

THE RED PLANET

FORCED INTERACTIONS:

**MISSION TO
MARS**

Teacher's Pet



VIDEO

Introduction

Guiding Question:

In what ways can interactions lead to physical change?



OUR MISSION

Analyze forces & relate them to interactions between objects.

- **INTERNAL & EXTERNAL FORCES**
- **TEMPORARY & PERMANENT CHANGES IN SHAPE, SIZE & POSITION**
- **ACTION AND REACTION FORCES**



MISSION TO MARS

Our Goal:

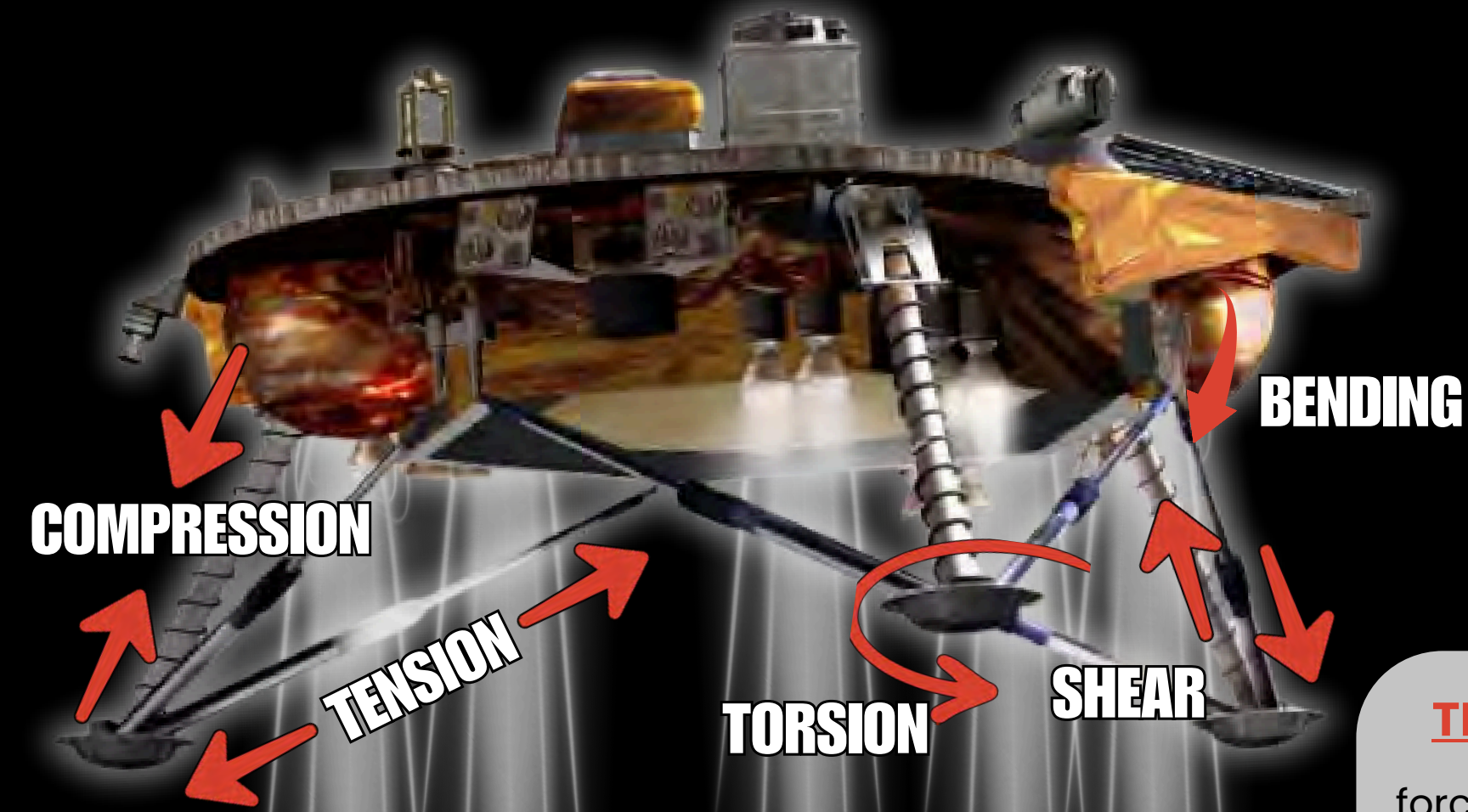
Design and build a Mars Lander to safely transport an astronaut.

WE WILL COMPLETE 5 SCIENTIFIC INVESTIGATIONS:

1. **What are the Effects of Internal Forces?**
2. **What are the Effects of External Forces?**
3. **How do Plasticity and Elasticity Affect Changes in Size and Shape?**
4. **How are Action and Reaction Forces connected?**
5. **How can we design & build a Mars Lander from a variety of objects we have tested today?**



INTERNAL FORCES ACTING ON A MARS LANDER



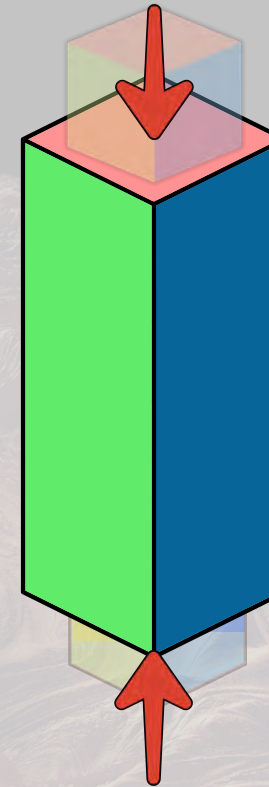
TENSION

forces PULL an object outward



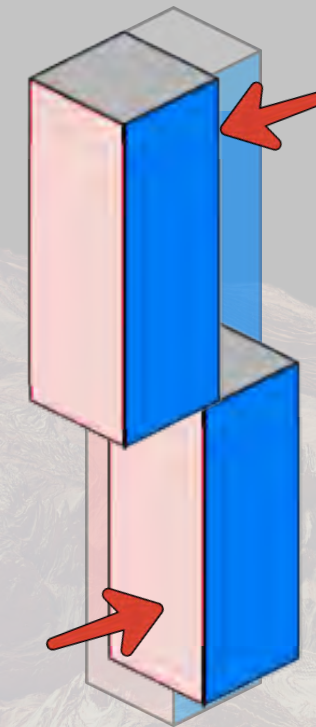
COMPRESSION

forces PUSH an object inward



SHEAR

forces PUSH in opposite directions



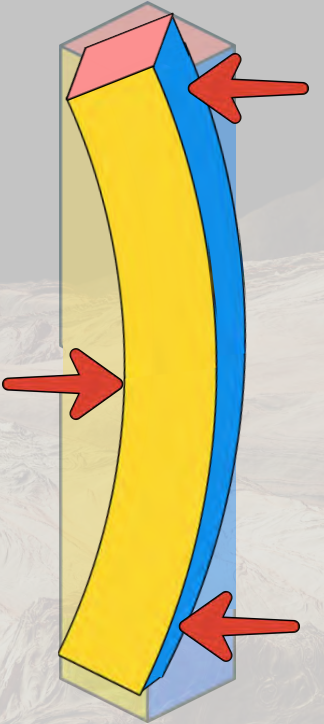
TORSION

forces TWIST an object

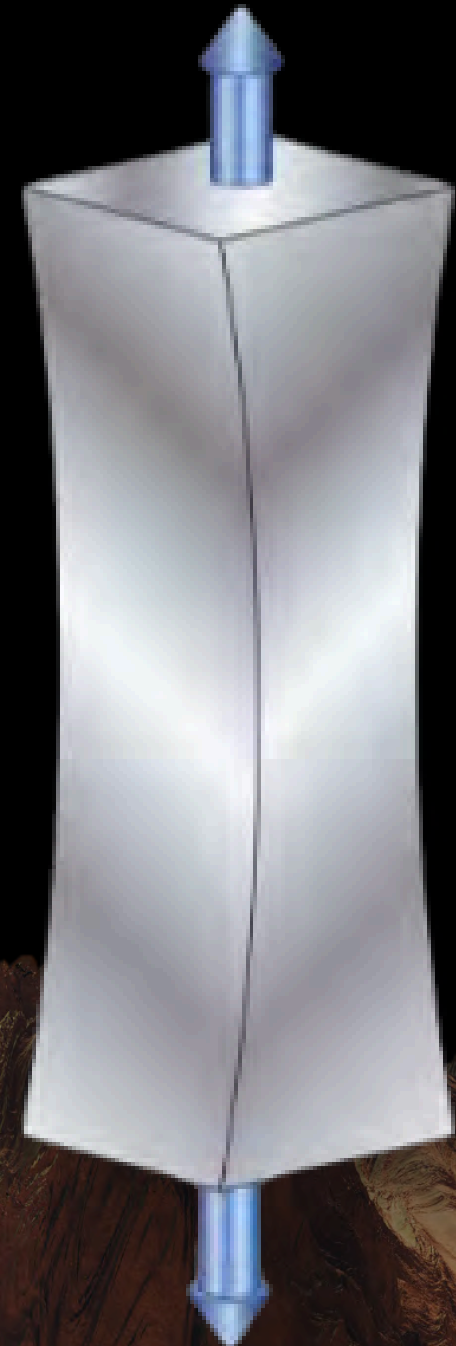


BENDING

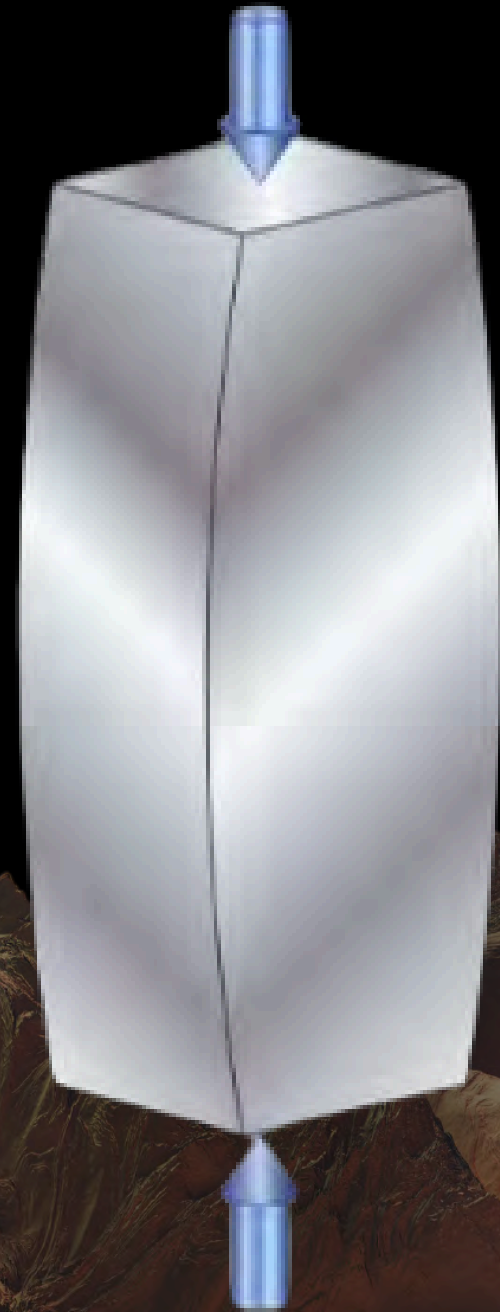
forces PUSH in opposite directions to curve object



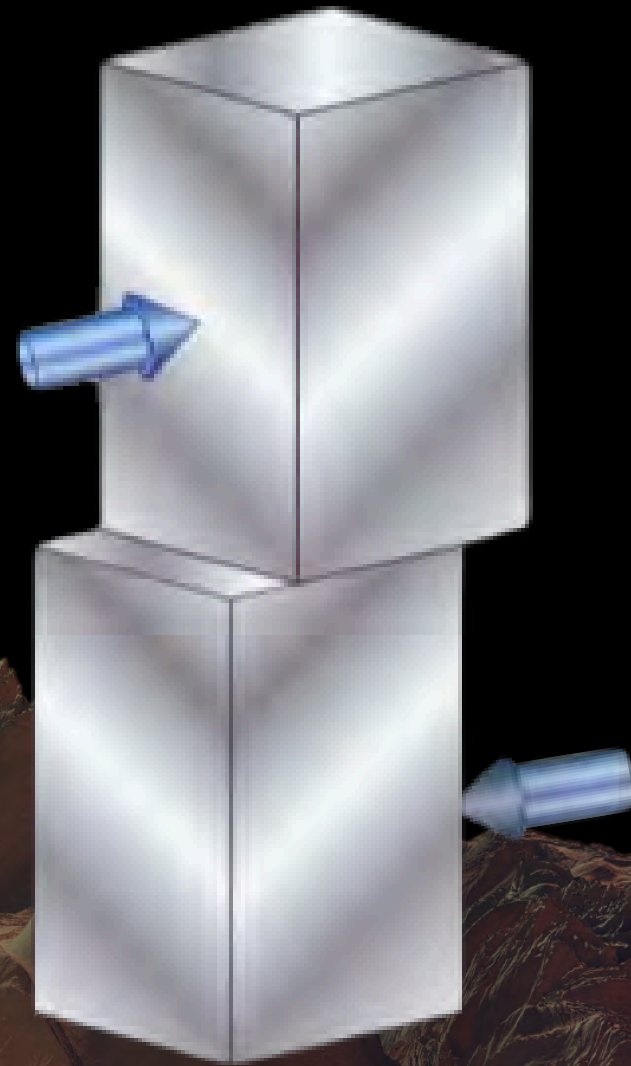
INTERNAL FORCES MAY CAUSE CHANGES IN SIZE, SHAPE & POSITION!



Tension



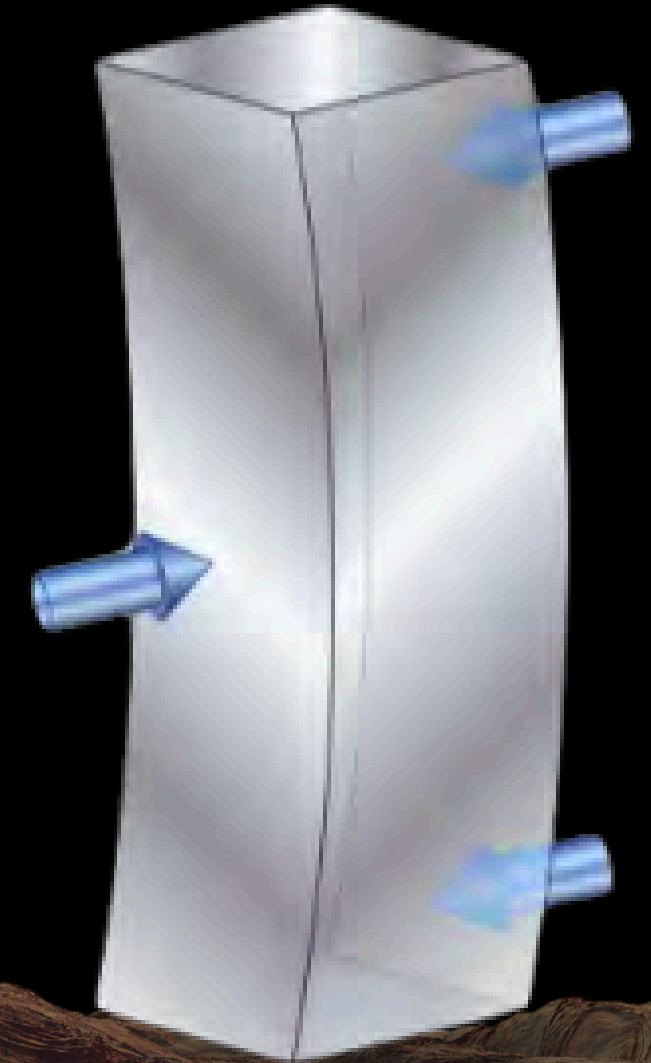
Compression



Shear



Torsion





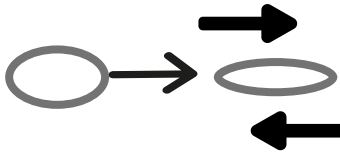

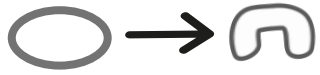
Bending

OBJECTS MAY DEFORM OR BREAK WHEN THESE FORCES ARE TOO STRONG!

MISSION LOG BOOK: ACTIVITY 1

WHAT ARE THE EFFECTS OF INTERNAL FORCES?

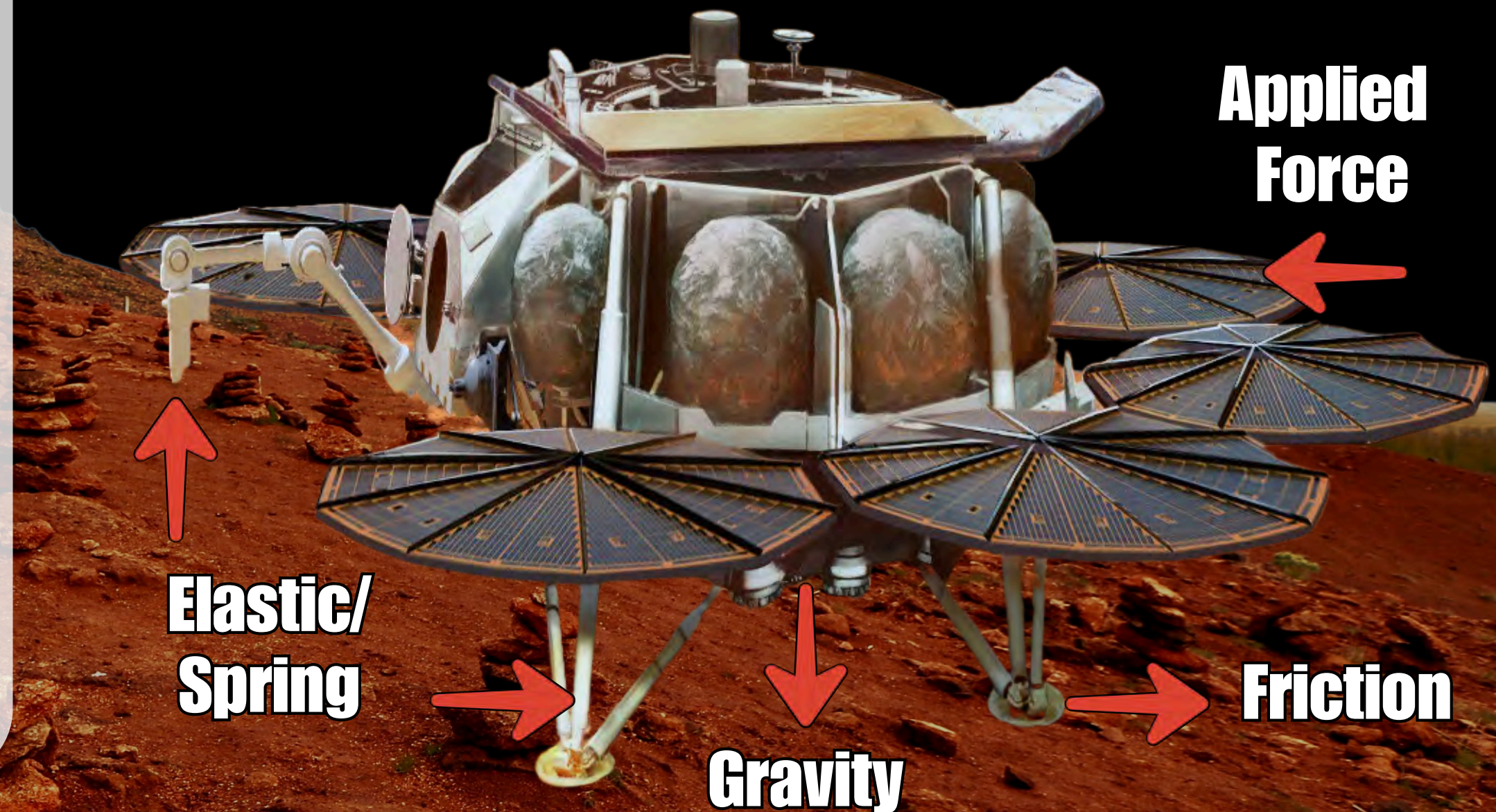
Table 1: Effects of Internal Forces on Various Objects

Object	Tension Before→After	Compression Before→After	Shear Before→After	Torsion Before→After	Bending Before→After
Elastic band					
Plastic egg					
Pom pom					
Pipe cleaner					
Foam					
Straw					
Clay					
Paper cup					

EXTERNAL FORCES ACTING ON A MARS LANDER

Forces outside the object may cause physical changes in size, shape or position!

1. **GRAVITY** – pulls the object DOWN to the surface
2. **APPLIED FORCE** – wind pushes or pulls on the object
3. **FRICTION** – ground grips or rubs the object
4. **ELASTIC/SPRING** – objects touch a stretched/compressed elastic or spring
 - spring loaded arms/legs



MISSION LOG BOOK: ACTIVITY 2

WHAT ARE THE EFFECTS OF EXTERNAL FORCES?

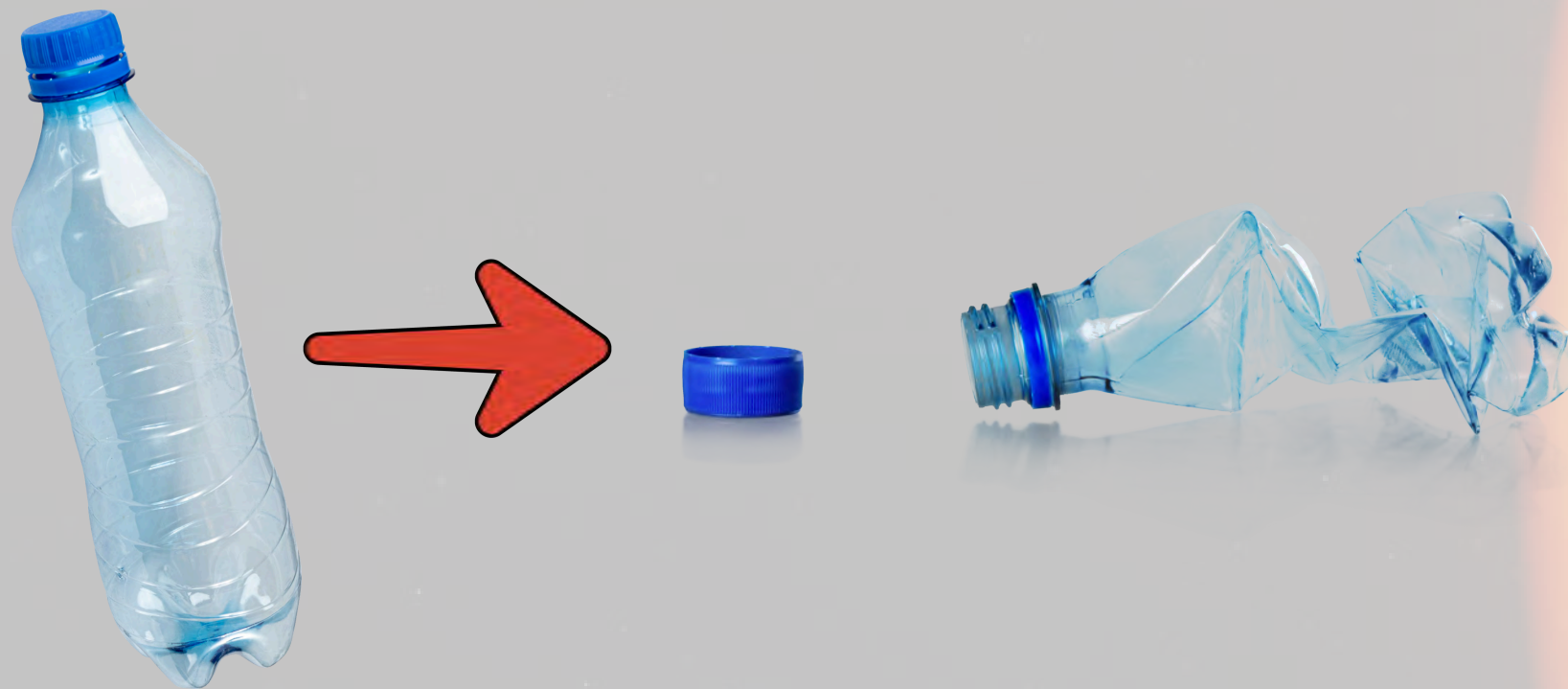
Table 2: Effects of External Forces on Various Objects

Object	Applied Force (push onto table)	Friction Force (rubber gripper)	Elastic Force (hits boundary)	Spring Force (travel < or > 30 cm)
Elastic band	squishes flat	grips the elastic	hits boundary	travels < 30 cm
Plastic Egg				
Pom pom				
Pipe cleaner				
Foam				
Straw				
Clay				
Paper cup				

PLASTICITY AND ELASTICITY LEAD TO CHANGES IN SHAPE

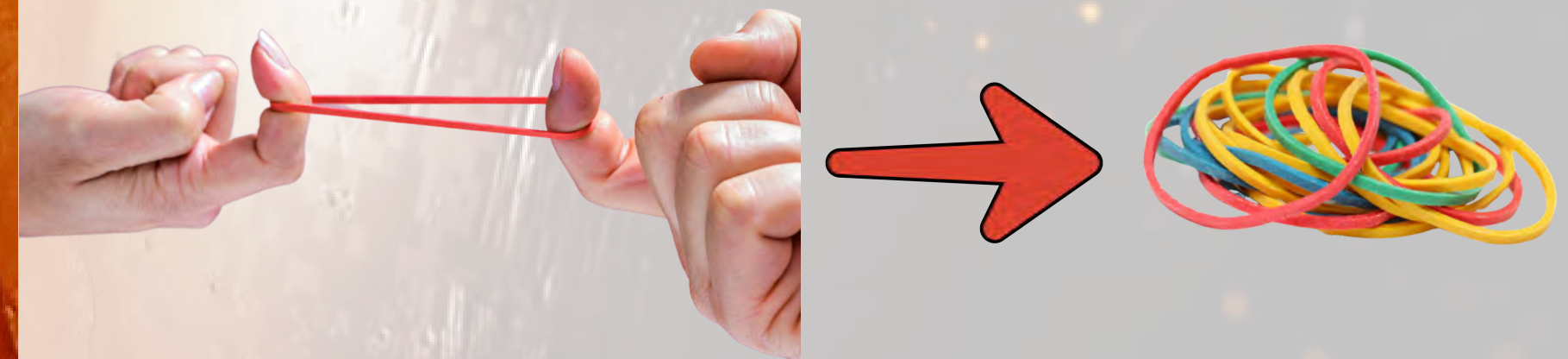
PLASTICITY

- Ability to be easily transformed into a new shape (flexible)
- Acts like a plastic bottle
- Causes **PERMANENT** change



ELASTICITY

- Ability to return to its regular shape after being stretched or compressed
- Acts like an elastic band
- Causes **TEMPORARY** changes



PLASTICITY AND ELASTICITY ACT IN A MARS LANDER

PLASTICITY: The flexible panels unfold into a new shape

PERMANENT change



ELASTICITY: The “balloons” stretch and compress as they change shape to absorb the shock of landing on Mars

TEMPORARY change



PLASTICITY AND ELASTICITY ACT IN A MARS LANDER

1. Parachute has **ELASTICITY**:
Temporarily stretches to create
drag to slow down the Mars Lander
as it falls

2. Legs have **PLASTICITY**: Permanently
change leg shape to stabilize the Mars
Lander on the surface



MISSION LOG BOOK: ACTIVITY 3

HOW DO PLASTICITY AND ELASTICITY AFFECT CHANGES IN SHAPE?

Table 3: Plasticity and Elasticity of Objects Cause Changes in Shape

Object	Plasticity (permanent change)	Elasticity (temporary change)
Elastic band	X	✓
Plastic Egg		
Pom pom		
Pipe cleaner		
Foam		
Straw		
Clay		
Paper cup		

ACTION AND REACTION FORCES

Newton's 3rd Law

For every ACTION there is an EQUAL and OPPOSITE reaction!

Thrusters:

- Gas is expelled down then the Mars Lander goes up
- Gas is expelled left then the Mars Lander goes right
- Opposing forces balance the Mars Landers



ACTION AND REACTION FORCES – FAILURE!

FAILURE TO UNDERSTAND ACTION AND REACTION FORCES MAY CAUSE:

- 1. Unstable landing**
- 2. Crash landing**
- 3. Permanent Change**



MISSION LOG BOOK: ACTIVITY 4

HOW ARE ACTION AND REACTION FORCES CONNECTED?

Table 4: Forced Interactions between Various Objects - Action and Reaction Forces!

Objects	Action Force	Reaction Force
Elastic band contacts straw	Tension applied to elastic band	Straw flies into the air due to transfer of elastic energy
Pipe cleaner contacts pom pom		
_____ contacts _____		
_____ contacts _____		

NEWTON'S 3RD LAW

DESIGN & BUILD YOUR MARS LANDER: WORK WITH A PARTNER

You may use any of the objects we investigated today!

COMPLETE 5 SCIENTIFIC INVESTIGATIONS:

Step 1: Draw and label a blueprint for your Mars Lander



Step 2: Build your Mars Lander

Step 3: Test your Mars Lander from a height of 1.5 m with the small astronaut inside

Step 4: Modify your Mars Lander as needed – RETEST!

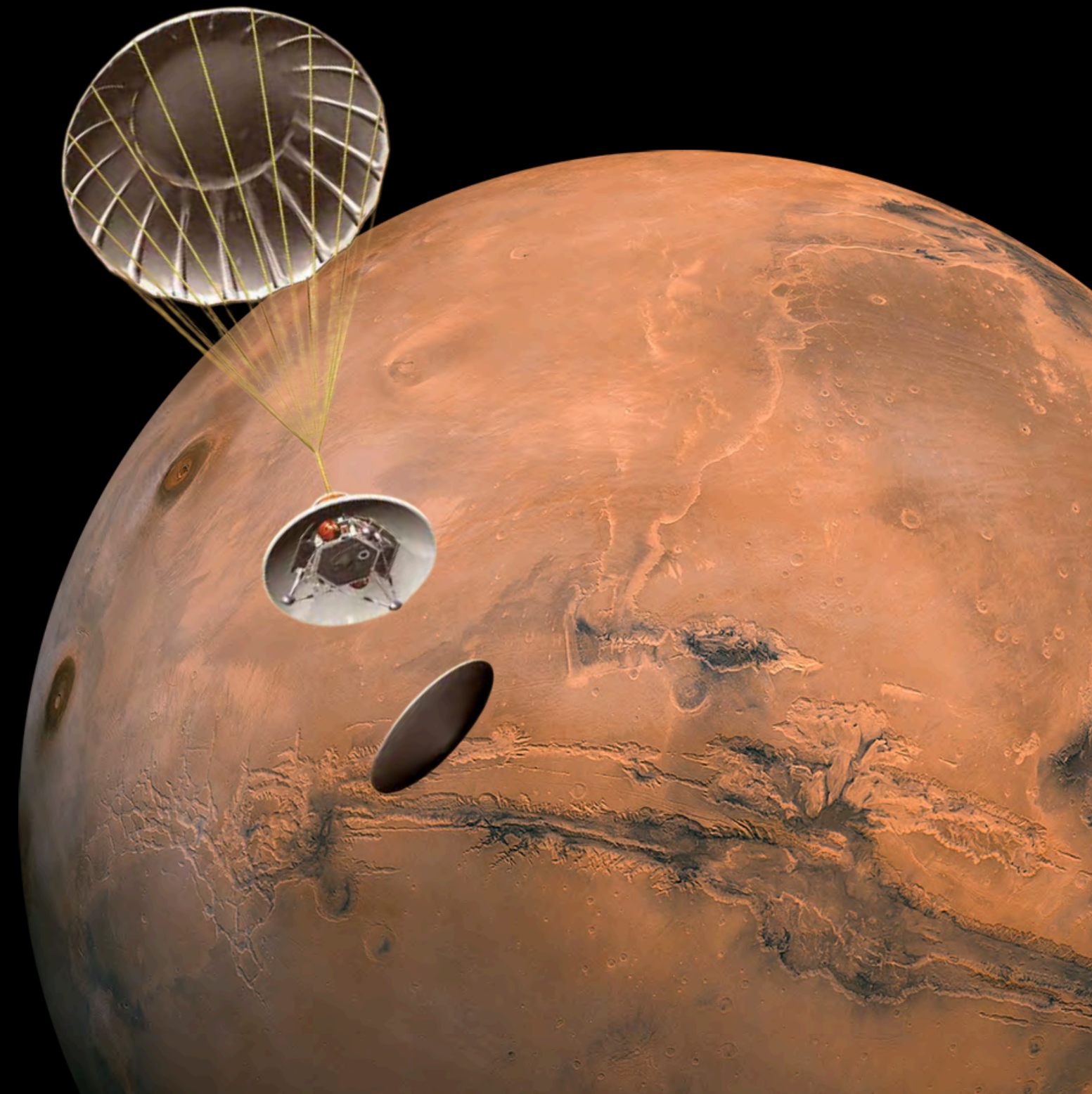


CLEAN UP TIME!

Complete an inventory count.

Replace damaged objects.

Check the tables and floors.



COLLABORATION: SHARE YOUR RESULTS WITH YOUR TABLE GROUP

1. What objects did you use in the design? Why did you create this design?
2. During impact, how did INTERNAL and EXTERNAL forces act on your Mars Lander?
3. Diagram and label internal & external forces acting on your Mars Lander!
4. In what ways did force interactions lead to physical change in your Mars Lander?



CONCLUSION

**IN WHAT WAYS CAN INTERACTIONS LEAD TO
PHYSICAL CHANGE?**

INTERNAL & EXTERNAL FORCES

TEMPORARY & PERMANENT CHANGES

ACTIONS AND REACTIONS

TAKE HOME INVESTIGATION

Cosmic Cubes

How do
FORCE INTERACTIONS
lead to physical changes
in the shape of the cosmic
cube?



Can you make
all 72 shapes?

