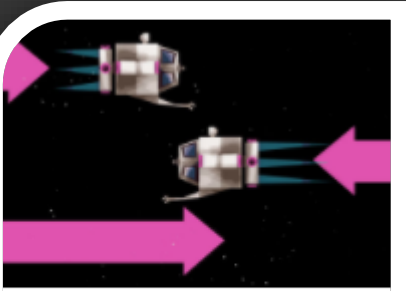


Chapter 1: Force and Velocity



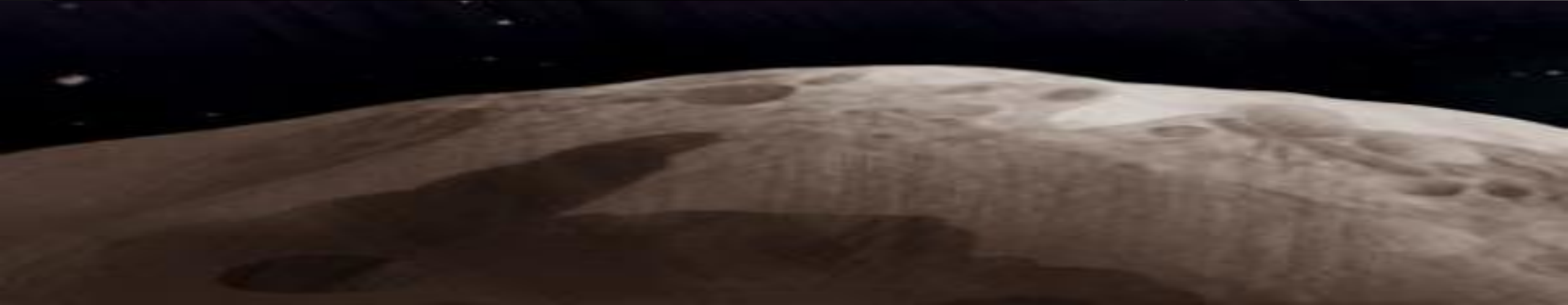
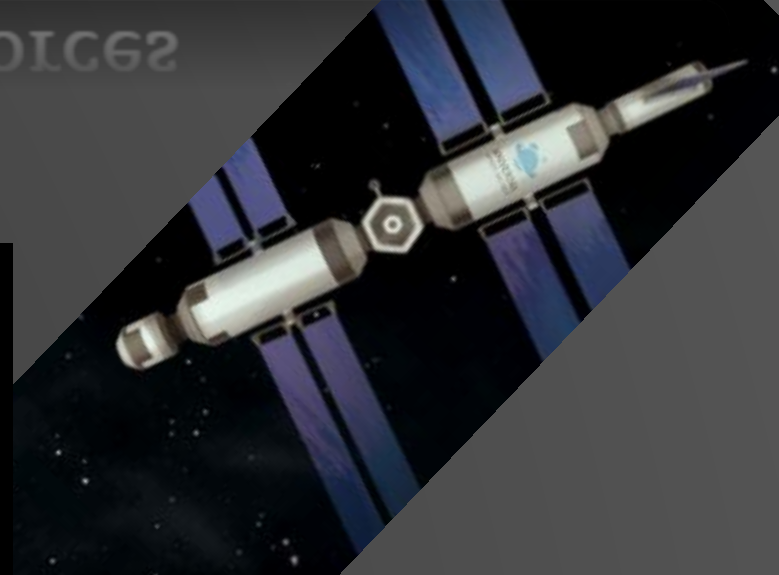
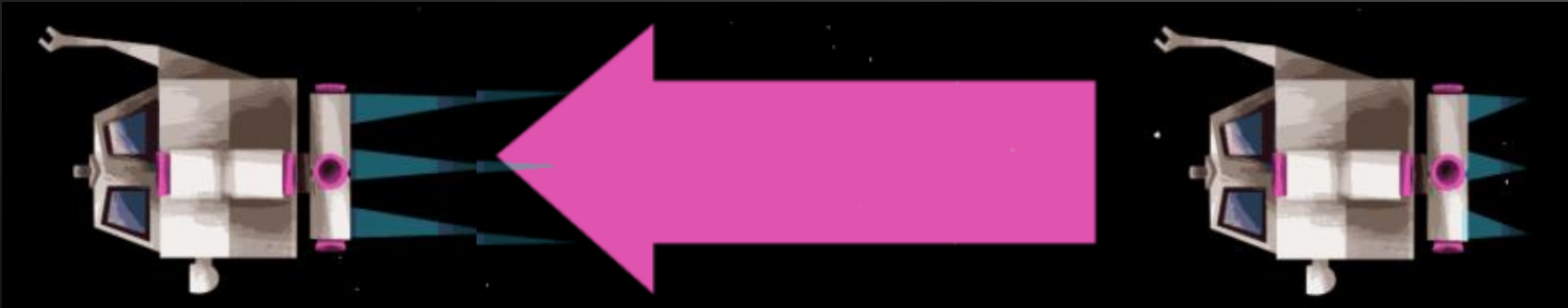
Chapter 1: Force and Velocity



6

1.6: Evaluating Claims and Thruster Forces

FOIC62





FM: 1.6.1 WARM-UP

HAND IN

Students describe what would have happened with the thruster force if either Claim 1 or Claim 2 were true. (8 min)

Thruster Force

ACM pods normally fire the thrusters with a force that stops the pod and allows it to dock at the space station. For this pod, something else happened.

Think about the thruster force in successful missions, and then compare that to the thruster force that would cause the situation in each of the claims. Then, complete the claims (below the image).

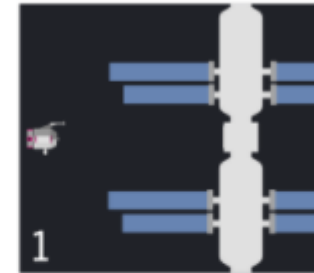
Claim 1: If this pod went in the opposite direction because of the thrusters, the thrusters would have exerted **a force Greater than** the thrusters in other missions.

Claim 2: If this pod crashed into the space station because of the thrusters, the thrusters would have exerted **a force Weaker than** the thrusters in other missions.

Normally, when the thrusters fire, the pod will stop, but this mission was different.

Claim 1: The thrusters caused the pod to move in the opposite direction.

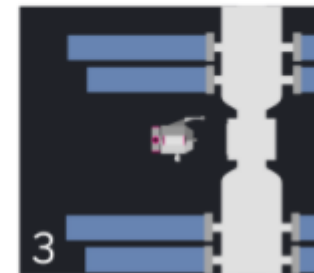
Claim 2: The thrusters only slowed the pod, it didn't stop; the pod hit the space station, which made it bounce and move in the opposite direction.



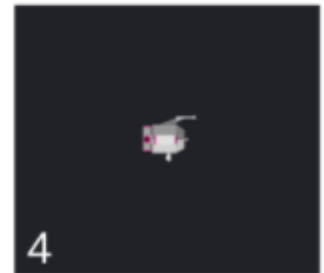
1 Pod approaches space station at medium speed.



2 Thrusters fire to stop the pod.



3 Thrusters cause pod to move in opposite direction OR pod hits space station and bounces off.



4 Pod travels far away from the space station.



Students apply their understanding of force and velocity as they create models to show how different strength thruster forces would affect the velocity of the pod. (20 min)

Thrusters and Pod Velocity

Ana Gonzales

To: Student Physicists
Re: Thruster Force



Great work so far on your investigation into what happened when we lost contact with the ACM pod. As our team investigates what kept this pod from docking, your **models and arguments** will play a key role in helping us understand what could have caused the pod to move away from the space station. Was there a problem with the amount of force exerted by the thrusters? Your explanations will help us interpret the data we are trying to recover from the pod. We hope to have some data soon.

Keep up the thorough work!

Dr. Ana Gonzales, Program Scientist
Asteroid Collection Mission

You will create two models to offer a visual explanation of the two claims and they will be submitted to the space agency along with your written arguments for a thorough explanation of how the thrusters could have affected the pod's motion.



FM: 1.6.2 MODELING THRUSTER FORCES

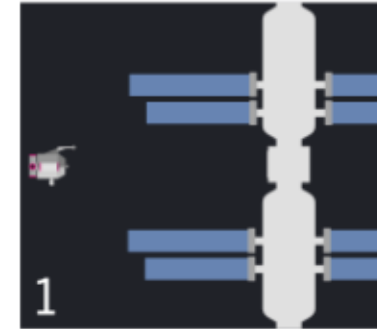
You will use the Modeling Tool to complete two models.

The FIRST showing how the thruster force could have caused the pod to reverse direction.

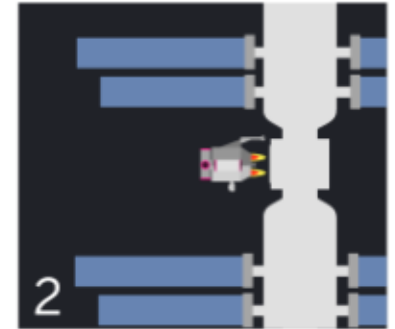
Normally, when the thrusters fire, the pod will stop, but this mission was different.

Claim 1: The thrusters caused the pod to move in the opposite direction.

Claim 2: The thrusters only slowed the pod, it didn't stop; the pod hit the space station, which made it bounce and move in the opposite direction.



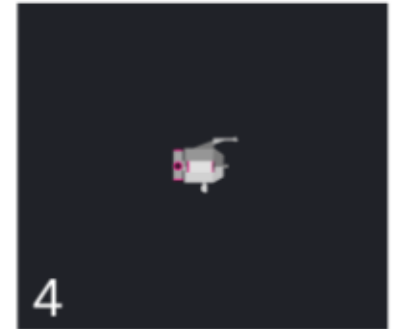
Pod approaches space station at medium speed.



Thrusters fire to stop the pod.



Thrusters cause pod to move in opposite direction OR pod hits space station and bounces off.



Pod travels far away from the space station.



Modeling Claim 1

1. Open the *Force and Motion* Modeling Tool activity: **Claim 1**.
2. When your model is complete, press HAND IN.

Goal: Model the thruster force that would cause the pod to move in the opposite direction.

Do:

- Use the first row as a reference; use the second row to show what happened to this pod.
- Drag one force arrow into the During Force panel so it shows the direction and strength of the thruster force.
- Drag velocity lines into the After Force panel so it shows the pod's final velocity.

NEXT >

Hand In

Instructions

Reset Undo Redo

Before Force

During Force

After Force

Most ACM Pods



Press HAND IN to see a screenshot of your completed model.



This ACM Pod



UPLOAD AN IMAGE

Object



Slow



Medium



Fast



Small



Medium



Large



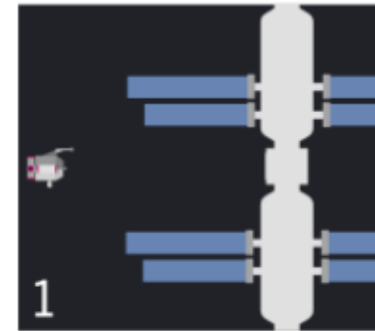
FM: 1.6.2 MODELING THRUSTER FORCES

Complete your model for Claim 2.

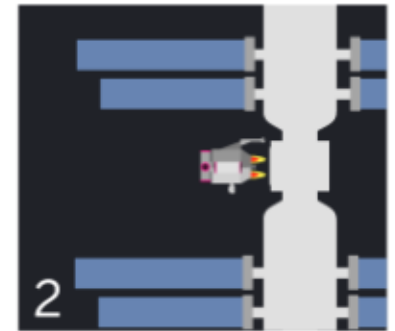
Normally, when the thrusters fire, the pod will stop, but this mission was different.

Claim 1: The thrusters caused the pod to move in the opposite direction.

Claim 2: The thrusters only slowed the pod, it didn't stop; the pod hit the space station, which made it bounce and move in the opposite direction.



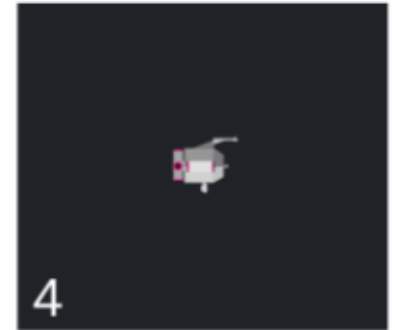
Pod approaches space station at medium speed.



Thrusters fire to stop the pod.



Thrusters cause pod to move in opposite direction OR pod hits space station and bounces off.



Pod travels far away from the space station.



Modeling Claim 2

1. Open the *Force and Motion Modeling Tool* activity: **Claim 2**.
2. When your model is complete, press HAND IN.

Goal: Model the thruster force that would only slow the pod (not stop) and cause it to hit the space station.

Do:

- Use the first row as a reference; use the second row to show what happened to this pod.
- Drag one force arrow into the During Force panel so it shows the direction and strength of the thruster force.
- Drag velocity lines into the After Force panel so it shows the pod's final velocity.

HAND IN

Hand In

Instructions

Reset Undo Redo

Before Force

During Force

After Force

Most ACM Pods



Press HAND IN to see a screenshot of your completed model.



This ACM Pod



UPLOAD AN IMAGE

Object



Slow



Medium



Fast



Small



Medium



Large

FM: 1.6.3 EXPLAINING THRUSTER FORCES

Students write about the cause-and-effect relationship between the force exerted by the thrusters and the pod's change in velocity. (17 min)

You will write about the two claims in terms of cause and effect.

Dr. Gonzales is especially interested in understanding the relationship between thruster force and the change in the pod's velocity. This will help the team at USA interpret the data.

Key Concept

Understanding a cause-and-effect relationship can help you infer what led to a particular result.

You've learned about the general relationship between force and changes in velocity. Understanding this as a cause-and-effect relationship allows you to infer how a change in thruster force could affect the pod's velocity.

Students write about the cause-and-effect relationship between the force exerted by the thrusters and the pod's change in velocity. (17 min)

When you are writing about the claims, you will need to **clearly state** how a stronger or weaker thruster force would affect the pod's motion. You should use science vocabulary to make your thinking clear.

What caused the jar lid to start moving across the floor?

A. The launcher caused the lid to start moving across the floor.

B. **When** I released the launcher, the launcher exerted a **force** on the jar lid. **As a result** of the force exerted by the launcher, the **velocity** of the jar lid changed, and it started to move across the floor.

Students write about the cause-and-effect relationship between the force exerted by the thrusters and the pod's change in velocity. (17 min)

Example A does mention a cause and effect,

Example B is a clearer description of the cause-and-effect relationship that resulted in the jar lid sliding across the floor. It also uses the scientific vocabulary words force and velocity.

What caused the jar lid to start moving across the floor?

A. The launcher caused the lid to start moving across the floor.

B. **When** I released the launcher, the launcher exerted a **force** on the jar lid. **As a result** of the force exerted by the launcher, the **velocity** of the jar lid changed, and it started to move across the floor.



FM: 1.6.3 EXPLAINING THRUSTER FORCES

Students write about the cause-and-effect relationship between the force exerted by the thrusters and the pod's change in velocity. (17 min)

Writing About Cause-and-Effect Relationships

1. Explain the events that would cause these changes in velocity. For each claim, describe the thruster force and how that would result in the pod moving away from the station.
 - **Claim 1:** The thrusters caused the pod to move in the opposite direction.
 - **Claim 2:** The thrusters only slowed the pod, it didn't stop; the pod hit the space station, which made it bounce and move in the opposite direction.
2. Use the word bank, cause-and-effect words and phrases, and your two Modeling Tool diagrams, if they are helpful.

Word Bank

force	exert	velocity
cause	effect	

Cause-and-Effect Words and Phrases

If . . . , then	When	As a result,	This led to . . .
Because	Therefore,	Next,	



FM: 1.6.3 EXPLAINING THRUSTER FORCES

HAND IN

Students write about the cause-and-effect relationship between the force exerted by the thrusters and the pod's change in velocity. (17 min)

We have two claims that describe what could have happened to cause the pod to change direction.

We know there was something different about how the thrusters affected this pod's motion as compared to normal missions.

Either the pod's thrusters caused the pod to move in the opposite direction or the thrusters caused the pod to slow down but not stop, so it hit the space station and bounced off in the opposite direction.

In your writing, you will explain what could have caused this effect on the pod's motion.

Claim 1: Firing the thrusters would have caused the pod to move in the opposite direction if . . .

B I U | [bulleted list] [numbered list] [checkbox list] [checkbox list] | [undo] [redo] [clear] [undo] [redo] | [undo] [redo]

Word Count: 2

Write here...

Claim 2: Firing the thrusters only slowed the pod, it didn't stop; the pod hit the space station, which made it bounce and move in the opposite direction. This would happen if . . .

B I U | [bulleted list] [numbered list] [checkbox list] [checkbox list] | [undo] [redo] [clear] [undo] [redo] | [undo] [redo]

Word Count: 2

Write here...



FM: 1.6.4 HOMEWORK, SELF-ASSESSMENT

HAND IN

This homework provides a chance for students to reflect on their learning so far.

Check Your Understanding

This is a chance to reflect on your learning so far. This is not a test. Be open and truthful when you respond.

Scientists investigate in order to figure things out. Are you getting closer to figuring out what happened to the ACM pod during the time when Mission Control lost contact?

1. I understand how forces could have caused the pod to move in the opposite direction.

Explain your answer choice.

2. I understand how something about the pod could have affected its velocity change.

Explain your answer choice.

3. I understand the forces in a collision, the moment when two objects hit.

Explain your answer choice.

4. I understand why the objects in a collision can have different changes in motion.

Explain your answer choice.

5. What do you still wonder about force and motion as it relates to the pod and Asteroid Collection Mission that did not go as planned?