LESSON 12: How do we get a massive object moving as fast as possible?

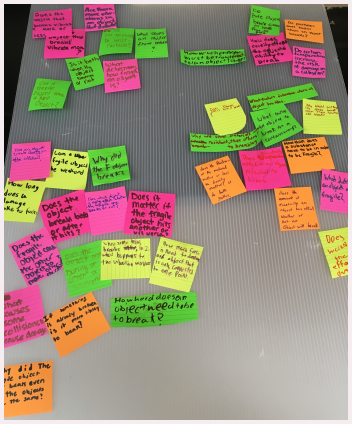
PREVIOUS LESSON

We planned and carried out an investigation to test the relationship between force and the motion of objects with different masses that we wanted to speed up.

THIS LESSON

PUTTING PIECES TOGETHER

2 days



In this lesson, we discuss our evidence and ideas about forces, change in motion, mass, and speed and come to consensus about what scientific principles we are clear about and what questions we still have.

NEXT LESSON

We will use images of packing material and a simple investigation with sticky notes to convince ourselves that small forces over a long distance can stop a destructor and protect our phones. We will use this understanding to sketch our designs for protecting our phones, and we will describe why we believe our designs will work.

BUILDING TOWARD NGSS

MS-PS2-1, MS-PS2-2

WHAT STUDENTS WILL DO

Construct an explanation based on evidence from students' own experiments to explain the cause and effect relationship between a larger **net** force and a larger change in motion with the caveat that increasing the mass of an object will increase the force required to achieve the same change in motion.

WHAT STUDENTS WILL FIGURE OUT

Both mass and speed matter for destructiveness, but it would be really hard to have both at the same time because it takes a lot of force to get something really massive to change its motion a lot.

Lesson 12 • Learning Plan Snapshot

Part	Duration	Summary	Slide	Materials
1	5 min	**NAVIGATION** Students discuss their ideas about how to get a massive object moving as fast as possible.	A	
2	30 min	**SCIENTISTS CIRCLE** Students make sense of their learning to date in a Scientists Circle.	B-C	Progress Tracker,
3	5 min	**NAVIGATION** Students bring up any new questions they have and add them to the DQB.	D	
				End of day 1
4	15 min	**NAVIGATION** Students determine which questions on the DQB have been answered and what new questions need to be added.	D	*Let's Answer Questions from our Driving Question Board!*, DQB,
5	20 min	**EXIT TICKET** Students will complete an exit ticket that gives them an opportunity to apply their thinking to different situations.	E	
6	10 min	**NAVIGATION** Students consider their original lesson and if they have yet figured out how to protect what they most want to protect.	F	
				End of day 2

Lesson 12 • Materials List

	per student	per group	per class
Lesson materials	• science notebook • Progress Tracker • *Let's Answer Questions from our Driving Question Board!*	• DQB	

Materials preparation (15 minutes)

Review teacher guide, slides, and teacher references or keys (if applicable).

Make copies of handouts and ensure sufficient copies of student references, readings, and procedures are available.

Fill out *Let's Answer Questions from our Driving Question Board!* with questions from the DQB from each class. Make sufficient copies for students in each class.

Obtain a ping pong ball to show students before the exit ticket on day 2 to ensure that all students have familiarity with this item.

Lesson 12 • Where We Are Going and NOT Going

Where We Are Going

In this lesson, students will solidify their understanding that larger mass and greater speed are more destructive in collisions and that more force is needed to speed up or change the motion of more massive objects. They will recognize both mass and speed matter to destructiveness and there are tradeoffs to each because it takes a lot of force to get something really massive to change its motion a lot.

Where We Are NOT Going

Students *may* make connections to prior learning and recognize that moving objects have energy (kinetic energy) and that the mass and speed of objects are related to the energy of objects. It's OK if this doesn't come up in the Scientists Circle discussion. Although we don't formally delve into kinetic energy in this version of the unit, we intend to do that in the next version.

LEARNING PLAN for LESSON 12

1 · NAVIGATION

5 min

MATERIALS: None

Discuss with a partner. Remind students that we've figured out that larger mass is more destructive and greater speed is more destructive. We also know that we need more force to speed up or change the motion of something heavy or massive. Ask students, *How can we get a massive object moving as fast as possible?* Give students a minute to think and ask them to share their ideas with a partner. Display **slide A**.

Say, *Let's meet in the Scientists Circle to make sense of our learning so far and try to come to consensus about what scientific principles we are clear about and what questions we still have.*

2 · SCIENTISTS CIRCLE

30 min

MATERIALS: science notebook, Progress Tracker

Consensus Discussion in Scientists Circle. Display **slide B**. Have students meet in the Scientists Circle and lead a Consensus Discussion.

KEY IDEAS

Purpose of this discussion: In this discussion, students will solidify their understanding of the relationship between force and motion. They will use evidence from investigations to explain that more force is needed to speed up or change the motion of more massive objects. They will also describe how both mass and speed matter to destructiveness and that there are tradeoffs to each because it takes a lot of force to get something really massive to change its motion a lot.

Look for:
Students should use evidence to describe the following ideas:

- The same object moving at different speeds does different amounts of damage in collisions; faster motion equals more damage.
- The same size object moving at the same speed but with different mass does different amounts of damage--more mass causes more damage.
- More net force results in more change in motion.
- It requires more force to get something with more mass to change its motion from 0 to a fast speed.
- The effect of a force changes depending on the mass of an object.
- Both mass and speed matter for destructiveness, but it would be really hard to have both at the same time because it takes a lot of force to get something really massive to change its motion a lot.
- Students *may* make connections to prior learning and recognize that moving objects have energy (kinetic energy) and that the speed and mass of objects might be related to the energy of objects.

Before addressing new evidence, students should review what they've figured out so far. Ask a few students to remind the class of prior understandings. Students should mention the following ideas:

- It takes two things interacting to make a force pair, and forces always come in equal and opposite pairs at the point of interaction.
- When objects collide, equal and opposite forces are being applied, regardless of the mass, speed, or material of the objects colliding.
- Different materials have different elastic limits (how hard you can push or bend it before it breaks).

Reference "Things We Know" and "Evidence We Have" charts to support this discussion.

Suggested prompt	Sample student response
What activities did we do to figure out what happens with objects moving at different speeds?	*We launched carts at graham crackers, used different forces to launch a cart, and used the same force to launch carts with different masses.*
What did we figure out?	*It takes more force to get an object moving faster.*
What did we figure out when we used graham crackers and carts to see how speed is related to damage?	*Faster objects can cause more damage.*
What did we figure out when we applied different forces to launch carts in races?	*The more force we apply, the more we can get an object to speed up.*
What did we figure out when we changed the mass of carts in races?	*It takes more force to get a massive object to speed up the same amount as a lighter object.*

Say, *We've figured out so much! Let's revisit our DQB and see if we can answer any of our questions.*

Take out science notebooks. Instruct students to use the evidence they collected in their science notebooks to identify and highlight questions from the Driving Question Board they can answer, choose 3 questions they like, and write the answers with supporting evidence to those 3 questions. This activity can be completed in class with a partner or individually, or it can be completed as home learning. Time permitting, allow students to share their ideas in a whole-group discussion. Display **slide C**.

HOME LEARNING OPPORTUNITY

Students can complete *Let's Answer Questions from our Driving Question Board!* as a home learning assignment. Ask students to take home their notebooks. They need to be able to support their answers to questions with evidence from their lab activities during the unit.

3 · NAVIGATION

5 min

MATERIALS: None

Turn and talk. Give students time to talk with a partner about any new questions they have. If needed, allow students to add new questions to the DQB. Display **slide D**.

End of day 1

4 · NAVIGATION

15 min

MATERIALS: *Let's Answer Questions from our Driving Question Board!*, science notebook, DQB

Revisit the DQB. Remind students of where we ended the previous lesson and say that it's time to work together to check off questions we can answer. Look for questions on the DQB that students think they can answer using evidence and add check marks to those questions. Display **slide D**.

Students work in pairs to answer questions. Ask students to share their answers to questions with an elbow partner. Be sure to have students describe evidence for any questions answered.

- Students *may* recall and apply previous ideas about energy and realize that the mass and speed of an object are related to its energy.
- Students may ask whether mass or speed has a greater effect on the energy of a destructor.

Go public with our responses to why we think we can answer these questions. Ask students to share which questions have the most check marks. Then have a students explain the evidence for their answers. Select 2 students to be class scribes and write down a consensus statement (from all of the responses) to stick on the question on the DQB. Do this for 5-10 questions, depending on time.

5 · EXIT TICKET

20 min

MATERIALS: None

Complete an exit ticket. Give students time to independently complete *Exit Ticket*. Display **slide E**. See *Exit Ticket Key* for suggested answers.

6 · NAVIGATION

10 min

MATERIALS: None

Say, *We've answered many questions! Let's think back when we started this unit. What phenomena were we wondering about? What's the thing we were trying to protect?*

Turn and talk to motivate going back to our anchoring phenomenon. Display **slide F**. Give students time to discuss the question on the slide and hear a few ideas in whole-group discussion.

Say, *Before we meet for our next lesson, let's do some reading about how we protect our heads*.
Give students the reading assignment *Anatomy of a Bike Helmet* for home learning. There are discussion questions at the conclusion of the reading. Students should be prepared to discuss their ideas during the next class.

HOME LEARNING OPPORTUNITY

Students should think about the intentional design of bicycle helmets during the reading assignment. They should consider the nature of the materials used, which parts are close to the head, and the behavior of the materials during a collision.

SUPPORTING STUDENTS IN MAKING CONNECTIONS IN ELA	**WHST.6-8.1.B Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources.** In this lesson, students will verbally support claims with logical reasoning and relevant, accurate data and evidence to demonstrate an understanding that larger mass and greater speed are more destructive in collisions and that more force is needed to speed up or change the motion of massive objects.