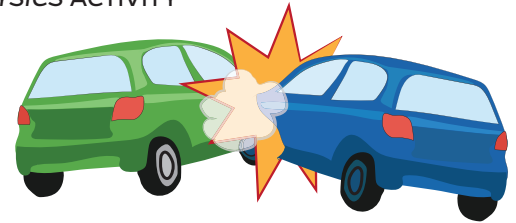




Name: \_\_\_\_\_ Class: \_\_\_\_\_ Date: \_\_\_\_\_

## UNDERSTANDING CAR CRASHES: IT'S BASIC PHYSICS ACTIVITY

### MOMENTUM BASHING 2



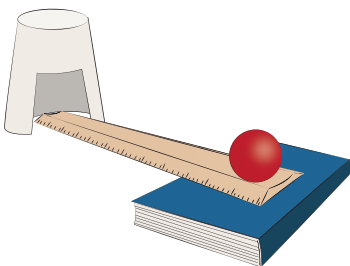
#### MATERIALS NEEDED

For each group of 3-4 students

- » One 30.5 cm wooden or plastic ruler with center groove
- » One marble
- » One 5-ounce (148 ml) paper cup
- » One pair of scissors
- » Two meter sticks or metric measuring tapes
- » Books or papers to support the ruler track at different heights
- » Three to four sheets of notebook paper
- » One sheet of graph paper
- » One calculator

Per Student

- » One copy of the "Momentum Bashing 2" Student Activity Sheet



#### Key Questions

- » How does changing an object's velocity change its momentum or "bashing power"?
- » What determines if one car has more momentum than another in a two-car collision?

#### Purpose

- » To determine how changing an object's velocity changes its momentum
- » To collect data and construct a graph illustrating the relationship between velocity and momentum

#### Did You Know?

During Activity 2 "Momentum Bashing," you investigated the effect of an object's mass on its momentum. However, during the investigation, you identified flaws and sources of error in the experiment's design. Specifically, when you rolled three or four marbles into the cup they often caused the cup to spin, thereby allowing marbles to escape and reduce the momentum transferred to the cup. According to the formula for momentum ( $p = mv$ ), another way to change momentum besides changing mass is to change velocity. So, in this activity, you will use the same set of materials from Activity #2 to design and conduct an experiment to investigate the effect of an object's velocity on its momentum while keeping the mass of the object constant.

#### Procedure

Before planning and conducting an experiment to determine the effect of an object's velocity on its momentum, discuss ways you could use the materials listed above to change the velocity of a marble with your group members. Then

#### 1. Write the Experimental Procedure

On a separate sheet of paper, work with your group members to revise the Activity 2 "Momentum Bashing" procedure using the materials listed above. Include the following items in your experimental procedure:

- » Identify your independent (manipulated) and dependent (responding) variables
- » Identify your controlled variables. (Remember, controlled variables are variables that could affect the outcome of the experiment but are kept from doing so by you. The more variables you control, the more reliable your results. Try to control at least three variables that could affect the outcome of your experiment.)
- » Operationally define your manipulated and responding variables. (NOTE: You can choose four different values of your manipulated variable and conduct three trials for each value. e.g. Starting heights of 1 cm, 2cm, 3cm, and 4cm.)



## MOMENTUM BASHING 2



### Procedure (continued)

#### 1. Write the Experimental Procedure (continued)

- » Write a hypothesis predicting what you think the relationship is going to be between the manipulated and responding variables in your experiment. (HINT: As \_\_\_\_\_ increases, \_\_\_\_\_ will increase/decrease/stay the same).
- » Number the steps in your procedure.
- » Describe your procedure in detail so that another group could follow it and replicate the experiment.
- » Draw pictures to help show important steps in the procedure.

#### 2. Create and Complete a Data table

After identifying and operationally defining your manipulated and responding (independent and dependent) variables, you can create the template for a Data Table to be completed during your experiment. Follow the guidelines listed below to create and complete a data table for your experiment:

- » Provide the specific names of the manipulated and responding variables AND the specific units used to measure each variable.
- » Sequentially order your four pre-determined manipulated variable values in the far left column.
- » Clearly label columns for each trial number and the overall averages for the three trials.
- » Record the values measured for each responding variable in each trial during the experiment.
- » Calculate averages for the responding variable after all data have been recorded.



#### 3. Create a Graph of Data from the Data Table

Use the graph paper provided to create a line graph of the data collected from your experiment. Clearly indicate the names of the manipulated and responding variables AND the units used for each on each axis. Follow the guidelines listed below when creating your graph:

- » Make the graph large.
- » Title the graph and label both axes.
- » Place the manipulated variable on the x-axis and the responding variable on the y-axis.
- » Divide each axis into 4-6 gradations that start slightly lower than the lowest data point recorded and end slightly higher than the highest data point recorded (e.g, 5, 10, 15, 20, 25 cm)
- » Plot one dot for each matched data pair from the data table.
- » After all data pairs have been plotted, draw a best-fit line (straight line or smooth curve) illustrating the relationship between the two variables shown on the graph.



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## MOMENTUM BASHING 2



### Analysis Questions

1. Using your group's Data Table and Graph, describe the relationship observed between the starting height of the marble and the distance the cup moves.

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2. How is the marble's starting height related to the marble's final velocity before impacting the cup?

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3. Explain how the marble's final velocity affects its momentum.

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4. For two identical cars of the same mass, what would determine if one car has more momentum than another in a two-car collision?

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5. Given a choice, in which type of vehicle would you feel SAFEST in a two-car collision at 35 miles-per-hour and why?

A. Small two-door sports car

C. Large SUV

B. Medium size four-door sedan

D. Semi tractor trailer truck

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