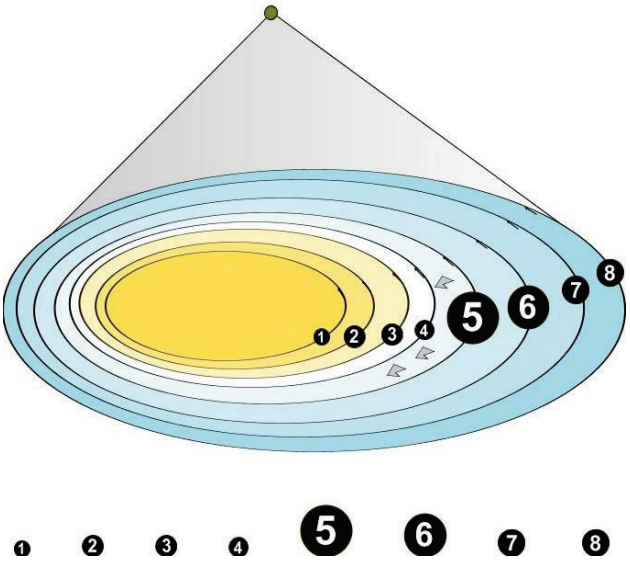
Orbit and Size – Teacher Notes

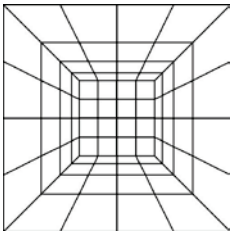


This diagram is an artist's impression of the planets in our solar system, their orbits and their relative sizes. After finishing these activities, decide how accurate this diagram is.

This is not very accurate. The orbits are too elliptical and they are not spread out enough. The distance between the planets should be much greater.

We look towards the Moon or the planets in the night sky and they appear to be quite small because they are far away. Artists use this apparent shrinkage to create a sense of distance or perspective. Let's test this idea.

Activity A - Perspective and Scale



Materials per student

- 2 rulers

Method

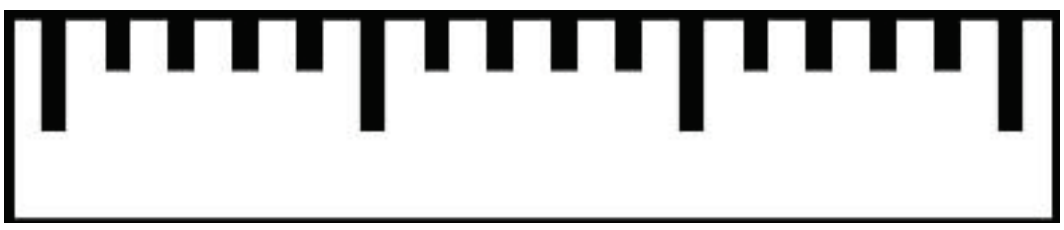
1. Place one ruler on top of the other with the closer ruler displaced downwards so that the measurement units on both rulers can be seen.
2. Hold up both rulers about 8cm in front of your nose.

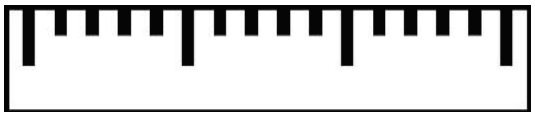
Q. Do both rulers appear to be the same length? YES

3. With your right hand move the back ruler away until your right arm is fully extended.

Q. Do both rulers look the same length now? No, the back ruler appears to get smaller the further away it moves. The average student will find that the apparent length of the ruler is halved on full extension of one arm.

Long ago many people thought that the Sun was smaller than the Earth because it appeared to be so in the sky. They did not appreciate how big it really was because of how far away it was.
When we deliberately draw things smaller than they are we say they are "***scaled down***".





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By how much has the lower ruler been scaled down? By half or 1:2

Has the real length of the ruler changed? No

Making scale models of the solar system

Scientists often have to work out the best way to describe things so people can more easily understand them. Scale models and scale drawings are often used as the old adage goes, "a picture is worth a thousand words". When it comes to astronomy, however, the distances between planets and their size are so large that any models have to be severely scaled down because of the enormous distances involved.

It is often a good idea for students to make a rough attempt at a scale drawing on scrap paper before they attempt the final copy. That way any mistakes can be avoided and difficulties can be overcome with a little more thought or direction.

Activity B - Distances of Planets from the Sun

Measurements across our solar system are HUGE! The average distance of the Earth from the Sun is 149,597,870.7 kilometres. My pocket calculator refuses to attempt to compute the distance from Earth to Neptune in kilometres (39.53 x 149,597,870,7km). To fit the distances from the Sun onto a small area we need to change scale to another unit of measurement. Instead of kilometres we use the distance of the Earth to the Sun and call this one Astronomical Unit or AU.

1 Astronomical Unit (AU) is 149,597,870.7km

Why do we use the mean (average) distance of planets from the Sun?

Planets travel in an elliptical orbit around the Sun so their distance from the Sun will vary during their orbit.

Use the information in the table below in this activity.

Planet	Distance to the Sun (mean) AU	Scaled distance on paper (cm:AU)		
		1:1	1:0.75	1:0.5
Mercury	0.39	0.39	0.29	0.19
Venus	0.72	0.72	0.54	0.36
Earth	1.00	1.00	0.75	0.5
Mars	1.52	1.52	1.14	0.75
Jupiter	5.2	5.2	2.60	3.90
Saturn	9.51	9.51	7.13	4.76
Uranus	19.3	19.30	14.48	9.65
Neptune	30.07	30.07	22.55	15.04

Materials

- One sheet of A4 paper for good work
- Scrap paper for rough work
- Sellotape or glue
- A pencil eraser and ruler
- A calculator

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Method

1. Lay your worksheet "landscape" and measure the length of the longest edge.
   29.6cm or 296mm
2. Do you think these measurements need to be scaled up or scaled down to fit onto your worksheet?
   Scaled down.
3. Select an appropriate scale so that the largest distance will fit across this paper

You may prefer to give students some scrap paper to work this scale out for themselves. If 1 cm: 1 AU is used, the worksheet will be too small as its greatest length (including border) is only 29.6 cm. Half scale may be used simply dividing the distance from the Sun in AU by 2. However this will cause the first three planets to be squashed into the first cm. 1:0.75 or three quarter scale has been given as this allows for all planets to fit on the page. By sticking another sheet landscape onto the worksheet a scale of 1cm = 1Au can be achieved.

4. Calculate the model distances from the Sun according to your scale and put these in the table provided.
5. Draw up the scaled model on the worksheet

Discussion

What problems did you have working at the scale you chose?

Depends on their choice. It was difficult to fit the first three planets into 1cm. The paper wasn't big enough.

Extension

Method

- Select a student to represent the Sun
- Select groups of 3 or 4 students to represent each of the eight planets
- Grab a long measuring tape (perhaps borrowed from Phys. Ed.) and locate the groups in the correct position along the tape using scales of 1m:1AU.

Activity C - Relative Sizes of Planets

Materials

- Ruler
- A pair of compasses and pencil

Method

1. Estimate the scale required to fit Uranus and Saturn on one page.

What scale can you use to be able to draw all the planets on the paper provided?

To fit Saturn and Uranus on the same page a scale of 1cm: 1 AU is required. The other planets can be fitted into the remaining spaces

Planet	Diameter of planet (km)	Diameter of planet 1cm: 10,000 km
Mercury	4,879	0.48
Venus	12,104	1.21
Earth	12,756	1.27

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Mars	6,792	0.68
Jupiter	142,984	14.30
Saturn	120,536	12.05
Uranus	51,118	5.11
Neptune	49,528	4.95

Extension

The diameter of the Sun is 1,392,700 km.
How many sheets of A4 paper would you need to be able to represent the Sun at the scale 1cm: 10, 000 km?
1 sheet of A4 paper measures 21cm X 29.5 cm
The diameter of the Sun is 139.27 cm.
You would need paper to cover an area of 140 cm X 140 cm
You would need a block of papers 7 (140/21) by 5 (140/29.5)
You would need 35 pieces of A4 paper.

Take a piece of string 70 cm long, attach this to a piece of chalk. Ask one student to anchor one end and use the end with the chalk to draw a circle to represent the relative size of the Sun. Compare this to a bead or marble representing the relative size of the Earth.

RESOURCE POSTER
Paul Floyd has generously created an A3 poster comparing the sizes of Earth and Saturn correctly scaled. The poster is free to download at: http://nightskyonline.info/?page_id=17508