



## Prepare for Launch

**Objective:** Students will select components to help their SLS carry out their mission goal and remain within budget.

**Materials Needed:**

- o SLS Card Sheet (1/student)
- o SLS Design Sheet (1/student)
- o Scissors (to cut out cards)
- o Tape or Glue (to attach cards to SLS Design sheet)
- o Dice
- o Calculator

**Summary of Student Actions:**

To prepare for their mission, students are designing an SLS using cards. In the first step, they are selecting a mission goal from three options, or they can create their own. Once they have decided on a mission goal, they will prepare their SLS. Equipped with a budget of \$150 million, students will select a rocket, a power system, a communication antenna, and a landing system. They will also select science tools that align with the mission goal. Each type of equipment (except for the landing system) has 2-3 options that have their own pros and cons.

As they select cards, they will cut them out and record (in pencil) the information into the table on the SLS Design sheet. This is to help them keep track of the budget and their science points. They want to earn as many science points as possible. After they have selected all their pieces, they go to the next step: “The Event.”

During “The Event,” students will roll a dice. The number they roll corresponds to a different event; some are positive (adding money to their budget) and some are negative (science tools are removed). They must make the necessary changes to their SLS based on what they roll. This is to show how plans always change and they must adjust accordingly. Once they make the changes, they proceed to the final step: “The Launch.”

The final step is to get launch approval. Each rocket states whether it is approved 3, 4, or 5 times out of 6. They again roll the dice. If the rocket is launched 3 out of 6 times, rolling a 1, 2, or 3 is approved. Rolling a 4, 5, or 6 is not. If the rocket is successful 4 out of 6 times, rolling a 1, 2, 3, or 4 is approved. These values are listed on the rocket cards. If their launch is not approved, they must remove \$5 million worth of science tools and roll again to try for launch approval.

When their launch is approved, students can tape the cards in their respective places (on the back of the SLS Design sheet) and get a stamp on their passport.

**Setup Instructions:**

- There are three stages to this piece. It is recommended that each stage has its own area and students physically move through the stages, but it is not necessary. Put the instruction cards at each stage.
- Stage One needs:
  - Component Cards and SLS Design Sheets (every student needs one of each).
  - Scissors
  - Calculators
- Stage Two needs:
  - Dice
- Stage Three needs:
  - Dice
  - Tape (or glue)

**Additional Notes:**

- Students may be confused about knowing which cards to pick. Remind them that it's up to them; they need one from each type of rocket equipment and additional cards to accomplish their mission goal.
- Students may need guidance transitioning from one stage to the next.
- The cards should be attached to their worksheet at Stage 3, after they have gone through the event and ensured that their launch was approved.

## **PHASE ONE: PREPARE FOR LAUNCH**

*Congratulations! You have been selected to help plan the first human mission to Mars. To get there, you need a Space Launch System, or SLS. Your task is to design an SLS that will launch to Mars and is equipped to carry out your mission. However, you must stay within the NASA budget of **\$150 million**. You cannot spend more than that.*

***There are 3 stages to completing this:***

- *Stage One: Design the SLS*
- *Stage Two: The Event*
- *Stage Three: Obtain Launch Approval*

***You will need:***

- *A SLS Design Handout*
- *Sheet of SLS Component Cards*
- *Scissors and Tape*
- *Calculator*
- *Pencil*

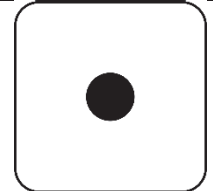
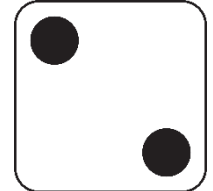
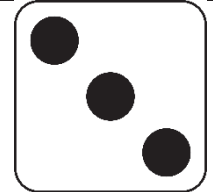


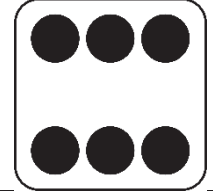
## STAGE ONE: DESIGN THE SLS

1. Decide on your mission goal. What do you want your crew to study on Mars? Some options are below, or you can create your own!
  - Mission Goal 1: Measure radiation levels of several locations on Mars
  - Mission Goal 2: Analyze rocks and dirt to search for past water activity on Mars
  - Mission Goal 3: Look for geological clues as to the environmental conditions that existed when liquid water was present on Mars
2. Write the MISSION GOAL on the back of your SLS Design sheet.
3. Select **ONE** rocket. Pay close attention to the risk; you will be attempting to launch this rocket later.
4. Cut out this rocket card. Record the information in the table on your SLS Design sheet.
5. A landing system is required. Cut this out and prepare to add it to your rocket. Record the information in the table on your SLS Design sheet.
6. Select **ONE** source of power. Cut this card out. Record the information in the table on your SLS Design sheet.
7. Choose **ONE** communication antenna. Cut this card out. Record the information in the table on your SLS Design sheet.
8. Finally, select your science equipment. You can select as many pieces as you want, within your remaining budget. Remember: you can only spend \$150 million total. Be sure to select equipment that will help you achieve your mission goal. The more science points you earn, the better! Cut all your selections out and record the information in the table on your SLS Design sheet.
9. Go to **STAGE TWO**.

## STAGE TWO: THE EVENT

*Plans can change at any moment!*

- With big projects, events can occur that have consequences. Roll the dice.  
Refer to the chart to see what event has occurred.

	<p><b>POWER FAILURE!</b> Sorry! Your power system failed during testing. You had to buy another one.</p> <p><i>Effect:</i> Your mission loses one science tool to pay for the new power system.</p>
	<p><b>SPIN-OFF INVENTION: Automobile sensors.</b> Hooray! Sensors created for your Mars mission help cars become more energy-efficient and easier to maintain!</p> <p><i>Effect:</i> \$15 million to invest in your mission!</p>
	<p><b>SYSTEM FAILURE!</b> Sorry! During system testing, one science tool failed to work.</p> <p><i>Effect:</i> Your mission loses one science tool.</p>
	<p><b>SPIN-OFF INVENTION: Communications.</b> Hooray! People around the world can stay in touch more easily by using new communications technologies created for your Mars mission.</p> <p><i>Effect:</i> \$5 million to invest in your mission!</p>
	<p><b>BUDGET CUT!</b> Sorry! Congress reduced NASA's budget.</p> <p><i>Effect:</i> Your mission loses one science tool.</p>
	<p><b>SPIN-OFF INVENTION: Weather prediction.</b> Hooray! Your Mars mission discovered new clues about Earth's atmosphere. Scientists can now predict weather better!</p> <p><i>Effect:</i> \$10 to invest in your mission.</p>

- Make necessary changes to your SLS design based on the listed effect. If you received extra money to invest in your mission, you can buy more science tools or upgrade parts of your SLS design.
- Proceed to **STAGE 3**.

## **STAGE THREE: OBTAIN LAUNCH APPROVAL**

*Are you approved for launch?*

1. Find the risk factor for your rocket (on the Rocket card).
2. If it works 3 out of 6 times, rolling a 1, 2, or 3 means the launch is approved. Rolling a 4, 5, or 6 is not approved. If it works 4 out of 6 times, rolling a 1, 2, 3, or 4 means the launch is approved, and so on.
3. Roll the dice.
  - o If your launch is approved, congratulations! You have successfully planned the launch for your Mars mission!
  - o If your launch is not approved, you must pay \$5 million to try again. If you need to remove a piece of science equipment to pay for this, you must do so.
4. You can attempt as many times as necessary to get approval, paying \$5 million each time.
5. When your SLS design is final, use tape or glue to attach the pieces onto your SLS Design sheet.

***You have completed PHASE ONE: PREPARE FOR LAUNCH!***

*Stamp your passport.*



### ROCKET Heavy- Lift

**COST:**  
\$100 million

Pros:

- Most powerful rocket
- Able to lift the most science tools

Cons:

- High risk: approved 3 out of 6 times



### ROCKET Medium- Lift

**COST:**  
\$75 million

Pros:

- Balance between power and cost

Cons:

- Somewhat high risk: approved 4 out of 6 times



### ROCKET Small- Lift

**COST:**  
\$50 million

Pros:

- Cheapest rocket
- Safest rocket: approved 5 out of 6 times

Cons:

- Cannot lift as many science tools

### LANDING SYSTEM



Heat Shield  
Parachute  
Retro-rockets

**COST:**  
\$20 million



Pros:

- Allows for safe landing

Cons:

- Adds mass to SLS



### POWER Fuel Cell

**COST:**  
\$25 million

Pros:

- Gives mission electricity
- Does not need the Sun or a battery; works everywhere
- Provides more power

Cons:

- Lasts a few months



### POWER Solar Panels

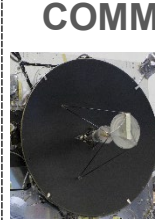
**COST:**  
\$15 million

Pros:

- Gives mission electricity
- Low cost
- Lasts a few years

Cons:

- Must have sunlight
- Only works near the equator



### COMMUNICATION ANTENNA High-Gain

**COST:**  
\$10 million

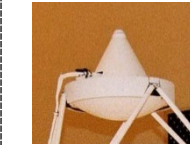
Pros:

- Allows communication with Earth
- Sends large amounts of information at one time

Cons:

- Costs more and uses more power

### COMMUNICATION ANTENNA Low-Gain



**COST:**  
\$5 million

Pros:

- Allows communication with Earth
- Low cost and power

Cons:

- Cannot send much information at one time



### SCIENCE TOOL Rock Drill

**COST:**  
\$5 million

*Collects samples by drilling into rocks*

**+1 Science Point**



### SCIENCE TOOL Robotic Arm

**COST:**  
\$5 million

*Collects samples and carries many science instruments*

**+1 Science Point**

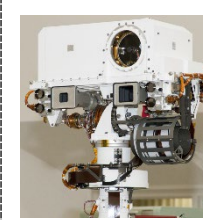


### SCIENCE TOOL Laboratory

**COST:**  
\$10 million

*Helps discover signs of past or present life on Mars*

**+2 Science Points**



### SCIENCE TOOL Camera

**COST:**  
\$5 million

*Makes discoveries about the environment on Mars*

**+1 Science Point**

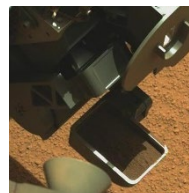


### SCIENCE TOOL Radiation Sensor

**COST:**  
\$10 million

*Helps discover if Mars could be a habitat for humans*

**+2 Science Points**



### SCIENCE TOOL Sample Collection Device

**COST:**  
\$5 million

*Collects air, rocks, and soil samples for study*

**+1 Science Point**

# SLS DESIGN

The Space Launch System, or SLS, will be used to get a crew and materials to Mars. As you select parts for your SLS, record the information in the table below to keep track of the cost. **The budget is \$150 million.** Your total cannot be more than \$150 million!

Paste your selections on the back of this paper in their respective places, along with the name for your SLS system and your mission goal.

Part	Cost (in millions)	Science Point(s)
<b>Rocket</b>		
<b>Power System</b>		
<b>Landing System</b>		
<b>Communication Antenna</b>		
<b>Science Tools</b>		
<b>TOTAL</b>		

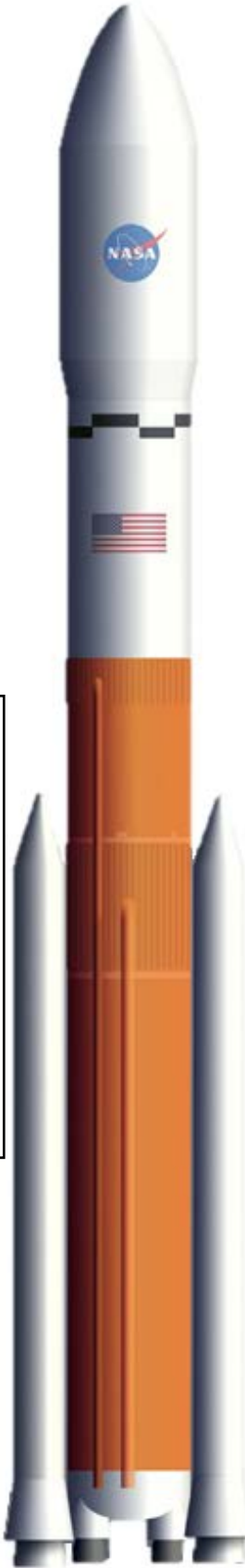




SLS NAME:

MISSION GOAL:

**SCIENCE TOOLS**



**ROCKET**

**POWER**

**COMMUNICATION**

**LANDING SYSTEM**