FOR THE FAMILY OF: ______________________

INVESTIGATING Astronomy CONNECTIONS

Investigating Planets

If you could hover in your spacecraft above the rings of Saturn at a distance of 600,000 miles, this is the view you would have out your window!
See story on page 2.

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TERC

Family Features

Moon Jump/ Planet Jump

Materials You'll Need

To start, you'll need two sticky notes for each participant. You'll also need a ruler or meter stick, and you might find a calculator helpful.

The planets in our solar system are quite wonderfully different from each other. Although we've yet to set foot on any one of them beside Earth, we can imagine what it might be like, just by understanding some of the planets' physical characteristics. Some are big, but not very dense; some are small and rocky. All of this affects how strong the pull of gravity is at their surface. Some planets don't have a solid surface, and the surface that we see is really cloud tops.

Use the table below to find out how high you could jump on each of these worlds.

Put your initials or name on your sticky notes. Face a wall, stand flat-footed, and reach up and place one of your sticky notes on the wall to mark the spot where your fingertips touch.

Hold your second sticky note with your fingertips, take one step back, jump as high as you can, and slap the sticky note onto the wall.

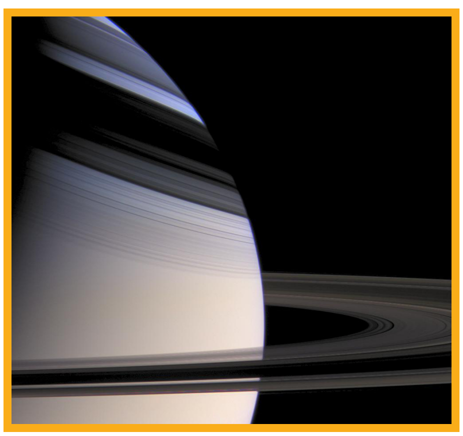
Now take your ruler or meter stick and measure from the top of the lower sticky note to the top of the higher one. Record this number in the table below. Repeat this for each participant or family member. Now multiply the numbers you got by the factors in the table to see how high you could jump on each of the other worlds in the solar system.

World	Height Jumped on Earth	Gravitational Factor	Height of Jump on Another World
Sun*		x 0.036	
Mercury		x 2.63	
Venus		x 1.1	
Earth's Moon		x 6.0	
Mars		x 2.63	
Jupiter*		x 0.4	
Europa (one of Jupiter's moons)		x 7.7	
Saturn*		x 1.1	
Titan (Saturn's largest moon)		x 7.1	
Uranus*		x 1.1	
Neptune*		x 0.83	

Note: You can use the same factors with your weight to find out how much you weigh on each of these places. Just divide instead of multiply.

*The sun and the four *'d planets don't have solid surfaces. They are made of gas, so in reality, jumping on their surfaces would be impossible.* ★

On the Cover



If you could hover in your spacecraft above the rings of Saturn at a distance of 600,000 miles, this is the view you would have out your window! In this true-color view, the shadow of the rings strikes the golden and azure clouds of the northern hemisphere. The rings are made up of billions of bits of ammonia, carbon dioxide, and water ice. (Credit: NASA)

Solar System in Your Pocket

Materials You'll Need

I meter of paper tape

colored markers

Building scale models of the solar system is a challenge because of the vast distances and huge size differences involved. This is a simple little model to give you an overview of the distances between the orbits of the planets in our solar system.

To do this activity, each person will need about a meter of paper tape, the kind used with a cash register or adding machine and something to write with. You can use colored markers to jazz it up. Just to review, the order of the planets going out from the sun is:

- Mercury
- Venus
- Earth
- Mars
- (Asteroid Belt)
- Jupiter
- Saturn
- Uranus
- Neptune
- Pluto (dwarf planet)
- 2003UB313 (recently discovered "10th planet")

To start, place a mark on each end of the tape, right at the edge. Label one "Sun" and the other "Pluto."

Next, fold the tape in half, crease it, open it up again and place a mark at the halfway point. Surprisingly, this is Uranus.

Now refold the tape in half, and then fold in half again. Unfold and lay it flat. Now you have the tape divided into quarters, with the sun at one end, Pluto on the other, and Uranus in the middle. Place a mark at the ¼ and ¾ creases, and label as Saturn (closer to the sun) and Neptune (closer to Pluto), respectively.

Stop and observe your work. Which part of the solar system has filled 3/4 of your tape? That's right, you've only been mapping out the locations for the four most distant planets. That means you've still got five, plus the asteroid belt, to fit into the quarter between the sun and Saturn! Let's keep going to see how this will work.

Fold your tape back into quarters, then in half one more time. This will give you eighths. Unfold and lay the whole tape flat again. Place a mark for Jupiter at the 1/8 fold line (between the sun and Saturn), and label it.

From this point on, there is no need to fold the length of paper again. If you take a look, you'll see you've got the four gas giants and Pluto there. For the remaining terrestrial (small rocky) planets, you'll only need 1/2 of the first 1/8th! That's the inner 1/16th of your meter of paper! Fold the sun out to meet Jupiter to mark the 1/16th spot. A planet does not go on the 1/16 line, but the Asteroid Belt does, so label that mark as such.

At this point, things start getting crowded and folding won't result in precise distances, so fold the remaining 1/16th in half and crease at the 1/32nd spot. Place a mark for Earth just inside this fold (between the sun and the Asteroid Belt) and a mark for Mars just outside the fold (closer to the Asteroid Belt) and label them.

For Mercury, and then Venus, look at the space between Earth and the sun. You'll need to divide that space into thirds, making a mark for Mercury closest to the sun and for Venus closest to Earth.

Smooth out your model and admire your work. Are there any surprises when you look at the distances between the planets this way? Many people are unaware of how empty the outer solar system is (there is a reason they call it space!) and how crowded, relatively speaking, the inner solar system is.

Here are some questions to consider as you contemplate your solar system model:

1. *Given this spacing, why do you think the Earth-sized planet Venus can outshine Jupiter, the largest planet, in the night sky?*
2. *Can you estimate where the recently discovered "10th planet", 2003UB313, should be located using the same scale as your model?* It is approximately 97 astronomical units (AU) from the sun.
3. *On this scale, where would the nearest star be?* (1m = 40 AU; Proxima Centauri is 4. 3 light years from the sun, and 1 light year = 65,000 AU)★

Answers:

1. Both are covered with highly reflective clouds and although it is much smaller Venus is also much, much closer.

2. A planet 97 AU's from the sun would require more than twice the length of the model, so you'd need to add another one and a half meters to the model.

3. The nearest star would be about 7 kilometers, or 4.2 miles, away!

Star Witness

Daniel Durda

Planetary Scientist

What do an F18, a NASA hypervelocity gas gun, and a paint brush have in common? They are all tools of the trade for planetary scientist Dr. Daniel Durda of the Southwest Research Institute.

Dan says he's always loved science, but the real turning point for him was the Carl Sagan television series, *Cosmos*, which aired in 1980. Dan was a sophomore in high school then, and after seeing just a few episodes, he announced to his guidance counselor that he would get a PhD in astronomy and do research. This was not a common goal for kids growing up in rural Michigan, but it is exactly what he did. Dan received his Bachelor of Science degree in 1987, his Masters in 1989, and his Ph.D. in 1993.

In graduate school, Dan worked with an advisor whose area of research was the evolution of asteroids and interplanetary dust. And since then, he has studied how asteroids contribute to the dust in the plane of the solar system, how collisions with asteroids may create asteroids with moons in orbit around them, and how stray asteroids may impact Earth with devastating results.

That's where the F18 (a high-speed jet that can fly at relatively high altitudes) comes into the picture. After graduate school, Dan landed a great job in Arizona, which gave him the freedom to fulfill a personal aspiration—to become an instrument rated pilot. That personal interest, combined with his research, led him to his job with the Southwest Research Institute. There, they used F18s to demonstrate the usefulness of small planes for astronomical research. And Dan has flown in the back seat of several F18s piloted by space shuttle commanders.

So what about that hypervelocity gas gun? To really understand the dynamics of asteroid impacts, you can go to sites of ancient impacts, you can run mathematical models, or you can crash rocks together. Dan's done all of these, and a hypervelocity gas gun is the device that crashes rocks together. Actually, it shoots small aluminum pellets at real meteorites—bits of asteroids that have been collected on Earth—and then Dan studies the properties of the dust, including the size and chemical distribution of the debris created by the impact.

One additional personal interest that has influenced Dan's professional life is painting. He was stunned and inspired by space art that he saw at a gallery in Tucson, AZ, and he took it on as a personal challenge to try to create the same kind of visualizations. After all, a mathematical model gives you one perspective on the collision process (temperatures, pressures, chemical distribution, etc.), but a painting shows you what it might look like. Dan is completely self-taught, and he enjoys the photo-realism, flexibility, and efficiency of digital imagery. Still, when he wants to have fun and relax, he picks up the brush.

Finally, Dan is interested in flying in space. After a decade of submitting applications, he at last made it to a finalist slot in a NASA astronaut selection cycle. He was called to Houston for a week of medical exams and interviews. Alas, he was not selected—out of 99 folks interviewed only 12 were selected—but he describes it as a wonderful experience that he will value all his life.★

Credit: D. Durda

Dan has a special message for students: "Don't be afraid to dream big. There are lots of possibilities out there. You may be the first to hand collect a sample of an asteroid."

Hot Link

[To find out more about Dan and his research, you can check out his web page: http://www.boulder.swri.edu/~durda/]

Sky Watch

Jupiter—The Colossus of the Solar System

Jupiter is the largest planet in the solar system. It outshines everything in the night sky, except the moon and sometimes Venus. Venus is only seen as a morning or evening phenomenon, but Jupiter, when it's at opposition, can be viewed all night long. That last happened in May, 2006 and will occur again on June 6, 2007. Opposition is when the sun and planet are on opposite sides of Earth, as with a full moon. The planet rises as sun sets and doesn't set until the sun rises the next morning.

Because of its size and brilliance, Jupiter is a good object to view with binoculars. Consult the list below to see when to go out and look for it in the southern skies.

- July 9, 2008
- August 14, 2009
- September 21, 2010
- October 29, 2011
- December 3, 2012
- January 5, 2014
- February 6, 2015

Jupiter will outshine everything else in its part of the sky. ★

Jupiter is the bright dot of light below the moon. (Credit: NOAO)

Talk Like an Astronomer

Opposition: An alignment of the sun, Earth and a planet where the sun and planet are on opposite sides of Earth. This can only happen with planets that are farther from the sun than Earth. When a planet is at opposition, you can observe it high in the southern part of the sky around midnight.

Proxima Centauri: The star closest to our solar system. A very dim red star, Proxima Centauri orbits the bright binary star Alpha Centauri in the constellation Centaurus.

Iron oxide: A compound produced when iron combines with oxygen. More commonly known as rust.

Cultural Connections

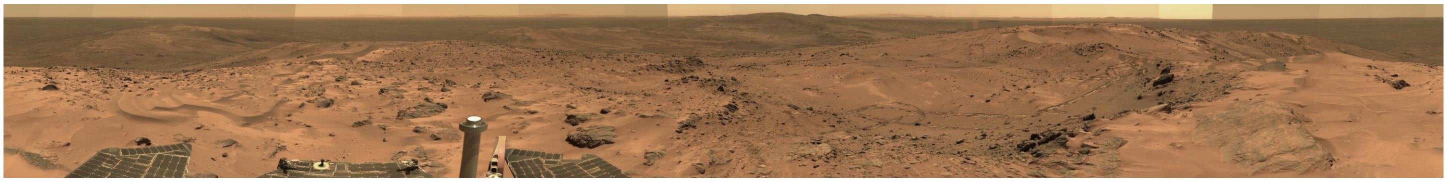
Why do we have seven days in a week? When you dig into the history of the development of calendars, that turns out not to be a simple question to answer. There does seem to be a connection to seven of the brightest celestial bodies visible to the unaided eye, however. No telescopes are necessary to enjoy the sight of these seven. While it's not obvious from the English names, look at the names of the days of the week in the languages on the table below and try to match them to a celestial body (sun, moon, or planet) that would have been visible to the ancients. ★

Latin	Spanish	English	Old English	German	French	Celestial Body
Dies Solis	domingo	Sunday	Sunnandaeg	Sonntag	dimanche	
Dies Lunae	lunes	Monday	Monandaeg	Montag	lundi	
Dies Martis	martes	Tuesday	Tiwesdaeg	Dienstag	mardi	
Dies Mercurii	miércoles	Wednesday	Wodnesdaeg	Mittwoch	mercredi	
Dies Jovis	jueves	Thursday	Thunresdaeg	Donnerstag	jeudi	
Dies Veneris	viernes	Friday	Frigedaeg	Freitag	vendredi	
Dies Saturni	sábado	Saturday	Saeternesdaeg	Samstag	samedi	

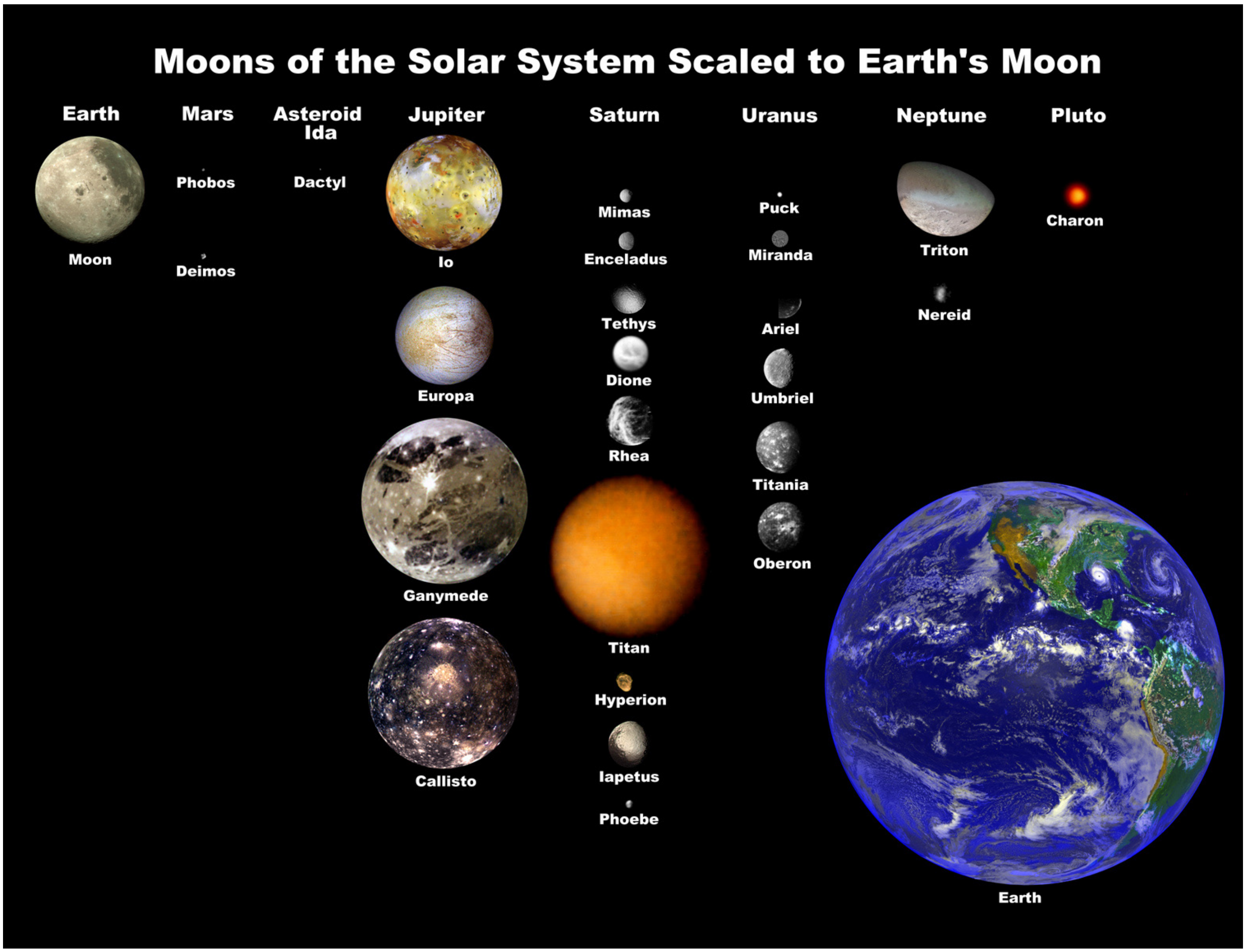
Hot Link

[**Go to http://webexhibits.org/calendars/week.html for an in-depth look at the origin of the names of the days of the week.**]

Investigating Images



You are standing on the surface of Mars on December 2, 2005. In this true-color, 180˚ panoramic view, the rolling plains extend in every direction. Iron oxide in the rocks of Mars gives it the reddish hue. The temperature is normally below freezing and there is no oxygen in the Martian atmosphere, so make sure you wear a good spacesuit when visiting this planet! (Credit: NASA)



This is a composite of many of the moons of our solar system represented to scale with Earth and our moon. Titan is the only moon with a substantial atmosphere. (Credit: NASA) ★

Cultural Connections Answers:

Sunday (Sun), Monday (Moon), Tuesday (Mars), Wednesday (Mercury), Thursday (Jupiter), Friday (Venus), Saturday (Saturn)