# LET'S LEARN ABOUT OUR SOLAR SYSTEM

**BOSTON UNIVERSITY CENTER FOR SPACE PHYSICS**

# Sun Station:
# Scale of the Solar System

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Center for Space Physics

How away far are planets from us and each other?

How far away is your school from your home? How far away is it from Boston to Paris? These are typically distances we measure in miles or kilometers (km). In our solar system, planets are so far apart that instead, astronomers use AU to measure distance. An AU means Astronomical Unit. It is the distance between Earth and the Sun.

Our Sun is REALLY far away.

One AU is about 150 million km, that's about 90 million miles. If you were driving a Bugatti Super Sport at 250 miles per hour, it would take you about 42 years to get from Earth to the Sun – that's if you don't stop for gas or a nap!

In order from the Sun, our planets are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. Mercury is about half an AU from the Sun. Pluto (a dwarf planet) is about 35 AU from the Sun. Let's pretend to shrink the solar system to get it to fit into this hallway and hang balloons where the planets should be. In this case, the length of 5 tiles on the floor is about one AU.

5 tiles = 1 AU
10 tiles = 2 AU
20 tiles = 4 AU
30 tiles = 6 AU
50 tiles = 10 AU
100 tiles = 20 AU

Can you figure out how many floor tiles are between the Sun and Jupiter? _____

How many AU would that make? _____

What about Saturn? _____ tiles, _____ AU

What can go faster than a Bugatti? _____

# Mercury Station: Craters

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What makes crater marks on some planets and moons?

When our solar system first formed (about 4 ½ billion years ago), the smooth surfaces of planets and moons were changed by objects in space hitting them REALLY hard. Objects that are flying about in space include broken up pieces of comets or asteroids (called meteoroids).

Some meteoroids can move WICKED fast! A race from Cape Cod to Boston would take them about one second!

When an object moving that fast hits the surface of a planet, it creates an impact crater. Different sizes of meteoroids moving at different speeds can create different sizes of craters. Some planets have enough air around them to slow down these meteors, or to break them up completely.

Pretend the bucket of sand is the smooth surface of Mercury.

Pick a weight and drop it from one-meter height into the bucket using the meter stick as a guide. You just made a crater! Notice how big the crater is.

Try dropping the same weight from half a meter. Does the new crater look different? How?

_____ Smaller _____ Larger _____ Same

Try dropping another ball of the same size from half a meter. Does the new crater look different? How?

_____ Smaller _____ Larger _____ Same

Try dropping another weight (bigger or smaller), from half a meter height. How is this crater different from the previous one?

_____ Smaller _____ Larger _____ Same

Questions? Contact majdm@bu.edu.

# Venus Station: Gyro-motion

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Planets rotate about their axis. This is due to how planets form, and their circular motion. A gyroscope is a tool that demonstrates rotation about an axis, just like a planet. A top is a simplified gyroscope.

The way a gyroscope behaves is used to help scientists determine the orientation of flying objects like planes, rockets, and satellites, when they are flying.

Examine the gyroscope in the Station. Ask the guide to spin it.

Watch what happens to the axis when it is spinning. You might see it tracing a circle. This type of motion is called precession. Does this circle being traced change when the tilt of the axis is changed?

Try to spin a top. Do you see precession?

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# Earth Station: Virtual Reality

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Virtual reality means 'almost real'. It is a popular way for people to be able to 'almost' experience something without 'actually' experiencing it. This type of tool uses models to project images and sounds of environments as realistically as possible on a screen.

You may have heard of VR (a cool abbreviation for Virtual Reality) in video games or some movie theaters. Scientists use VR to generate images of space that can be used to train astronauts, help them visualize a remote environment, and to make cool demonstrations for kids and grownups to see and tell their friends about… because, let's face it: space is cool.

Use the apps and Google cardboard to experience the virtual reality of being in space and looking around.

What did you look at? _____

What one word can you use to describe outer space? _____

How badly do you want to go there someday?

- ☐ Where do I sign up?
- ☐ Meh
- ☐ Naaa, I prefer to read about it.

In what ways can VR be used to help people, other than looking at space?

_____

# Mars Station: Rockets

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Ever tried jumping really high? Betcha always come right back down. What about throwing a ball really high up into the sky. It will always come back to the ground.

Rockets are heavy! How do we get them to launch into outer space without falling back?

The part of the rocket that takes care of that is called the propulsion. It generates enough force to PUSH the rocket so far out into space that the rocket can get to where it needs to without falling back to Earth like the ball.

Use the materials at this station to build your own rocket!

In the rocket you make today, your fuel will be Alka-Seltzer and water. When these two are mixed, the water gets bubbly. When you have a lid on the container, the bubbles are trapped and start to form enough pressure that the lid will 'POP'. You will use this POP to get your rocket to launch.

Once your rocket is assembled, continue through the solar system and wait your turn for the roof launch by Neptune and Pluto.

At your turn, Follow the guide's instructions on how to fill your canister with your fuel. Step back and watch.

Did your rocket launch? _____

How high up did it go? _____ miles (just kidding – you can use feet for this)

You can take your rocket home with you and try this again. Try using different sized Alka-Seltzer tablets. What does adding too or too little do to your launch? How about changing how much water you use? How does that change your launch?

Can you try to weigh down your rocket by taping pebbles to it? How does that affect the launch?

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# Jupiter Station: Spectroscopy

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When we study an object like a seashell, we can pick it up, look at it, feel its texture, listen to the echoes inside it, even sniff it. How do scientists study planets and stars that are too far away?

The universe is made up of elements that do different things to light. When we look at an object using special telescopes, we see the properties of light change in ways that tell us what the planet or star is made of. This is called spectroscopy.

A few elements that affect light in ways that we can see are Hydrogen, Helium, Sodium, Neon, and Argon (to name a few).

There are a few lights on the station that have different colors.

Examine these lights and ask about what elements are producing different colors:

Color 1 is _____. This is from the element _____ .

Color 1 is _____. This is from the element _____ .

Color 1 is _____. This is from the element _____ .

Look up at the lights on the ceiling using your diffraction grating. What are some of the colors that you see?

_____

If you see 'red' from looking at Jupiter, then what does Jupiter probably contain (circle one)?

Hydrogen A lot of Anger Sodium

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# Saturn Station: Optics

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We use our eyes to see a lot of cool things. When we look up into space, we either have things that are too bright to safely look at (like the Sun), or too faint and far away to see clearly.

We can use a pinhole camera (also known as camera obscura) to help us see things that can be too bright to look at directly. This type of camera helps us project an image onto a screen for us to look at more carefully. Check out the pinhole camera at the station.

What did you look at? _____

How did the pinhole camera change it? _____

Telescopes are used to magnify an image of something far away. A telescope is made of lenses that have special shapes and are placed a special distance apart. Some lenses flip the image upside down, so we can use two of them to flip the image right back up!

Look at the different lenses at the station. Use the laser light to see what they do to the light beam.

What type of lens do you think will flip an image upside down? _____

What type of lens do you think will make an image bigger? _____

Questions? Contact majdm@bu.edu.

# Uranus Station: Balloons

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The stuff inside a planet can tell scientists about many properties of this planet. It's not always possible to send an astronaut, rover or orbiting satellite to objects in space. So, scientists use models as tools to understand the interiors of planets.

A model is a 'pretend' simulation of a planet that scientists can use to best understand a faraway object by how it behaves. Using models, we learned that Uranus is an ice giant that is tilted to its side due to an impact after it was formed about 4 billion years ago… so before you were born.

Planets with different interiors behave differently.

On this station, you will find balloons with different things inside them. What properties can you find that are unique to each balloon?

Balloon 1 behavior: _____

What is inside Balloon 1: _____

Balloon 2 behavior: _____

What is inside Balloon 2: _____

Balloon 3 behavior: _____

What is inside Balloon 3: _____

How can scientists check if the inside of Pluto has ice-cream (chocolate flavored, of course)?

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# Neptune Station: Weight & Gravity

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What we weigh on a scale is made up of how much mass we have in and on us (bones, skin, hair, sneakers, etc.) as well as how much gravity pulls on us.

Gravity is a force that is generated by every object with a mass. You feel the gravitational pull of the Earth when you try to jump up. Instead of floating away, you come back down. You have gravity, a tree has gravity, your eyelash has gravity… the gravitational pull from these smaller objects are very small though, compared to the gravitational pull of the Earth. That is why a refrigerator does not attract a car key, or the other way around, in a way that you can notice.

Gravity on the surface of a planet depends on how big it is. On Earth, the gravitational pull is about 10 $m/s^2$. On the Moon, it is 6 times smaller than that, because the Moon is smaller than Earth. On Pluto, the gravitational pull is 16 times smaller than at Earth. A 100 lb box on Earth would weigh only 6 lbs on Pluto! It would be every Fedex carrier's dream job to work there, but they aren't hiring – we checked.

This station has different weight scales to copy the different gravitational pulls of different Solar System objects. Use the weight of objects to see how the numbers on the scale change.

How much does the object weigh on Earth? _____

How much does the object weigh on Jupiter? _____

How much does the object weigh on Mars? _____

Which of these planets do you think is the biggest, based on its largest gravitational pull?

_____

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# Pluto Station: What's Beyond?

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Our Sun has a magnetic field that forms a big bubble that separates our Solar System from regions beyond. What's out there? We are a small part of a galaxy called the Milky Way, and we turn around its center that is a big black hole. There are lots more galaxies out there (billions and billions of them!) and we can't even see all of them.

In those galaxies, near and far, other planets orbit stars. These are called exoplanets. Scientists are very interested in trying to find as many planets that are Earth-like to see if they are habitable, like our world.

Imagine another planet kind of like Earth but not exactly. It orbits a star kind of like the Sun, but not exactly.

List what you think this planet would need to be able to have plants grow on it.

_____. _____. _____.

_____. _____. _____.

Draw a picture of what you think people on this planet would look like. Why would they be the same or different than us?

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# Cool Tools:
# Camera Obscura

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A camera obscura is another name for a pinhole camera. It is a box-like object with a small hole at one end that can be used to see objects at a distance projected onto the other end of the box. When a pinhole is used, the image will be faint and require a dark room for it to be clearly seen. This is why this device got its name. Obscura means 'shadowy' in Latin.

When a camera obscura is built using a lens instead of a pinhole, it allows for an image to form and be seen without the need for a darker room because it can collect more light from the original image. It is still called a camera obscura though, because it just sounds cool to say. Can you say camera obscura 10 times? Fast?

Look through the camera obscura at your station.

What did you look at?

_____

How different was it from the original image?

_____

What can you do to make the image look more like the original?

_____

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