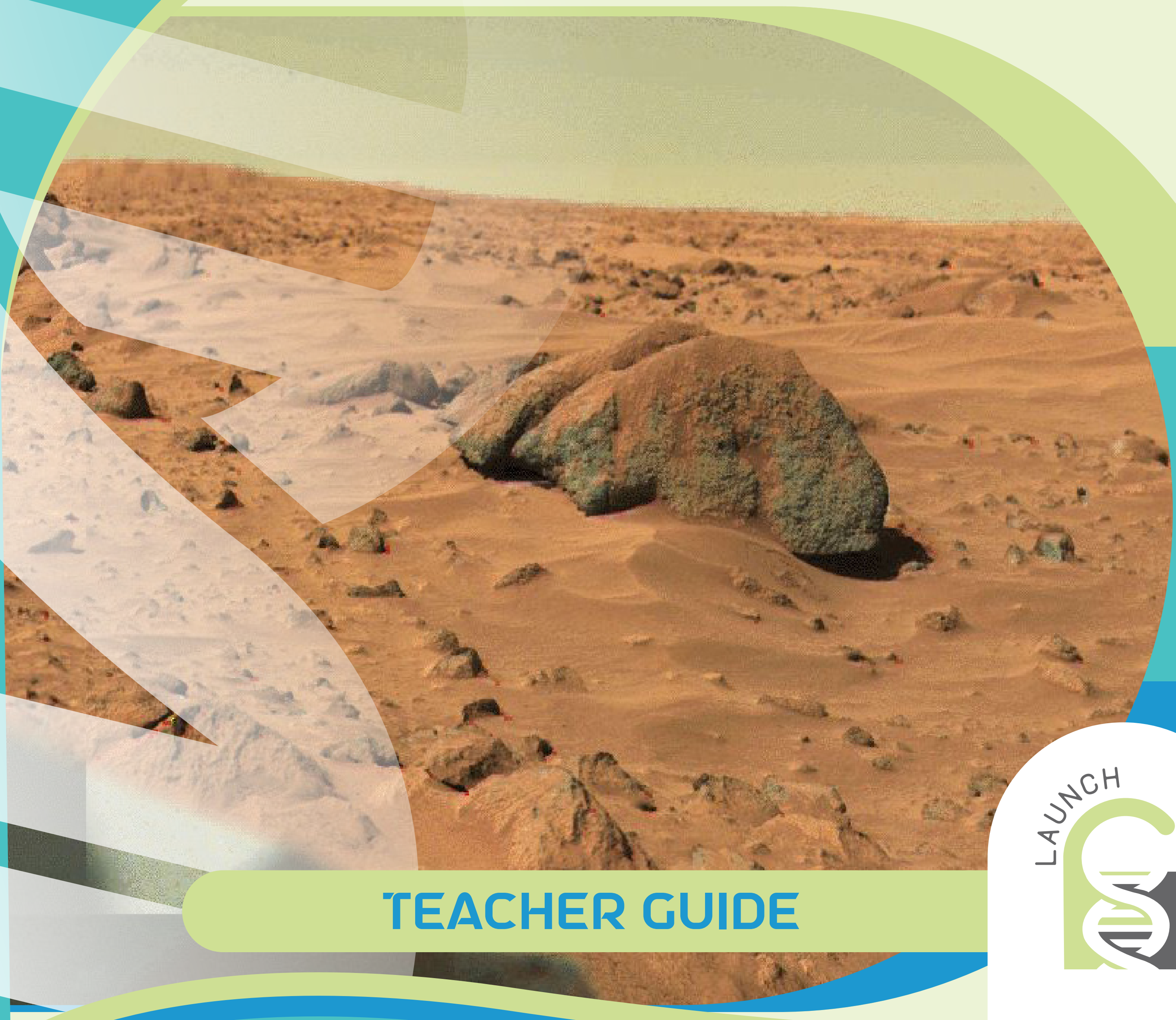
MARTIAN IMPACT



TEACHER GUIDE

PLANNING

Here's a suggested schedule for this kit! The activities are designed to be completed in order, but you can decide when to do them over time. Required times are estimated.

ACTIVITY INFORMATION	SECTION(S)	TIME REQUIRED	DAY/ LESSON
ACTIVITY 1: MULTI-MILLION DOLLAR MISTAKE Learn about a costly mistake on a space mission. **Time required: 45 min**	☐ Mars Climate Orbiter	45 minutes	Day 1
ACTIVITY 2: THE X FACTOR Learn about the foundations and conversions between systems of measurement. **Time required: 3 h**	☐ Metric System	90 minutes	Day 2
	☐ Conversion Factor	90 minutes	Day 3
ACTIVITY 3: NO ROOM FOR ERROR Investigate how precision and accuracy can inform the design of spacecraft. **Time required: 3 h 30 min**	☐ Round About Data	90 minutes	Day 4
	☐ Feel the Force ☐ Show What You Know	120 minutes	Day 5
ACTIVITY 4: SIGNIFICANT SUBSTANCE Explore properties of matter that must be considered in engineering. **Time required: 2 h 30 min**	☐ A Density Mystery	90 minutes	Day 6
	☐ The Air is Thick	60 minutes	Day 7
ACTIVITY 5: LANDER DESIGN CHALLENGE Design and launch your own spacecraft! **Time required: 3 h 45 min**	☐ Space Tech	45 minutes	Day 8
	☐ Design Challenge Launch!	120 minutes	Day 9
	☐ Reflect and Revise	60 minutes	Day 10
ACTIVITY 6: IMPACTFUL LEARNING Take your learning to the next level with more physics-related concepts. **Time required: 2+ h**	☐ Egg Drop Challenge	60+ minutes	Day 11
	☐ Mars Mission Mishap Report	60 minutes	Day 12
	☐ Mars Mission Profile	60+ minutes	Day 13

Total time: 15+ hours

1

activity

I

MULTI-MILLION DOLLAR MISTAKE

In this activity, your student will learn about a costly miscalculation that led to a missing spacecraft. They will read about the Mars Climate Orbiter mission from the National Aeronautics and Space Administration (NASA).

MARS CLIMATE ORBITER

CONTACT

- The Mars Climate Orbiter (MCO) was a part of a larger NASA mission to study the climate of the red planet. The student will learn more about another spacecraft in this mission in a later activity.
- The vocabulary terms atmosphere, gravity, and orbit are defined.
- The student will learn more about the difference between newtons and pounds in the next activity.
- Communication signals through space can travel at the speed of light. On Earth, satellite signals transmit information in a fraction of a second.
    - Earth and Mars orbits reach their closest distance about every 26 months. This provides an ideal window to launch spacecraft to Mars.
    - Even though radio transmissions travel at the speed of light, it takes more than 4 minutes for a signal to travel to Earth.
    - When Earth and Mars are at their farthest distances, on opposite sides of the Sun, communication signals take over 20 minutes to travel one way.
- To this day, the official fate of the MCO is unknown.

THINK ABOUT IT!

Question 1: How do you think the team of scientists and engineers was able to determine their mistakes without transmissions from the MCO?

Answer: Answers will vary. The team needed to check their math, review the software designed for the MCO, and analyze other data from sensors to determine the trajectory of the spacecraft.

How to Help:

- *The student is not expected to know how the team solved this unknown.*
- *More information about the analysis will be covered in the next activities.*

Question 2: What solutions do you think were developed to prevent future problems like this at NASA?

Answer:

- Answers will vary.
- NASA determined that its processes for communication and verification needed to be improved.
- They thoroughly review software for spacecraft, especially when developed by outside contractors as was the case with this mission.

How to Help: *The student is not expected to know the outcome of the mission. This question is meant for the student to draw their own conclusions based on information from the reading.*

Question 2: How would a "hand" length compare if your teacher measured with their hand?
Answer:
• Answers will vary.
• If the teacher's hand is longer than the student's, then the measurements would result in a smaller number of hand lengths per object.
• If the teacher's hand is shorter than the student's, then the measurements would result in a larger number of hand lengths per object.
How to Help: *Have the student compare hand sizes, make predictions, and help the student by measuring the objects with your own hand lengths.*

Question 3: Based on your answer, predict the length of the objects you measured if your teacher's hand lengths were used to measure. Give a reason for your prediction based on your answer to the previous question.
Answer:
• Answers will vary.
• The student can use the estimated hand length and math to solve a new approximate hand length for each object in their data table.
How to Help: *The student is not expected to calculate or remeasure any objects. Help the student support their reasoning with clear explanations based on their comparable hand size.*

3

Start From the Base

• In this reading, your student will learn about the foundations of the metric system, or International System of Units (SI).
• In the late 1700s and early 1800s, several standard measurements were established. Modern physics has used constants in nature to make these constants further established in nature.
  - The International Treaty of the Meter was signed in 1875.
  - In 1879, an international prototype of a kilogram was used to calibrate scales around the world.
  - By the mid-1900s, physicists were learning more about atomic mass and the speed of light, which would redefine the "prototype" model of the metric system.
  - In 2019, the last of the SI units were redefined using constants found in nature.
• In addition to kilograms, meters, seconds, and Kelvin, three other units make up the SI units: ampere – electric current, candela – the intensity of light, mole – the amount of substance in a molecule.

THINK ABOUT IT!

Question 1: In your measurement activity, how would your estimates and measurements have changed if you measured with millimeter detail instead of centimeters? Explain your reasoning.
Answer:
• Answers will vary.
• If the student was asked to measure with greater detail and precision, they may have been off by several millimeters, while being more accurate than a larger unit of centimeters.
How to Help: *Have the student try to estimate another household object in millimeters, then measure the object to check their accuracy.*

Question 2: In your opinion, what are the reasons for and against the use of SI units in the United States?
Answer:
• Answers will vary.
• The units for speed would be consistent when driving a car across an international border.
• U.S. companies must communicate to their customers in customary units even though their equipment and standards are designed in SI units.
• U.S. companies often sell internationally, so it is a burden to communicate units in two different forms.
How to Help: *This question is purely opinion, so the student should support their opinion with examples of technology, sales, etc.*

LAUNCH SCIENCE UNLOCKED

Contact us at: www.homesciencetools.com/customer-service/

A Product of Homesciencetools.com

Kit	SU-MARTIM
Instructions	SU-MARTIMT
Revision Date	7/2022