleaning agent)
1 plastic disposable cup containing 20 ml of PVA glue solution*
1 wooden lolly stick for stirring
1 plastic dropper for the borax solution
food colouring/glitter - optional
clingfilm to wrap slime to take it home
Results table [PDF version] [Word version] *see below for how to prepare these solutions

METHODS:
SAFETY: This should be done under adult supervision. Borax and PVA are unsafe in their concentrated forms for use by children, though the diluted solutions used here are suitable for children to use with supervision. Neither Borax or PVA should be swallowed, and subsequently the slime is inedible. The children should wash their hands after making the slime and before eating or going to the toilet. Any leftover solutions should be diluted further with water and washed down the sink by an adult.
Prepare in advance (by and adult):
Prepare the borax solution as follows: find a container which can hold enough water for the amount of slime to be made (20ml each). Fill with the appropriate amount of water and slowly add borax powder a little at a time, stirring until no more dissolves.
Prepare the PVA glue solution: find a container which can hold enough water for the amount of slime to be made. Calculate how much solution is needed (20ml each). Mix half PVA glue and half water to reach the target amount. Stir until a uniform consistency is reached.
2 cups are needed per group/pair/child. Pour 20 ml of borax solution into one cup - labeled borax, and pour 20ml of PVA solution into the other cup - labeled PVA. Repeat until you have enough for everyone.

Making the slime:
Children should be made away of the safety aspects about not drinking any solutions and not eating the resulting slime. Also, remind them that it is important to wash their hands afterwards.
Take the PVA solution. A few drops of food colouring/glitter may be added to it at this stage – to make the finished slime more interesting to look at. Mix with the wooden stirrer.
Add a few drops of borax solution at a time with the dropper and stir with the wooden stick.
Continue adding the borax solution in drops until there is no liquid left and only slime remains. At this point the slime will not stick to the container.
Remove the slime from the cup and knead it by hand.
Allow the children to investigate the properties of the slime. The results table might help focus the investigation.
Wrap the slime in cling film when finished – to prevent it drying out. The children can take it home.
Discuss the obvervations with the rest of the class.

THEORY:
Polymers are long chains of molecules and they can be cross-linked, joining several chains together. This will change the properties of the polymer.
PVA is a polymer – polyvinyl alcohol.
When borax is added to PVA it causes a reaction where the PVA chains cross-link, or join together in places.
This makes the PVA less runny as the PVA chains can not easily slide past each other any more.
If more borax is added, more PVA chains join together until finally the slime is formed and the PVA looks more like a solid.
The slime has very different properties depending on what you do to it – it is viscoelastic.
It can be squishy (viscous behaviour) or bouncy (elastic behaviour).

If you make a ball from the slime and drop it on the table, it will bounce. The energy from bouncing spreads through out all the chains which are joined together and can not spread out in the time it takes to bounce.

If you place the slime on the table, it has time to slowly spread out, similar to a liquid. It is put in a container (e.g. the cup) it will spread and become the same shape as the container.

'Silly Putty' is the commercially available version of the slime made here. There are also some things you can try with it as it holds its shape better.

Make two sausages out of the silly putty. Pull one apart slowly, and pull the other apart quickly. What is the difference? Think about what might be happening.

If left overnight the silly putty will spread out like the home-made slime.

The slime can be kept for several days before it dries out – it should then be thrown away. It will last longest if you keep it in an airtight container in the fridge.

If left on clothes, carpets etc, leave to dry and then scrape it off. Any residue can be washed with warm water as the clime is water soluble. But it is always best to avoid this happening in the first place