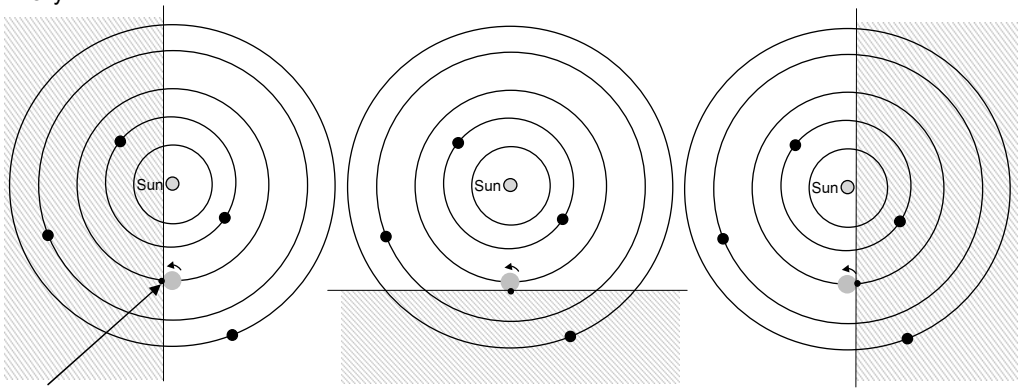
Which planets can I see when?
The diagram below shows the positions of a person on Earth's equator at evening sunset, midnight and morning sunrise as viewed from north of the ecliptic. The straight lines represent where the observer's horizon cuts through the ecliptic to the East and West. The shaded area is the visible sky.



You can see that the person could only ever see the inner planets Mercury and Venus (the planets closer to the Sun than Earth) in the morning or evening. When planets are only visible in the morning or evening they are also called "morning stars" or "evening stars" respectively. The outer planets (those farther from the Sun than Earth) may be seen at different times depending on their position.

If used with the orrery set up with today's longitudes, this method gives an approximate guide to which planets one could see tonight.

Looking at the Orbit Orrery lit up; two other factors that determine how easily a planet is seen are visible:

- The larger planets reflect more light
- The planets closer to the sun reflect more light.

With the naked eye (without using a telescope or other instrument), one can only see the planets from Mercury to Saturn as Uranus and Neptune are too far away.

Other factors affecting visibility include the proximity of the planet to Earth, cloud cover, physical obstructions and background light.

The Moon
Whilst a number of planets have moons only the Earth's moon is shown on the model. The Moon orbits the Earth in an anti clockwise direction when viewed from North of the Ecliptic. This is the same direction as the Earth's rotation and orbit.

The Orbit™ Orrery: Made by Cochranes of Oxford Ltd. Shipton under Wychwood, OX7 6DG, UK.
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The Orbit™ Orrery v2

Reference 0156
(Version 2)

The Orbit™ Orrery helps students understand the solar system in a simple yet effective way. The orrery shows the Sun and eight planets. The Sun lights up when batteries (not supplied) are fitted.

Assembly instructions.
Push the stem with the planets on it into the base until you have a tight fit. Add 2 X AA batteries to the holder if you want the Sun to light up. The planets are rotated around the Sun by hand.

Introducing the solar system
Set the model up with the Sun lit and planets spaced out around it. In this situation the following can be seen:

- The Sun is at the centre of the solar system
- The Earth is one of many planets
- The planets rotate around the Sun in *orbits*
- The Moon rotates around the Earth

In a darkened room*, the following can also be seen:

- The sun is the source of light in the Solar system
- The planets and Moon are visible because they reflect the light from the Sun
- The sunlight divides the surface of the planets and Moon into a lit side (daytime) and unlit side (night-time)

*An alternative to darkening the room is to get a big box, cut peep holes in the sides (about 150mm X 50mm) and place the box upside down over the Orbit orrery. This is very effective and really intrigues the younger students.

The order of the eight planets starting closest to the sun is: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune.

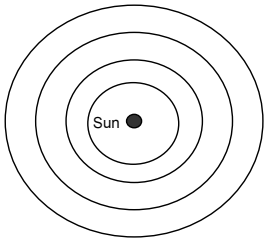
Orrerys are named after the Earl of Orrery, who was very interested in models of the planetary system.

Pluto, dwarf planets and plutoids
In addition to the eight planets there are many smaller objects orbiting the sun including dwarf planets, asteroids and comets. Most dwarf planets, including Pluto, exist outside the orbit of Neptune and are also known as plutoids. Whereas the dwarf planet Ceres is located in the main asteroid belt between Mars and Jupiter.

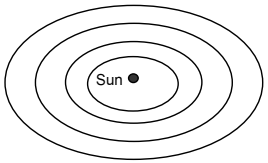
Is the model to scale?
Whilst the larger planets Jupiter and Saturn on the model are bigger than the smaller planets like Earth and Venus they are not to scale nor are the distances separating them. This is hardly possible on a model like this one as the smaller planets would hardly be visible. A set of posters printed to scale is recommended for this purpose.

Are all the orbits of the planets really in a flat plane?
Very nearly. The only divergent orbits are those of Mercury, which is set at 7° to the Earth's orbit. All other planets have orbits set within 3.5° of the plane of the Earth's orbit. This plane is called the Ecliptic.

How elliptical are the orbits?
The orbits of most of the planets are very nearly circular although all are slightly elliptical. The orbit of the Earth, for example, moves from between just under 148 to just over 150 million kilometres from the Sun. At the scale of this model the distance from the Earth to the Sun would vary by only 1.5mm over the whole orbit. Many pictures of the solar system show the orbits from one 'side'. A circle seen from one side looks very elliptical and this is the source of much confusion. The two drawings below illustrate this point.



Circular planetary orbits seen from directly 'above'



The same circular orbits seen from the side, about 30° above the Ecliptic.

The only planet with an orbit that would be 'visibly' elliptical on the model is Mercury. The orbits of some dwarf planets, asteroids and comets are more elliptical than those of the planets.

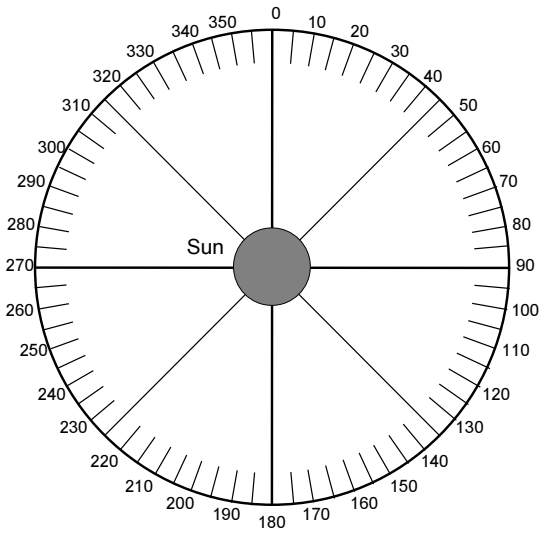
Which way do the planets go?
If you imagine that you are in space above the North Pole, looking down on the Solar System then;

- the planets all go round the Sun anti-clockwise
- the Moon goes round the Earth anti-clockwise
- the Earth rotates on its axis anti-clockwise

This point of view is sometimes called 'from North of the Ecliptic'. The Ecliptic is the plane of the Earth's orbit around the Sun. From South of the Ecliptic these motions will appear to be clockwise. To understand this, look at the anti-clockwise arrow above. Now move the paper above your head without turning it over and look at the arrow through the paper - the arrow is now pointing clockwise.

How quickly do they go?
The time a planet takes to orbit the Sun depends on how far away it is from the Sun. The nearer to the Sun it is, the less time it takes. Measured in Earth years and days the times are Mercury 88 days, Venus 225 days, Earth 1 year, Mars 1 year 321 days, Jupiter 11 years 321 days, Saturn 29 years 131 days, Uranus 85 years, Neptune 166 years and Pluto 250 years.

Where are they now?
The positions of the planets relative to each other and to the Sun are constantly changing. To set up an orrery, Helio-centric (Sun-centred) Longitudes are most useful. Positions for 2016 and 2017 are given below. Positions for future months will be found in the astronomy section of our website www.cochranes.co.uk. To position your planets, copy and cut out the degree scale (printed right) and place it on your orrery. Then align the planets with the longitudes given.



N.B. The direction of zero degrees is not important for the activities in this leaflet. It is important if one wants to consider the positions of the stars relative to the planets or the apparent height of the planets above the horizon due to the Earth's tilt. This is covered by more detailed models such as the Helios™ Planetarium.

Heliocentric longitudes for setting up the Orbit™ orrery

2016	Jan 1st	Feb 1st	Mar 1st	Apr 1st	May 1st	Jun 1st	Jul 1st	Aug 1st	Sep 1st	Oct 1st	Nov 1st	Dec 1st
Mercury	30	195	281	48	202	293	67	216	306	92	228	316
Venus	185	235	281	330	18	67	115	166	216	264	313	1
Earth	100	131	161	192	221	251	280	309	339	8	39	69
Mars	174	188	201	216	231	247	263	281	300	319	338	357
Jupiter	163	165	168	170	172	175	177	179	182	184	186	189
Saturn	248	249	250	251	252	253	254	255	256	257	258	259
Uranus	19	20	20	20	21	21	21	22	22	22	23	23
Neptune	339	339	340	340	340	340	340	340	341	341	341	341

2017	Jan 1st	Feb 1st	Mar 1st	Apr 1st	May 1st	Jun 1st	Jul 1st	Aug 1st	Sep 1st	Oct 1st	Nov 1st	Dec 1st
Mercury	116	239	323	128	242	339	144	253	357	163	265	11
Venus	50	100	145	195	244	293	341	30	79	128	178	226
Earth	101	132	160	191	221	251	280	309	339	8	39	69
Mars	16	35	51	67	83	98	112	126	140	153	167	180
Jupiter	191	193	195	198	200	202	205	207	209	212	214	216
Saturn	260	260	261	262	263	264	265	266	267	268	269	270
Uranus	23	24	24	24	25	25	25	26	26	26	27	27
Neptune	341	342	342	342	342	342	342	343	343	343	343	343