Name: _____
Partner(s): _____
1101 or 3310: _____
Desk # _____
Date: _____

Motion of the Inner Planets

Purpose

- Identify and describe the motions of the inner planets.
- Explain conjunction, elongation, synodic period and sidereal period.
- Describe the transit of Venus.
- Draw and describe the phases of Venus.
- Describe the retrograde motion of Mars.

Equipment

- Starry Night College

Question 1: General Motions.

a) List the planets in the night sky as seen from Vancouver tonight.

b) Hide daylight. View the zodiac. Play time with a step of 1 sidereal day so that you keep looking at the same portion of the celestial sphere. Do all the planets seem to be moving at the same speed? Describe what you observe.

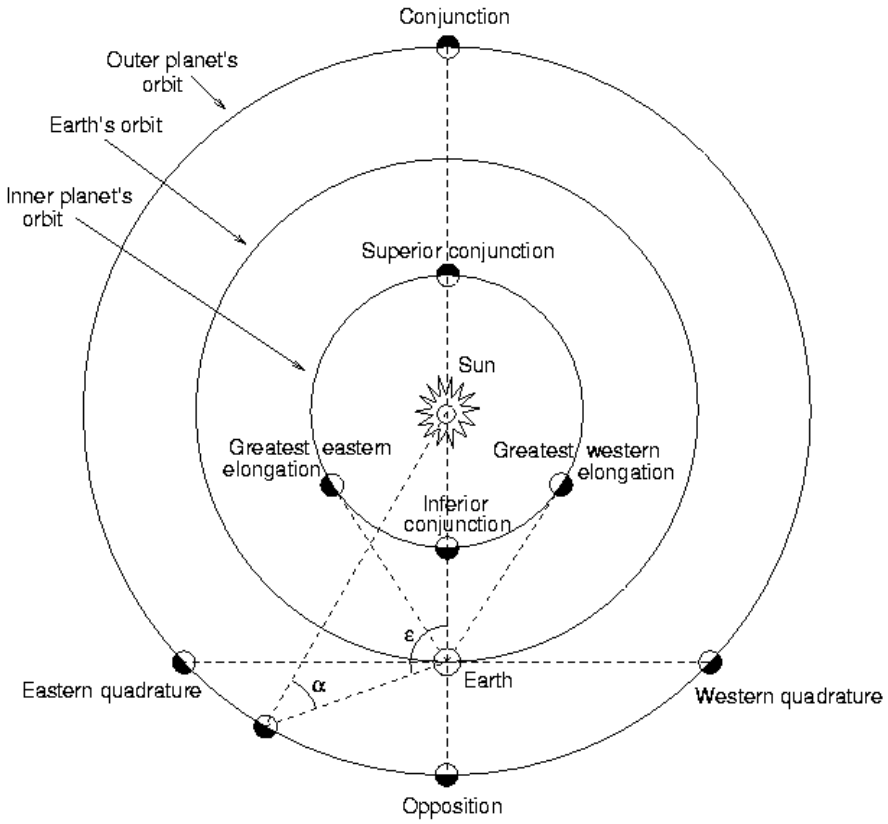
c) Do the planets mostly move East or West?

d) Which planets sometimes move backward?

e) How long does it take for the Sun to be back to its original position against the background of the stars (i.e. to the same RA and Dec)? (Right-click on Sun and choose "Show Info", and check the "More Info" box.)
List out the two dates and time with almost the same RA and Dec of the Sun. (Answer should be to the nearest minutes.)

Mercury: Click Search and find Mercury. Play time with a step of one sidereal day.

Question 2: Orbit. Since we know that the Earth is orbiting the Sun, we can draw the following diagram. Note the terms **Conjunction** and **Elongation**.



a) Is the angular diameter of Mercury changing? (Right-click on Mercury and choose "Show Info".)

b) Track the celestial path of Mercury. Imagine you are an ancient Greek. What would you conclude about the motion of Mercury relative to the Sun?

c) Show the orbit of Mercury. Using the Measure Tool ., what is the greatest angle between the Sun and Mercury to the nearest degree? Provide the greatest angle when Mercury is to the west of the Sun and when it is to the east of the Sun. This angle is called **elongation**.

Question 3: Conjunction. Observe the conjunction on May 2, 2007. Right-click on the Sun and click "Orbit". Zoom in to see the orbits of Mercury and Earth.

a) Where is Mercury with respect to the Earth and Sun?

b) Is it an inferior or superior conjunction?

c) Observe the conjunction on October 23rd, 2007. Is it an inferior or superior conjunction?

Question 4: Period. There are two kinds of periods for objects orbiting the Sun.

- The **sidereal** period is the time that it takes the object to make one full orbit around the Sun, relative to the stars. This is considered to be the true orbital period of an object.
- The **synodic** period is the time that it takes for the object to reappear at the same point in the sky, relative to the Sun, as observed from Earth; i.e. returns to the same elongation. This is the time that elapses between two successive (inferior or superior) conjunctions with the Sun. The synodic period differs from the sidereal period since Earth itself revolves around the Sun.

a) Right-click on Sun and select "Orbit". Zoom in, so that you can see the orbit of Mercury. Play time and watch for the time it takes Mercury to go through two successive (inferior or superior) conjunctions. What is the synodic period of Mercury (in days)?

b) Measuring the synodic period of Mercury from Earth is relatively straightforward, but in the time it took Mercury to go from conjunction to conjunction, Earth has moved some fraction of its own orbit around the Sun. You'll now go through the steps to find the sideral period of Mercury with observations from Earth. You know the Earth goes through 360° in 365.25 days. How many degrees did the Earth travel in the amount of time you found in (a)? (Show your calculations.)

c) In one synodic period, Mercury traveled 360° plus the number of degrees you found in (b) because it went all the way around once, plus a bit. How many degrees did Mercury travel in one synodic period?

d) With your answer from (a) and (c), how long does it take Mercury to travel 1°?

e) With your answer from (d) how long does it take Mercury to travel 360°? This is the sidereal period of Mercury which you can measure from Earth with this method.

Venus: Check the box of "Show Daylight" under SETTINGS > LOCAL HORIZON.

Question 5: Observing.
What are the best times of the day to observe Venus?

Question 6: The transit of Venus. This occurs when Venus passes directly between the Sun and the Earth, obscuring a small portion of the Sun's disc. During a transit, Venus can be seen from the Earth as a small black disc moving across the face of the Sun.

Transits of Venus are the rarest of all predictable astronomical phenomena and currently occur in a pattern that repeats every 243 years, with pairs of transits eight years apart separated by long gaps of 121.5 years and 105.5 years.

Before 2004, the last pair of transits of Venus were in December 1874 and December 1882.

The first of a pair of transits of Venus in the beginning of the 21st century took place on June 8, 2004 and the next in this pair was on June 6, 2012.

a) Was the transit of Venus on June 5th/6th 2012 visible from Vancouver?

b) Observe the transit of Venus. Remove the horizon if needed. How long does the transit of Venus last? (Round your answer to the nearest hour.)

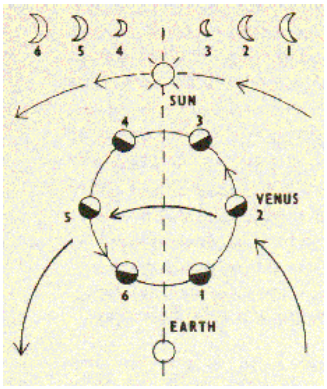
c) When is the next transit of Venus? Write down the date.
(Show your calculation based on information given and check your answer with the software.)

Question 7: The phases of Venus. At the beginning of the Renaissance, the geocentric model developed by the ancient Greeks was still taught in all western universities: the Earth was the centre of the universe and the Sun was orbiting it. Copernicus, a German priest, proposed the heliocentric model: the Sun was the centre of the solar system. This model was used for calculations but nobody could prove that it was an actual representation of the solar system.

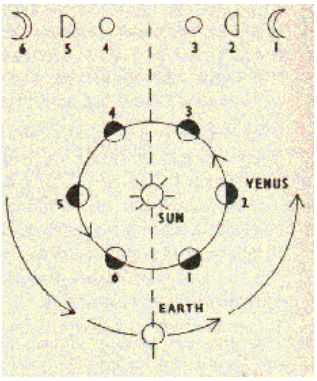
Click Search and find Earth. Click on "Orbit Mode" and play time. Observe the motion of the planets and the Sun around the Earth.

Galileo (1564-1642) was the first to study the sky with a telescope. He speculated:

"If the Sun were orbiting the Earth, then the phases of Venus as seen from the Earth should look like:"



"However, if the Sun was the centre of the solar system, them they should look like:"



a) Right-click on Sun and select "Orbit". Zoom in, so that you can see the orbit of Venus. Play time and to the nearest day, find the length of a year on Venus (how long it takes for Venus to return to the same position in its orbit.

b) Observe Venus from Earth. Remove the horizon if needed. Play time (1 sidereal day). Observe the changing phases of Venus (zoom in). Go over one synodic period. Record the phase and angular size of Venus for four different positions of Venus. Draw four phases of Venus TO SCALE using 1mm for 1 arc second (1″).

c) Which of the two models of the solar system do your drawings from (b) support?

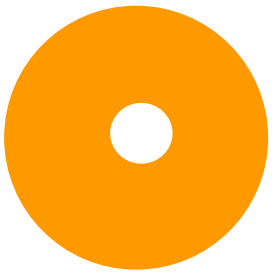
d) Draw a diagram showing the positions of the Sun, Venus, Earth and the phase of Venus at greatest western elongation.

Question 8: Mars. Click Search 🔎 and find Mars. Right-click on Mars and select "Orbit". And you may also find some information at SKYGUIDE > Unit C: The Planets > C1: The Inner Planets of the Solar System > 5: Mars.

a) Find the name of the two moons of Mars.

b) How long is a day on Mars from noon to noon (round off to the nearest hour)?

c) Zoom in to see the "North Pole" of Mars. Fly 20,000 km up to see the Northern polar cap from above. The diagram on the right is a top view of Mars' polar cap. Draw the dark side of Mars on an equinox.



d) How long does it take between two successive equinoxes in Earth days?

e) How long is the cycle of the seasons on Mars (i.e. a martian year)?

Question 9: Opposition. Mars is a superior planet. Look at the diagram in Question 2 on Page 2.

a) Name the superior planets of the solar system.

b) Name the four possible configurations for an outer planet.

c) On October 26th 2006, is Mars in opposition or conjunction, as seen from Earth?

d) When is the opposition of planet Mars in 2007, as seen from Earth? Explain the method that you used.

Question 10: Retrograde motion. Go home. Remove the horizon. Select Mars and Center Mars. Go to SETTINGS > SOLAR SYSTEM > ORBITS and check the box of "Selected Object Path". Start on August 15, 2020. Play time with step of 1 sidereal day. Observe the retrograde motion of Mars.

a) How long does it take Mars to go over a full loop? Once you see the path of the loop on the screen, determine the number of days Mars spends making that loop.

b) What date will the retrograde motion of Mars be observed again?

One of you should play the part of Mars and another one the part of the Earth. Use your arm to symbolize the line of sight of somebody standing on the earth and looking at Mars. Reproduce the orbital motion of the two planets and explain the retrograde motion of Mars.

c) Explain the retrograde motion of Mars to your instructor. Instructor initial: _____
Beware: do not skip this question!

d) Explain the retrograde motion of Mars using a diagram and a few (complete) sentences.