Colossal Collisions

Unit 1

This slide deck is intended to help guide you and your students through the sequence of this unit. While you may choose to use these slides as a helpful tool to prompt and facilitate students, all detailed information for each unit is in the student and teacher unit booklets.

Unit Essential Question

What are the effects of an asteroid collision and how can we prevent a future one?

Asteroid Collisions

Lift-Off Task

There is a theory that there was an asteroid collision 65 million years ago

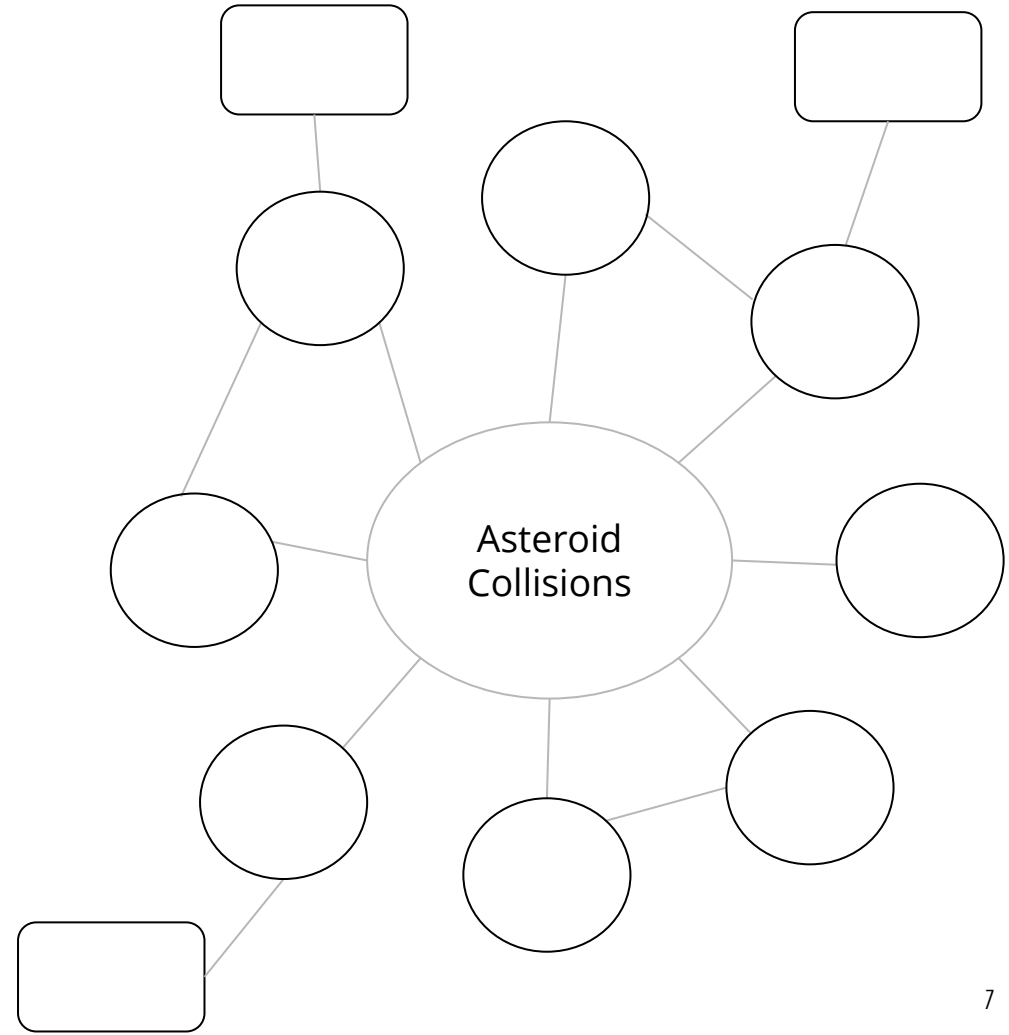
Generate Questions!

If you wanted to know more about this historical asteroid collision, what questions would you ask?

Group Concept Map

As a group, create a concept map that shows:

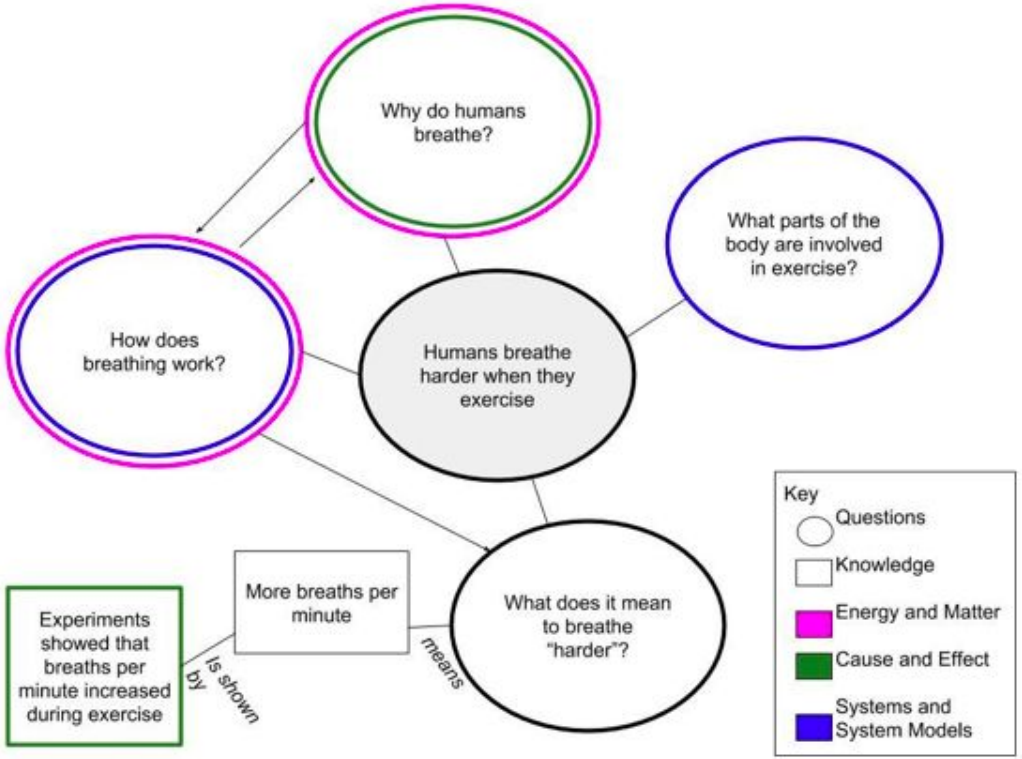
- Questions your group members had in common (circles)
- Possible answers to some questions (squares)
- Connections between related questions (lines)



Class Concept Map

As a class, create a concept map that shows:

- Key questions (circles)
- Possible answers to some questions (squares)
- Connections between related questions (lines)
- Crosscutting concepts used (trace in color)



Introduction to the Culminating Project

Prevent the impending collision of *Etiam* with Earth!

Group Project - Video news segment describing how you plan to prevent the impending asteroid collision

Individual Project - News article telling people more about asteroid collisions with Earth and the science behind your solution

Background Data on *Etiam*

Shape: Irregular bone shape

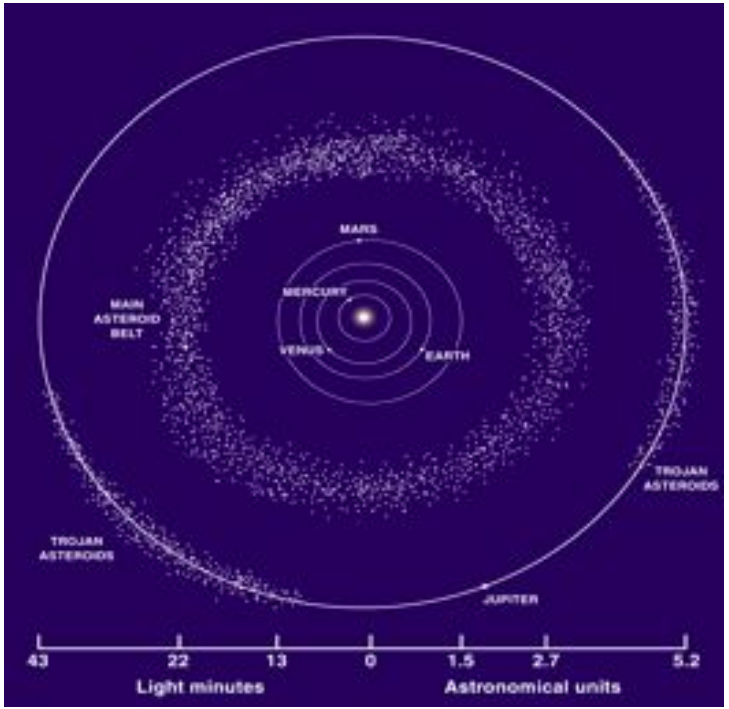
- Length at longest point: 78 km
- Width at thickest point: 20 km
- Width at thinnest point: 12 km

Mass: 6,890,000,000,000,000 kg (6.89×10^{15} kg)

Speed: 103,450 km/h

Background Data on *Etiam*

Etiam is 104.7 million km from Earth and about 84 million km from the edge of the asteroid belt. When triangulating with the sun, *Etiam* forms the point furthest from the Sun and the Earth in what appears to be - roughly - a right triangle (90° from the Earth, when compared to the Sun).



Connecting to the Culminating Project

You will be designing a solution to prevent the impending collision of the asteroid *Etiam* with Earth. In order to develop a solution to an impending collision with asteroid *Etiam*, we need to learn everything we can about the impacts of an asteroid collision.

- Summarize what you already know about collisions, including:
  - Possible negative consequences
  - The types of methods humans use to prevent everyday collisions.

Complete this **<u>individually</u>** in your Project Organizer.

Reflection

Complete the questions at the end of your student guide to reflect on what you have learned in the Lift-Off Task.

An Ancient Collision

Task 1

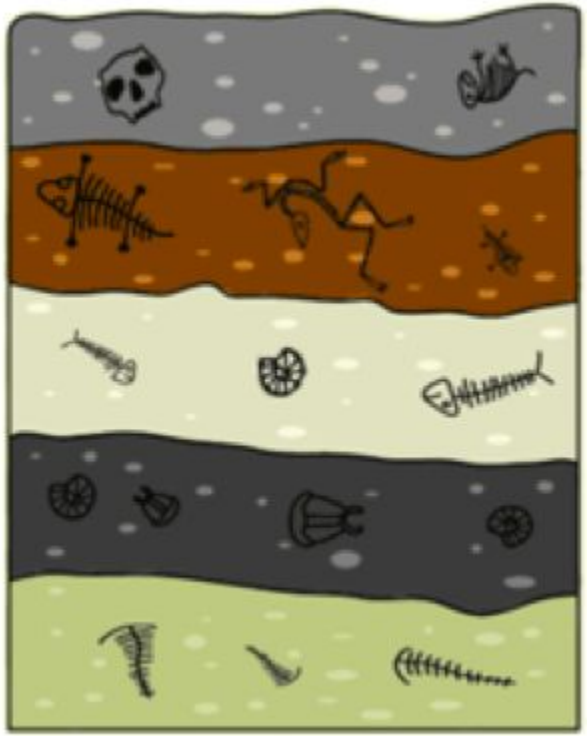
What questions do you still have?

Engage

Make a Guess

There is a theory that a large asteroid hit Earth 65 million years ago.
With your group, can you guess what asteroid collision this refers to?

Practice how to read the fossil record!



In pairs,

1. Which do you think are the oldest fossils and the youngest fossils?

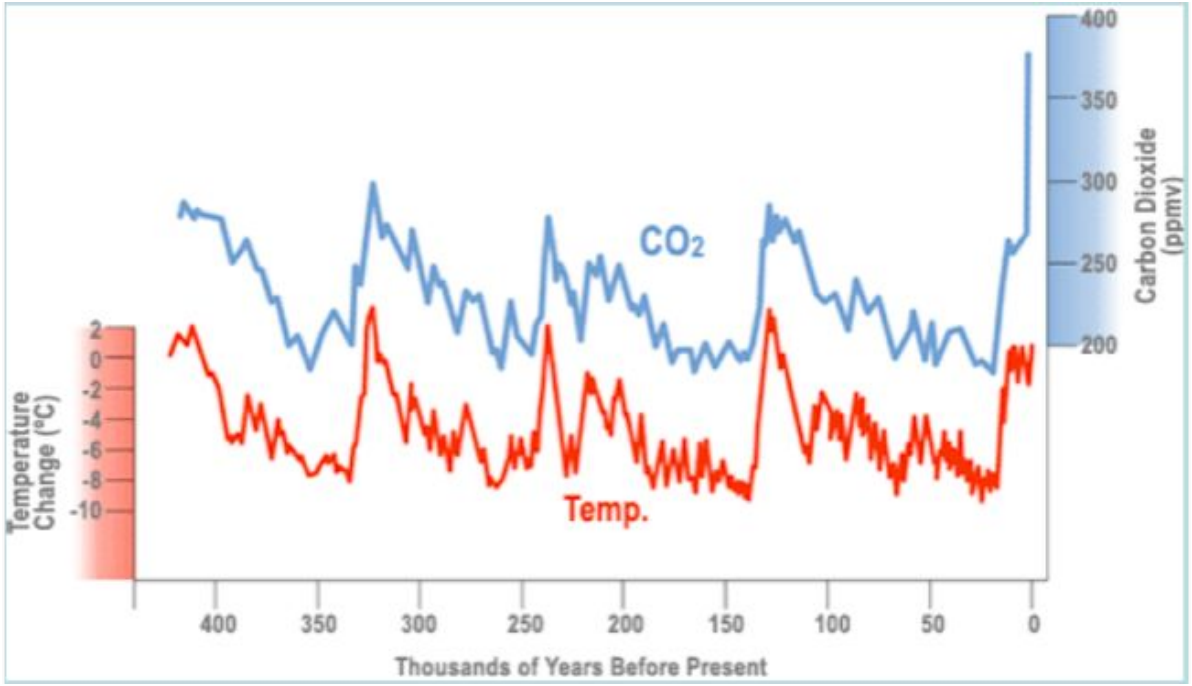
2. How do you see species changing over time?

Answer the questions in your student guide

Explore

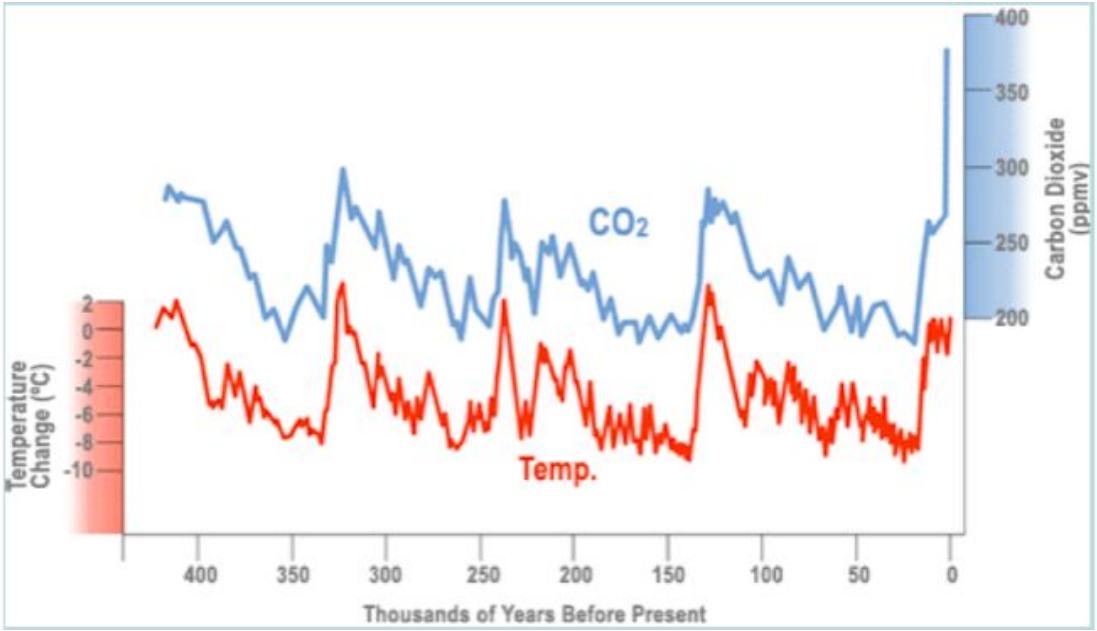
Analyzing and Interpreting Data:
Did an asteroid collision actually happen 65 million years ago?
If so, what were the consequences?

Practice: How to Analyze a Graph



What is this graph about?

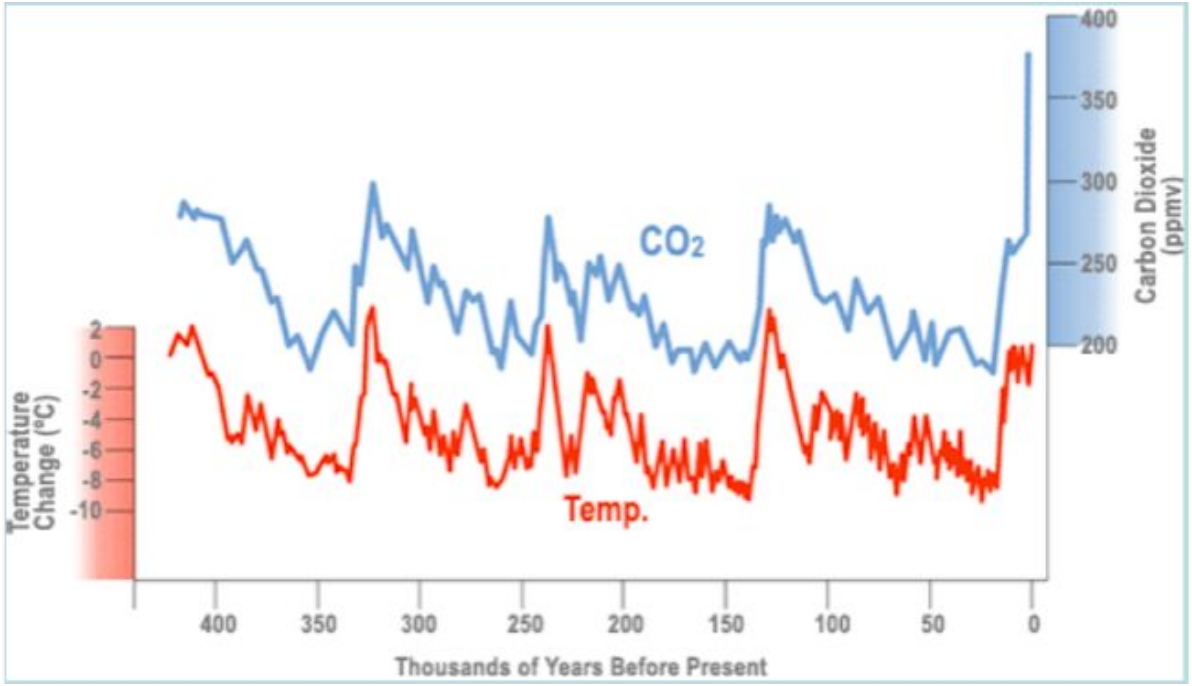
Practice: How to Analyze a Graph



- What is the graph measuring, according to the axes?
- Describe patterns (repetitions) using axes labels.
- Describe exceptions to patterns...are there parts of the graph that are different from the pattern?

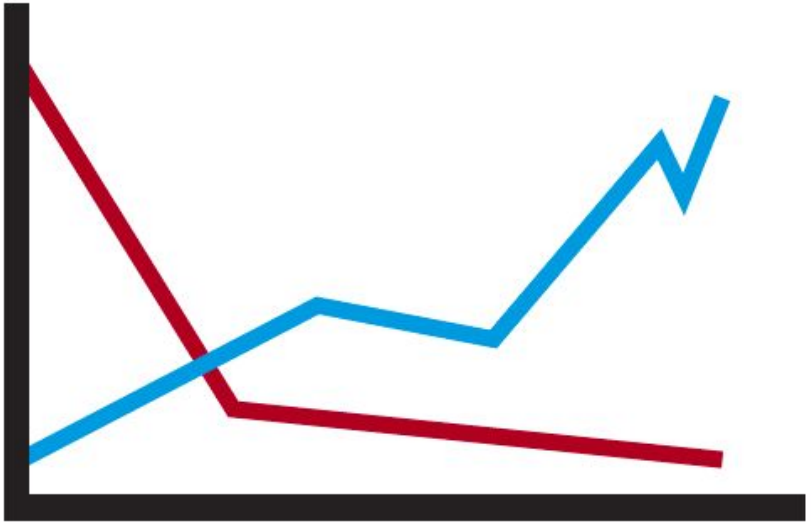
Optional Sentence Stem: “As _____ increases/decreases, _____ increases/decreases.”

Practice: How to Analyze a Graph



Carbon dioxide and temperature changes have paralleled each other until the present, when carbon dioxide increased dramatically but temperature remained about the same.

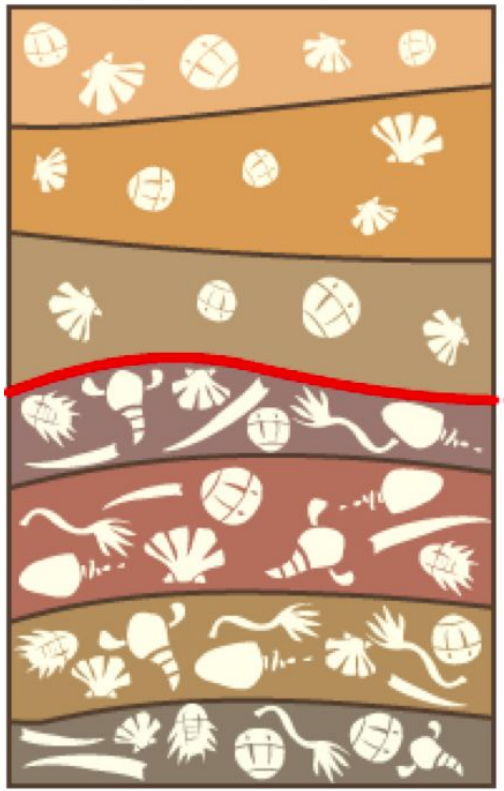
Questions to Ask Yourself When Analyzing Graphs



1. What does each axis of the graph say?
2. What are the units?
3. What does the graph measure?
4. What patterns do you notice on the graph?
5. Are there any exceptions to the pattern?

Practice: How to Analyze a Resource

Stratigraphic layers:



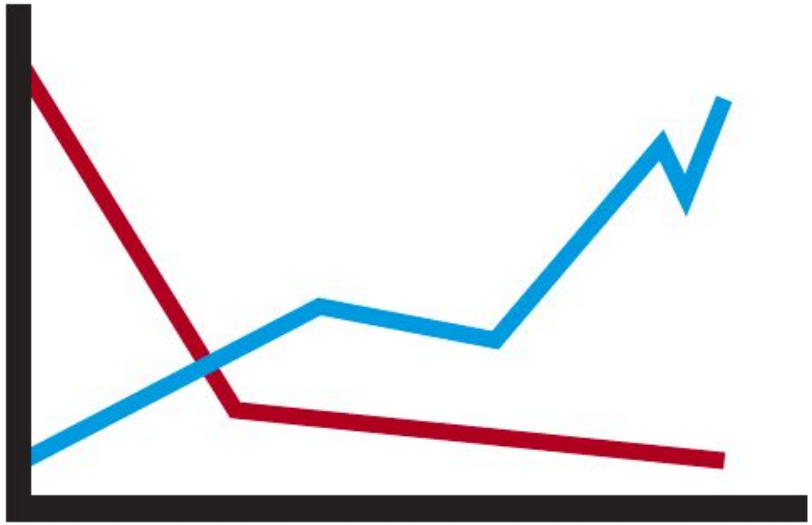
	Type of Data	Observations: What do you see?	Responses to the Discussion Questions
Resource Card 1			1. Compare the layers below and above the red line. How are they different? 2. What do you think the red line represents?

Analyzing and Interpreting Data: Did an asteroid collision actually happen 65 million years ago? If so, what were the consequences?

As a group,

1. Explore the stations.
2. Record your observations in the chart on your student guide.
3. Discuss the questions provided and record responses in the chart.

Whole Class Debrief



What patterns did you notice in the data across the different stations?

Explain

Constructing Explanations

Has a large asteroid hit Earth before? If so, what were the effects?

Write a CER paragraph, using **patterns** from the *Explore* data as evidence to help support your claim.

Elaborate

Stronger Clearer

1. **Individual Think Time:** What will you say to your partner without looking at your explanation?

2. **Partner Discussions:**
   a. **Student A:** Describe your explanation.
   b. **Student B:** Listen and ask clarifying questions.
   c. **Student A and Student B:** Write down any notes to make your explanation stronger and clearer.

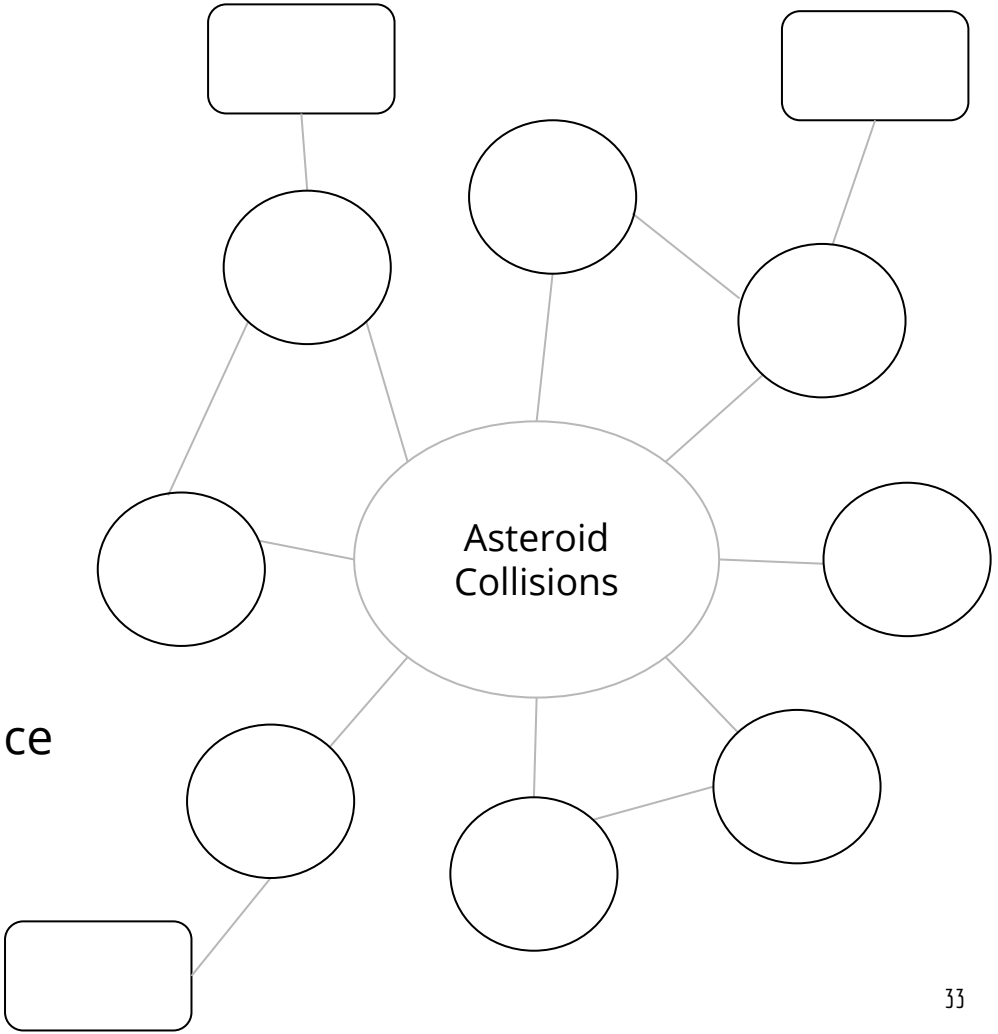
3. **Repeat with 2 more partners!**

4. **Revise your explanation.**

Class Concept Map

Add to your class concept map:

- New questions (circles)
- New ideas learned (squares)
- New connections (lines and connector words)
- Crosscutting concepts used (trace in color)
    - Patterns



Evaluate

Connecting to the Culminating Project

You will be designing a solution to prevent the impending collision of the asteroid *Etiam* with Earth. Today we learned that there has already been an asteroid collision in the past that had huge consequences. Use this ancient collision to justify your design solution:

- What evidence is there that this has happened before?
- What were the effects last time?
- How will you use the evidence to convince the public that it is important to protect Earth from another asteroid collision?

Complete this **individually** in your Project Organizer.

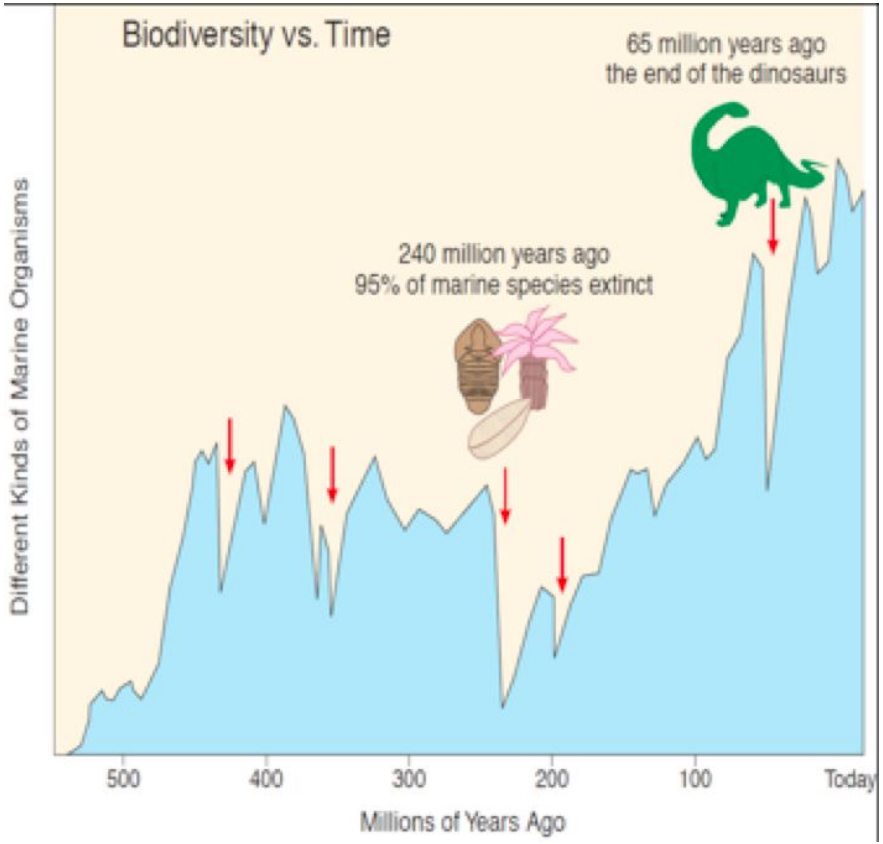
Reflection

Complete the questions at the end of your student guide to reflect on what you have learned in Task 1.

Contact Forces

Task 2

What questions do you still have?



Engage

What happens when things move or collide?

For each scenario:

1. Discuss with your partner.
2. Describe with words and with pictures.
3. Write your best explanation for why you think it happens the way it does.

A moving soccer ball gets kicked.

A rocket launches from Earth, leaves the atmosphere, and goes into space.

You are standing in a bus that stops suddenly, and you keep moving/falling forward.

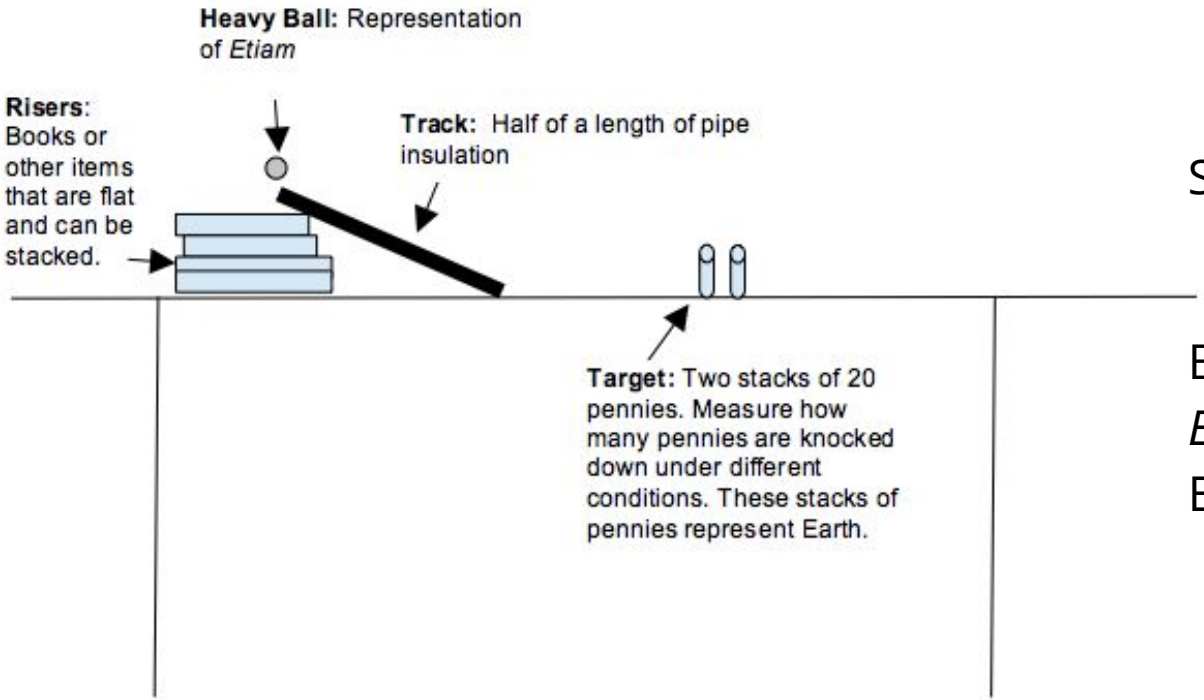
A comet in space continues to move without slowing down or speeding up.

A large asteroid crashes into the moon.

A small asteroid crashes into the moon.

Explore

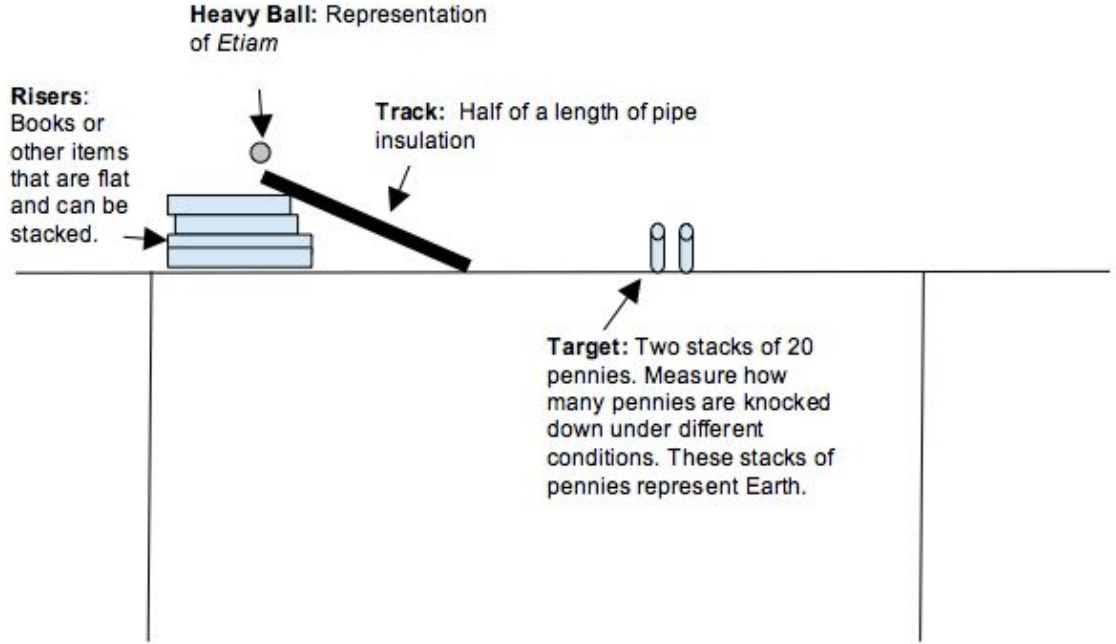
Make a Model of an Asteroid Collision



Stack of pennies = Earth

Ball rolling down track = *Etiam* heading towards Earth

How can we stop a rolling ball (*Etiam*) from knocking down a stack of pennies (Earth)?



<u>Materials for deflecting *Etiam:*</u>

- String
- Balls of varying mass
- Foam
- Rubberbands
- Popsicle sticks
- Plastic spoons
- Tape

Design Solutions to Deflect *Etiam*

As a group,

1. Use any scientific ideas or experiences to design ways to deflect the asteroid *Etiam* from its collision course with Earth.
2. Record and explain all attempts in the table in your student guide.
    a. Set-Up
    b. How did the objects move?
    c. Why do you think they moved the way they did?

Make a poster that shows your best strategy

Optional: Slow-motion record your best strategy to use in your news segment!

Explain

KWL Chart - What is a force?

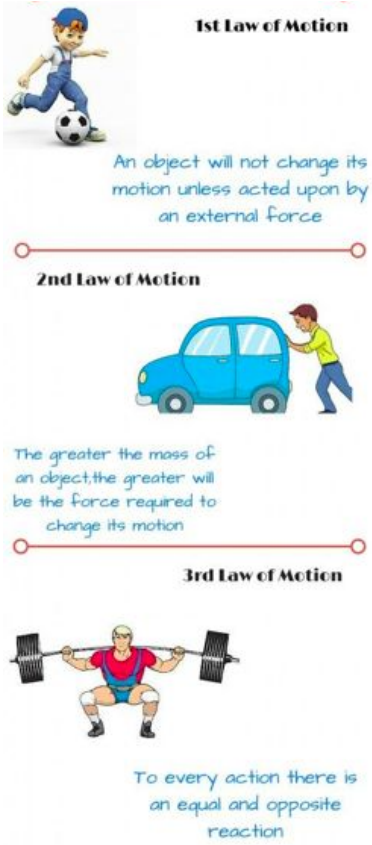
K: What do you **K**now?	**W:** What do you **W**ant to know?

What is a force?

https://www.youtube.com/watch?v=GmlMV7bA0TM

Record what you learn in your student guide.

What are Newton's Laws?



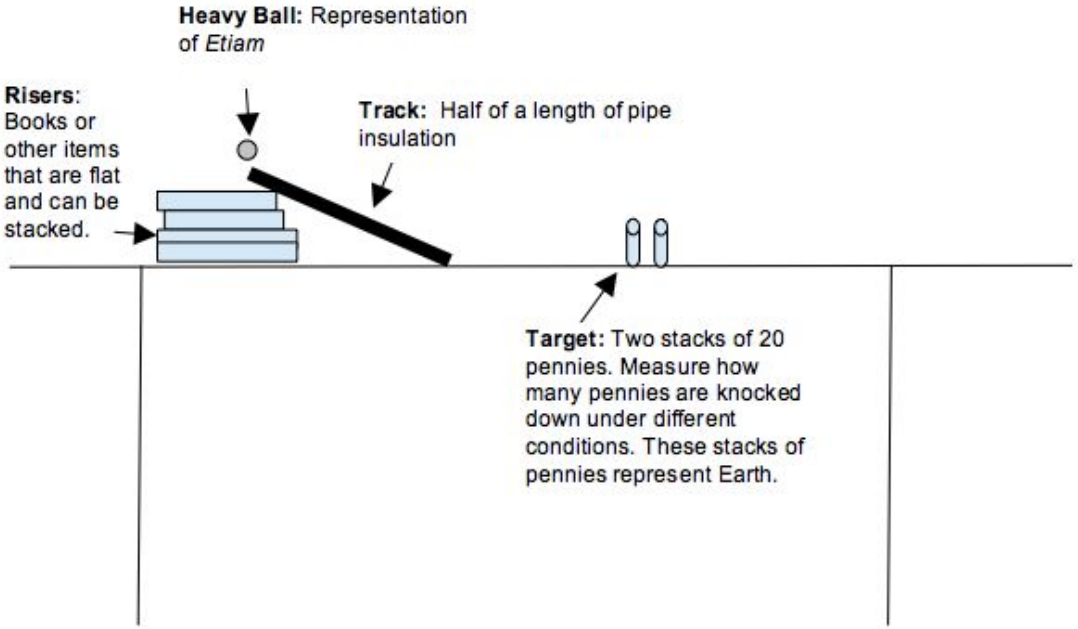
With a partner,

1. Watch the videos provided by your teacher.
2. Complete the graphic organizer in your student guide. For each of Newton's Laws,
    a. Write a definition
    b. Give an example
    c. Draw a diagram

KWL Chart - What is a force?

K: What do you **K**now?	**W:** What do you **W**ant to know?	**L:** What did you **L**earn?

Check for Understanding

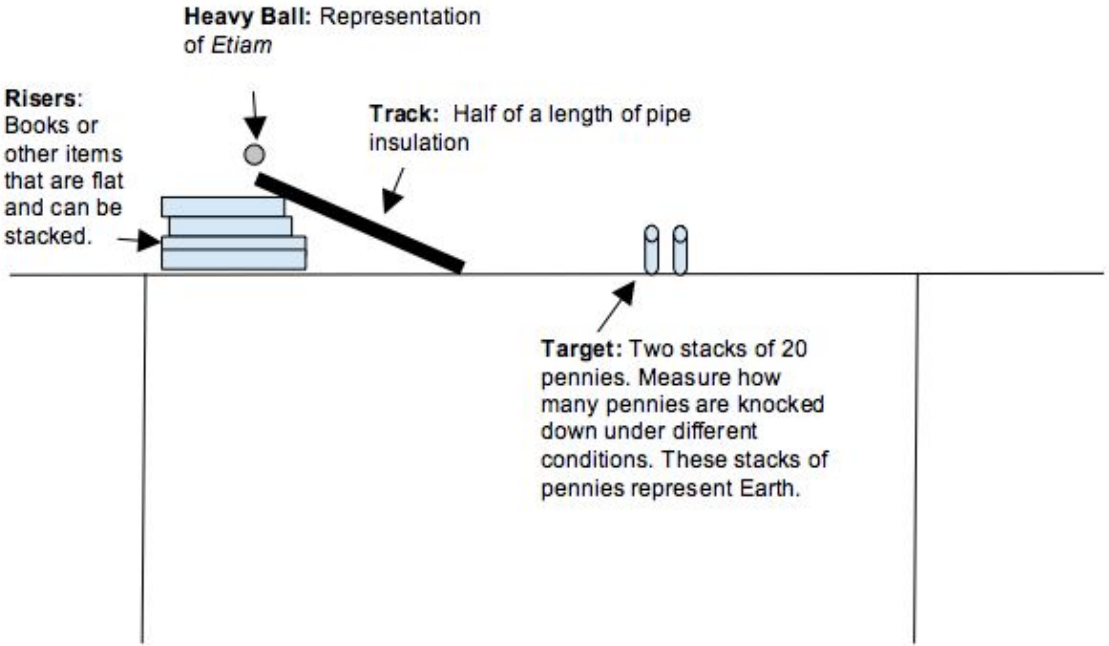


Think-Pair-Share:

1. How do the videos help explain what you saw in your investigations?
2. Where do you see each of Newton's laws occuring in the investigations?

Elaborate

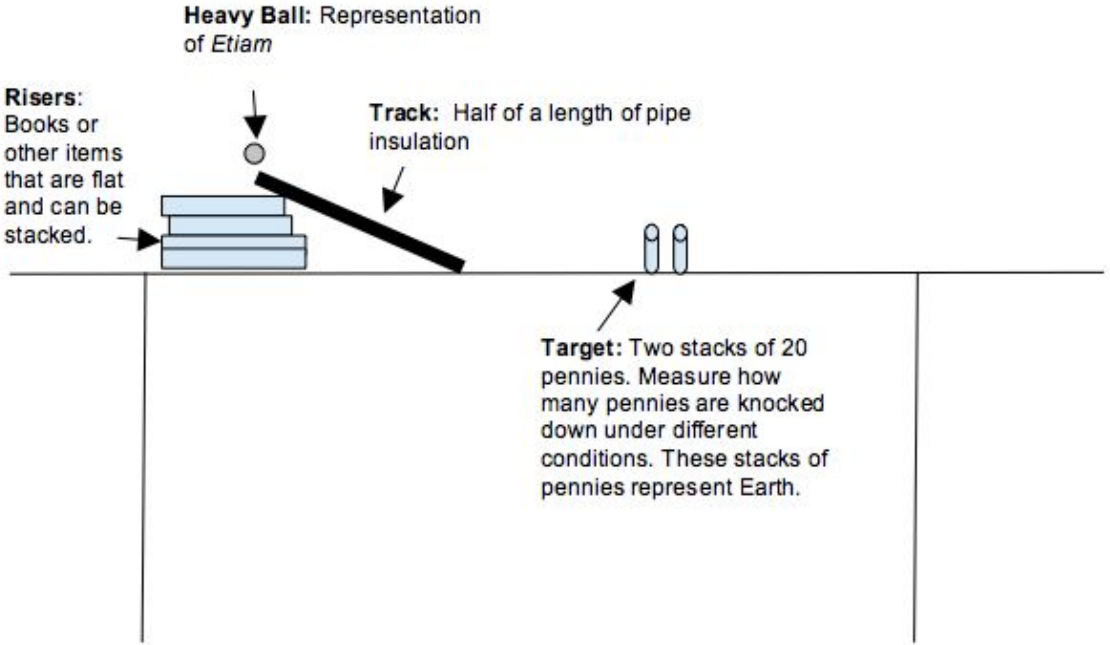
Remember Our Model of an Asteroid Collision?



Stack of pennies = Earth

Ball rolling down track = *Etiam* heading towards Earth

How can I knock over different amounts of pennies?



<u>Materials available:</u>

- Stack of 40 pennies (Earth)
- Pipe insulation tubing
- Risers
- Ruler
- **Marbles of varying mass**

This time, investigate the impact of different kinds of “asteroids” and their impact on “Earth.”

Plan and Conduct an Investigation

As a group,

1. Use the questions and template in your student guide to plan an investigation that tests different conditions of an asteroid hitting Earth.
2. Once your teacher has approved your experimental design, run your experiment and record your data.

Think-Pair-Share

As we run demonstrations of different investigations, consider the following questions:

Investigation 1: Ball with small mass	Investigation 2: Ball with larger mass
• What kind of energy does the ball have while in motion? • What are all the different forces acting on the pennies? • Where do we see Newton's first law happening? • Where do we see Newton's third law happening?	• How are the balls different? • What differences did you notice when you changed the type of ball? • Why do you think this happened? • How does this show Newton's second law?

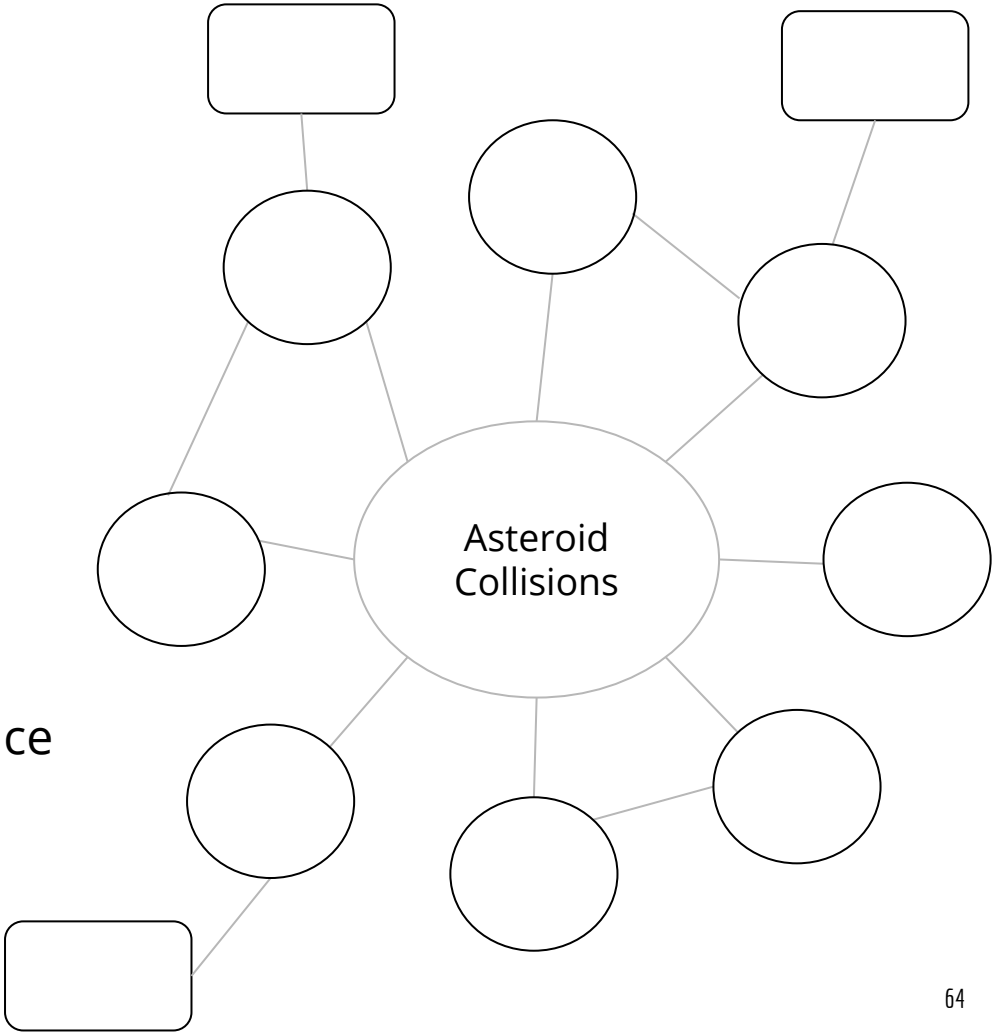
Draw Conclusions

In pairs, use your experimental results and scientific knowledge to answer the lab analysis questions in your student guide.

Class Concept Map

Add to your class concept map:

- New questions (circles)
- New ideas learned (squares)
- New connections (lines and connector words)
- Crosscutting concepts used (trace in color)
  - Scale, Proportion, and Quantity
  - Systems and System Models
  - Stability and Change



Evaluate

Connecting to the Culminating Project

You will be designing a solution to prevent the impending collision of the asteroid *Etiam* with Earth. In this task, you explored and studied how different contact forces and factors like mass help predict the motion of objects. Now, let's use these ideas to start deciding how to deflect *Etiam* from its path towards Earth.

- How will *Etiam's* large mass affect Earth? Use experimental evidence from the task as well as scientific ideas of mass, kinetic energy, and speed to back up your response.
- How can Newton's three laws help us predict and explain what will happen when *Etiam* hits Earth?
- Record ideas you have on deflecting *Etiam*, using the following questions to help you:
  - In the experiments, which solutions worked best?
  - Based on the data, can you combine characteristics from the best solutions to create an even better one?
  - How does each solution use contact forces and your understanding of mass and motion?

Complete this **individually** in your Project Organizer.

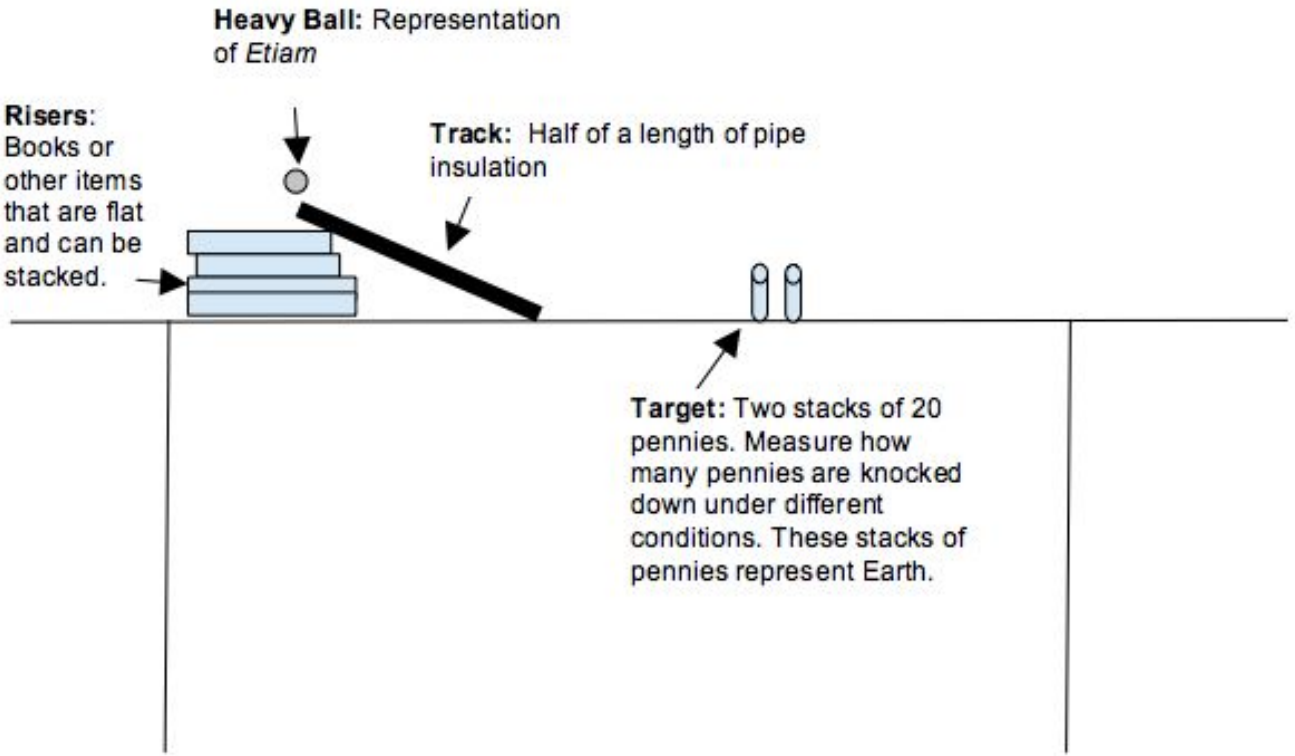
Reflection

Complete the questions at the end of your student guide to reflect on what you have learned in Task 2.

Gravity - A Non-Contact Force

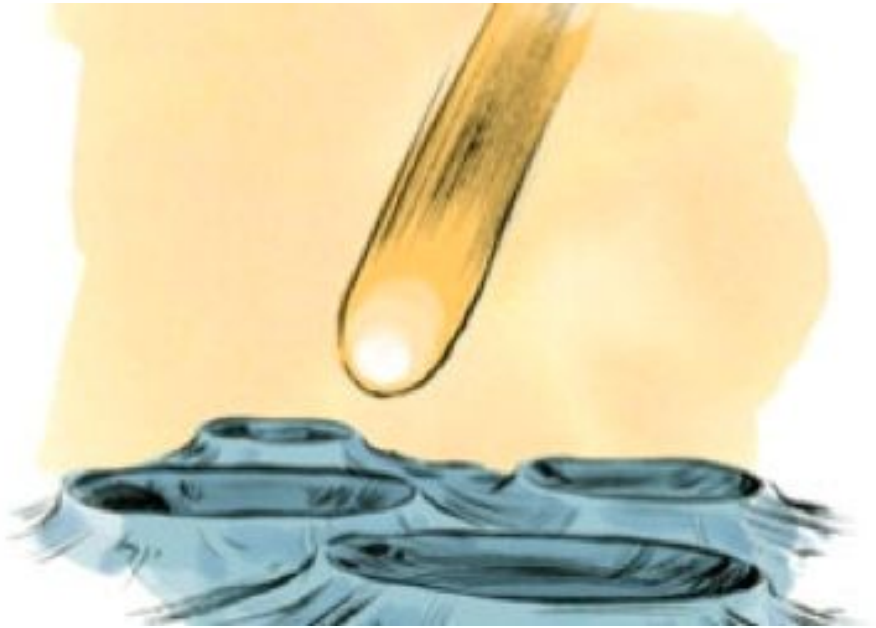
Task 3

What questions do you still have?



Engage

What other force also affects the collision course of *Etiam*?



In this class model, the sand = Earth and the ball = *Etiam*.

1. Observe the teacher demonstration.
2. Discuss your observations and analyses with a partner.
3. Discuss the questions in your student guide and record responses.

Explore

Learn more about gravity, so we can use it to prevent the collision of *Etiam* and Earth!

With your group,

1. Follow instructions on the resource cards to learn about gravity from three resources.
2. Discuss each resource.
3. Draw pictures and answer the discussion questions in your student guide.

Explain

KWL Chart - Gravity

K: What do you now **K**now about gravity**?**	**W:** What do you **W**ant to know about gravity?

More Information on Gravity

https://www.youtube.com/watch?v=EwY6p-r_hyU

Record what you learn in your student guide.

KWL Chart - Gravity

K: What do you now **K**now about gravity**?**	**W:** What do you **W**ant to know about gravity?	**L:** What did you **L**earn from the video?

Draw Conclusions About Gravity

1. In your own words, how would you describe gravity? Use an example from the Explore resources to back up your description.

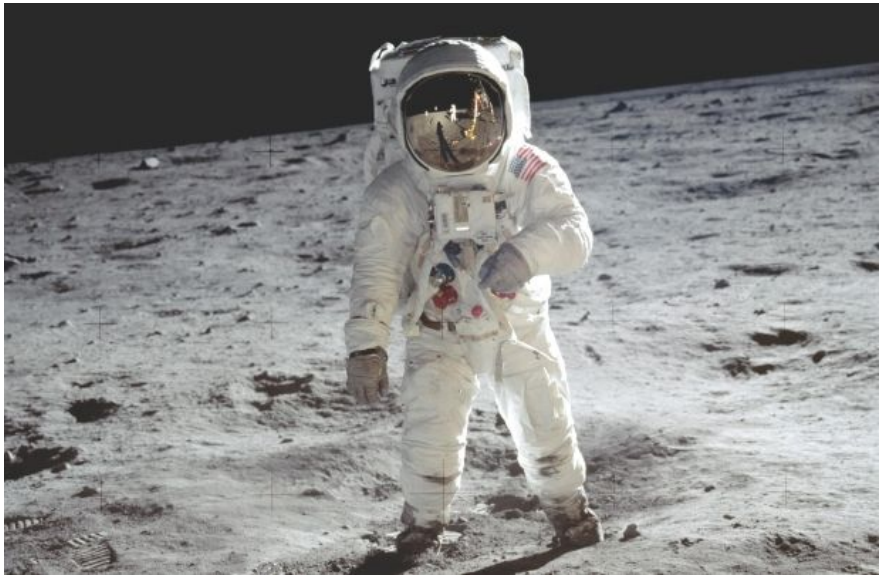
2. In your own words, explain how the *mass* of an object affects its *gravitational force*. Use an example from the Explore resources to back up your explanation.

Elaborate

Apply What You Know to a Science Dilemma

Two of your friends are arguing how astronauts on the moon avoid floating away into space.

- Friend 1: “Astronauts must have a cord tied to them at all times in order to avoid floating into space.”
- Friend 2: “Astronauts must always wear heavy boots to avoid floating into space.”

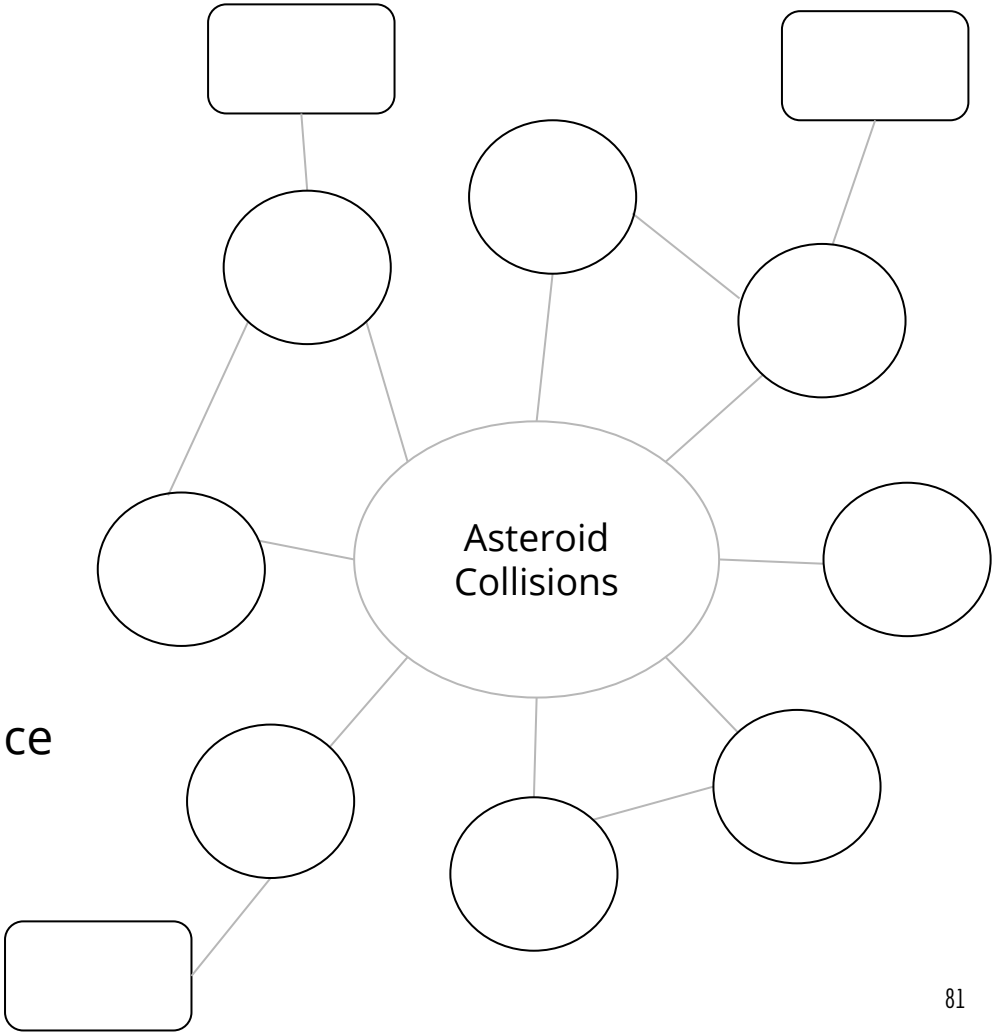


Why are they both wrong? Explain why, citing evidence from this task to support your argument.

Class Concept Map

Add to your class concept map:

- New questions (circles)
- New ideas learned (squares)
- New connections (lines and connector words)
- Crosscutting concepts used (trace in color)
    - Systems and System Models



Evaluate

Connecting to the Culminating Project

You will be designing a solution to prevent the impending collision of the asteroid *Etiam* with Earth. In this task, you learned about another, less tangible force that also affects the motion of *Etiam*. Look back at the trajectory of *Etiam* from your Culminating Project handout and brainstorm how this force may help you prevent *Etiam's* collision with Earth.

- Draw a diagram showing how gravity is currently influencing *Etiam*.
- What other objects in our solar system might influence *Etiam's* movements as it travels through space? Why?
- Illustrate moments in *Etiam*'s trajectory where the asteroid might be impacted by other gravitational forces in a way that changes its trajectory.
  - Explain how this works.

Complete this **<u>individually</u>** in your Project Organizer.

Reflection

Complete the questions at the end of your student guide to reflect on what you have learned in Task 3.

Culminating Project

Prevent the impending collision of *Etiam* with Earth!

Group Project - Video news segment describing how you plan to prevent the impending asteroid collision

Individual Project - News article telling people more about asteroid collisions with Earth and the science behind your solution

Don’t forget to use your checklist of criteria!

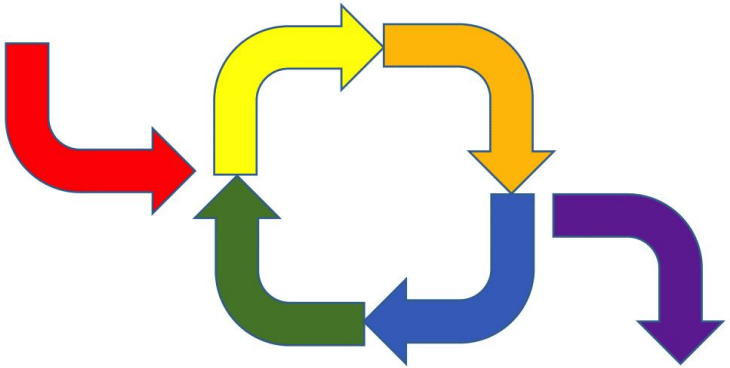
Group Project Criteria for Success

Your news segment should:

- ❑ Explain the situation to the public
- ❑ Propose a Solution
  - ❑ How does your group plan to prevent a collision between *Etiam* and the Earth?
    - ❑ Show in a diagram and/or video
    - ❑ Explain the science concepts you used to help create your plan
  - ❑ Why did your group decide on this strategy instead of other strategies?
  - ❑ What are problems/concerns with your solution?
- ❑ Have High Video News Segment Quality
  - ❑ Includes a visual model that shows how your solution works
  - ❑ Is organized logically
  - ❑ Is interesting to the audience
  - ❑ Practices good oral presentation skills

Graphic Organizer - Engineering and Design Process

Use this graphic organizer to help guide you in the process of designing a solution to thwart the collision of Earth and *Etiam*. This process includes:



1. Developing models of all possible design solutions
2. Planning and running an experiment to test design solutions
3. Collecting and evaluating data
4. Using the data to inform an improved design solution

Prevent the impending collision of *Etiam* with Earth!

Group Project - Video news segment describing how you plan to prevent the impending asteroid collision

Individual Project - News article telling people more about asteroid collisions with Earth and the science behind your solution

Don't forget to use your checklist of criteria!

Individual Project Criteria for Success

Your news article should:

- ☐ Explain the problem of how *Etiam* is on a trajectory to hit the Earth.
  - ☐ What are the criteria for success in solving this problem?
  - ☐ What constraints exist that limit possible solutions?

- ☐ Convince your audience why it is important we protect Earth from an asteroid collision.
  - ☐ Cite data from the fossil record as evidence of past effects of asteroid collisions.
  - ☐ The public is familiar with another recent asteroid collision from February 2013. An asteroid known as *Chelyabinsk*, hit Russia. Its mass was 10,000,000 or 1×10^7 kg and its speed was 60,000-69,000 km/hr. How can you compare the force of *Chelyabinsk's* collision with the force of *Etiam*'s collision? Explain why the impact of one of these asteroids will be greater by describing the specific relationships between mass and kinetic energy and speed and kinetic energy.

- ☐ Describe and diagram all possible solutions for the public. These solutions must collectively use and explain all the following scientific concepts:
  - ☐ Gravity and mass
  - ☐ Newton's first law
  - ☐ Newton's second law
  - ☐ Newton's third law

  *You do not have to create a separate solution for each scientific concept. Some solutions may use many of these concepts within one solution.

- ☐ Propose a best solution.
  - ☐ Explain the investigation of solutions:
    - ☐ Describe the experiment you ran to evaluate all the potential design solutions. Include: independent variable, dependent variable, controls, procedure, and data collected.
    - ☐ Evaluate the different solutions: According to the test data, how well did each design meet the criteria of the problem?
  - ☐ What is your final design solution to prevent a collision between *Etiam* and the Earth?
    - ☐ How did you combine best characteristics of different designs to come up with the best possible design?
    - ☐ Show diagram of final design solution (and any calculations, if applicable).

Optional Guide for News Article

News Article Title

1-2 catchy sentences summarizing your article.

By YOUR NAME Month, ##, 20##

NAME OF YOUR CITY – In this paragraph, explain the problem of how *Etiam* is on a trajectory to hit the Earth. Use the Individual Project Criteria for Success Checklist to make sure you include all parts.

In these next two paragraphs, convince your audience why it is important we protect Earth from an asteroid collision. One paragraph should cite data from the fossil record and the next paragraph should compare *Etiam* to *Chelyabinsk*. Use the Individual Project Criteria for Success Checklist to make sure you include all parts.

Fig 1. _____ Fig 2. _____ Fig 3. _____ Fig 4. _____

In this next set of paragraphs, describe all possible solutions to the public, including the science concepts behind them. For each solution, draw a diagram. As you describe these diagrams in the paragraphs, you can refer to them by using figure numbers in parentheses. For example, "... (see Fig. 1)." You may use all the boxes above, or just some of the boxes, depending on the number of solutions you describe. Use the Individual Project Criteria for Success Checklist to make sure you include all parts.

In this next set of paragraphs, describe the experiment you ran and how you used the data to evaluate all the potential design solutions. Use the Individual Project Criteria for Success Checklist to make sure you include all parts.

In this paragraph, describe how you combined best characteristics of different designs in order to come up with the best solution to prevent a collision between *Etiam* and Earth. Use the Individual Project Criteria for Success Checklist to make sure you include all parts.

End with a brief conclusion of 1-2 catchy sentences. You may wish to look at some online articles as samples to inspire ideas.

Draw a diagram and/or report calculations for your proposed solution here.

Peer Review

News Article Peer Review Feedback

Complete after you have a full first draft of your news article.

News Article Owner's Name	
News Article Reviewer's Name	

Review the following sections of the News Article:

- ❑ Explain the problem of how *Etiam* is on a trajectory to hit the Earth.
  - ❑ What are the criteria for success in solving this problem?
  - ❑ What constraints exist that limit possible solutions?

  ➢ Positive Comment:

  ➢ Constructive Comment:

- ❑ Convince your audience why it is important we protect Earth from an asteroid collision.
  - ❑ Cite data from the fossil record as evidence of past effects of asteroid collisions.
  - ❑ The public is familiar with another recent asteroid collision from February 2013. An asteroid known as *Chelyabinsk*, hit Russia. Its mass was 10,000,000 or 1×10^7 kg and its speed was 60,000-69,000 km/hr. How can you compare the force of *Chelyabinsk's* collision with the force of *Etiam's* collision? Explain why the impact of one of these asteroids will be greater by describing the specific relationships between mass and kinetic energy and speed and kinetic energy.

  ➢ Positive Comment:

  ➢ Constructive Comment:

- ❑ Describe and diagram all possible solutions for the public. These solutions must collectively use and explain all the following scientific concepts:
  - ❑ Gravity and mass
  - ❑ Newton's first law
  - ❑ Newton's second law
  - ❑ Newton's third law

  ➢ Positive Comment:

  ➢ Constructive Comment:

- ❑ Propose a best solution
  - ❑ Explain the investigation of solutions:
    - ❑ Describe the experiment you ran to evaluate all the potential design solutions. Include: independent variable, dependent variable, controls, procedure, and data collected.
    - ❑ According to the test data, how well did each design meet the criteria of the problem?
  - ❑ What is your final design solution to prevent a collision between *Etiam* and the Earth?
    - ❑ How did you combine best characteristics of different designs to come up with the best possible design?
    - ❑ Show diagram of final design solution (and any calculations, if applicable).

  ➢ Positive Comment:

  ➢ Constructive Comment: