EXPLORE

WHERE DO METEORITES COME FROM?

SOLAR SYSTEMS

30 MINUTES

Milo looks a bit like the beginnings of a solar system.

SUMMARY

Most of us are familiar with the planets and the order they are in from the sun out to Pluto. But what does that look like? and why do they stay there? And what else is there? Here's a few ways of 'viewing' the solar system before we get onto calculating the scale.

Things in space spin. Most scientists agree the initial energy for this came from a massive explosion called the Big Bang. A spinning top on a table slows down and falls over because it rubs with air and drags along the table – causing friction and energy transfer from movement to sound and heat. There's very little resistance in space because there's no air or table, so things keep spinning.

Gravity is an attractive force. Everything with mass has gravity and the bigger it is, the stronger pull it has. In our solar system, the big player is the sun, but every other planet, moon and rock has it's own gravity which does it's best to pull anything smaller in. When there's two objects with a decent sized gravity (such as the Earth and the moon), they don't crash into each other, they keep each other at arms length because they're also caught up in the Sun's stronger pull and that ever-present spin.

What's often forgotten in model solar systems is all the meteoroids, asteroids and comets out there too, so let's include them.Use the table on page 64 to get approximate positions of each object in our solar system. We will look more closely at the objects in our solar system and their scale in the next activity, but for this activity, we are making a 'standard issue' solar system - estimates put them at over 100 billion solar systems in our galaxy alone!

OUTCOMES

1. Students explore the forces exerted on objects in a solar system
2. Students get familiar with the parts of the system of which Earth is a part

EQUIPMENT - BOWL SOLAR SYSTEM

- Deep bowls and spoons – 1 between 3 (or you can do it one each with milk and every students gets a Milo drink afterwards)
- Water (or milk)
- Dirt, (or Milo)

THE ACTIVITY - BOWL SOLAR SYSTEM

1.Students stir the water with a spoon until they've created a vortex – this is establishing the 'spin energy' given to the solar system from the original explosion
2.Add a (dry) spoon of milo directly to the centre vortex and observe what happens

Analyse:
Why does the spinning stop?

EQUIPMENT - OVAL SOLAR SYSTEM

- 1 x biggest ball you can find (representing the sun)
- Up to 10 x various sized balls (representing planets of different sizes)
- Up to 10 x buckets (representing different sized asteroids, meteoroids)
- Up to 10 streamers/fabric strips (representing comets)
- Have enough props for every person in the class

THE ACTIVITY - OVAL SOLAR SYSTEM

1. Explain to students that they're going to make a solar system on the oval, with each person representing either a planet, an asteroid (or bucket full of asteroids) or a comet.

2. Discuss how and where each person will need to move to complete the solar system,

3. Introduce the various objects (people) jogging their orbit one at at time:
- leave the sun as a ball at the centre of the oval/playground.
- inner rocky planets,
- outer gas planets - all orbiting the sun,
- then asteroids - chose a belt area, and then some asteroids can have a different orbit, then the
- comets will come in from out at the edge of the oval, doing a quick fling past the sun before heading back out again.

4. Have a student film the whole group moving to watch back later, or rotate students out of the system so they can see it from a distance.

Analyse:
How were the two models like the solar system? how were they different?
How many different bodies colided (or almost collided)?
How many would have caused meteor showers on earth?
Meteors come from comet trails, asteroids, loose meteoroids floating about in space, and chips off planets now and in the past.

EXPLAIN

WHERE DO METEORITES COME FROM?

SOLAR SYSTEMS - SCALE MODELS

30 MINUTES

SUMMARY

Now that the students have a grasp of all the types of objects present in a solar system and their orbiting habits, it's time to take a look at the actual distances between them. In this activity students will calculate scale models of the solar system, and it's suggested that they try it out on a sheet of paper, then work it up to the school oval.

The vast size of the solar system introduces a new unit of measure – the Astronomical Unit (AU). The AU is equal to the mean distance between the Sun and the Earth. It was used by early astronomers before they could accuratley calculate the individual distances between planets, to compare the distances within our system. For example, Jupiter and Pluto are 5.2 and 39.5 AU from then sun respectively. One AU is equal to 149,597,871 km. Some other comparison measurements we use commonly are the height of Mt Everest (Olympus Mons on Mars is three times the height of Mt Everest) or Olympic Swimming pools (the volume of Sydney Harbour is equal to 200 000 Olympic swimming pools).

With the following resources your students will sketch a scale model on an A4 sheet of paper - but wait! Does it all fit with the first scale we try? How can we fix the problem? Once everyone's got an A4 version, it's time to test our estimating technique by up-scaling to the school oval. The A4 version should help, but there's nothing like pacing it out to get a feel for it. With some flags and prior warning to the sports classes, You'll be able to demonstrate the scale solar system to other classes too.

OUTCOMES

1. Students create scale models of the solar system, and its components, inside and outside the classroom
2. Students use scale instruments such as rulers, tape measures and trundle wheels to measure and compare lengths choosing appropriate metric units and converting between cm/m/Km/AU

EQUIPMENT

- Solar system distances resource and worksheet, page 64
- Rulers, measuring tapes, trundle wheels

- Calculators and compasses
- Flags, markers or various sized balls (for outside solar system)
- 3 plain A4 sheets of paper (per student), coloured pens

THE EXPERIMENT

Set up:

Students will create a scale model of the solar system. Discuss what kinds of things are in our solar system, and what's outside. Our solar system contains one star, 8 (or 9 with Pluto) planets, comets, asteroids, moons, an asteroid belt, the Kuiper belt, the Oort Cloud. To start our making a scale model, students will need to measure the greatest area they have available – i.e. the maximum radius of their piece of paper/school oval.

Plan:

Students calculate the scale of their solar system, based on:

distance from edge of the solar system to sun ÷
distance from edge of model to middle

= distance outer edge of Oort cloud to sun ÷
distance outer edge of A4 paper to centre (lengthways)

= 100 000 AU ÷ 148 mm

= 676 AU / mm

i.e. 1 mm = 676 Astronomical Units (AU)

(see worksheet)

Predict:

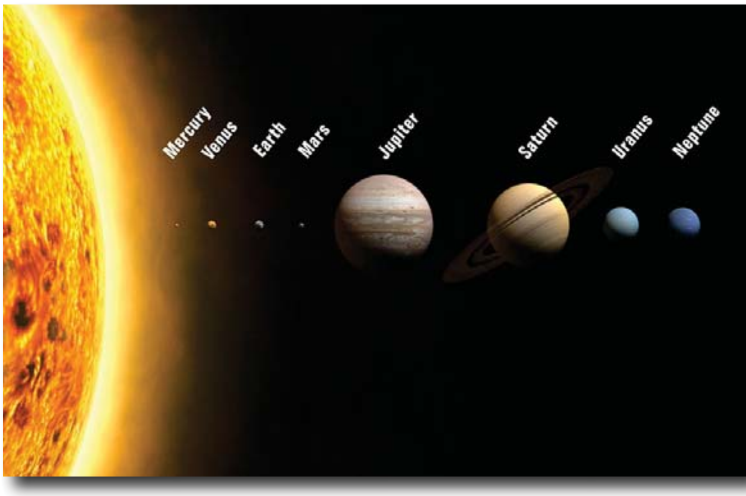
Now that we have an outer perimeter for the system, students can estimate where the rest of the objects will go and sketch a few points in to record their predictions.

Test:

Now calculate the rest of the objects' mean orbit, using the table and the same scale from before, e.g.

distance from Pluto to the sun on model =
acutal distance from Pluto to the sun ÷ scale

= 39.5 AU ÷ 676 AU / mm



Another not-to-scale solar system image

= 0.058 mm

Oh no! That's ridiculously close to the sun, how will the rest of the planets fit in? This scale just won't work without a micrscope. Brainstorm with the students how to rectify the problem, without discounting the true size of the solar system, or losing the scale.

Your best option will be to use three separate pieces of paper and three different scales - a chance to experiment further with scale! This shows how truly big our solar system is, and explains why we rarely see images of the whole thing to scale.

See images on page 39.

For A4 paper, you should be able to fit the following onto each sheet:

1. The outer edge of the Oort cloud to the inner edge of the Oort cloud (with the sun in the middle)

   scale is 1 mm = 676 AU

2. The inner edge of the Oort cloud to the span of the Kuiper belt (with the sun in the middle)

   scale is 1 mm = 67.6 AU

3. The rest of the planets, asteroids, Halley's comet's reach to the inner edge of the Kuiper belt

   scale is 1 mm = 0.338 AU

The next bit of fun is to expand it out - to the size of the oval, using the same steps as follows here - see 'communicate'

Analyse:

Not all scientists agree on what the 'edge' of the solar system is - you may have noticed that the probe Voyager has passed the edge of the solar system multiple times, as the years go on and we find out more about where we live. What do the students think constitutes the edge of the solar system? Is it how far the sun's gravitational influence extends? Is it measurable by temperature? By the last known object?

Commmunicate:

Using the same process as before, establish a scale for the whole solar system (including Oort cloud) to fit the school oval. Will it work? (ie, is there enough space to mark out the objects closest to the sun?) Have the students decide on the scale you should use, and mark with flags or balls the objects that you can. Invite another class to come out and see it and get the students to explain how they worked out the scale.

SUGGESTIONS FOR THE CLASSROOM

- This activity, while stressing the importance of the scale of distance has neglected a bunch of important points - can the students identify what is wrong?
    - No planet's orbit is perfectly circular, they are ellipses
    - The scale size/volume of each planet and rock has not yet been considered
    - While the planets orbit relatively close to the same plane (imagine the horizontal layer of jam in a layer cake), most comet orbits are out of the plane (imagine a diagonal cut through the cake)
    - What about moons?
- Check out an online interactive that lets you zoom in and out of the universe: http://scaleofuniverse.com/
- Find out more about the Voyager mission:

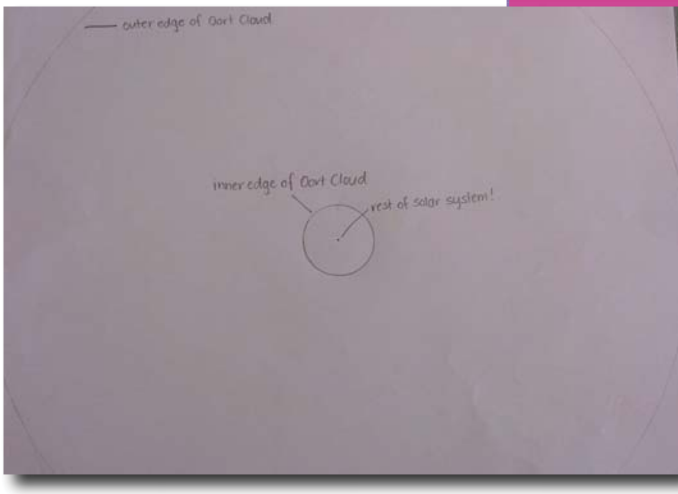
http://voyager.jpl.nasa.gov/

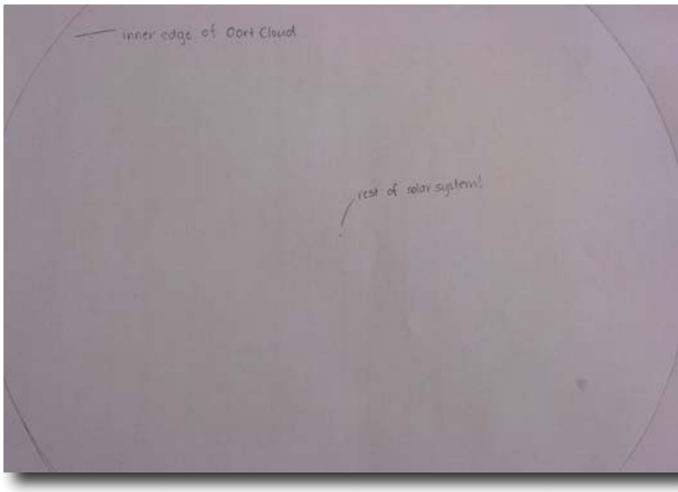
More information about the solar system:

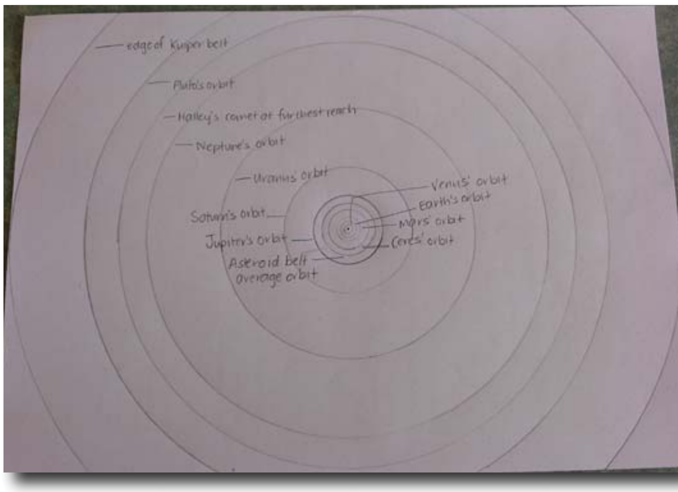
http://umanitoba.ca/observatory/outreach/solarsystem/

http://www.universetoday.com/15462/how-far-are-the-planets-from-the-sun/

http://www.space.com/18584-dwarf-planets-solar-system-infographic.html







Scale solar system - the first includes the entire Oort Cloud, the second page zooms into what's inside the oort cloud, the third shows what's inside the Kuiper belt's radius.
In other words, the third picture fits into the tiny dot at the centre of the 2nd picture, which fits into the tiny dot at the centre of the 1st picture.
(Note, while the average distance from the sun is to scale, the perfect circular shape of the orbits is not true to reality)