Force & Energy Lab

Grade 7 student investigation worksheet

Name: _____ **Class / period:** _____

Driving question
What is the relationship between mass, force, speed, and kinetic energy?

Before you begin

Open the Force & Energy Lab website in Chrome or Edge. Type your name and create the autosave file when the lab asks. Keep that tab open during class so your trials and CER stay saved.

The lab has two ways to work:

[ ] **Explore mode:** change settings freely, run trials, and look for patterns.

[ ] **Begin recording trials:** starts the one required investigation for the simulation you selected. The lab locks the settings that must stay the same.

Every trial follows this pattern

1. Run and watch	2. Write an observation	3. Add to data table
Watch the object or cart move.	Describe what you noticed.	This saves the trial and unlocks the next setup.

Warm-up exploration

Use Explore mode before starting each recorded investigation. These are not graded for a single correct answer. They help you notice what variables you can control and what measurements the lab gives you.

A. Tower & sandbox: choose two objects with different masses. Keep the same tower height. What changes?

B. Rocket cart: keep the same cargo and try two boosters on the 40 m track. What changes?

C. Head-on collision: launch two different objects toward each other. What changes after they touch?

Save check
Before leaving Explore mode, make sure each trial has an observation and has been added to the data table. Explore trials remain available later when you make graphs.

Recorded investigation 1: Tower mass and impact

Goal: collect evidence about how object mass changes impact force when the drop conditions stay the same.

Set up the recorded investigation
In the menu select **Tower & sandbox**, then choose **Begin recording trials**. In the plan, choose a fixed tower height and a fixed downward throw speed. The example below uses 10.00 m and 0.0 m/s, but use the values your class chooses.

Fair-test plan

Change	Measure	Keep the same
Object mass	Estimated impact force	Tower height, downward throw speed, and sandbox

Your fixed conditions

Tower height: _____ m Downward throw speed: _____ m/s

Run at least three different masses. Include a pair where one mass is twice the other. Suggested set: soccer ball (0.50 kg), medicine ball or disco gnome (1.00 kg), and training weight (2.00 kg).

Trial #	Object	Mass (kg)	Impact speed (m/s)	Impact force (N)	Observation

Think about your evidence

1. Which two trials show a doubled mass? Write their trial numbers and masses.

2. Compare the impact forces for those two trials. What pattern do you see?

3. Use the Data & graphs tab. Make a graph with object mass on the horizontal axis and impact force on the vertical axis. Describe the shape or direction of the pattern.

Recorded investigation 2: Rocket cart speed and energy

Goal: collect evidence about how speed changes kinetic energy when the cart mass stays the same.

Set up the recorded investigation
In the menu select **Rocket cart**, then choose **Begin recording trials**. Choose one cargo object to keep. The cart travels 40 m before it hits the wall. Change only the booster.

Fair-test plan

Change	Measure	Keep the same
Booster force	Speed at the wall and kinetic energy	Cargo and the 40 m track

Your fixed cargo

Cargo object: _____ Cargo mass: _____ kg Total cart + cargo mass: _____ kg

Run at least three boosters. Suggested set: Mini (2 N), Standard (4 N), and Mega (8 N). Mini to Mega gives a useful doubled-speed comparison when cargo stays fixed.

Trial #	Booster force (N)	Speed at wall (m/s)	Kinetic energy (J)	Wall wobble	Observation

Think about your evidence

1. Which trials show a doubled speed? Record the trial numbers and speeds.

2. When the speed doubled, what happened to the kinetic energy? Use numbers from your table.

3. In Data & graphs, graph speed at wall on the horizontal axis and kinetic energy at wall on the vertical axis. How does the graph compare with a straight line?

Explore: Head-on collisions

Goal: observe how mass and launch speed affect two objects in an ideal elastic collision.

Set up the exploration
In the menu select **Head-on collision** and **Explore**. Choose a left object, a right object, and both launch speeds. The arrows show direction: right is positive and left is negative.

What the model shows

Motion	Contact forces	Energy and momentum
Each object can rebound, stop, or continue in the same direction. Record both speed and arrow direction.	During contact, each object pushes on the other with the same-size force in the opposite direction.	Total momentum and total kinetic energy are the same before and after an ideal elastic collision.

Run and record three collisions

Begin with watermelon (4.00 kg) on the left and training weight (2.00 kg) on the right, both at 4.0 m/s. Then change one mass or one launch speed at a time.

Trial #	Left object / mass	Right object / mass	Launch speeds	Left after	Right after	Avg. force	Observation

Think about the collisions

1. In the watermelon and training-weight trial, which direction did each object move after contact? Include speeds and arrows.

2. Compare two trials where you changed one mass or one launch speed. How did the after-collision motion change?

3. How do the force arrows demonstrate Newton's third law during contact?

Model note
The contact-force value is an average estimate based on a fixed 0.25 m total compression distance. It is not a measured peak force. The lab conserves total momentum and total kinetic energy from before to after the collision.

From evidence to CER

Use your two recorded investigations and helpful head-on-collision Explore trials to answer the driving question.

Driving question
What is the relationship between mass, force, speed, and kinetic energy?

Prepare your evidence

[ ] Tower mass investigation shows three different masses and a doubled-mass comparison.

[ ] Cart energy investigation shows three boosters and a doubled-speed comparison.

[ ] Each trial has an observation and was added to the data table.

[ ] I made at least one graph using the Data & graphs tab.

Use these ideas carefully

Mass and force When tower drop conditions stay the same, a larger mass has a larger estimated impact force.	**Speed and kinetic energy** For the same mass, kinetic energy grows faster than speed. The model uses KE = 1/2 mv^2.	**Collisions** Contact forces are equal and opposite. In an ideal elastic collision, total momentum and total KE are conserved before to after.

Claim

Write one sentence that answers the driving question.

Evidence

Use at least two trial numbers and their numerical measurements. Include evidence from both the tower and cart; collision evidence is optional.

Reasoning

Explain why the evidence supports your claim. Connect to force, mass, speed, and KE = 1/2 mv^2. If you use a collision trial, explain the equal-and-opposite forces or conserved totals.

Finish: Open the CER tab in the simulation and type your final Claim, Evidence, and Reasoning. Submit or export your work as directed by your teacher.