Force & Motion Lesson 2: *The Make*

Student Handout

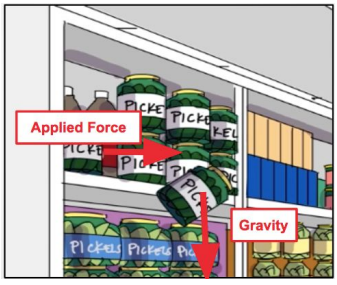
A local magazine has been claiming that mysterious forces are occurring in your town. And the terrifying headlines have been hurting local tourism as people avoid public spaces out of fear. The mayor says the claims are absurd, but the news won't stop running them. You've been hired to investigate each headline to set the record straight.

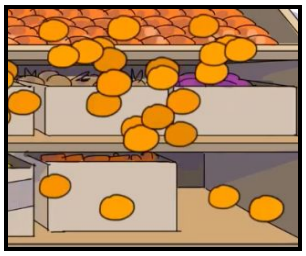
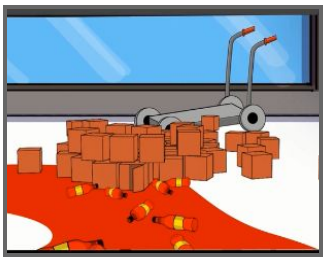
Your *Make* task today is to:

1. Review the examples of force you learned in *The Solve*.
2. Plan and complete investigations that answer these questions:
    a. What makes objects move? What makes objects stop moving?
    b. Can the same amount of force be used to move objects of different masses?
    c. What happens when two objects collide?
3. Relate Newton's Laws of Motion to each of your investigations.
4. Present your results to the town.

Before You Begin

View the slide presentation and complete the guided notes below.

Episode Motion (with time code)	**What forces are responsible for the motion observed?**	**Draw in arrows and label the force(s) acting on the object**
Leaping Pickles (2:15–2:30)	***Example Answer:*** Applied Force (*pushing of jars*), Gravity	

Flying Cans (3:11–5:00)		
Falling Oranges (5:07–6:07)		
Running Red Liquid (6:23–7:50)		

↓

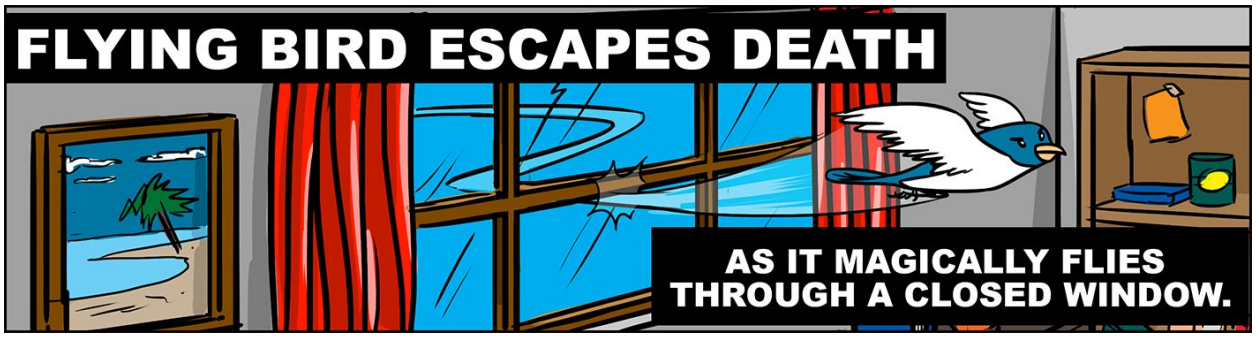
Make a list of all the forces you noticed in the above table.

Materials: Your teacher will either provide you with materials in an investigation bag, or you will collect the materials on your own. If collecting the materials on your own, use the following list as suggestions. You can substitute with other materials as needed:

- 2 textbooks or 2 wooden blocks of equal size
- 3–4 rulers (to be used as "tracks" for objects to roll on)
- 2 marbles (of same size and mass)
- Golf ball
- Tennis ball
- Ping pong ball
- 4 straws
- Cardboard ramp
- Pieces of "frictional" materials (a dish towel, a piece of sandpaper, a strip of crumpled aluminum foil)

Let's Investigate The Headlines!

Headline 1: "Flying bird escapes death as it magically flies through a closed window."



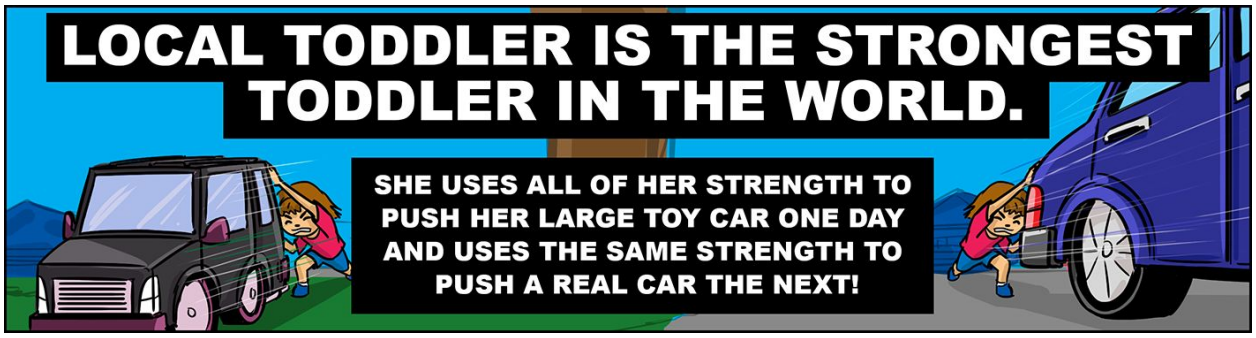
Today, you'll conduct an investigation to determine whether this headline could be true. Your investigation will answer these questions:

What makes objects move? What makes objects stop moving?

Explore *Use the materials in your investigation bag, or materials from home, to explore the following.*	
List or sketch all the ways that you can make objects move:	List or sketch all of the ways that you can make objects stop moving:

Reflect
1. In each exploration above, what forces were used to make objects move or stop moving? 2. Make a rule about what happens if you apply force to an object. 3. Could this headline be true? “Flying bird escapes death as it magically flies through a closed window.” Explain with evidence from your investigation.

Headline 2: “Local toddler is the strongest toddler in the world. She uses all of her strength to push her large toy car one day and uses the same strength to push a real car the next!”



Today, you’ll conduct an investigation to determine whether this headline could be true. Your investigation will answer the question:

Can the same amount of force be used to move objects of different masses?

Explore

Taking each object in your investigation bag in turn, blow into a straw to attempt to move the object. Using the straw, can you use the same amount of force to move the different objects? Record your observations below.

Now let’s make this an official investigation. And if it needs some tweaking along the way, you can tweak it to answer the key question:

Can the <u>same amount of force</u> be used to move objects of different masses?

Type of Sphere	Marble	Ping Pong Ball	Golf Ball	Tennis Ball
Mass (g)				

*If a balance is not available**, rank the masses in order from greatest to least: #1 = greatest mass** and **#4 least mass.***

Materials
(List the materials you will use in your investigation below.)

Investigation Design
(List the steps for how you will conduct your investigation.)

Data and Observations

Force applied = Air blown through a straw
Keep the force of air applied the same (controlled) for each trial.

Sphere Type This is your independent variable because it's the variable you're changing	**Trial #**	**Acceleration Rating** (how does the motion change?) ***Circle one*** This is your dependent variable because it's the variable you're measuring.	**What did you notice about all three trials?** Write a summary of your observations for each setup after the third trial.

	1	Not at all Moved a little Moved a lot	
	2	Not at all Moved a little Moved a lot	
	3	Not at all Moved a little Moved a lot	
	1	Not at all Moved a little Moved a lot	
	2	Not at all Moved a little Moved a lot	
	3	Not at all Moved a little Moved a lot	
	1	Not at all Moved a little Moved a lot	
	2	Not at all Moved a little Moved a lot	
	3	Not at all Moved a little Moved a lot	
	1	Not at all Moved a little Moved a lot	
	2	Not at all Moved a little Moved a lot	
	3	Not at all Moved a little Moved a lot	

Reflect

1. Can the same amount of force be used to move objects of different masses? *Be sure to use the information in the data table above to help you answer the question.*

2. Could this headline be true? “Local toddler is the strongest toddler in the world. She uses all of her strength to push her large toy car one day and uses the same strength to push a real car the next!” *Explain with evidence from your investigation.*

Headline 3: “Local car accident literally sends car flying into the air.”

Today, you’ll conduct an investigation to determine whether this headline could be true. Your investigation will answer the question:

What happens when two objects collide?

Explore

Use the materials in your bag, or materials you have at home, to explore collisions.

List or sketch different types of collisions that you could create between the objects in your bag. *For example, head-on collisions between two marbles, etc.*	How can you control the force applied to each object to be sure that the force is the same?

Make a Track

Today you're going to be testing different crash scenarios, but to be sure the objects collide, you'll first need to create a ramp. This ramp will need two ends, where you'll be placing the two different objects, and an area in the center where the objects will meet. Use the materials your teacher has provided (or your own materials) to create your own ramp. You can use the image to the right as inspiration or create it exactly. Sketch your final ramp below.

My Track Sketch

Data and Observations			
Force Applied = Gravity (pulling spheres down the track)			
Type of Collision	**Trial #**	**Direction of Motion of Object #1 AFTER Collision**	**Direction of Motion of Object #2 AFTER Collision**
Head-on collision *(Example: Marbles of same size traveling toward one another)* Object #1 = _____ Object #2 = _____	1		
	2		
	3		
One object at rest, one object in motion *(Example: Marble at rest on track; golf ball in motion)* Object #1 = _____ Object #2 = _____	1		
	2		
	3		
Opposite scenario from above *(Example: Golf ball at rest on track; marble in motion)* Object #1 = _____ Object #2 = _____	1		
	2		
	3		
Head-on collision of objects that are two different masses. *(Example: Golf ball and marble traveling toward one another)* Object #1 = _____ Object #2 = _____	1		
	2		
	3		

Reflect
1. What happens when two objects collide? *Be sure to use the information in the data table above in your answer.* 2. Could this headline be true? “Local car accident literally sends car flying into the air.” Explain with evidence from your investigation.

Reviewing Newton's Laws: Force & Motion

Great work! But hold on a moment... Just when you're about to present your findings to the mayor, you're asked to take your presentation up a notch. To prove that you are qualified to speak on the matter of Force and Motion, let's do a quick review of Newton's Laws.

Newton's Laws of Motion	
First Law	*An object at rest stays at rest unless another force acts upon it to make it move. An object in motion stays in motion unless another force acts upon it to make it slow or stop.*
Second Law	*Acceleration (a change in motion) is produced when a force acts upon a mass. The greater the mass of the object, the greater the amount of force needed to accelerate the object.*
Third Law	*Every action has an equal and opposite reaction.*

Reflect

1. Which of your investigations helped to prove Newton's First Law of Motion? Explain how. Add an annotated sketch showing forces and motion.

2. Which of your investigations helped to prove Newton's Second Law of Motion? Explain how. Add an annotated sketch showing forces and motion.

3. Which of your investigations helped to prove Newton's Third Law of Motion? Explain how. Add an annotated sketch showing forces and motion.

Presenting your Findings

You have been invited to present your findings to the mayor. With your team, or individually, create a presentation that you will be sharing in order to help her set the record straight. Your presentation should be created in PowerPoint or Google Slides and should incorporate the following presentation requirements:

- ❏ Title of Presentation
- ❏ Presentation addresses Headline A: “Flying bird escapes death as it magically flies through a closed window”
    - ❏ Draws a conclusion about the headline
    - ❏ Uses photography or video evidence of experimental design as evidence
    - ❏ Explains which of Newton's Laws of Motion supports results
- ❏ Presentation addresses Headline B: "Local toddler is the strongest toddler in the world. She uses all of her strength to push her large toy car one day and uses the same strength to push a real car the next!"
    - ❏ Draws a conclusion about the headline
    - ❏ Uses photography or video evidence of experimental design as evidence
    - ❏ Explains which of Newton's Laws of Motion supports results
- ❏ Presentation addresses Headline C: “Local car accident literally sends car flying in the air"
    - ❏ Draws a conclusion about the headline
    - ❏ Uses photography or video evidence of experimental design as evidence
    - ❏ Explains which of Newton's Laws of Motion supports results

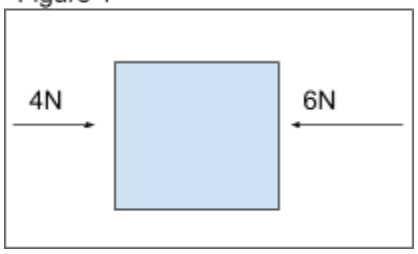
Name: _____ **Date:** _____

Exit Ticket: Connection to the Design

1. Describe two forces that can influence the motion of an object.

2. Refer to Figure 1 to answer the following question. Force is measured in units called Newtons. The box shown below has two opposing forces acting on it (N = Newtons). Based on the diagram, in which direction will the box move? Explain why.

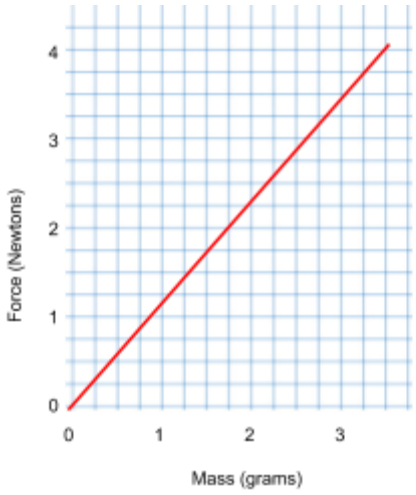
Figure 1



3. The graph below shows the relationship between mass (g) and force (N). Based on the graph below, fill in the following statement:

The greater the mass that an object has, the _____ the force required to move the object.

The Relationship between Mass (g) and Force (Newtons)

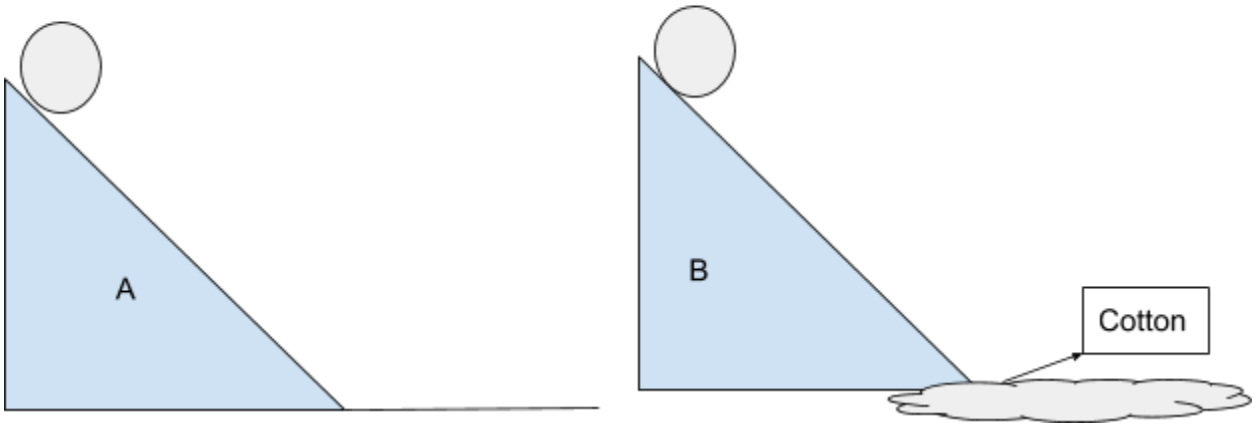


4. Refer to Figure 2 to answer the following question. A rocket launch is planned to help get astronauts to the International Space Station. How can Newton's 3rd Law explain the action force, and the reaction force that successfully gets the rocket into space?

Figure 2

5. Refer to Figure 3 to answer the following question. Scenario: Two marbles of equal size and mass were placed on ramps of equal length of heights. Marble A traveled a distance of 15 cm before stopping. Marble B traveled a distance of 8 cm before stopping.
    a. Explain why Marble A would have traveled farther than Marble B based on the diagrams below.
    b. Use arrows to label the forces that act on or against the motion of the marbles in the diagram below.

Figure 3



***The Make* Assessment**

Use the Checklist and Cognitive Skills Rubric to ensure you have addressed all aspects of *The Make* with quality work.

Newton's Laws *The Make* Checklist

Your Challenge: You have been invited to present your findings to the mayor. With your team, or individually, create a presentation that you will be sharing in order to help her set the record straight. Your presentation should be created in PowerPoint or Google Slides and should incorporate the following presentation requirements:

Project Completeness

- ❏ Title of Presentation
- ❏ Presentation addresses Headline A: "Flying bird escapes death as it magically flies through a closed window"
  - ❏ Draws a conclusion about the headline
  - ❏ Uses photography or video evidence of experimental design as evidence
  - ❏ Explains which of Newton's Laws of Motion supports results
- ❏ Presentation addresses Headline B: "Local toddler is the strongest toddler in the world. She uses all of her strength to push her large toy car one day and uses the same strength to push a real car the next!"
  - ❏ Draws a conclusion about the headline
  - ❏ Uses photography or video evidence of experimental design as evidence
  - ❏ Explains which of Newton's Laws of Motion supports results
- ❏ Presentation addresses Headline C: "Local car accident literally sends car flying in the air"
  - ❏ Draws a conclusion about the headline
  - ❏ Uses photography or video evidence of experimental design as evidence
  - ❏ Explains which of Newton's Laws of Motion supports results
- ❏ Newton's Laws
  - ❏ Completes Reflection Questions

DCI Standards Checklist

- ❏ PowerPoint Guided Notes
  - ❏ Accurate analysis of forces applied in each scenario
  - ❏ Arrows accurately indicate forces applied to the motion of objects
- ❏ Investigations
  - ❏ Data tables are accurate
  - ❏ Conclusions are supported by data collected through experimentation
- ❏ Newton's Laws
  - ❏ Accurately relates investigations to one or more of Newton's Laws of Motion

- ❏ Present your Findings
  - ❏ Each of Newton's Laws of Motion are shown accurately
  - ❏ Supporting evidence for each law is accurate
  - ❏ Scientific study and results are effectively communicated to audience

Cognitive Skills Assessed

	Emerging (1)	Developing (2)	Proficient (3)	Advanced (4)
Planning and Carrying Out Investigations	Investigation does not produce the relevant data to align with the research question. Or no procedure is detailed.	Investigation minimally produces the relevant data to align with the research question. Procedure is lacking the necessary detail to be carried out.	Investigation identifies dependent and independent variables, and will produce the relevant data to align with the research question. Procedure is detailed enough to be carried out, but has some clarity issues.	Investigation identifies dependent and independent variables, as well as controls and will produce the relevant data to align with the research question. Procedure is concise.
Analyzing and Interpreting Data	Constructs data tables or graphs that do not display all data. Analyzes data with major misconceptions or omissions.	Constructs data tables or graphs that display all data, but does not analyze relationships. Analyzes data with minor misconceptions.	Constructs data tables or graphs that display all data and makes simple connections between variables. Analyzes data to provide evidence for a phenomena.	Constructs data tables or graphs that display all data and makes complex connections between variables. Analyzes data to provide evidence for a phenomena and acknowledges limitations.
Constructing Explanations or Arguments From Evidence	Constructs an explanation with no clear sources of evidence.	Uses scientific principles and/or data from at least one source to construct or evaluate an explanation, but explanation contains minor misconceptions.	Uses accurate but incomplete scientific principles and/or data from multiple sources to construct or evaluate an explanation.	Uses accurate and complete scientific principles and/or data from multiple sources to construct or evaluate an explanation.
Communicating Findings/Design (Oral Presentation)	Findings/design are incompletely and inaccurately communicated. Or no evidence of using appropriate eye contact, adequate volume, or clear pronunciation.	Findings/design are completely communicated with some misconceptions. Or uses minimal eye contact, inappropriate volume, or inconsistent pronunciation.	Findings/design are completely communicated but lacking depth and complexity. Or often uses eye contact and engaging and appropriate volume and pronunciation, but is inconsistent.	Findings/design are completely communicated with depth and complexity. Or mostly uses eye contact and engaging and appropriate volume and pronunciation.