Ozobot Evo Classroom Application: Conjunctions of the Goddess of Love and God of War

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Mythology of the planets has been of interest since ancient times. The planet Venus, second closest to the Sun, is named after the Roman goddess of love, and is sometimes known as the Morning Star or Evening Star, due to its brightness at dawn and dusk. Mars, the fourth planet out from the Sun, is named after the Roman god of war. It appears red in color, hence its association with bloodshed and war. Because Venus is closer to the Sun than Mars, Venus is said to be an inferior planet as viewed from Mars.

With growing interest in travel to and settlement on Mars, and a high likelihood that this will occur sometime during the 21st Century, it is interesting to consider ***how often Venus will be at inferior conjunction with Mars***. When Venus is directly between Mars and the Sun, *i.e.*, when Venus and Mars are the closest together, we say that Venus is at inferior conjunction. To help clarify, Figure 1 shows Venus at inferior conjunction with Mars. Mythology might be interested in the consequences of the goddess of love and god of war being so close together.

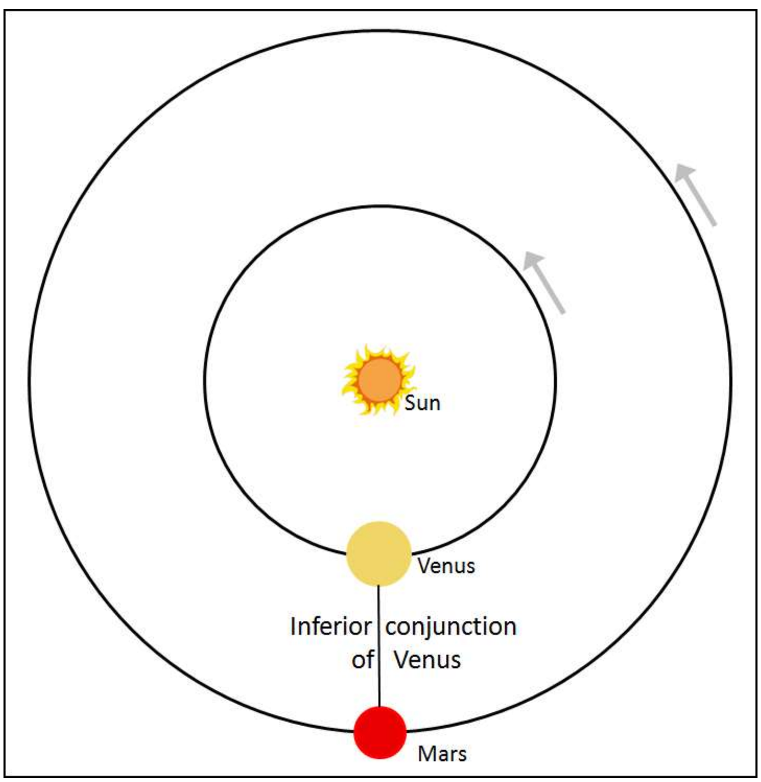

Figure 1

You may be asking "So what does this all have to do with Ozobot Evo?". Well, with **two** Ozobot Evos, one can be used to represent the planet Mars, and the other to represent the Venus. You will load each Evo with an OzoBlockly program specific to the planet that it will represent. The two programs are shown in Figure 2. ***(PlanetVenus.ozocode share code is o5k5ik. PlanetMars.ozocode share code is bzcsa5.)***

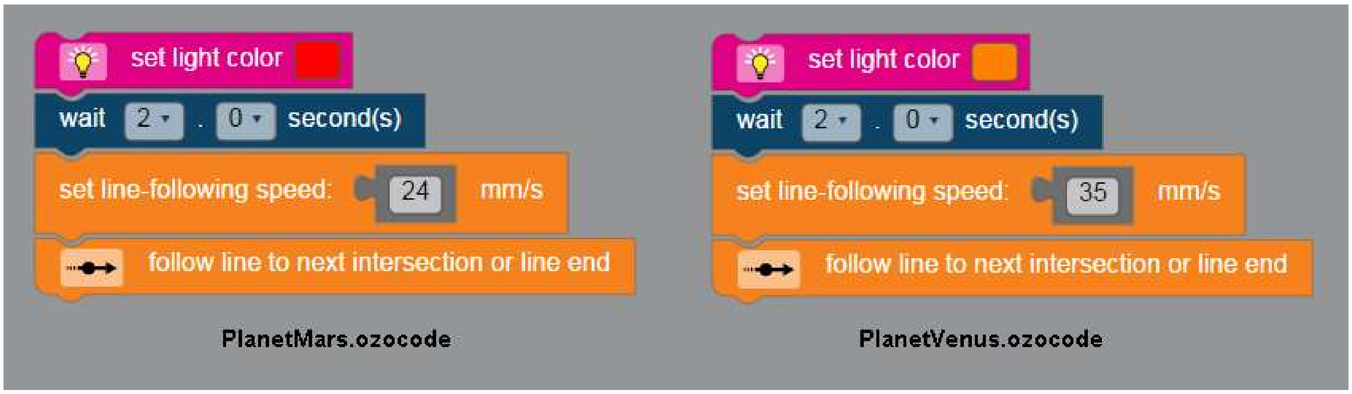

Figure 2

Mars will show a RED LED and will travel at a speed of 24 mm/s. Venus will show an ORANGE LED and will travel at 35 mm/sec. These are in proportion to the actual orbital speeds of these two planets, 24 km/s for Mars and 35 km/s for Venus. Note that the closer a planet is to the sun, the faster it travels.

The next page contains the "maze" that has been created for conducting your experiment to determine the time between successive inferior conjunctions of Venus as viewed from Mars. The orbits of Venus and Mars have been constructed in proportion to the known orbital radii of 0.72 AU for Venus and 1.52 AU for Mars. Note that AU is a mnemonic for "Astronomical Unit" and is the average distance from the Earth to the Sun. The two short, heavy arrows alongside each of the orbits represent the direction of motion of the planets in their orbits. All of the planets move counter-clockwise when viewing the solar system straight down on the Earth's North Pole. All of the planets orbit close to, but not exactly in, the same plane. The upper right corner of the "maze" provides you with the known orbital periods of 225 earth-days for Venus and 687 earth-days for Mars. You will need to make use of these times during your experiment.

Procedure:

1. Print a copy of the maze on the next page.
2. Load the OzoBlockly programs into two Evos. ***(PlanetVenus.ozocode share code is o5k5ik. PlanetMars.ozocode share code is bzcsa5.)***

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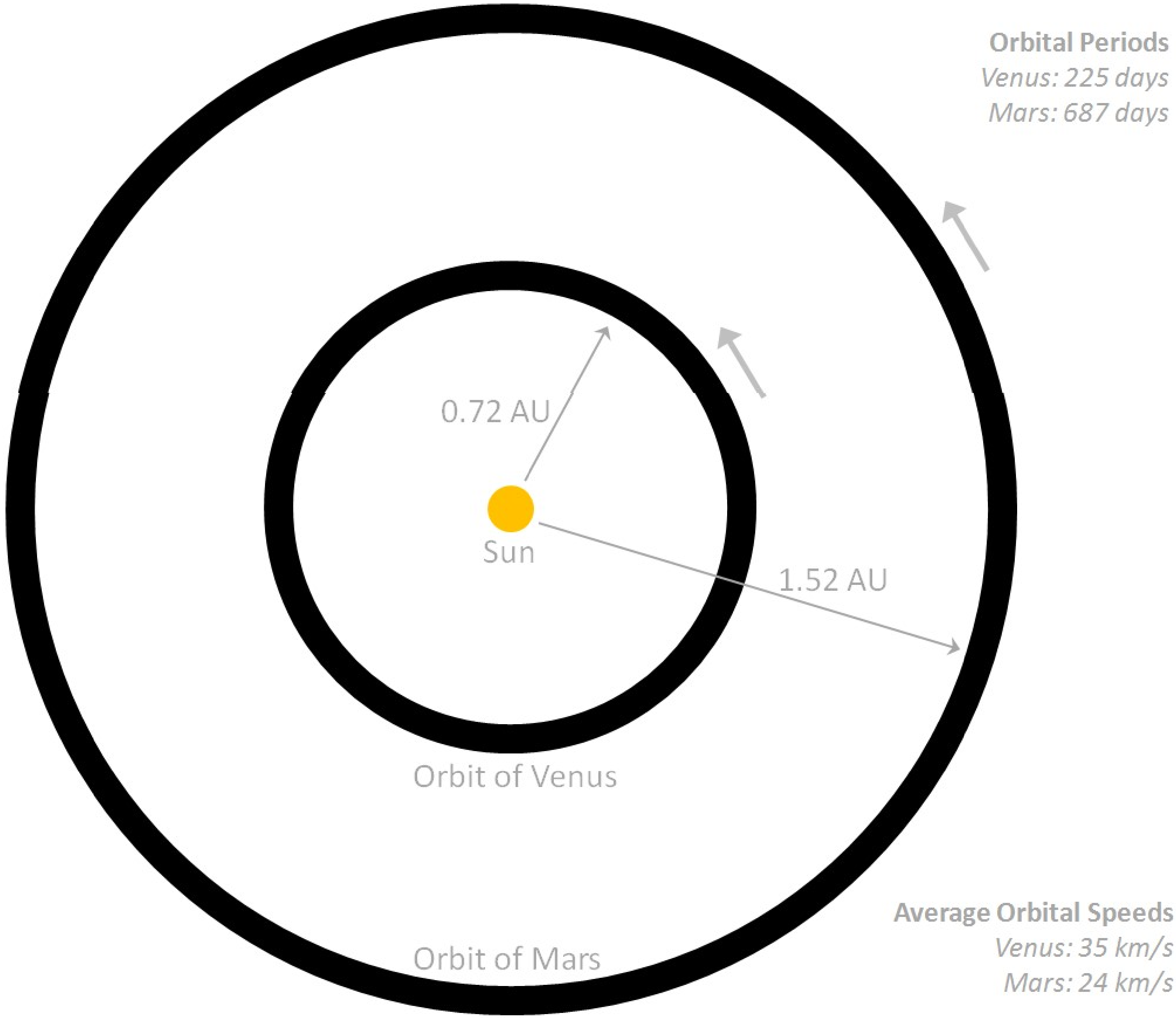

3. Press the start button on the Venus Evo and then double-press the button when the light turns blue to start the program. Place Evo anyplace on the “maze” in its orbit so that it is moving in the direction shown by the arrow. The Venus Evo will have an orange-yellow LED color.
4. Using the thin grey arrow as a marker for where an orbit starts, use a stop watch to measure the time in seconds required for the Venus Evo to make ten complete orbits. Divide this by 10 to get the time for a single orbit. *Answer:* ______________
(If you don’t have an actual stop watch, note that most cell phones have stop watch apps.)
5. Divide the number of days for a single orbit of Venus (225 days) by your answer to step 4. This will give you number of actual days corresponding to each second that you measured in step 4. *Answer* _______________ *days per Ozobot second.*
6. Press the start button on the Mars Evo and then double-press the button when the light turns blue to start the program. Place Evo anyplace on the “maze” in its orbit so that it is moving in the direction shown by the arrow. The Mars Evo will have an orange-yellow LED color.
7. Using the thin grey arrow as a marker for where an orbit starts, use a stop watch to measure the time in seconds required for the Mars Ozobot to make ten complete orbits. Divide this by 10 to get the time for a single orbit. *Answer:* ______________
8. Divide the number of days for a single orbit of Mars (687 days) by your answer to step 7. This will give you number of actual days corresponding to each second that you measured in step 7. *Answer* _______________ *days per Ozobot second.*
9. Your answers to steps 5 and 8 are probably not exactly the same. So for the remainder of the experiment, use the average of your answers in steps 5 and 8. *The average number of days per Ozobot second corresponds to* ________________ *actual days.*
10. Now comes the fun part! Measure the time in Ozobot seconds for 11 successive interior conjunctions of Venus as viewed from the planet Mars. Divide by 10 (why 10?) to get the time between successive conjunctions in Ozobot seconds. Answer ___________________ seconds
11. To get the actual time in days, multiply your answer to step 10 by your answer to step 9. Answer: ____________________ actual days between successive inferior conjunctions of Venus and Mars.

Congratulations! You have just used Ozobot Evos to solve an interesting problem is solar system astronomy!

(Note that your answer is an approximation as the orbit of Mars is fairly eccentric. Its perihelion is about 1.38 AU, while its aphelion is about 1.66 AU. Perihelion is when it is closest to the Sun, and aphelion is when it is furthest from the Sun. Your experiment assumed a constant distance of 1.52 AU from the Sun.)