Lesson 1: Overview of the Solar System

Engagement Questions:

Name the planets in order, starting with Mercury. _____
_____

How do the planets move around the Sun? _____
_____

Describe the difference between *rotation* and *revolution*. _____
_____

Exploration Activity:

Choose which bead will represent each planet. Then, tell why you chose each one.

Name	Bead Color	Why did you choose this color to represent this planet?	Scaled Distance from the Sun (in cm)
Sun			0 cm
Mercury			4 cm
Venus			7 cm
Earth			10 cm
Mars			15 cm
Jupiter			50 cm
Saturn			100 cm
Uranus			190 cm
Neptune			300 cm

1. Work with your team to measure 5 meters of yarn.
2. Then, tie the Sun bead to the end of the yarn.
3. Use your centimeter ruler to measure how far Mercury is from the Sun (Use the table above). Then, tie the Mercury bead at that distance (4 cm).
4. In order, and one at a time, measure out the rest of the distances and tie the correct bead at each point.

Explanation:

Using what you have learned, draw a picture of the solar system. Don't forget to put the planets in the correct order and label them.

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:

Look closely at your sample. Describe three things you observe about its surface.

1. _____
2. _____
3. _____

Think back to what you learned about Mars. What kind of surface does Mars have?

_____

_____

Draw a picture of the surface of your sample.

Exploration Activity:

Ask your teacher to cut your sample in half. Describe what you see inside your sample. _____
_____

Now, draw a picture of the inside of your sample.

How have you changed your sample while studying it? Have you changed the properties of the sample? Explain. _____
_____
_____

Think about what you have learned about Mars. Could this sample have come from Mars? Why or why not? _____
_____
_____
_____

Evaluation:

How will what you learned today about the planet Mars and about making observations help you design a successful mission for your Mars Rover? _____
_____
_____
_____
_____

Lesson 3: Research Tools and Skills

Engagement Questions:

In the 1900's our ability to explore Mars via telescope from the Earth had reached its limits. Combined with our space-faring abilities, _____ became an excellent candidate for robotic exploration.

The first successful landing was NASA's _____ in 1976.

In 2003, NASA launched the Mars Exploration Rovers (MER), which later came to be called _____ and _____.

Phoenix landed so far north at a position similar to the high arctic on Earth that the team knew the spacecraft wouldn't last very long. It could only operate until the Martian _____ or fall because the sun would dip down low on the horizon, the solar panels would not be able to charge the batteries.

Exploration Activity:

Mars Facts

Mars' Nickname	
Position from the Sun	
Average Distance from the Sun	
Diameter of Mars in km	
Length of a Day (Rotation)	
Length of a Year (Revolution)	
Atmosphere	
Rings	
Moons	

Exploration Activity:

What is Olympic Mons? _____

How high is it in feet? _____

How did Mars get its nickname? _____

Why can't Mars store heat from the sun? _____

_____

What are the ice caps on Mars made of? _____

What is another geographical feature of Mars? _____

Name two facts about this feature:

1. _____
2. _____

Describe three characteristics of the surface of Mars:

1. _____
2. _____
3. _____

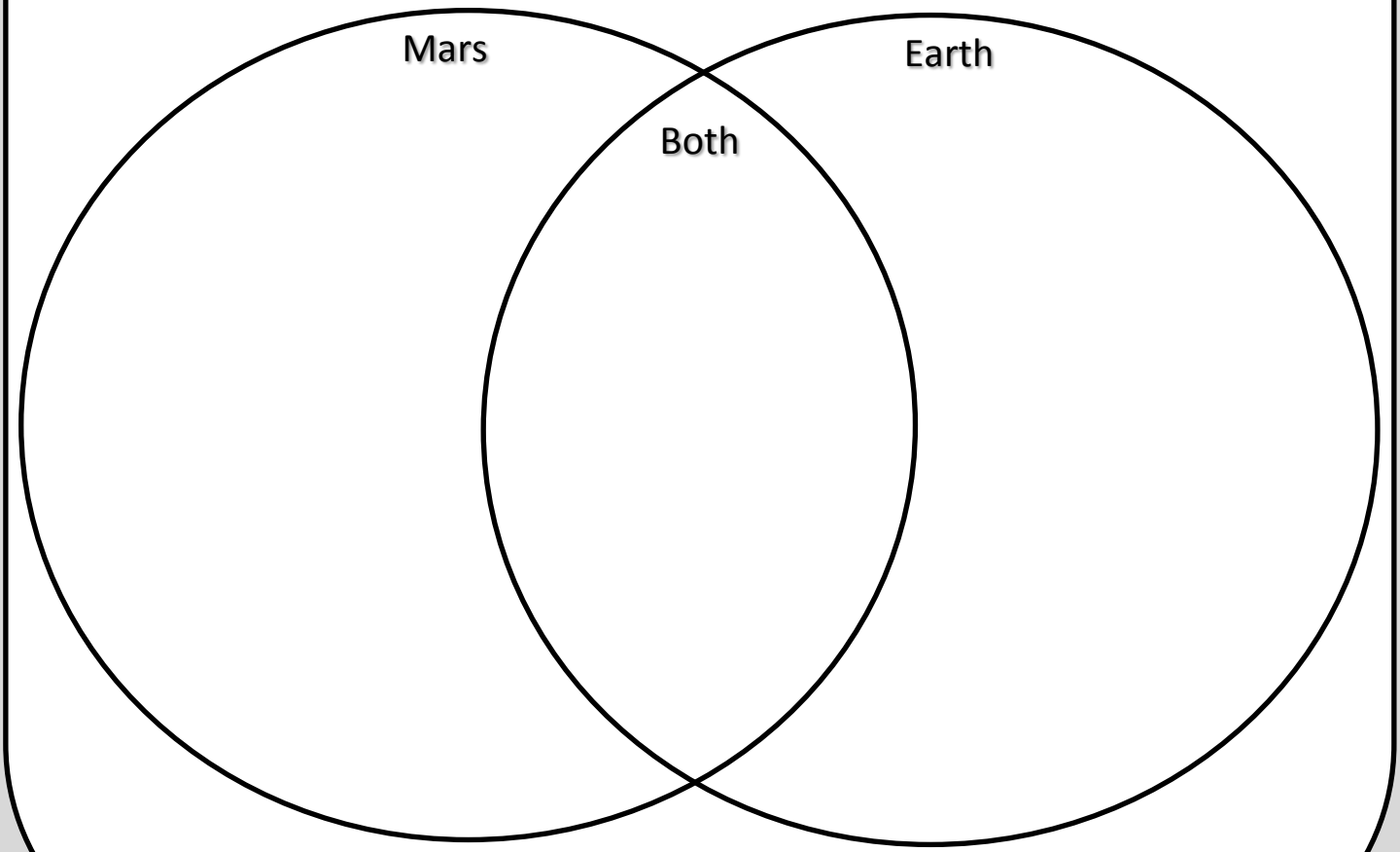
Why does Mars have seasons? _____

_____

_____

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.

Title

Picture

Important Details

Contact Information

Exploration Activity:

Using what you have learned about identifying important details, use the resources provided to learn about Mars. Record your important details below. Remember to look for only details that would help distinguish Mars from all the other planets.

1. _____
   _____
2. _____
   _____
3. _____
   _____
4. _____
   _____
5. _____
   _____
6. _____
   _____
7. _____
   _____
8. _____
   _____
9. _____
   _____
10. _____
    _____

Explanation:

After each team has shared their important details and you have discussed them with your teacher and class, write the five most important details that your class has found.

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

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 for your team. Write them below.

1._____
_____

2. _____
_____

3. _____
_____

Then, choose the one scientific question that:

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

Put a star next to the scientific or technological question that your team has chosen to answer.

Teacher Checkpoint: _____

Explanation:

Now that you have determined your team's scientific question, use the chart below to help refine your question.

Steps	My Teacher's Example	My Work
My Topic:	The rings of Saturn	
What I want to know:	Where objects can orbit Saturn	
Question:	Can an object stay in orbit around Saturn somewhere else besides the rings?	

Check	Work
Is my question clear?	
Is my question specific?	
Can I answer this by gathering data?	

Teacher Checkpoint: _____

Evaluation:

Why is it important to ask valid (good) scientific questions?

_____

_____

_____

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 on the worksheet that your teacher will give you. Narrow your solutions down to one and record it below:

Mission Questions	Chosen Mission
How might this happen?	
What else could happen?	
Have I thought this through?	
What measurements will I need to make to carry out my mission?	
Does this mission make sense? What problems could cause my mission to fail?	

Evaluation:

Why is it important to write your scientific question so you can answer it using data?

_____
_____
_____
_____

Lesson 7: How Do I Measure This?

Engagement Questions:

Why was it a bad idea for the king to walk around the queen to measure for her bed?_____
_____

Why did the bed end up being too small for the queen? _____
_____

How could this problem have been avoided? _____
_____
_____

Exploration Activity:

The reason to do an experiment is to answer a question. The question that you and your team will answer is:

How is the size of the crater related to the size of the item and the height from which it is dropped?

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, circle the **three** objects you will use:

marble ping pong ball dried peas
golf ball gumball cinnamon imperial

So that we can get good results, we will need to drop each object from the same height. Circle the **one** height that your team will drop your objects from:

30 centimeters 50 centimeters 70 centimeters

Then, use this information to fill in the shaded parts of the table on the next page.

Exploration Activity Cont.:

	Diameter of Crater from Drop Height _____	
Items that will be dropped ↓		
1.		
2.		
3.		

Teacher Checkpoint: Once you and your team have completed the shaded areas, 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 the height your team selected. 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). The diameter is the distance across the widest part of the circle.

Repeat these steps with your two other objects. Each time:

1. Drop the next object into the pan from the correct height.
2. Carefully remove the object with the tongs.
3. Measure the diameter of the crater left behind.
4. Record the diameter of the crater correctly on the chart.

When you have finished, we will need something to compare it to. Place an X over your Drop Height and work with your team to circle a different number. Then, write this number in the **third column** of your table above.

30 centimeters 50 centimeters 70 centimeters

Teacher Checkpoint: After you and your team have circled your second Drop Height and written it in the third column of your table, show it to your teacher. Teacher's Initials: _____

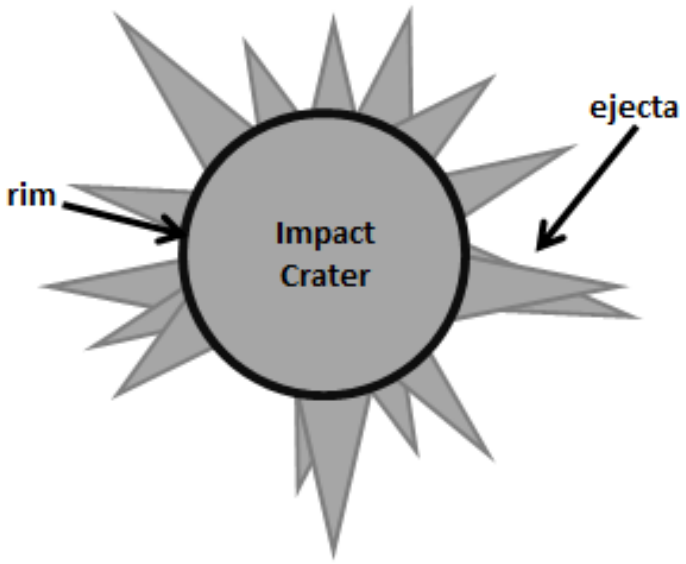
Exploration Activity Cont.:

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 in detail what the crater looked like after the object was removed.

_____
_____
_____
_____
_____



How does the crater change as the height an object is dropped from changes?

_____
_____
_____
_____
_____
_____

Explanation:

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

Our Team's Question: _____
_____

Now, think about the experiment that you conducted and how you measured the craters to help answer this question.

What things will you measure with 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	What are some characteristics of the climate on Mars ?	
Terrain	How does the terrain differ from the terrain on Earth? How is it the same?	
Constants	What elements will remain the same when you test your team's question?	
Variables	What elements will change when you test your team's question?	

Exploration:

Based on what you have learned about Gale Crater, name 3 reasons why it was a good place for Curiosity to land.

1. _____
   _____
2. _____
   _____
3. _____
   _____

Now, use Google Earth Mars to locate a place for your team's landing site. Use a separate pieces of paper to research the following locations:

- Eberswalde Crater
- Holden Crater
- Mawrth Vallis
- Olympus Mons
- Valles Marineris

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 and climate 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 climate, be sure to include:

Three reasons why your team chose this site

1. _____
2. _____
3. _____

How will this landing site help your team to answer your scientific question?

1. _____
2. _____
3. _____

Evaluation:

How did you select the place for your Mars rover mission? Describe how the site you selected 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
Satellite	
Ground Receiver/ Transmitter	

Scenario #2

Materials	Number
Satellite	
Ground Receiver/ Transmitter	

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 article to help you)?

_____
_____
_____

What three things will you need to think about when you build your space probe?

1. _____
2. _____
3. _____

During Building:
What design elements will you build to make sure 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 your observations.

Trial	Height	Scientific Observations
Trial 1	1 foot	
Trial 2	2 feet	
Trial 3	3 feet	

Exploration:

Research and Investigation

Team Job	Role	Name
Navigator	Using correct terms, gives the Operator directions	
Operator	Operates the mouse and keyboard	
Director	Keeps all team members focused and on task	
Monitor	Monitors the noise level of the group and watches the time	
Recorder	Record their data in their Science Notebooks	Everyone

<u>How Spacecraft are Built</u>

<u>How Spacecraft Enter an Atmosphere and Land</u>

<u>Scientific Instruments Spacecraft May Carry</u>

<u>Other Facts I found:</u> (If you need more space, record your data on another sheet and tape it into your Science Notebook.)

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 in the same way.		

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 we could land a rover on Mars:

1. _____
2. _____
3. _____

	Ways to Land a Rover on Mars		
Landing Strategy		Retro Rockets and Landing Lights	
Rover Size	small to midsize		
Landing Speed			lands at under 2 mph then gently lowered to the ground by cables

Exploration Activity:

My 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

The Landing Strategy my team decided to use: _____
_____

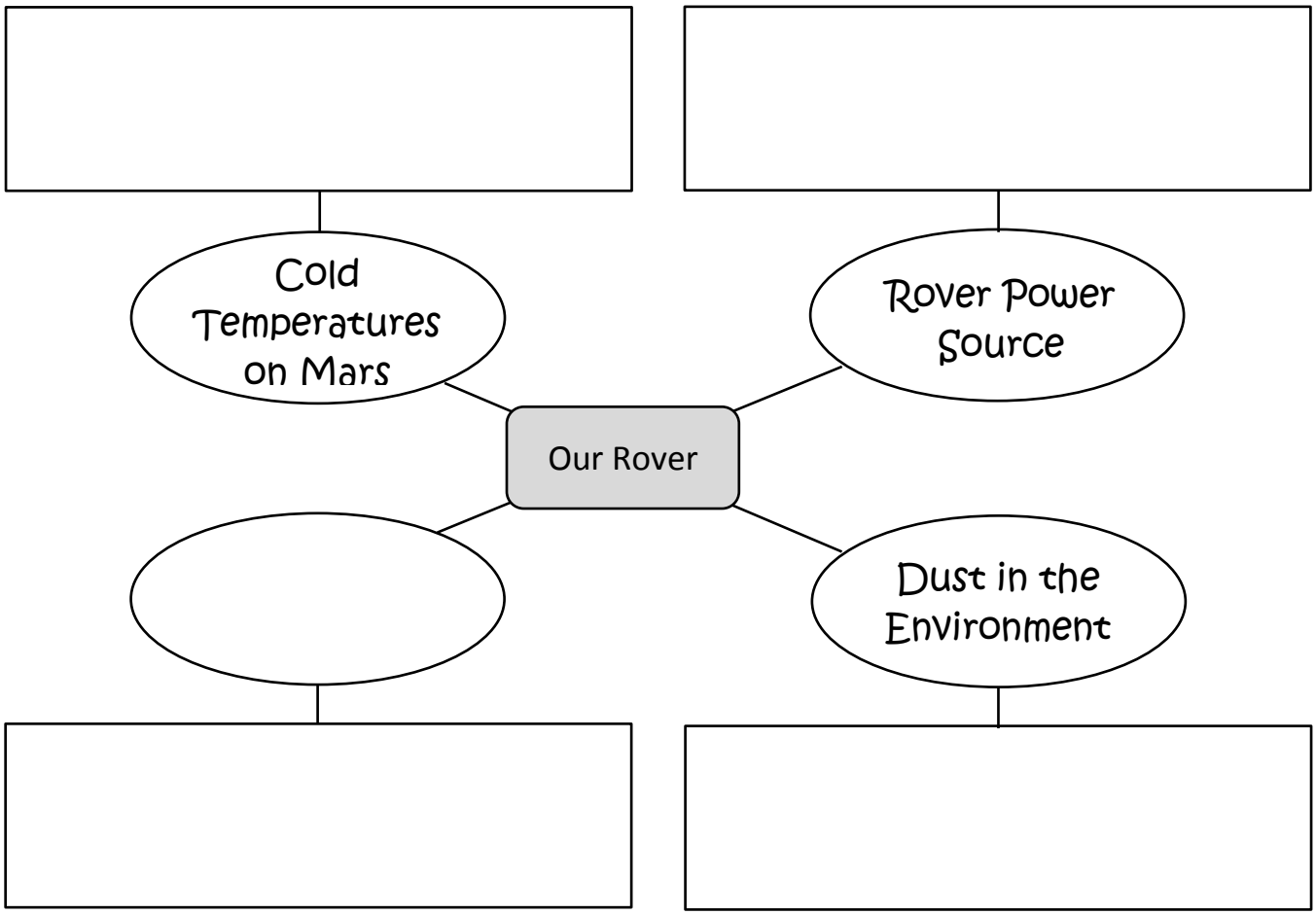
We picked this landing strategy because:

1. _____
2. _____
3. _____

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

Exploration Cont.:

How will your rover survive the harsh conditions on Mars?

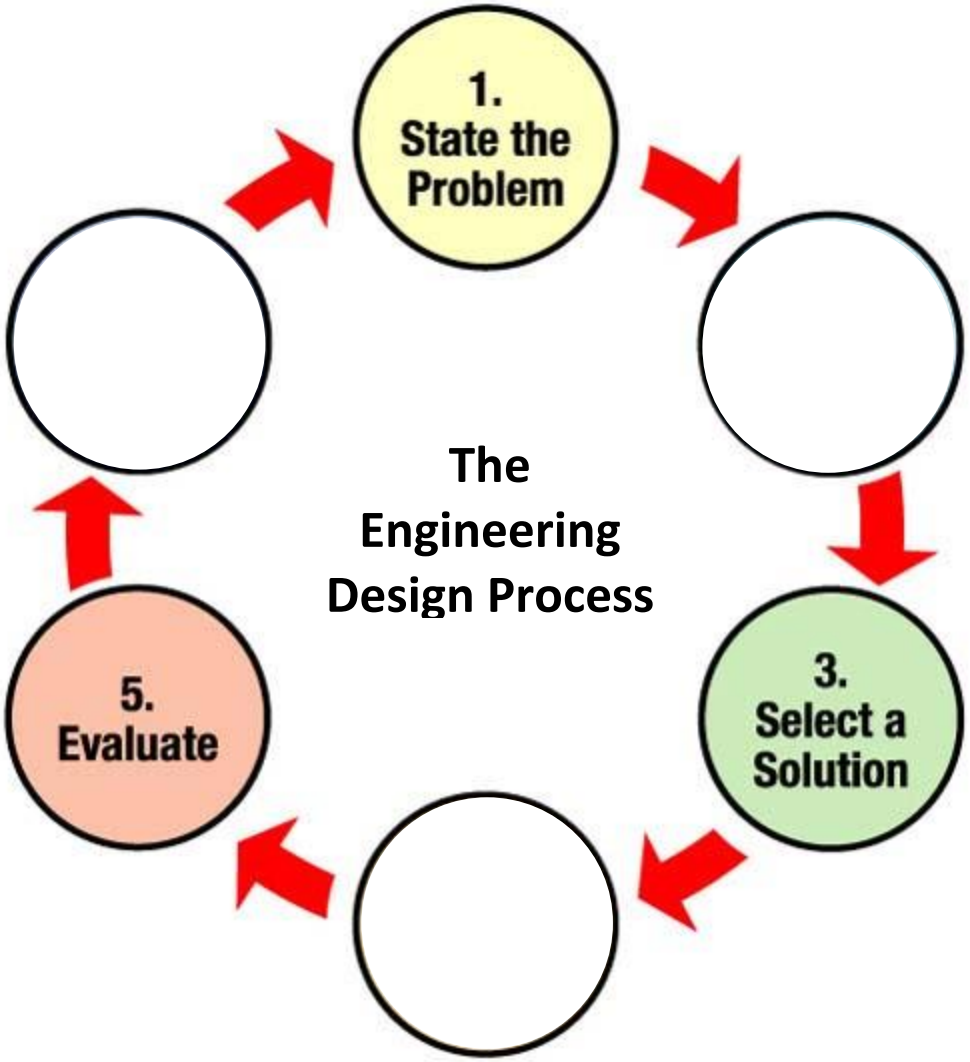


Evaluation:

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:



Why do we need the Engineering Design Process? _____
_____
_____
_____

How will you use the Engineering Design Process when you build your Mars rover? _____
_____
_____

Engineering Design Process Image courtesy of NASA

Exploration Activity:

Team Information:

Who are the members on your team?

_____
_____
_____
_____
_____

What is your team name? _____

What will each person do to help build your Mars Rover?

Team Member's Name	How will they help?

Teacher Checkpoint _____

Exploration Activity:

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

Explanation:

Show your completed concept map to your teacher for approval. Once it is approved, tape it neatly in the space below. (You may need to fold it so it will fit.)

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.

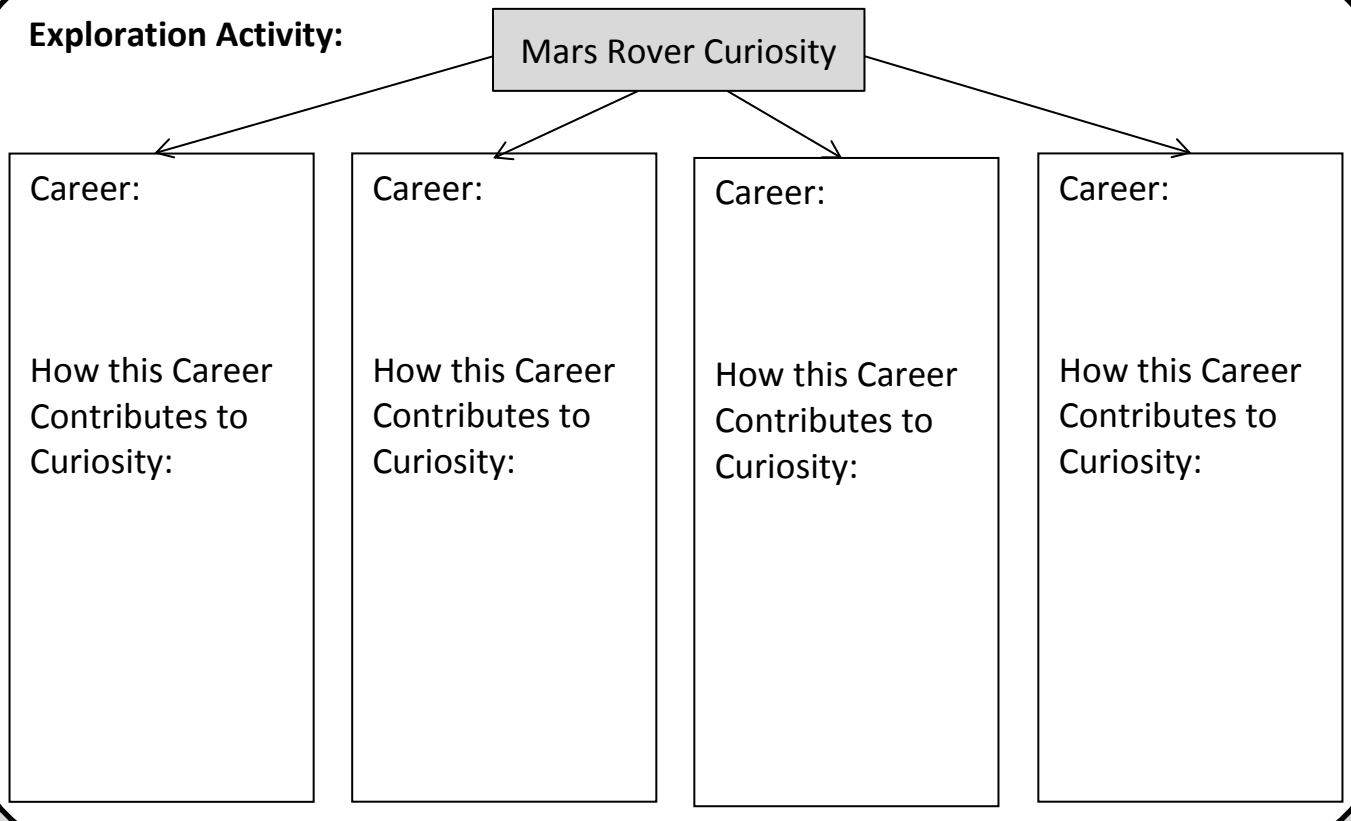
How does your original sketch compare with your actual prototype? What changes did you need to make? Why? _____
_____
_____
_____
_____

Lesson 12: Final Design

Engagement Activity:

Engineering Careers	Examples of this Career
Aerospace	Designing airplane engines,
Chemical	
Civil	
Electrical	
Mechanical	Creating a new part for a bicycle,

Exploration Activity:



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

Once you have gathered this information, work with your group to finalize your rover design. Then, copy it neatly onto a piece of chart paper. Be sure to state your mission, tell your specific location, and label your requirements and features. When you are finished, work with your team to write a caption for your poster.

Evaluation:

Essential Question? _____

_____

_____

_____

_____

_____

Lesson 13: Construct Mock-Up

Engagement Activity:

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. Landing on Mars _____
- b. Overcoming Conditions on Mars_____
- c. Powering & Controlling the Rover _____
- d. Communicating with Earth_____
- e. Special Instruments _____

V. Other Information (if needed)

- 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._____
_____
_____
_____
_____
_____