Patterns in the Sky - Teacher's Notes

Astronomers used to believe that the Solar System moved like clockwork and could be understood using mathematics.

The astronomical unit (1 AU)

We humans are used to using measurements in millimeters, centimeters, metres and kilometres. These are measurements that can be applied on a human scale. Once we start measuring across the enormous distances of the Solar System however, we need to use another standard for our calculations. We use the distance of the Earth from the Sun. The distances given below are when each planet is farthest from the Sun during its elliptical orbit.

1 Astronomical unit is 149,597,870.7km

Estimate the distance of each planet from the Sun in Astronomical Units. A calculator will help

PLANET	Distance from the Sun (million km)	Distance from Sun (AU)	Time taken to complete 1 orbit of the Sun
Mercury	57.91	0.39	88 Earth days
Venus	108.2	0.72	224.7 Earth days
Earth	149.6	1.00	365 Earth days
Mars	227.9	1.52	687 Earth days
Jupiter	778.3	5.2	4,331 Earth days
Saturn	1,427	9.54	10,747 Earth days
Uranus	2,871	19.2	30, 589 Earth days
Neptune	4,498	30.06	60,189 Earth days

From the data in the table, how long would it take between your 8th birthday and ninth birthday if you lived on Jupiter? 4,331 Earth days or almost 12 years!.

PALMS
PRIMARY AUSTRALIAN LITERACY MATHEMATICS AND SCIENCE

Santos & ESWA supporting earth science education

Patterns in the Sky - Teacher's Notes

Time Taken to Orbit the Sun

We will only be using data from the first five planets to see if there is a direct (straight line) relationship between the distance of the planet from the Sun and the time it takes to complete one orbit. Teachers might wish to demonstrate this using an Excel spreadsheet in their computer while explaining that astronomers such as Copernicus and Newton had only pen and paper.

Materials

- Graph paper
- Pencil, ruler & eraser

Or

- Excel spreadsheet and Smartboard or projector

Discussion

Can you see a direct relationship between the time taken to complete an orbit of the Sun and the distance between the planet and the Sun? No

Why do you think we did not include data from Uranus and Neptune?
Because we would need enormous pieces of graph paper.

Without the benefits of electric lighting and computers, in about 1621, the astronomer Johannes Kepler worked this out for himself using candlepower for light and pencil and paper for manual calculations.
With mathematical "proofs" Kepler devised the three laws of planetary motion.

1. The orbit of every planet is an ellipse with the Sun at a focus
2. A line joining a planet sweeps out equal

areas during equal intervals of time.

3. The square of the orbital period of a planet is directly proportional to the cube of the semi major axis.