TEACHER PAGE

PLOTTING THE PATHS OF SPACECRAFT

THIS ACTIVITY IS ADAPTED FROM NASA'S *Destination: Mars* curriculum.

Background Information

Many considerations for traveling to Mars are the amount of time the trip takes, the amount of fuel needed for the trip, and the size of the payload. A fast trip would be advantageous to the crew by reducing the time they are exposed to weightlessness, radiation, and other dangers inherent to space travel. However, fast trips require more fuel and that means less payload. People, equipment, and supplies would be reduced as larger amounts of fuel are carried to increase the speed of the trip.

Earth and Mars move at different speeds around the Sun. The Earth completes it solar orbit every 365 days while Mars completes its orbit every 687 days. This happens for two reasons. First, the Earth is closer to the Sun so it travels less distance. Secondly, it travels faster in its orbit. Planets closer to the Sun travel faster.

Objective

Upon completion of this activity, students will be able to:

- understand the importance of calculating trajectory for spacecraft launches.
- practice plotting trajectory paths from Earth to Mars and from Mars to Earth.

Instructional Time

45 Minutes

Materials

Student pages, *Plotting the Paths of Spacecraft*
Student pages, *Earth to Mars* and *Mars to Earth*
Pencils
Drawing compass

Procedure

1. Gather materials.
2. Review background information.
3. Complete the plotting exercise for practice.
4. Have the students share familiar experiences that require aiming at a moving target. Their examples might be passing a football, catching a fly ball, driving vehicles in paths to avoid being hit, or playing dodge ball. Lead students to discuss the how and why of the movements.

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5. Have students work with a partner. They may switch jobs for each plotting exercise.
6. Hand out the necessary materials to the students.
7. Help students become familiar with the data. Check for understanding. It is essential that students understand that Earth and Mars are moving and that the slashes on the Earth orbit represent the first of each month.
8. Help students plot the first date–May 11, 2018.
   NOTE: WHEN PLOTTING THE DISTANCE FORM SUN POINT, THE CMPASS POINT IS ALWAYS PUT ON THE SUN; WHEN PLOTTING THE DISTANCE FROM EARTH, THE COMPASS POINT IS PUT IN A DIFFERENT PLACE EACH TIME. THE POINT SHOULD BE PUT ON THE SLASH MARK THAT REPRESENTS WHERE THE EARTH WILL BE LOCATED ON THAT DATE.
9. Make answer keys available to students so they can check their work. If their orbits are not similar to the answer key, encourage them to redo the procedures to find their error.
10. Instruct students to apply the procedures to plot the return to Earth.
11. Closing discussion should encourage students to think about how a six month flight effects planning trips to Mars.

Discussion

1. What are the orbital challenges of traveling from one planet to another?
2. What are some possible paths for a spacecraft traveling form Earth to Mars?
3. What could make a spacecraft get to Mars faster?
4. What are some of the problems considered by engineers and scientists as they design trips to Mars?

ANSWER KEY

COMMUNICATION PRACTICE

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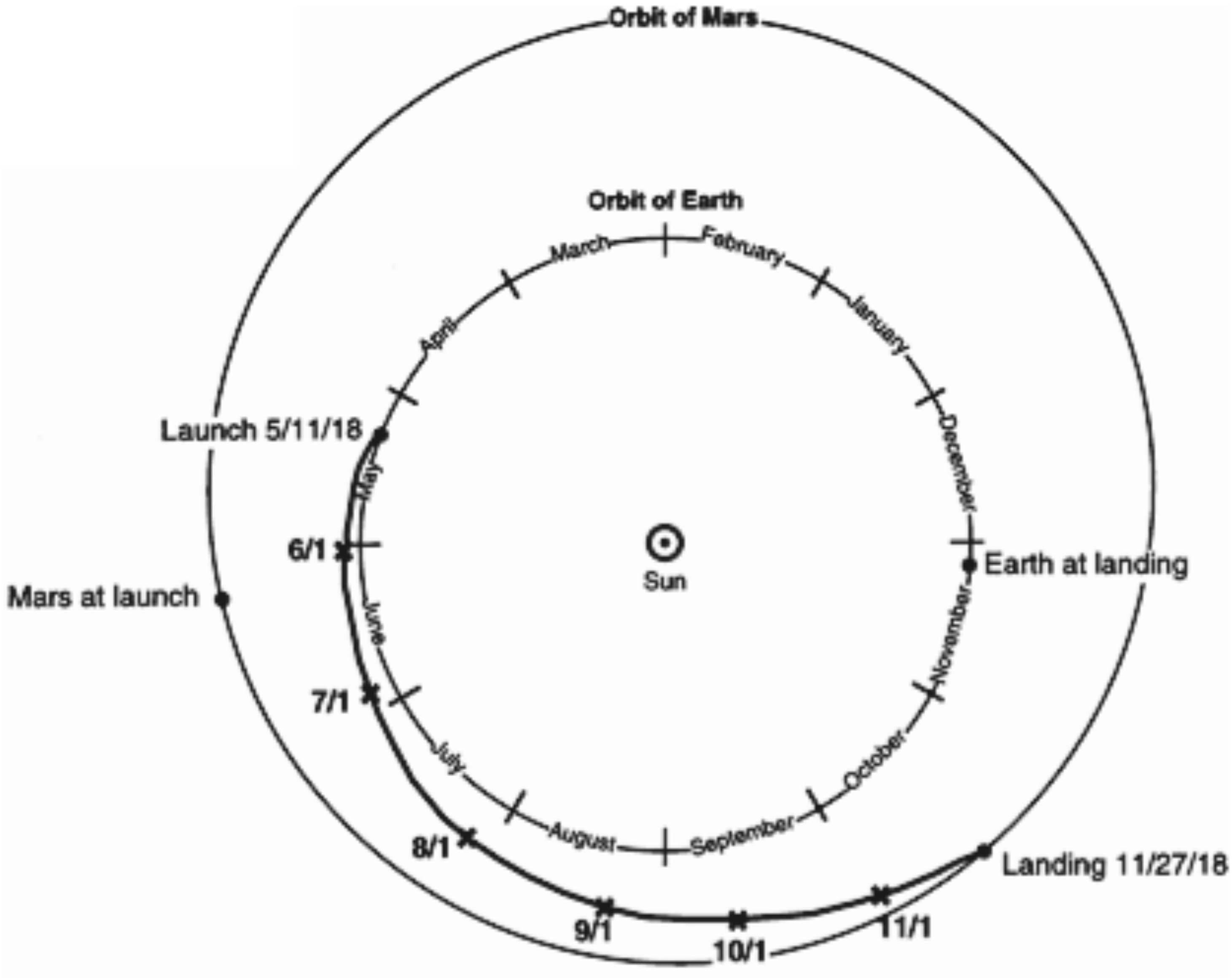

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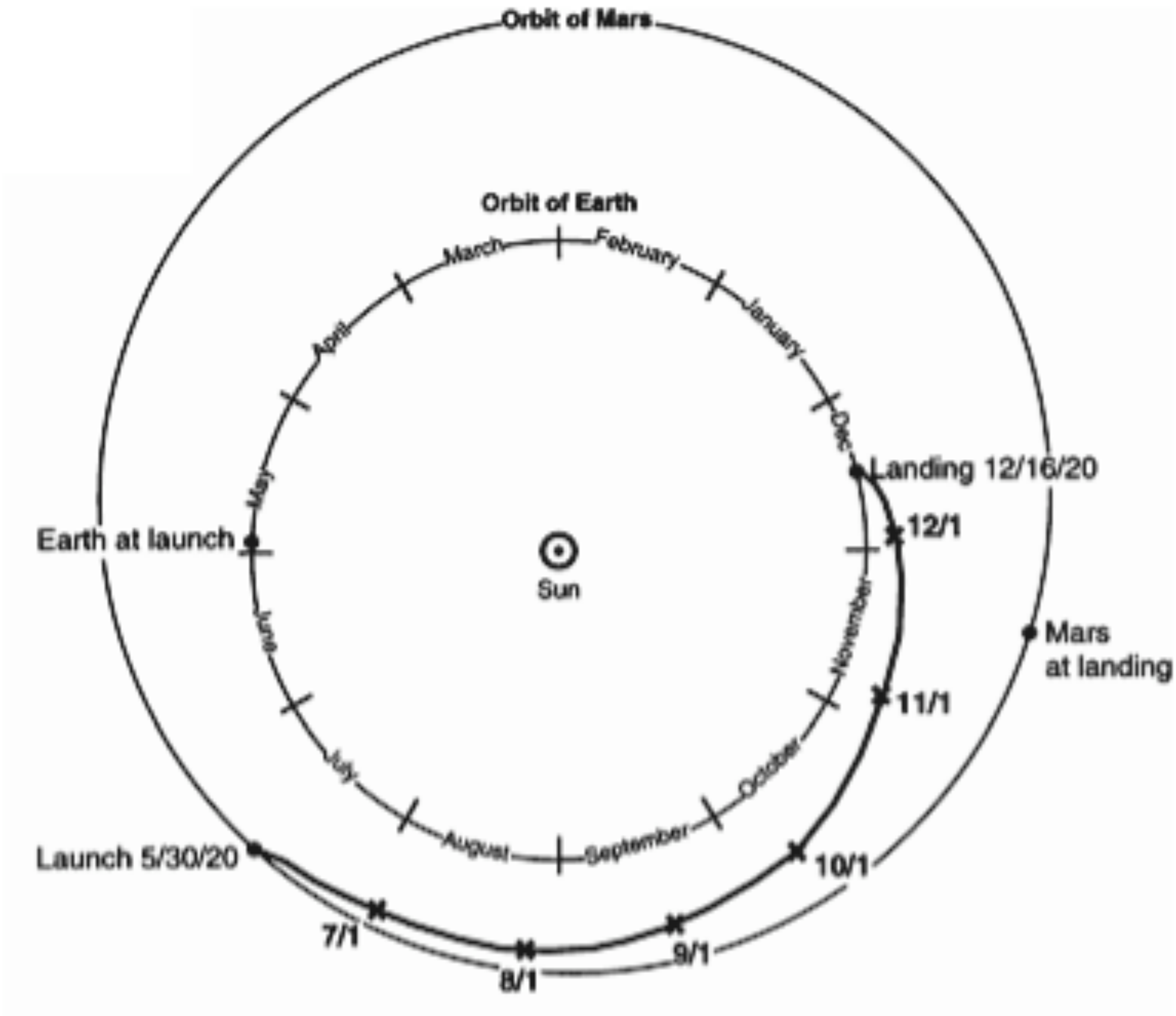

Student Name ______________________________________ Date _________________

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Directions:

1. Locate the following on the *Earth to Mars* student page:
2. Review the Spacecraft Position Data Table at the bottom of *Earth to Mars* student page. (The Data Table shows the position of the spacecraft on the first day of each month. The first column is the distances from the spacecraft from the Sun in million km. The second column is the distances for the spacecraft fro the Earth in million km.)
3. Plot the path (trajectory) of the spacecraft:
4. Using the key, check that your line is similar to the model. If the two lines differ, find the place in the process where the error occurred. Make sure you understand the process before going to step 5.
5. Plot the trajectory of the return trip to Earth from Mars using the second diagram and Data Table.
6. A minimum fuel trip between Earth and Mars takes about 200 days. Think about how this affects planning trips to Mars. Because of this long time in space, what must happen? What cannot happen? What might happen? These are the questions that mission planners must answer. What are other questions that might be asked about planning trips with minimum fuel orbits? Write your thoughts/answers on a separate sheet of paper.

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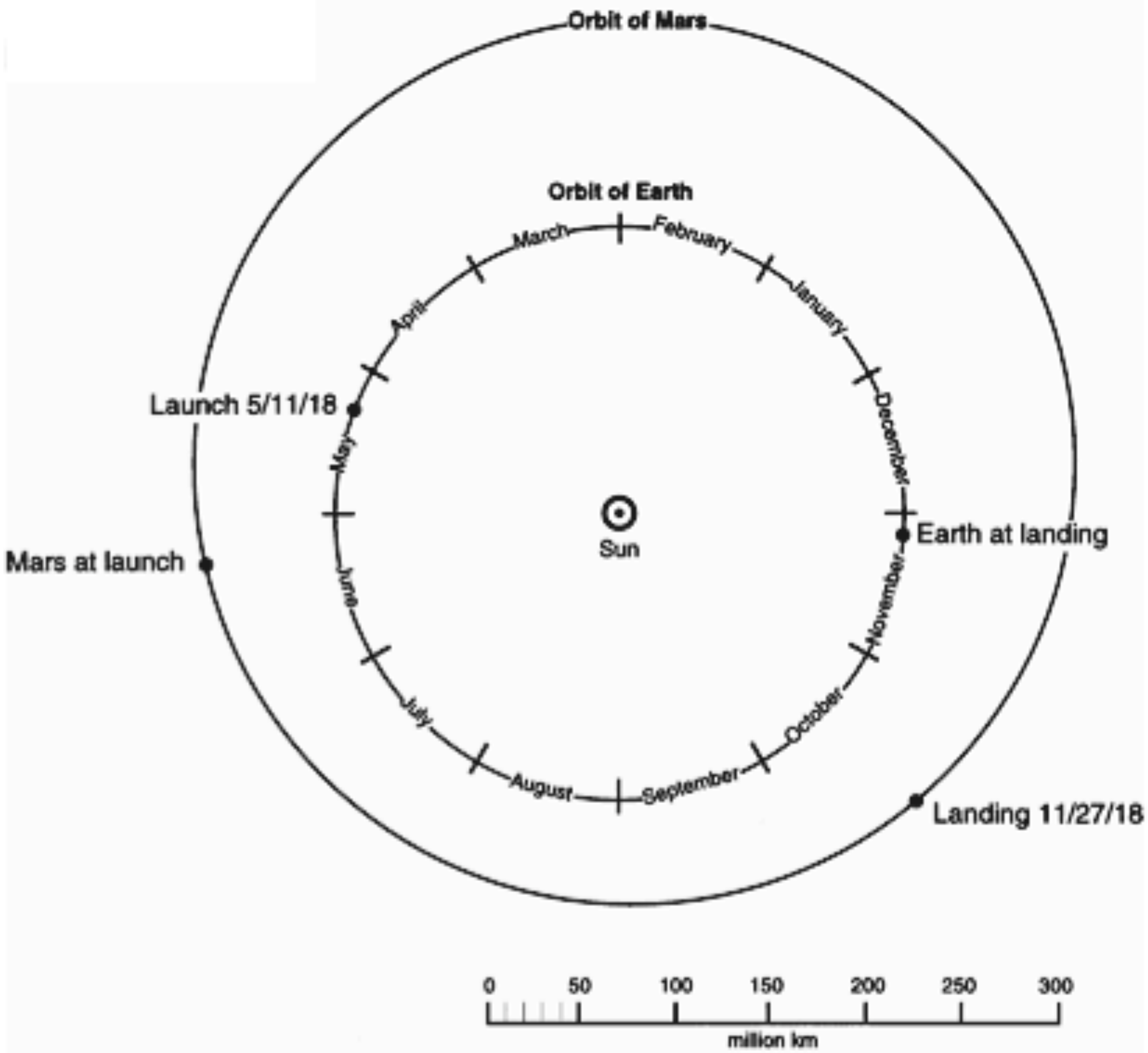

Spacecraft Position Data Table

	Date	Distance from Sun (million km)	Distance from Earth on this date (million km)	
(1)	May 11, 2018	152	0	Launch from Earth
(2)	June 1	155	5	
(3)	July 1	164	12	
(4)	Aug 1	176	25	
(5)	Sep 1	188	46	
(6)	Oct 1	199	76	
(7)	Nov 1	208	113	
(8)	Nov 27	213	147	Landing on Mars

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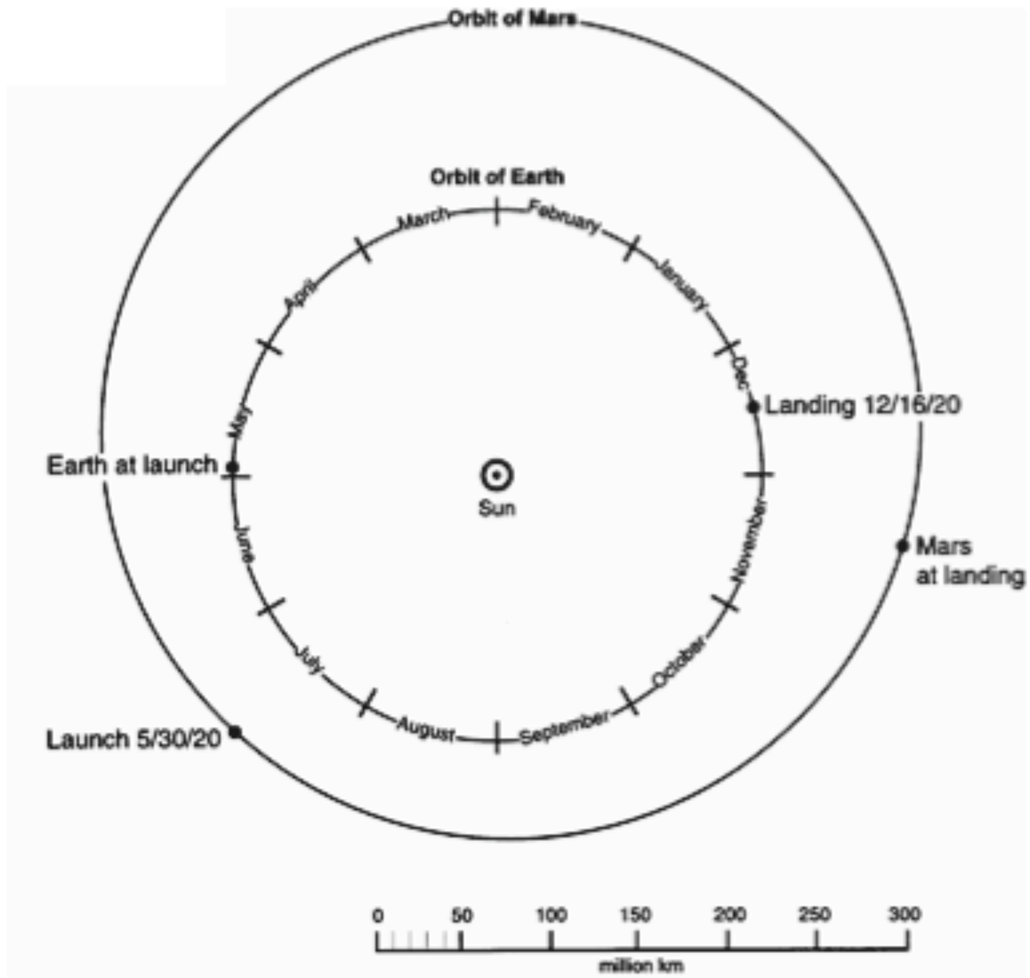

Spacecraft Position Data Table

	Date	Distance from Sun (million km)	Distance from Earth on this date (million km)	
(1)	May 30, 2020	212	153	Launch from Mars
(2)	July 1	207	115	
(3)	Aug 1	196	80	
(4)	Sep 1	187	50	
(5)	Oct 1	174	28	
(6)	Nov 1	161	14	
(7)	Dec 1	151	4	
(8)	Dec 16	148	0	Landing on Earth