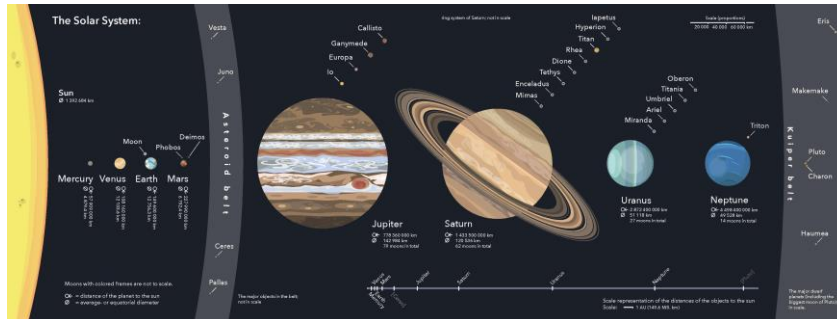


# Modeling the solar system

Astronomical play for older children



## You will need:

- These instructions
- Pictures, models or postcards showing the Earth, the Sun and the Moon
- A large circle, preferably marked in 12 “slices”

## Goal:

- To understand the movement of objects in the solar system and how the Sun's gravity causes influences the planets and other objects
- To understand how modelling a system (usually done in a computer) can help with solving questions and identifying new questions about the system.

## Setup:

Mark or identify a line on the floor. This is the starting position of the modelled solar system. Start simple with only a few elements, but then add more and more as you make your model more complicated.

The game is designed for 3-8 participants and you add them in the following order: The Sun, the Earth, the Moon, Venus, Mercury, the comet Kohoutek, Mars and the asteroid 2010TK7.

## The Game:

Start by placing one child furthest to the left on a straight line. He/she gets to be the Sun. Thereafter, add more and more children, each getting to be their own celestial bodies. Every time you add a new element into your “simulation” you explain how that celestial body moves in the span of 4 weeks and then you “run your simulation”. Everything orbits counter clockwise.

### 1. THE SUN

#### a. BASIC:

The Sun orbits around itself in about a month

#### b. ADVANCED:

The Sun rotates faster around the equator (ca 25d) than it does closer to the poles (ca 31d). The child can use its hands to represent this. Start with hands stretched as far to the right as possible and end with them as far left as one can reach.

### 2. THE EARTH

#### a. BASIC:

The Earth moves one twelfth of its orbit in 4 weeks. Estimate how far that is around the Sun. At the same time the child can simulate 28 rotations by simply pointing a finger down over their head and move it in 28 circles.

#### b. ADVANCED:

Make sure the Earth leans ca 23.5 degrees (towards Polaris). This is a good opportunity to discuss the seasons.

### 3. THE MOON

#### a. BASIC:

The Moon orbits the Earth in about 28 days. Make sure the Moon always points its face towards the Earth.

#### b. ADVANCED:

The lunar orbit leans 11 degrees compared to the Earth's orbit around the Sun. The Moon can bend down a bit on one side of the Earth and then go up to its toes on the other side. This is a good opportunity to discuss why we do not have eclipses every month.

### 4. VENUS

#### a. BASIC:

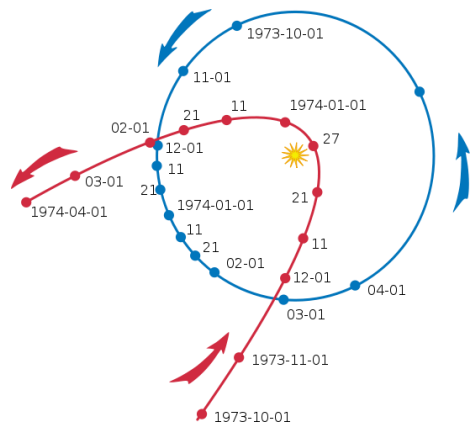
Venus orbits about an eighth of its orbit in 4 weeks. Estimate where on the floor Venus has to end up. This is a good opportunity to discuss how the Earth-Venus distance changes and how Venus varies in apparent size as we observe it through a telescope.

- b. **ADVANCED:**  
Instead of telling the children how far Venus moves, make them calculate it. It takes Venus 224.7 days to complete an orbit: How far will it go in 28 days? Note also that unlike the Earth, Venus does not have to simulate rotation around itself. Discuss the daily rotation on Venus and possible explanations for why it is as it is.

## 5. MERCURY

- a. **BASIC:**  
Mercury moves about a third of its orbit in 4 weeks. During this time Mercury has rotated half a circle (compared to the stars).
- b. **ADVANCED:**  
Instead of telling the participants how far Mercury moves, make them calculate it. It takes Mercury 88 days to complete an orbit: How far will it get in 28 days? On Mercury 2 years is exactly 3 days, so how far will Mercury have to rotate in 28 days?

## 6. KOHOUTEK (a comet)



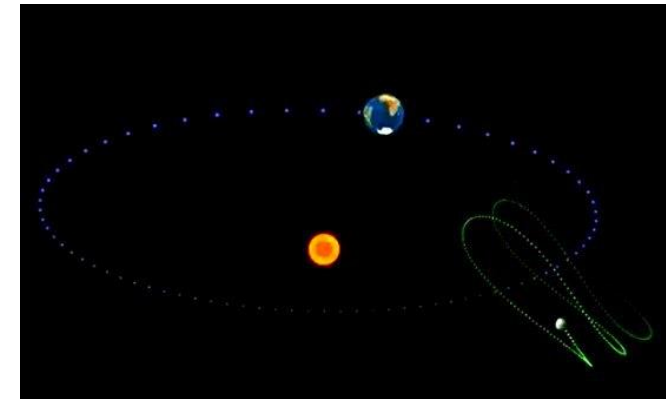
- a. **BASIC:**  
The comet Kohoutek (see picture) has a highly elliptic orbit. Start the motion in the orbit of the Earth, fall in towards the Sun and increase the orbital speed as you get close to the Sun.
- b. **ADVANCED:**
- 1) Kohoutek does not lie in the orbital plane of the solar system. Start low, and end your motion stretching upwards. The inclination between its orbit and the plane of the Solar System is about 15 degrees.
  - 2) The comet has two tails. One that reaches behind the comet in its orbit and one that always points away from the Sun. The pupil playing the comment can use his/her hands to represent the two tails.

## 7. MARS

- a. **BASIC:**  
Mars moves about four percent of its orbit in four weeks. As Mars barely moves along its orbit, it still rotates around itself in a similar manner as the Earth does (24h40m).
- b. **ADVANCED:**  
Instead of giving the answer to the participants, work out how far Mars moves in 4 weeks given that Mars completes one orbit around the Sun in about 687 days. Also, Mars tilts about 25 degrees, so remember to lean a bit.

## 8. 2010TK7 (an asteroid)

- a. **BASIC:**  
The Asteroid 2010 TK7 is a Trojan asteroid sharing the Earth's orbit, always preceding the Earth by about 60 degrees. This is a gravitationally stable point where the pull from the Earth and the pull from the Sun is in equilibrium (discuss Lagrange points and their usage if you want to).
- b. **ADVANCED:**  
Instead of orbiting exactly in the Lagrange point the asteroid 2010 TK7 orbits around it (see picture). Ask the participant to use a circular hand motion to simulate this movement.



## Points of discussions:

- What did you notice when observing the movement of the planets?
- Did you notice how the inner planets move further than the outer planets?
- This is the same reason for why the comet had to move faster closer than the sun than it did further out.
- Discuss how astronomers use computer simulations to follow the movement of stars in stellar clusters, gas particles in close binary systems, formation of planetary systems, colliding galaxies and the evolving universe.