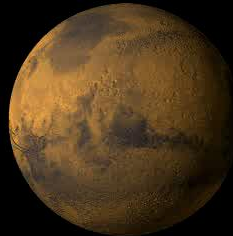


Planetary Calculator



Leonor Cabral – Cascais, 2nd September 2014

Introduction and Preparation

- **Description:** The concept of scale is directly associated to the construction of a model of the Solar System.
- **Keywords:** scale, space orientation, Solar System, orbit
- **Target:** Students from the 7th grade
- **Ages:** 12-13 years old

Introduction and Preparation

- **Context:** The Solar System is a curriculum content from the 7th grade. A model of the Solar System must always mind the relative size and distance between the Sun and the planets. This concept can be explored with other cross-curricular areas such as Science, Math's and Arts.
- **Learning time:** 90 minutes

Phase 1 - Engaging students and awakening curiosity



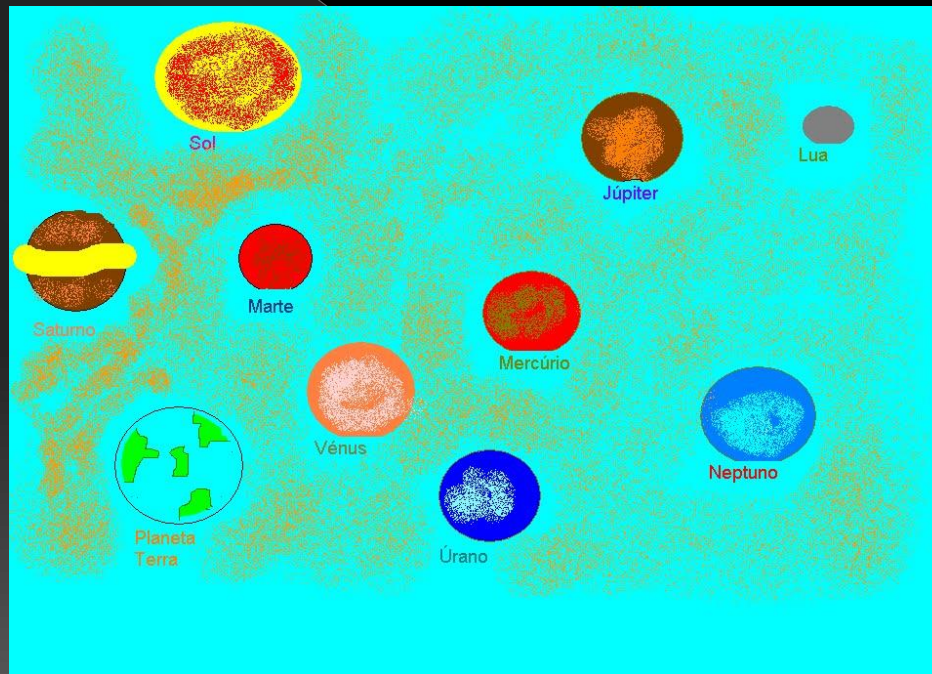
Make comments about the drawing!
Notice anything strange?



Is it possible that our brain can always represent the scales in the right way?

Phase 1 - Engaging students and awakening curiosity

? Make comments about the drawing!



Are the celestial objects at the right scale?

Phase 1 - Engaging students and awakening curiosity

- It is possible to use the same scale to represent the size of the planets and their distance to the Sun?
(1AU = 1cm and size of the Earth= 1cm)
- Is it possible to draw on an A4 sheet the Sun and the planets keeping relative sizes and distances correct?

Phase 2 - Plan investigation

The students propose a representation!








The students should start with an initial hypothesis of the distance and the size of the main elements of the Solar System.

Then they should plan an investigation and define the necessary steps to set up a model according to their own ideas.



Phase 3 -Active investigation (Retrieving data)

The teacher can choose by helping the students giving them the chart below or letting them do their own investigation choosing their sources of information:

	Distance to the Sun (AU)	Relative size to the Earth
 Sun	_____	109
 Mercury	0,4	0,4
 Venus	0,7	0,9
 Earth	1,0	1
 Mars	1,5	0,5
 Jupiter	5,2	11
 Saturn	9,5	10

Phase 4 - Analyse and describe data (Processing information and creating solutions)

The students should set up their models writing down their strategies step by step.

Phase 5 - Explain the results (Sharing the experience and ideas)

The students should describe their strategy and present their models to the classmates.

Eventually a new cycle can arise if they come to the conclusion that their initial hypothesis was wrong.

Phase 6 - Communication

The students should expose their models to the whole school. They should also have the opportunity to explain their strategy and steps along the process.

Phase 7 - Evaluation

The students should evaluate the whole process and used methodologies.

Introduction and Preparation

- **Description:** By going around the Sun, the planets have different positions in the sky when seen by an observer on Earth. The main goal of this activity is to understand this movement around the Sun.
- **Keywords:** scale, space orientation, Solar System, orbit
- **Target:** Students from the 7th grade
- **Ages:** 12-13 years old

Introduction and Preparation

- **Context:** The Solar System is a curriculum content from the 7th grade. A model of the Solar System must always mind the relative size and distance between the Sun and the planets. This concept can be explored with other cross-curricular areas such as Science, Math's and Arts.
- **Learning time:** 45 minutes



Introduction and Preparation

Material (phases 2 and 3):

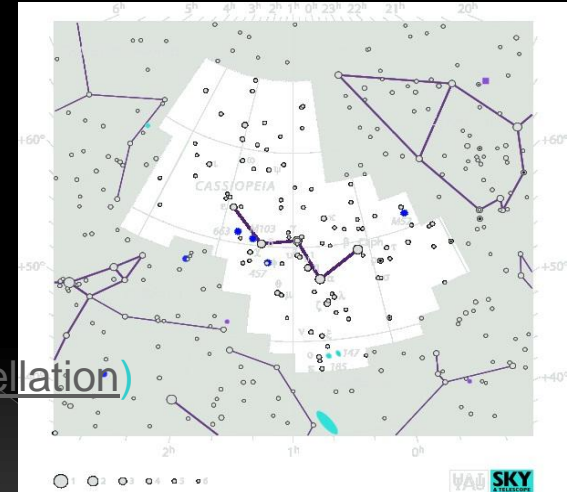
- Scissors;
- 3 A4 cardboard sheets
- Color pencils, pencils, ruler, paper fasteners, thread and protractor.



Phase 1 - Engaging students and awakening curiosity

What is a constellation?

- In the ancient times a constellation was an asterism (groups of stars that people associated with shapes).

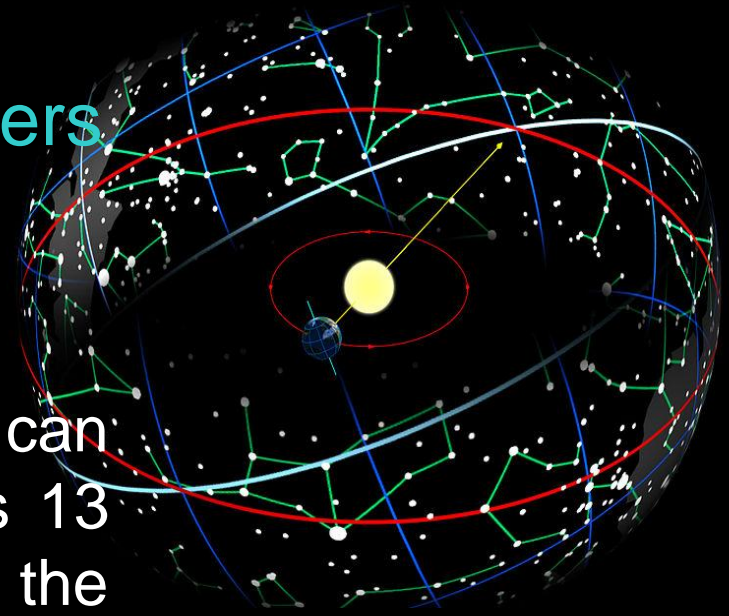


- Today, according to the International Astronomical Union (<http://www.iau.org/public/constellation>) a constellation is an area in the sky.
- When we observe a constellation we do not know the distance nor size between the stars within. Nowadays, the sky is divided in 88 different areas or different constellations.

Background information for teachers

- What is the zodiac?

- During the Earth's translation we can see the Sun being projected towards 13 different constellations. These are the constellations of the Zodiac.
- The time the Sun "takes" facing towards each constellation is not equal in number of days. For example, the Sun "stays" 8,4 days facing towards the constellation Scorpio and 44,5 days facing towards the constellation Virgo.



Phase 2 - Plan investigation

- Ask the students to plan an investigation about what constellations are.
- What is the Zodiac? How many are the constellations of the Zodiac?

Phase 3 -Active investigation (Retrieving data)

- The students should now proceed to the gathering of necessary data to support their initial hypothesis.

Phase 4 - Analyze and describe data (Processing information and creating solutions)

- The students should analyze and describe the gathered data.

Phase 5 - Explain the results (Sharing the experience and ideas) (proposal of set up)

- The students should present their gathering of data in a way they explain the initial hypothesis

Planetary Calculator

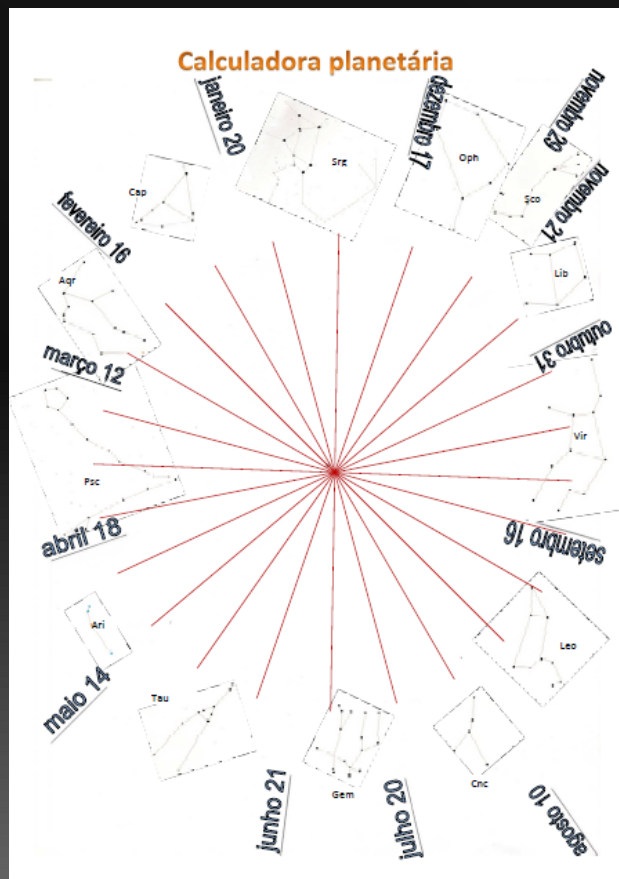
If a better orientation of the student's work is necessary, the teacher should set up a planetary calculator.

The process should be developed in two phases. The students can set up a base for the calculator according to the instructions below.

Setting up the planetary calculator's base

Use the web page (http://en.wikipedia.org/wiki/Zodiacal_constellations) or a software to simulate the sky such as **Stellarium**.

To set up the calculator's base mind that $365 \text{ days} \approx 360^\circ$



Planetary Calculator

An efficient way to proceed the discussions is the set up of a planetary calculator

Phase 6 - Show that they know how to work with the calculator

- The students should present their results using their own model or planetary calculator.

Phase 7 - Evaluation

- The students should critically analyze the whole methodology and process.



Introduction and Preparation

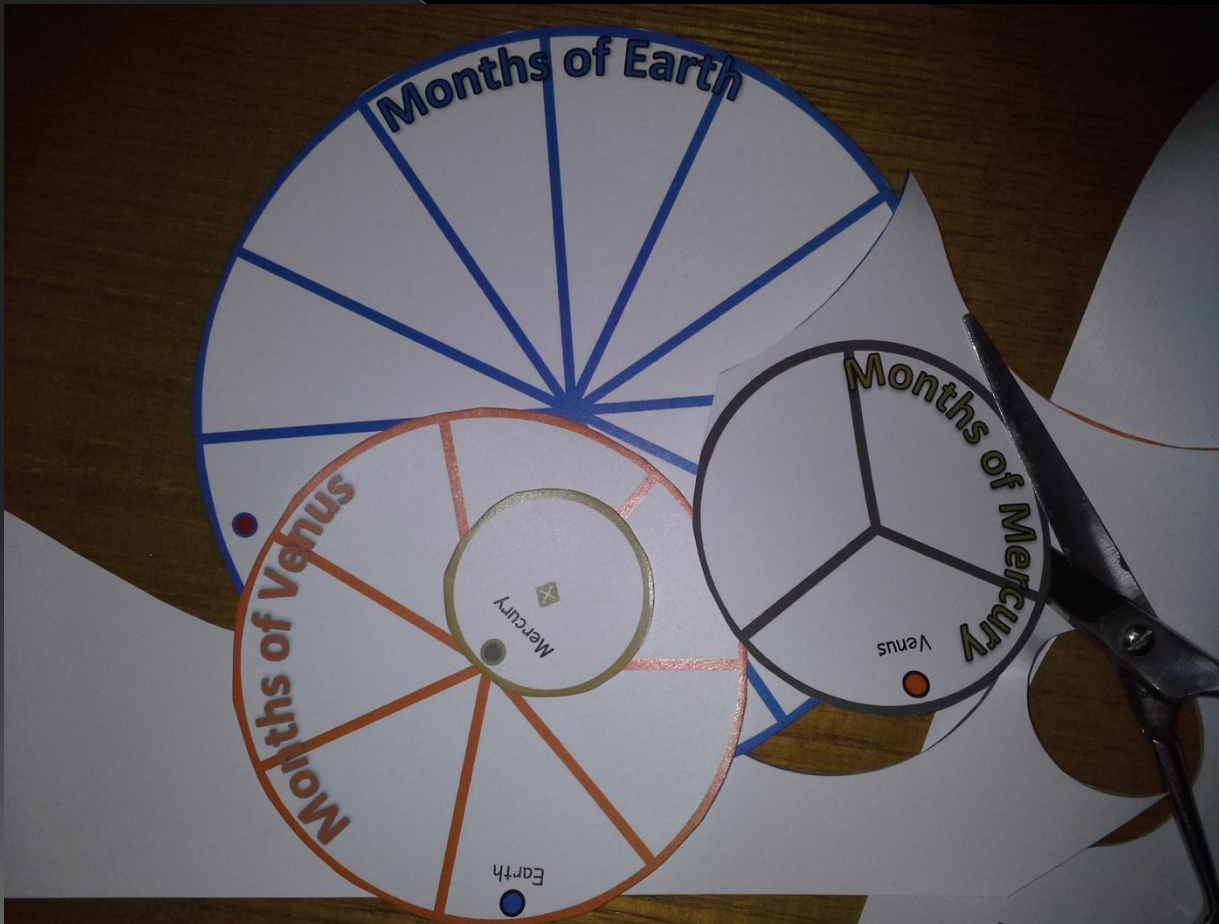
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- **Learning time:** 90 minutes

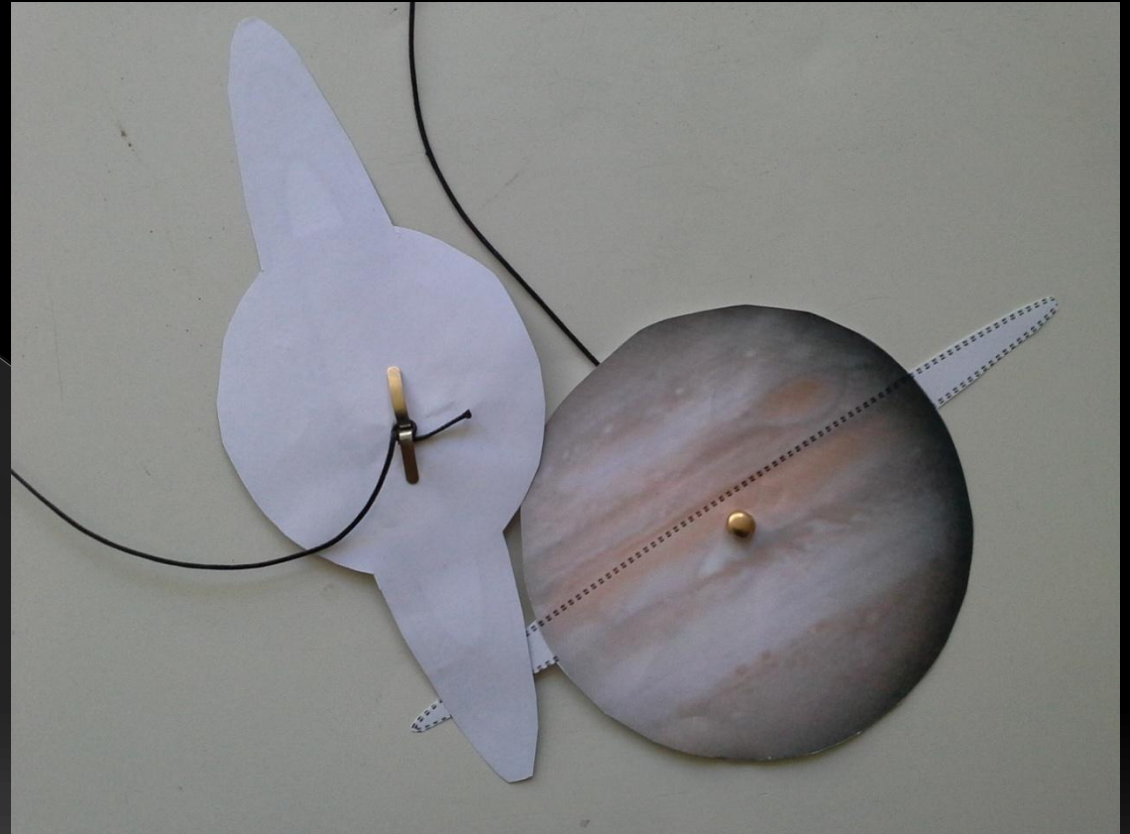
Setting up the calculator

- Cut all the circles that represent the orbits of the inner planets



Setting up the calculator

- Cut the giant planets and fasten Jupiter to the 25cm thread and Saturn to the 50cm thread, using the paper fastener



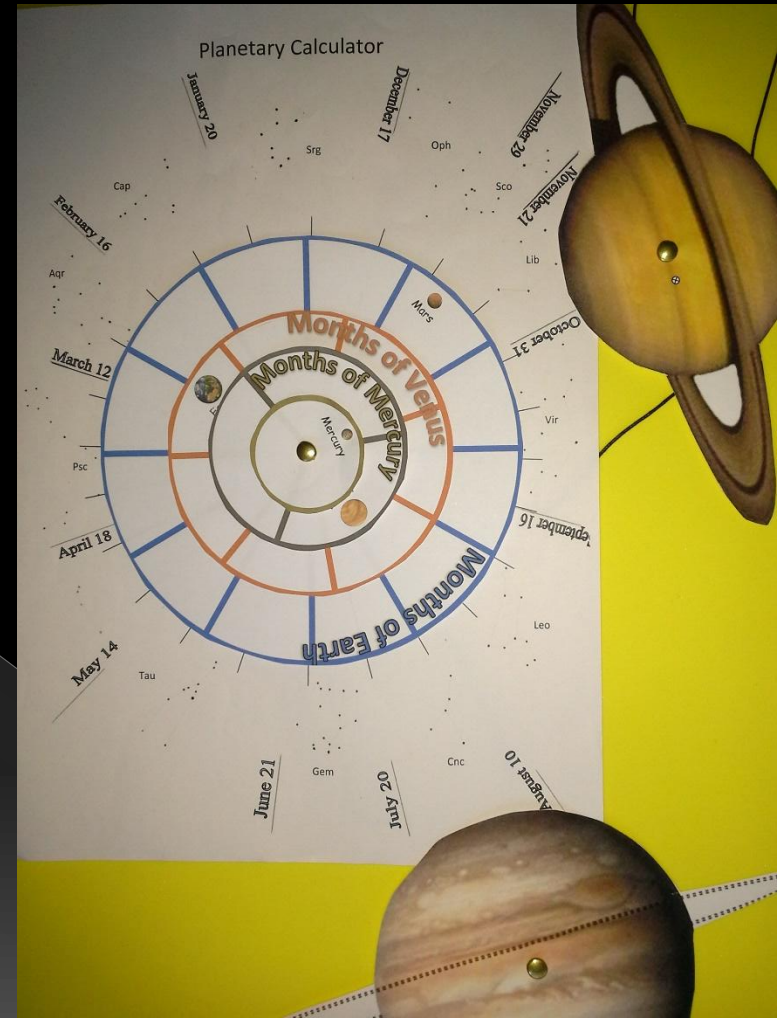
Setting up the calculator

- Place the paper fastener in circles' center according to the order of the planets placing Mercury on top.
- Secure Jupiter to the 25cm thread and Saturn to the 50cm thread, securing the other end of the threads to the paper fastener .



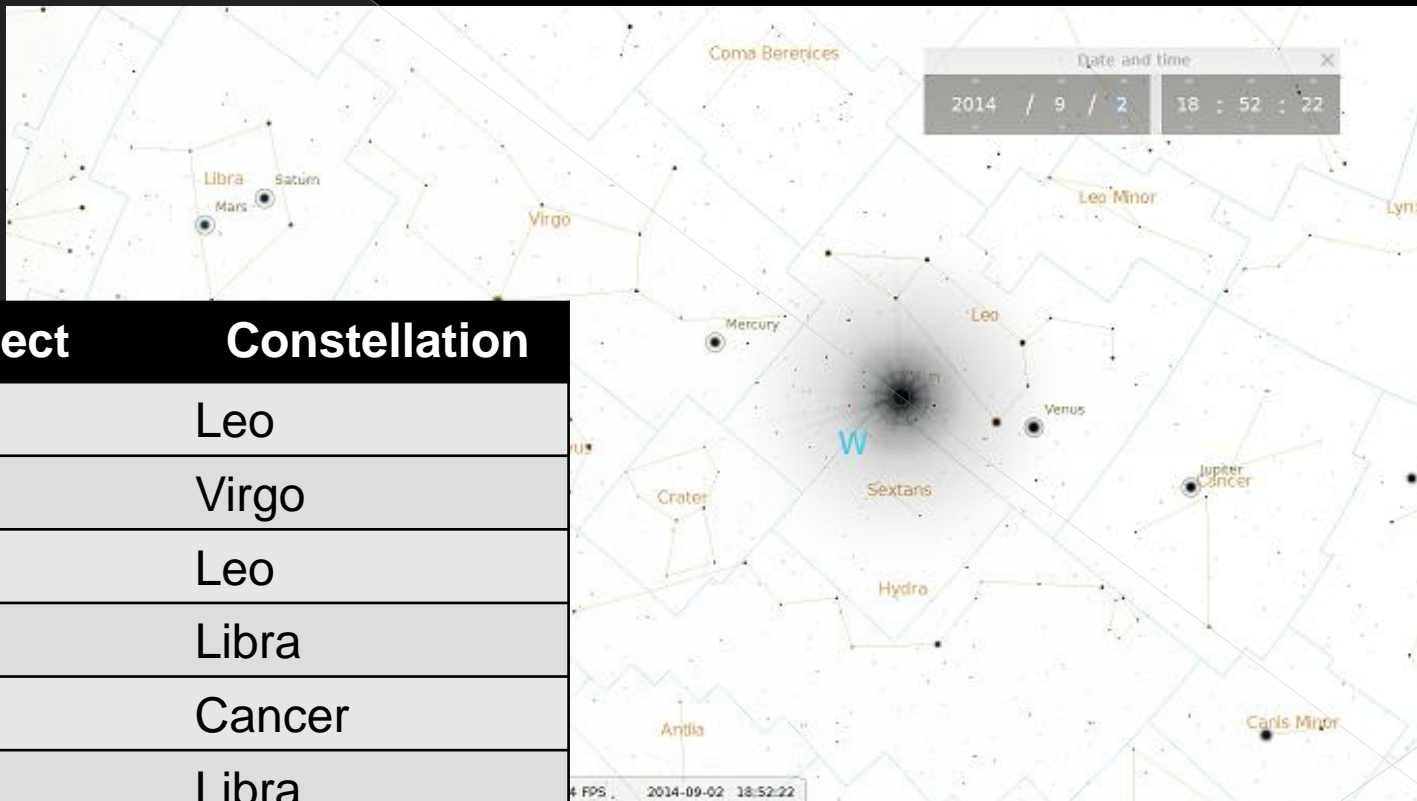
Setting up the calculator

- Join the previous set to the center of the calculator's base according to the picture.
- Mind that the paper fasteners should not be too tight to the cardboard so that the circles spin.



Working with the calculator

- Ask the students to choose a random day and find out which constellation are the planets and the Sun projected. (They may use the software Stellarium).



Object	Constellation
Sun	Leo
Mercury	Virgo
Venus	Leo
Mars	Libra
Jupiter	Cancer
Saturn	Libra

This chart is for:
2nd of September 2014

Working with the calculator

- Ask the students to verify if the inner planets, Mercury and Venus, are in inferior conjunction or superior conjunction (using Stellarium).

Center the Sun pressing the spacebar e zoom in by scrolling

The screenshot shows the Stellarium interface with several annotations. A central diagram of the solar system shows the Sun at the center with orbits for Mercury, Venus, Earth, and Mars. The Sun, Mercury, Venus, and Earth are circled in cyan. The interface includes a 'Location' window with a list of locations, a 'Date' window showing '2013 / 7 / 31 15 : 15 : 48', and a 'Sky' control panel with various settings. The status bar at the bottom shows 'Solar System Observer, New Location, 38m FOV 3.67° 10.6 FPS 2013-07-31 15:15:48'.

On the location, choose:
Solar System Observer

On this date, Venus and Mercury are in maximum declination

Choose the date

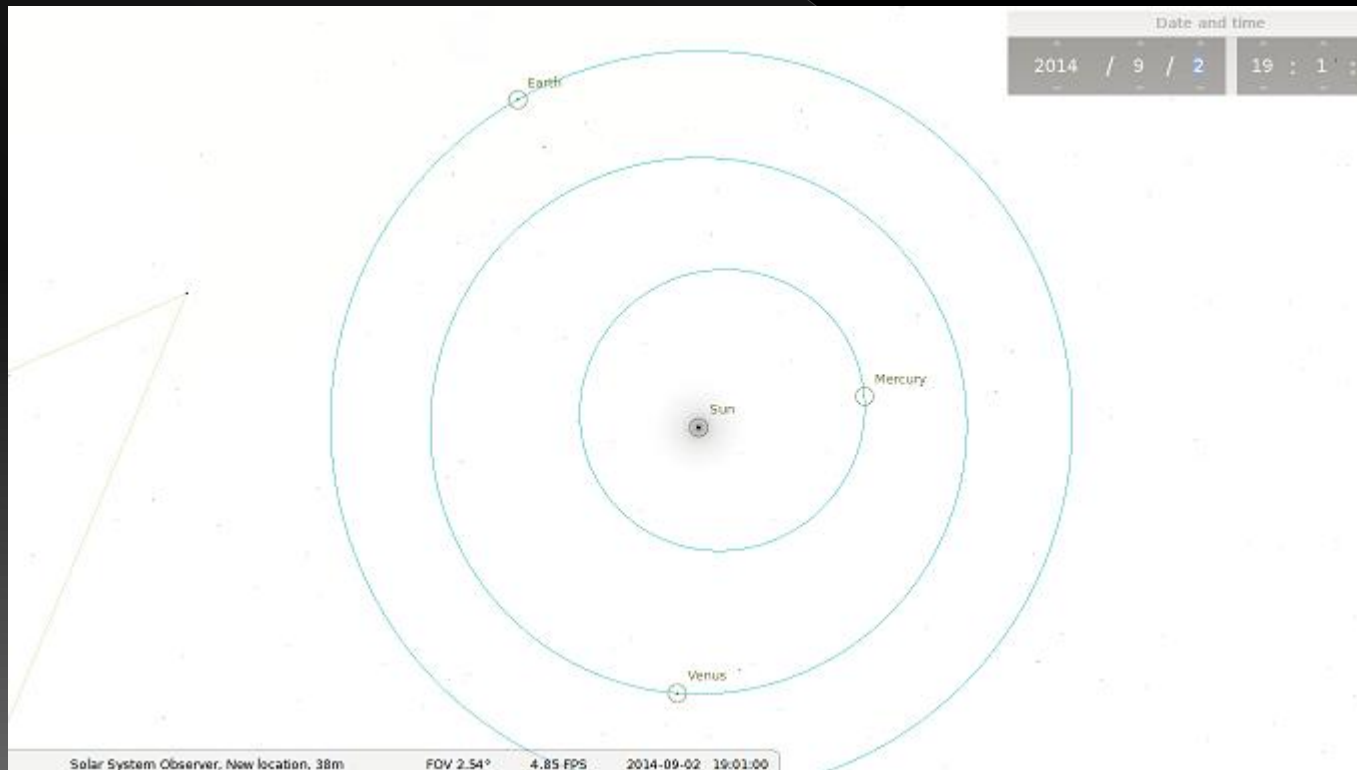
Turn off the horizon and atmosphere

Sky option - Select planets, markers, orbits. To see Mercury select the 0,25 relative scale

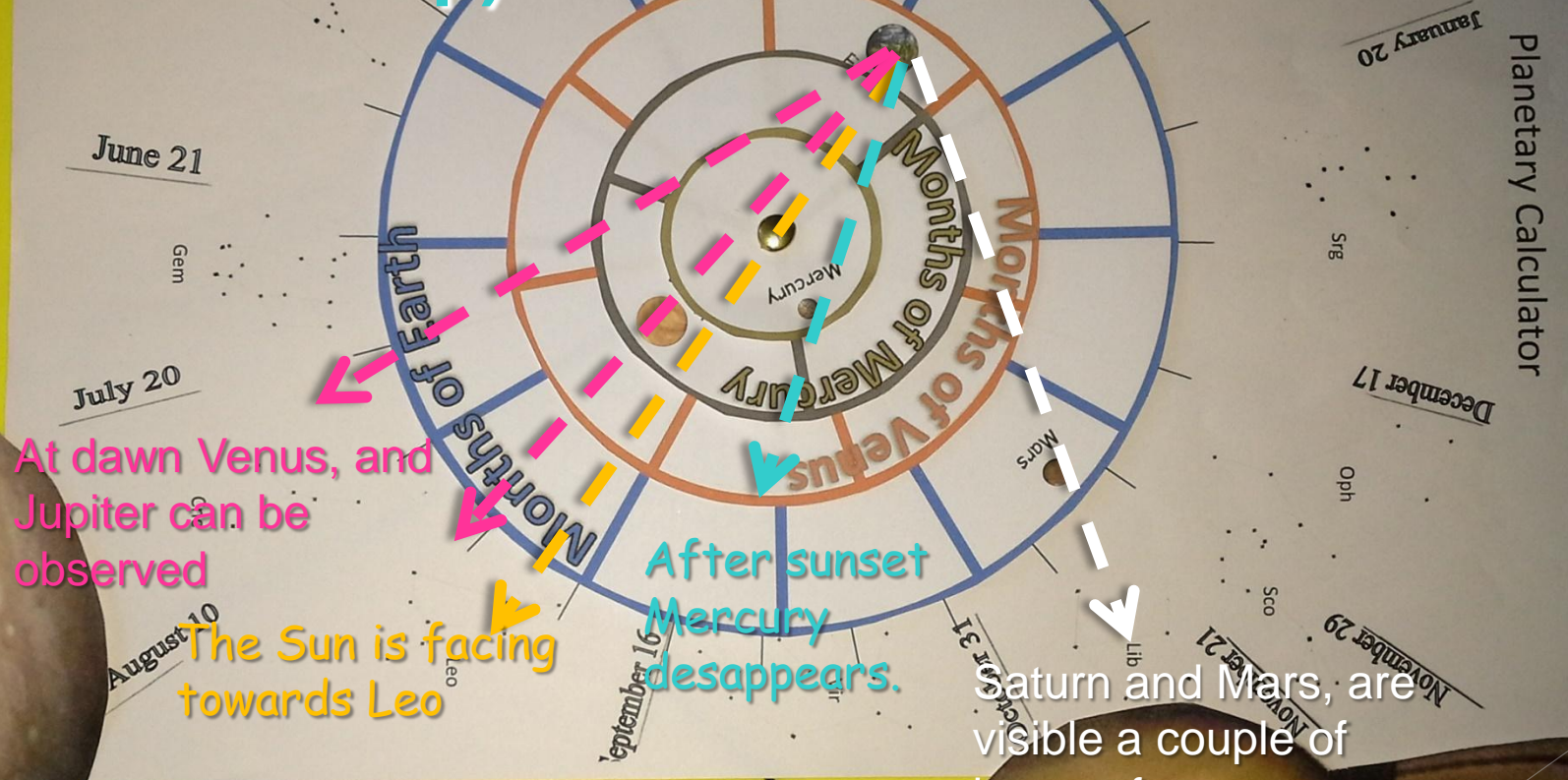
Working with the calculator

▪ Ask the students to verify if the inner planets, Mercury and Venus, are in inferior conjunction or superior conjunction (using Stellarium).

- Choose the date
- Turn off the horizon and atmosphere
- Sky option - Select planets, markers, orbits.
 - To see Mercury select the 0,25 relative scale
- Center the Sun pressing the spacebar e zoom in by scrolling
- On the location, choose: Solar System Observer



Phase 5– Explanation of the results and conclusions (Sharing of experiences and ideas) (proposal of set up)



At dawn Venus, and Jupiter can be observed

After sunset Mercury disappears.

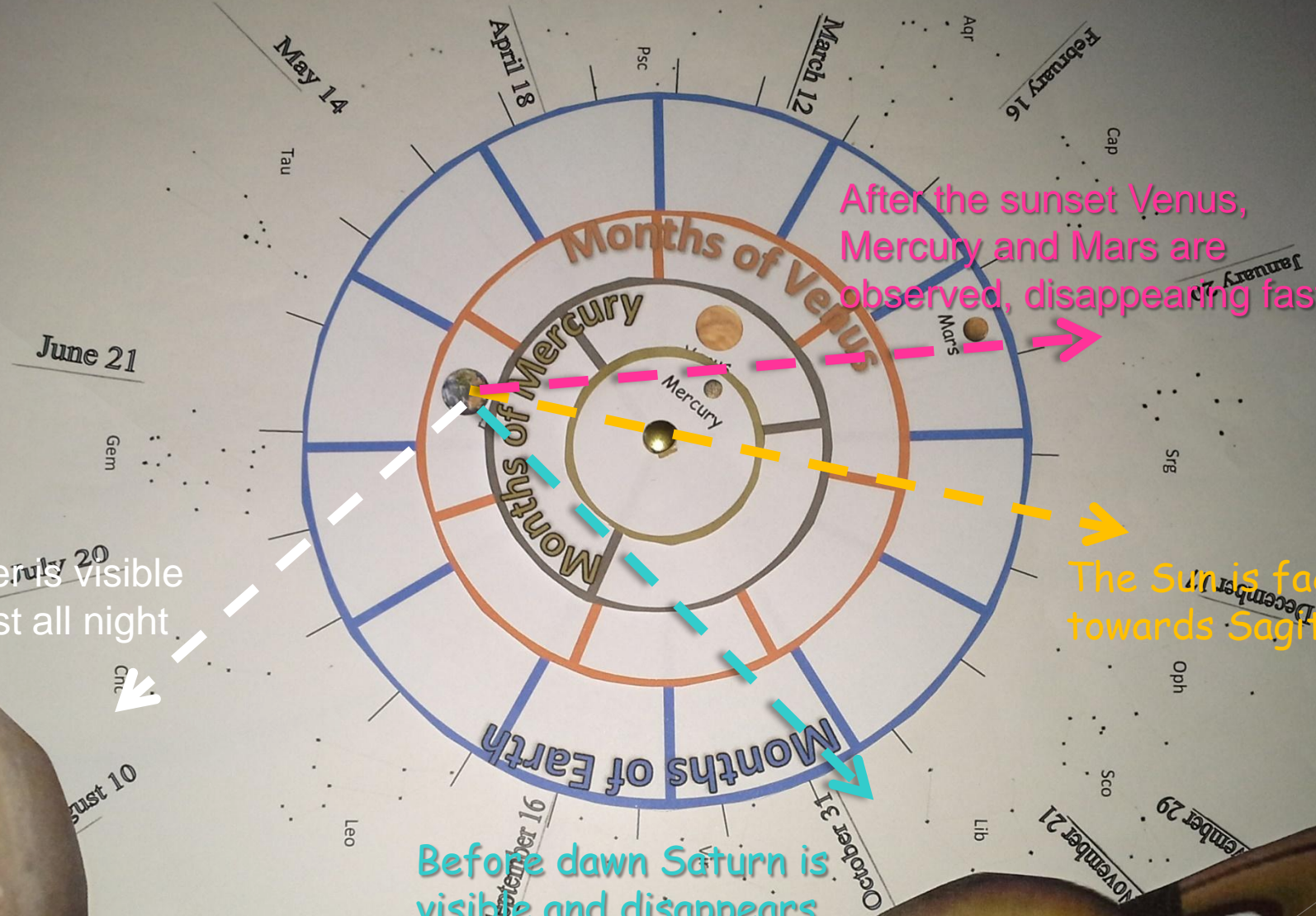
The Sun is facing towards Leo

Saturn and Mars, are visible a couple of hours after sunset

Phase 6 - Communication (show that they know how to work with the calculator)

Working with the calculator

- Ask the students to move the planets 4 terrestrial months counterclockwise (counting the months in the referred circles)
- They verify that the relative position of the planets has changed and therefore, its visibility is also different.



After the sunset Venus, Mercury and Mars are observed, disappearing fast

The Sun is facing towards Sagittario

Before dawn Saturn is visible and disappears when the Sun rises

Jupiter is visible almost all night

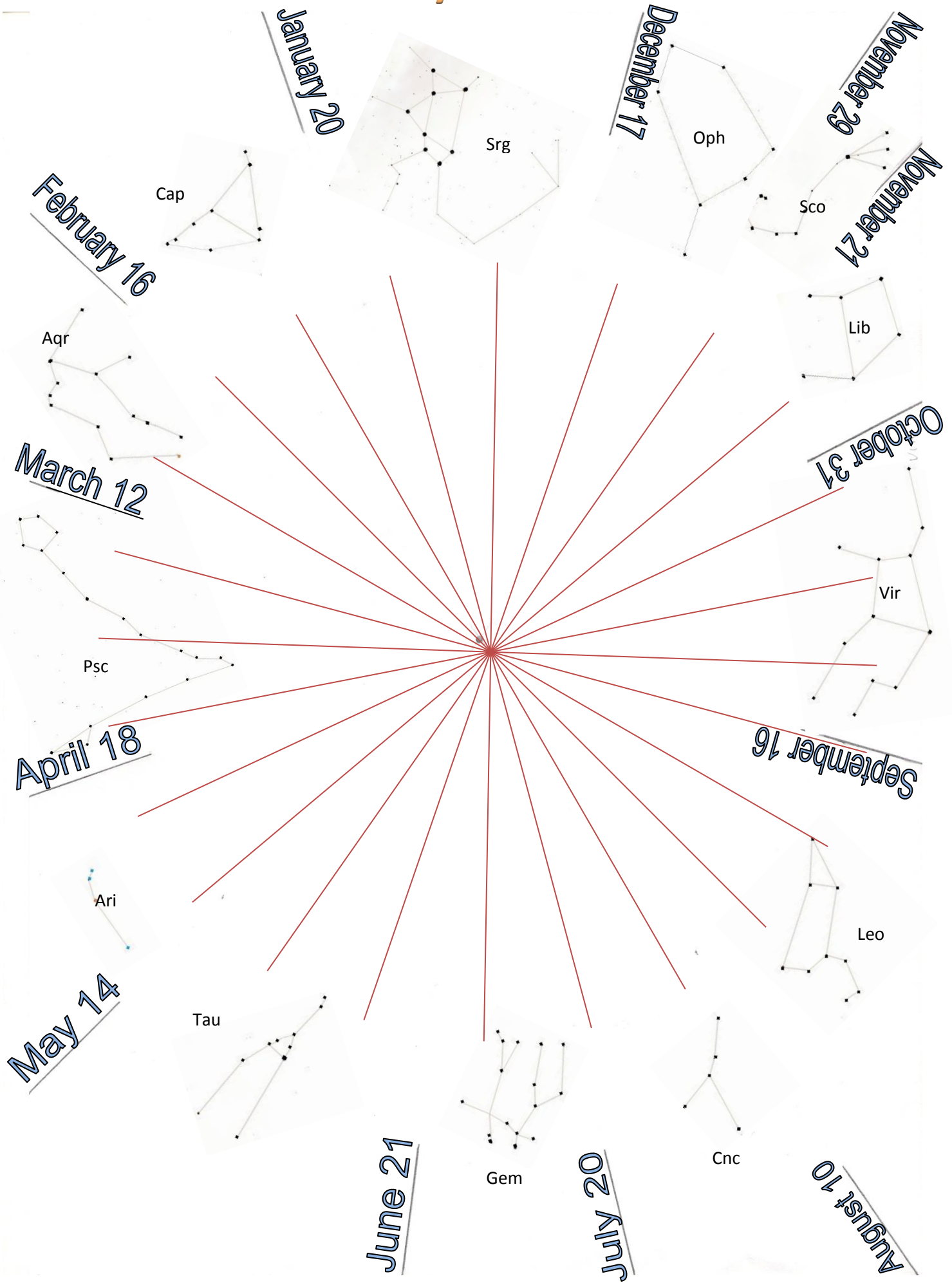
2nd of January 2015

Phase 7 – Evaluation (evaluate the process and expose the students' work)

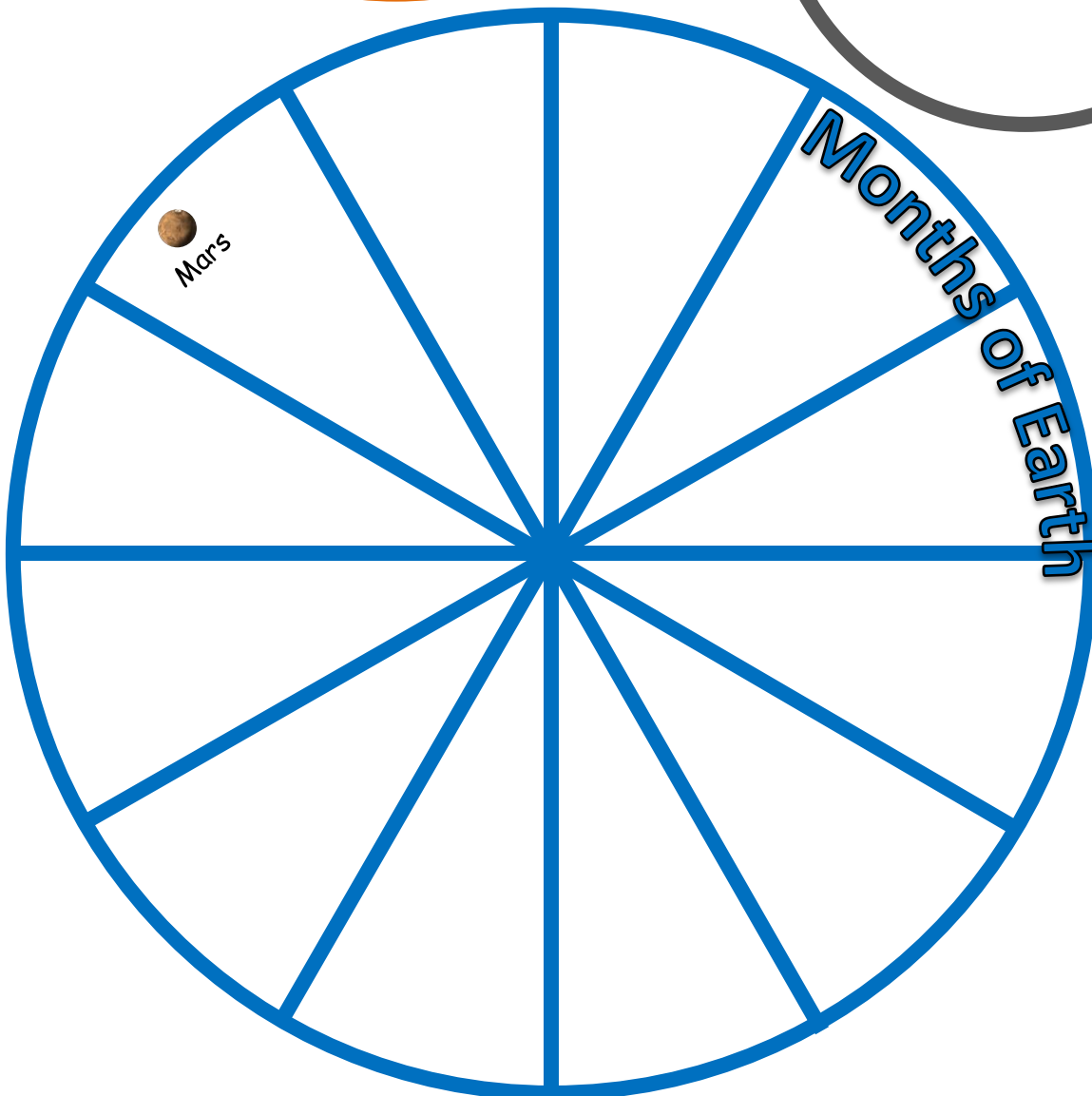
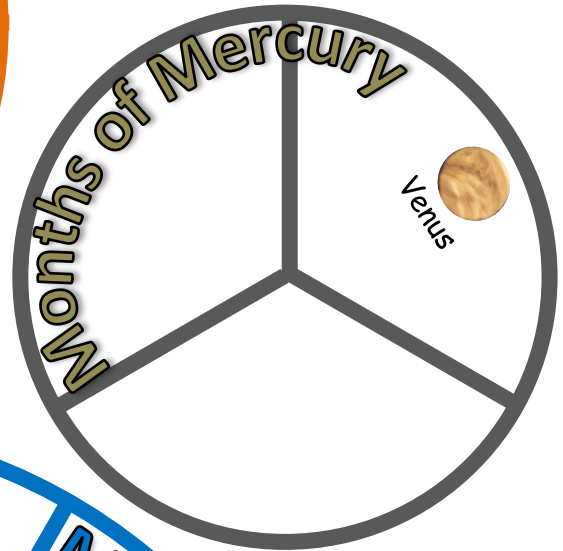
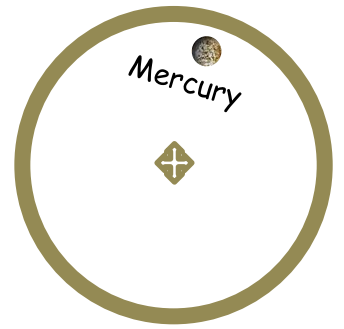


Contact: Leonor Cabral (e-mail: leonor.cabral.prof@gmail.com)

Planetary calculator

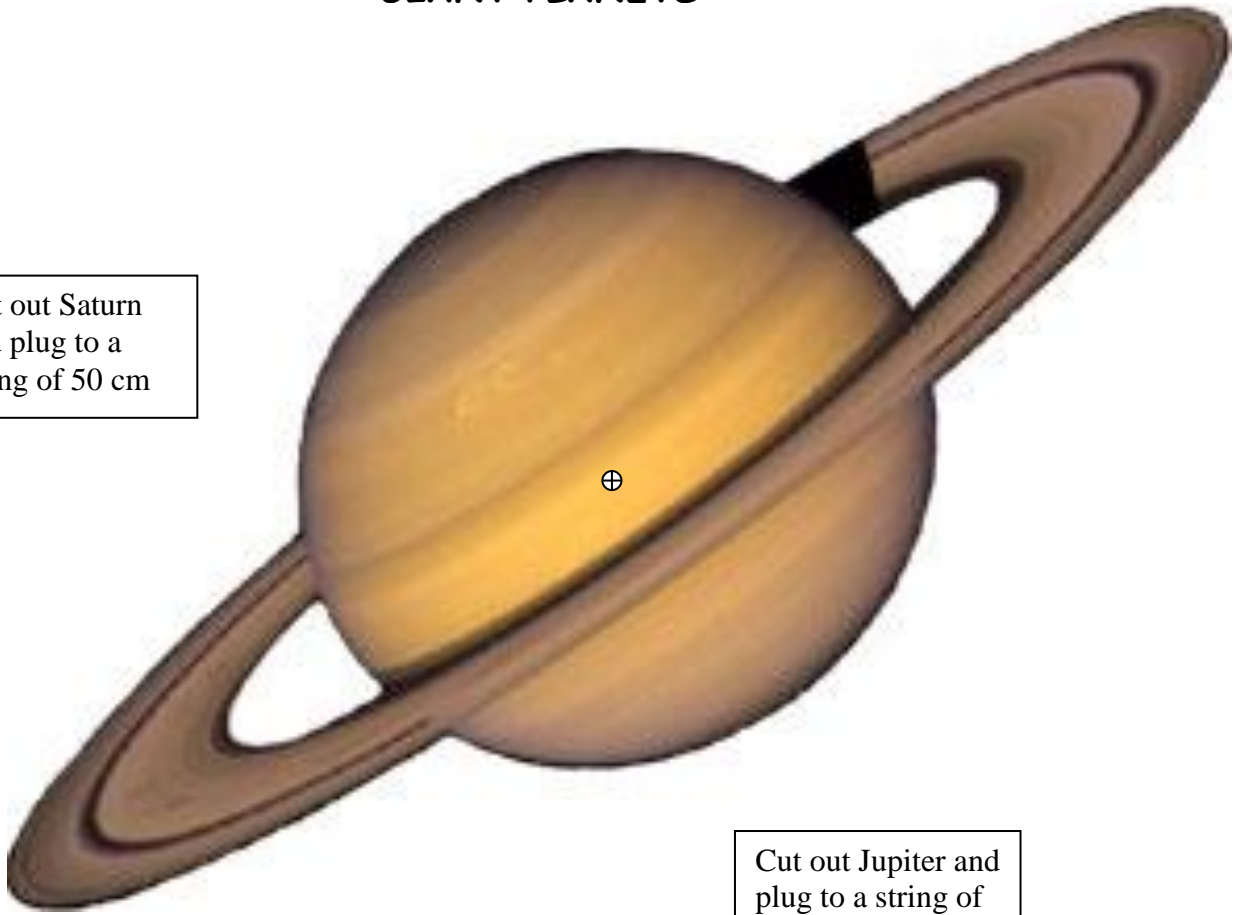


Circles of the orbits of rocky planets
(each division represents one month on Earth)



GIANT PLANETS

Cut out Saturn
and plug to a
string of 50 cm



Cut out Jupiter and
plug to a string of
25 cm

