Lesson 1: Overview of the Solar System

Engagement Questions:

How is the motion of Venus and Uranus different than the motion of the other planets?_____
_____

Describe the difference between *planetary spin* and *orbital motion*. _____
_____

Is it possible for a planet to have both *planetary spin* and *orbital motion*? Explain. _____
_____

What is an Astronomical Unit? Why is it important? _____
_____
_____

What is the value of an Astronomical Unit in kilometers? _____km

Convert an Astronomical Unit into miles _____mi

Convert an Astronomical Unit into light years _____ly

Exploration Activity:

After determining the scale factor of _____ complete the table below.

Planet	Actual Diameter (in km)	Scaled Diameter (in mm)	Corresponding Sphere
Mercury	4879.4 km	2.1 mm	bb shot
Venus			
Earth			
Mars			
Jupiter			
Uranus			
Neptune			

Exploration:

How does the distance between the planets compare to the size of the individual planets or even the sun? Explain. _____
_____
_____
_____

What observations can you make about the astronomical size of our solar system? _____
_____
_____
_____

Explanation:

Explain how you and your team calculated the correct scaled diameters of the planets. You may use words, pictures or equations to explain your answer.

Evaluation:

How might you describe the solar system to a friend who knows nothing about the relative sizes of the sun and planets or the distances among them? _____
_____
_____
_____
_____
_____

Lesson 2: Introduction to Mars

Engagement Question:

Mars

What I KNOW about Mars	What I WONDER about Mars	What I LEARNED about Mars

Exploration Activity:

Examine your unknown foreign object. What observations can you make about its surface?

_____
_____
_____

Based on what you have read about the surface of Mars, how does the surface of your unknown foreign object compare? _____
_____
_____

Draw a picture of the surface of your unknown foreign object.

Exploration Activity:

Next, cut your sample in half. Describe what you see. _____
_____
_____

Using your straw, take a core sample of your unknown foreign object. What observations can you make? _____
_____
_____

Using the reading selection of Mars as a guide, how does the core sample of your unknown foreign object compare? _____
_____
_____

Draw a picture of the core sample of your unknown foreign object.

As you have observed both the outside and inside of your foreign object, how have you altered your sample? What effect might this have on your conclusions? _____
_____
_____
_____

Exploration Activity Cont.:

Make a prediction of what would happen if your sample came into contact with water. _____
_____
_____

Now, take an interior slice of your sample that measures no more than 3mm (about 1/8") thick and submerge it in water. Record your observations:

Minutes Elapsed	Observation
1 minute	
2 minutes	
5 minutes	

Through your research and based on the data you have collected, could this unknown foreign object have come from Mars? Explain your conclusion. _____
_____
_____
_____

Evaluation:

How do you think the activities you completed on making observations and on researching Mars will help you design a successful mission for your Mars Rover? _____
_____
_____
_____
_____
_____

Lesson 3: Research Tools and Skills

Engagement Questions:

What kind of fly-by photographs were the Mariner IV, VI, and VII able to take of Mars? _____
_____

What evidence did Viking 1 discover that makes us think there might have been water on Mars? __
_____

What are the names of the twin Mars Exploration Rovers (MER) that landed on Mars in 2004?
_____

According to the tour, what is Opportunity's next big destination? _____

Why did the scientists know that the Phoenix Lander wouldn't last very long? _____
_____

Exploration Activity:

Mars Facts

Meaning of the Name	
Diameter of Mars in mi/km	
Length of a Day	
Length of a Year	
Maximum Distance from Earth in mi/km	
Minimum Distance from Earth in mi/km	
Gases in the Atmosphere	
Average Temperature in ˚C/˚F	
Temperature Range in ˚C/˚F	
Satellites	

Exploration Activity:

In what year was Mars first viewed by telescope? _____

What is Olympus Mons? _____
_____

Where is the largest gorge in the solar system located? _____

What is it called? _____

What causes Mars to have seasons? _____

How does that compare to how Earth has seasons? _____

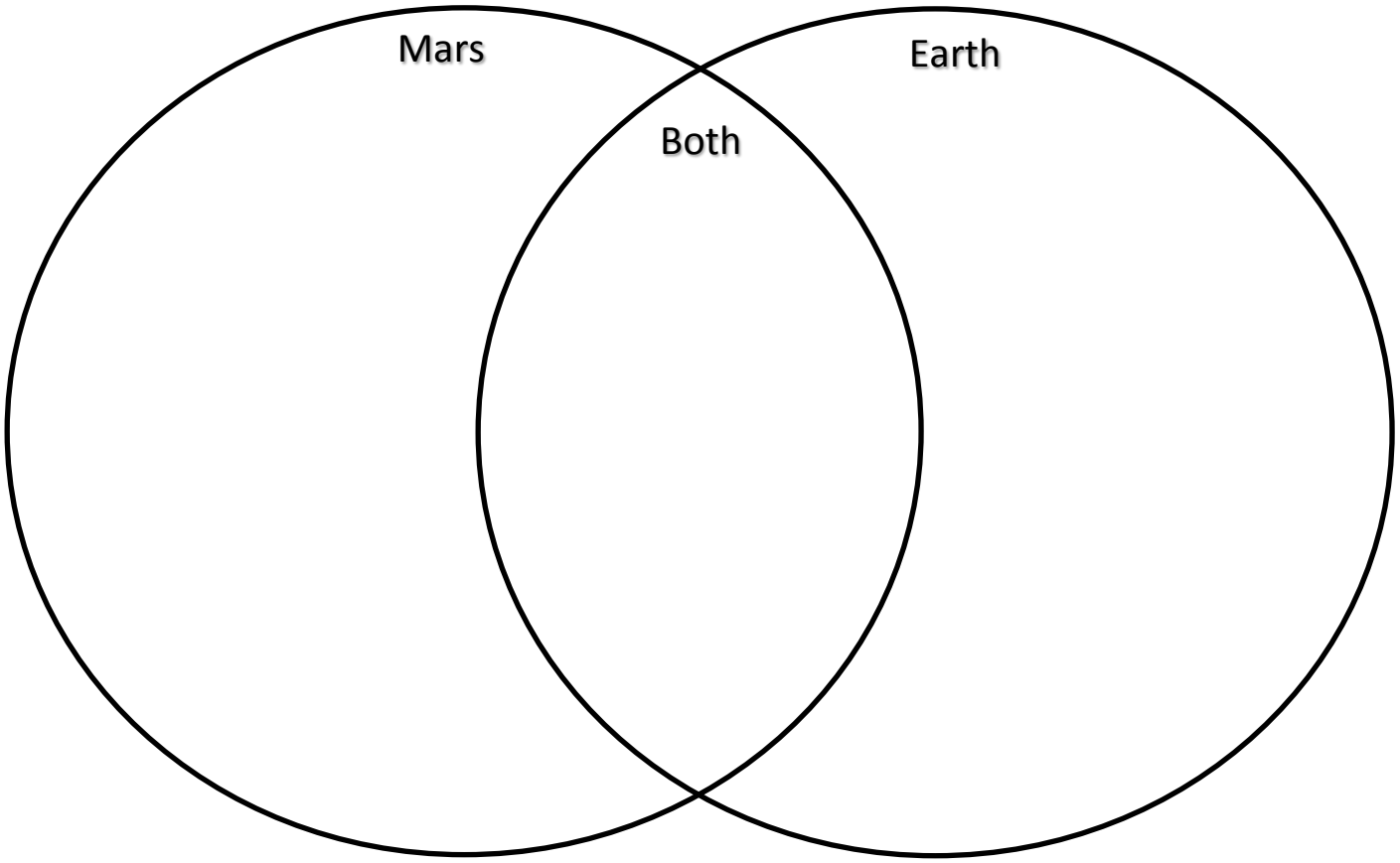
How does the length of a day on Mars compare to the length of a day on Earth? _____
_____

If you weigh 125lbs on Earth, how much would you weigh on Mars? _____

Year	US Lander Name	Reason for Mission
1975	Viking 1 Orbiter/Lander	First successful landing on Mars
1975		
	Mars Global Surveyor	
1996		
		High resolution images of Mars
2003		
	MER - Opportunity	
2005		Returned more than 26 terabits of data (more than all other Mars missions combined)
	Phoenix Mars Lander	
2012		

Explanation:

Based on the information you have researched about Mars, complete the Venn Diagram. If more space is needed, complete your Venn Diagram on a separate page and tape it neatly into the space below.



Evaluation:

Which of the informational text features you learned about today was the most helpful to you in researching information for your Mars Rover project?_____
_____
_____
_____
_____

Lesson 4: Investigate Mars

Engagement Questions:

What are the three most important details to help find the lost rover?

1. _____

2. _____

3. _____

Use the information above to design a draft of your lost rover poster. Then, create your final copy on the paper from your teacher.

Exploration Activity:

Using what you have learned about identifying important details, use the resources provided to learn about different aspects of Mars.

Terrain

1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____
5. _____
   _____
6. _____
   _____

Climate

1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____
5. _____
   _____
6. _____
   _____

Exploration Activity Cont.:

Atmosphere

1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____
5. _____
   _____
6. _____
   _____

Choose a team category: _____

1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____
5. _____
   _____
6. _____
   _____

Explanation:

After each team has shared their most important details with the class, record the most important details that would help you to identify and distinguish Mars from other planets or planetary bodies.

1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____
5. _____
   _____
6. _____
   _____
7. _____
   _____

Evaluation:

How do I know when I've found important information in my reading? _____
_____
_____
_____
_____

Lesson 5: Selecting Team Rover Missions

Engagement Questions:

As your teacher shares and discusses your ideas with the class, write the three questions that you think would be the most interesting to investigate.

1._____
_____

2. _____
_____

3. _____
_____

Exploration Activity:

Work with your team to narrow your possible questions to a total of three possible questions for your team to consider. Write them below.

1._____
_____

2. _____
_____

3. _____
_____

Then, choose the one scientific question that:

- Has a scientific basis
- Addresses a specific scope
- Is an interesting question to answer
- Interests all students on your team

Once, your team has decided on the one scientific or technological question that you will answer, Put a star next to it.

Teacher Checkpoint: _____

Explanation:

Now that you have determined your team's scientific question, use the chart below and circle the mission that best matches your question. If your question does not match any of the missions, select Mission 9 and create your own using the others as a guide.

Mission	Mars Rover Mission Choices
1	**Explore the craters on Mars**. Your vehicle will try to find a crater suitable for use as a domed settlement site. It should make measurements, test the soil and take photographs.
2	**Explore the polar ice caps of Mars**. Mars has carbon dioxide ice and water ice. Your vehicle should determine how much of each type of ice there is and map the distribution and depth. Samples of the ice should be analyzed for impurities, and its potential to be purified.
3	**Explore the valleys of Mars**. Rift valleys will provide information about the geologic history of the planet, while river valleys might provide clues as to the sources of past water or evidence of ancient forms of life. Devise a method to collect samples and analyze them.
4	**Analyze the weather at several sites that have been identified as possible areas for future settlement**. Instruments will need to make careful measurements of temperature, wind, and the composition of the atmosphere (gases and water vapor).
5	**Identify the elements and compounds found in the rocks and soil of Mars**. Determine how much oxygen is present, and whether the soil could be used for planting or if metal ores are present for future mining.
6	**Search for forms of water on Mars possibly found a layer of frozen soil, called permafrost**. Your vehicle will be exploring the areas near the poles, drilling tens to hundreds of meters below the surface, providing data for future Mars colonies.
7	**Explore for fossils of ancient life forms in the riverbeds and the canyons of Mars.** Samples that are collected will need to be mapped, analyzed and photographed.
8	**Search for present life on Mars in the Polar Regions**. Microbes have been found in the permafrost and glaciers on Earth, some remain dormant until they are warmed up. Design a system to gently warm and analyze polar and permafrost samples, looking for similar occurrences on Mars.
9	Develop your own mission _____ _____

Teacher Checkpoint: _____

Evaluation:

Why is it important to form a valid (reasonable or sensible) and specific scientific question before conducting your research?

_____
_____
_____
_____
_____

Lesson 6: Mission Measurements

Engagement Questions:

Your teacher's scientific question has to do with Saturn:

Can an object stay in orbit around Saturn somewhere else besides the rings?

Brainstorm some possible solutions to this scientific question to share with your teacher and your class.

Solution #1 _____
_____

Why is this solution a good idea? _____
_____

Solution #2 _____
_____

Why is this solution a good idea? _____
_____

Solution #3 _____
_____

Why is this solution a good idea? _____
_____

Solution #4 _____
_____

Why is this solution a good idea? _____
_____

Exploration:

Using your teacher's example as a guide, brainstorm your team's scientific or technological question. Narrow your solutions down to one and circle it:

Mission Questions	Proposed Missions		
How might this happen?			
What else could happen?			
Have we thought this through?			
Does this mission make sense?			
Can this be done?			
Is it possible and/or reasonable?			

Evaluation:

How does coming up with a plausible solution for your scientific question help you design the measurements you need for your Mars Rover mission? _____

_____

_____

_____

Lesson 7: How Do I Measure This?

Engagement Questions:

Why is it important to have a standardized unit of measure? _____
_____
_____

How can you ensure that you are making accurate measurements? _____
_____
_____

Exploration Activity:

The question that you and your team will answer during this experiment is:

How does the height of the item dropped affect the diameter of the crater?

During this experiment you will learn how craters form. To start, we will need three objects that we will pretend are meteors. With your team, decide which three objects you will use:

marble ping pong ball dried peas golf ball gumball cinnamon imperial

Then choose two heights that you will drop your objects from:

30 centimeters 50 centimeters 70 centimeters

Now, fill in the table so that you can record your results:

Exploration Activity Cont.:

Teacher Checkpoint: Once you and your team have completed created your table, ask your teacher to check it over. Teacher's Initials: _____

Now that you have correctly created your table, begin the experiment by **dropping** the first item from your first drop height. Then, carefully remove the object from the pan using the tongs.

With your team, examine the crater. Use your ruler to measure the diameter of the crater (in cm).

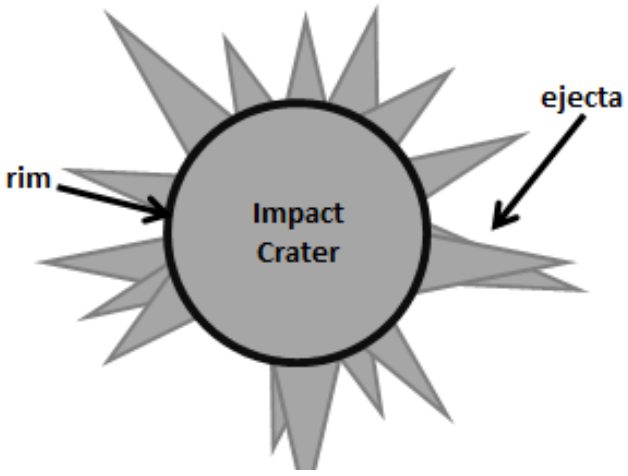
Repeat these steps with your two other objects. When you are finished, complete the remainder of the chart by dropping your objects from your second drop height.

Now that your chart is complete, we need to draw conclusions from the information we gathered.

Which item created the biggest crater? Why? _____
_____

Using the diagram below, choose one of your objects and describe the crater it produced in detail.

_____
_____
_____
_____
_____



Exploration Activity Cont.:

How is the crater an item produces related to the height it is dropped from? What are other factors that may affect the crater size? _____
_____
_____
_____
_____

Explanation:

What scientific or technological question will your team answer? (Go back through your Science Notebook and copy it from Lesson 6.)

Team Question: _____
_____

What things will you measure when conducting your own rover experiment?

1. _____
2. _____
3. _____

List three ways you and your team will take these measurements in your own experiment:

1. _____
2. _____
3. _____

Evaluation:

Why are taking accurate measurements critical to your Mars rover mission? _____
_____
_____
_____
_____

Lesson 8: Where is the Best Place to Measure?

Engagement Questions:

What is your team's scientific or technological question? _____
_____
_____

Why is it important to select a good landing site for Curiosity? _____
_____
_____

Exploration Activity:

Explore Gale Crater and complete the chart:

Weather/ Climate	
Terrain	

Exploration:

Controls	
Variables	

Based on what you have learned about Gale Crater, name 5 reasons why it was a good place for Curiosity to land.

1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____
5. _____
   _____

Exploration:

Once you have completed your research and decided on a landing site for your rover, complete the following details:

Chosen Landing Site _____

Exact Location on Mars _____

Description of terrain at this location _____
_____
_____

Description of atmosphere at this location _____
_____
_____

Explanation:

Now that you have gathered the important details of your team's landing site, record that information on a piece of chart paper.

Along with the landing site, exact location on Mars, description of terrain and atmosphere, be sure to include three reasons why your team chose this site and how this landing site will help your team answer your specific scientific question.

Evaluation:

How did you select the place for your Mars rover mission? Describe how your selected site meets the needs of your question. _____
_____
_____
_____
_____
_____

Lesson 9: Spacecraft Structure and Design

Engagement Questions:

3 Facts	
2 Questions	
1 Opinion	

Exploration Activity:

Rover Communication

Scenario #1

Materials	Number	Cost Each	Total Cost
Satellite			
Ground Receiver/ Transmitter			
Grand Total			

Scenario #2

Materials	Number	Cost Each	Total Cost
Satellite			
Ground Receiver/ Transmitter			
Grand Total			

Scenario #1

Trials	Total Seconds on Target in two minutes
Trial 1	
Trial 2	
Trail 3	
Trial 4	
Trial 5	

Scenario #2

Trials	Total Seconds on Target in two minutes
Trial 1	
Trial 2	
Trial 3	
Trial 4	
Trial 5	

Exploration Activity:

Spacecraft Design

Before building:
What is the purpose of your space probe? Use your resources to help you.

_____
_____
_____

What three things will you need to take into consideration when building your space probe?

1. _____
2. _____
3. _____

During Building:
What design elements will you put in place to ensure that your probe always lands bottom down?

_____
_____
_____

After Building:
How does your team's design compare with NASA's design?

_____
_____
_____

Testing:
Drop your probe from the following heights and record its performance.

Trial	Height	Scientific Observations
Trial 1	12 inches	
Trial 2	24 inches	
Trial 3	36 inches	
Trial 4	48 inches	

Exploration:

Research and Investigation

Use this space to record your research and investigation on spacecraft. Remember to write your notes in your own words and always document your sources.

Explanation:

Statement	True or False?	How do you know?
Astrology and astronomy are basically the same thing.		
Rovers communicate with Earth using radio waves.		
Since we already went to the Moon, it is easy to send people to Mars.		
Because Mars has a thinner atmosphere than Earth, the shape of a space probe is critical for landing on Mars.		
Although spacecraft are constructed for specific missions and purposes, they are all designed and built using the same process.		

Evaluation:

What attributes will my Mars Rover need to:

Get to Mars _____
_____

Carry out its mission _____
_____

Send the data back to Earth? _____
_____

Lesson 10: Landing, Moving and Surviving

Engagement Questions:

Different ways a rover could land on Mars:

1. _____
2. _____
3. _____

	Ways to Land a Rover on Mars		
Landing Strategy			
Rover Size			
Landing Speed			

Exploration Activity:

Chosen Landing Strategy: _____

How My Strategy Can be Successful	How My Strategy Can be Problematic

Continue your notes on the next page.

Exploration Cont.:

How My Strategy Can be Successful	How My Strategy Can be Problematic

After deliberating with my team, the Landing Strategy we decided to use is: _____
_____

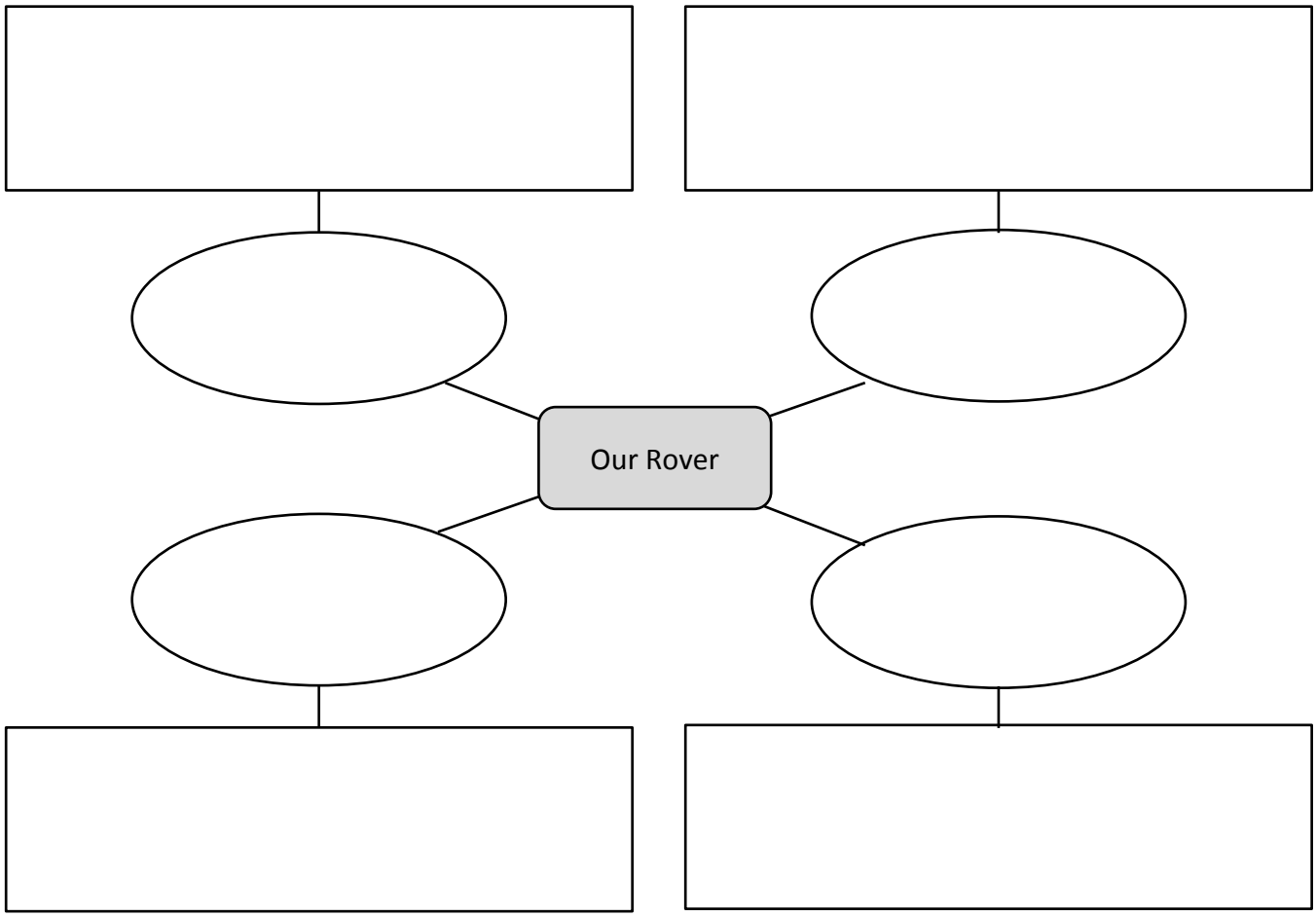
We picked this landing strategy because:

1. _____
2. _____
3. _____

Next, work with your team to decide how your rover will move around once it lands on Mars. Be specific. _____
_____
_____
_____

Exploration Cont.:

How will your rover survive the harsh conditions on Mars? In the circles, identify the conditions your rover may encounter. In the rectangles, tell how your rover will react and what features and criteria you designed to help the rover survive.



Evaluation:

Why is the method you chose for landing your rover on Mars the best one for your mission? _____

_____

_____

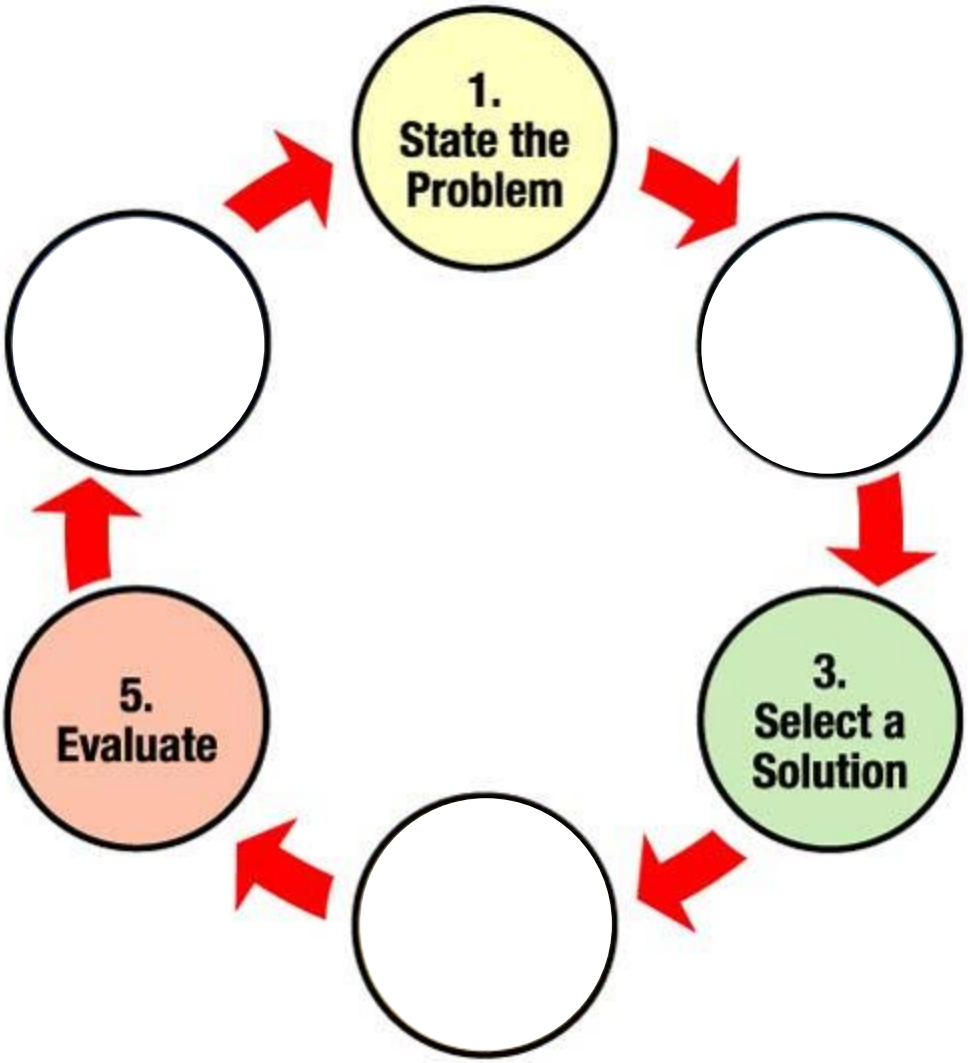
_____

_____

_____

Lesson 11: Brainstorm and Preliminary Design

Engagement Questions:



What is this process called? _____

What is the purpose of the Engineering Design Process? _____
_____
_____
_____

How will you use the Engineering Design Process to build a Mars rover? _____
_____
_____
_____

Engineering Design Process Image courtesy of NASA

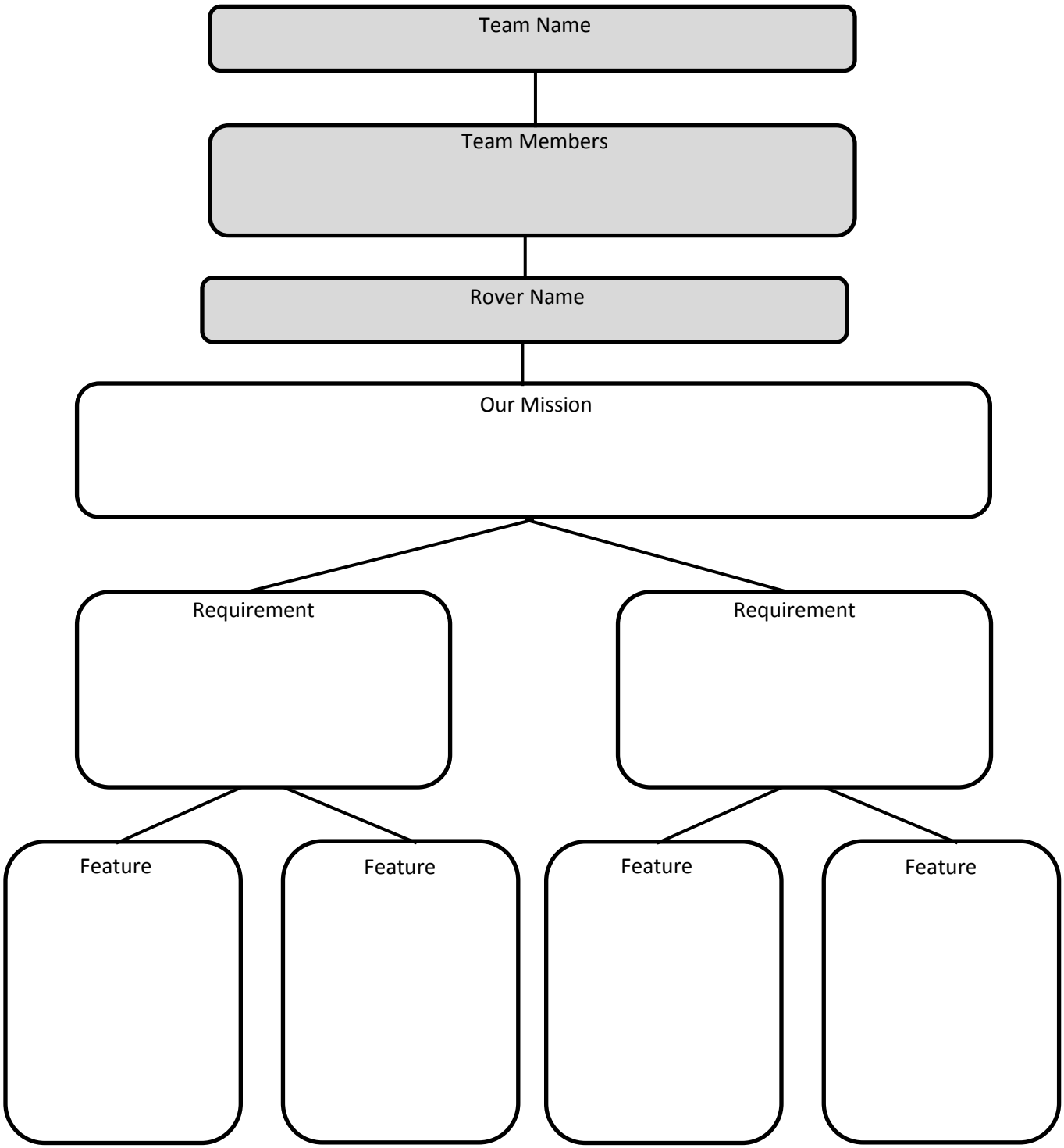
Exploration Activity:

Work with your team to draw a sketch of what your rover will look like. Tape or staple extra pages into your Science Notebook as needed.

Teacher Checkpoint: _____

Explanation:

Once you have completed the rough draft of your concept map on scratch paper and your teacher has approved it, copy it neatly in the space below. Use additional pages if needed.



Teacher Checkpoint _____

Evaluation:

Which step of the Engineering Design Process was the most difficult for your team? What made this step so challenging for you?

_____
_____
_____
_____
_____
_____

Elaboration (optional):

Once you are finished building your Mars Rover, make sketches of its top, front, and side views.

How does your original sketch compare with your actual prototype? What changes did you need to make? Why? _____
_____
_____
_____
_____

Lesson 12: Final Design

Engagement Questions:

Engineering Careers	Examples of this Career
Aerospace	
Chemical	
Civil	
Electrical	
Mechanical	

Exploration Activity:

Draw a concept map of at least three careers that might contribute to the designing and building Curiosity. Explain how each career would contribute to this project.

Mars Rover Curiosity

Exploration:

My Team	My Career Assignment

Use your Science Notebooks and additional paper to collect the following information:

- Mission (Scientific or Technological question to be answered)
- Specific Location of the Mission
- Requirements of the rover
- Features of the rover

Then work with your group to finalize your rover design. Copy it neatly onto a piece of chart paper. Be sure to include all of the information above on your drawing. When you are finished, work with your team to write a caption for your poster.

Evaluation:

Essential Question? _____

_____

_____

_____

_____

_____

Lesson 13: Construct Mock-Up

Engagement Questions:

Characteristics of a Successful…			
Engineer	Scientist	Designer	Project Manager

Evaluation:

How does assigning a different job to each member of your team (designer, scientist, project manager, engineer) help you to complete your Mars rover mission? _____
_____
_____
_____
_____

Lesson 14: Manual and Skit

STEP 1:

With your team, brainstorm ideas for your skit. As you share ideas, answer the following questions:

1. What is the purpose of our skit?_____
   _____

2. Who is our audience?_____
   _____

3. Should our skit be PROFESSIONAL or INFORMAL? (Circle one)
   Explain why_____
   _____

Use the information in the table below as you write your skit to ensure you are writing for the correct audience.

	Professional	Informal
Length	short or long	short
Preparation	large amount of time	very little preparation time
Visual Aids	frequently used, polished	sometimes used
Rehearsals	YES	NO
Refinements	YES	NO
Audience	large: adults, experts	small: family, friends, classmates
Vocabulary	academic, consistent	language often varies from one performance to the next

Teacher Checkpoint: _____

STEP 2:

Now that you have the idea for your skit, it's time to capture the details:

Skit Title:

_____

Props Needed/Team member responsible:

Prop	Team Member Responsible

Backdrop: YES NO
If YES….
What will the backdrop be?_____

Who will design backdrop? _____

What role will each team member play in the presentation?

Team Member	Character

Teacher Checkpoint: _____

STEP 3: Outline

Use your own paper to create your outline. Your outline doesn't have to follow this list exactly, but be sure to include all the major categories listed below.

I. Basic Information

a. Introduce our Team

b. _____

II. Purpose/Goals of the Rover Mission

a. _____

b. _____

c. _____

III. Important Facts/Notes to Tell Audience

a. _____

b. _____

c. _____

IV. Rover Design

a. _____

b. _____

c. _____

d. _____

e. _____

V. Other Information (OPTIONAL)

a. _____

b. _____

VI. Conclusion

_____

Teacher Checkpoint: _____

Explanation:

To make a large project easier, share the work. Using the chart below, record the duties each person on your team will be responsible for.

Team Member	Responsible For…

Teacher Checkpoint: _____

Evaluation:

What are the key elements of an effective presentation that your group should keep in mind when writing your Mars Rover skit?

_____
_____
_____
_____
_____

Lesson 15: Present Skits and Rovers

Engagement Questions:

Great ideas I heard from other teams that I can borrow and include in our presentation:

- _____
  _____
- _____
  _____
- _____
  _____
- _____
  _____
- _____
  _____
- _____
  _____
- _____
  _____
- _____
  _____

Evaluation:

How did listening to the other teams present help you to improve your own Mars rover presentation? Be specific. _____
_____
_____
_____