# Bell Ringer: Impulse – ID: 13599

Time required
*15 minutes*

## Topic: Impulse and Force

- *Explore how the impulse on an object is affected by force, time, and velocity.*
- *Calculate the impact force on an object.*

## Activity Overview

*In this activity, students will observe a force versus time graph to determine how the force and time interval affect the impulse on an object. Then, students will explore a simulation of a car crash to determine a relationship between the impact force and the time over which the force acts on the object.*

## Materials

*To complete this activity, each student will require the following:*

- *TI-Nspire™ technology*
- *pen or pencil*
- *blank sheet of paper*

## TI-Nspire Applications

*Graphs & Geometry, Notes*

## Teacher Preparation

*Before carrying out this activity, review with students how to calculate the total momentum in a system. Also, review resolving vectors into their components.*

- *The screenshots on pages 2–4 demonstrate expected student results. Refer to the screenshots on page 5 for a preview of the student TI-Nspire document (.tns file). The solution .tns file contains sample responses to the questions posed in the student .tns file.*
- ***To download the student .tns file and solution .tns file, go to education.ti.com/exchange and enter "13599" in the search box.***
- *This activity is related to activity 11655: Impulse of a Force. If you wish, you may extend this bell-ringer activity with the longer activity. You can download the files for activity 11655 at education.ti.com/exchange.*

## Classroom Management

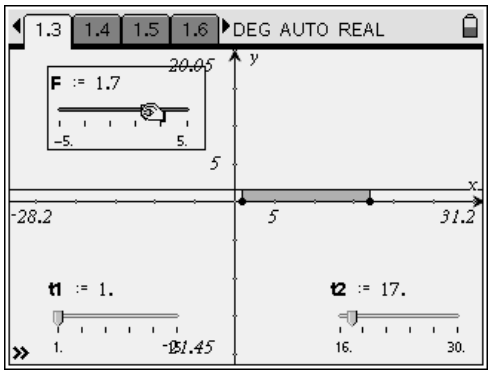
- *This activity is designed to be **teacher-led**, with students following along on their handhelds. You may use the following pages to present the material to the class and encourage discussion. Note that the majority of the ideas and concepts are presented only in **this** document, so you should make sure to cover all the material necessary for students to comprehend the concepts.*
- *If you wish, you may modify this document for use as a student instruction sheet. You may also wish to use an overhead projector and TI-Nspire computer software to demonstrate the use of the TI-Nspire to students.*
- *If students do not have sufficient time to complete the main questions, they may also be completed as homework.*
- *In some cases, these instructions are specific to those students using TI-Nspire handheld devices, but the activity can easily be done using TI-Nspire computer software.*

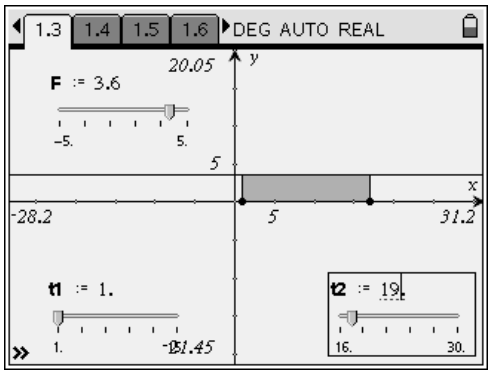
The following questions will guide student exploration during this activity:

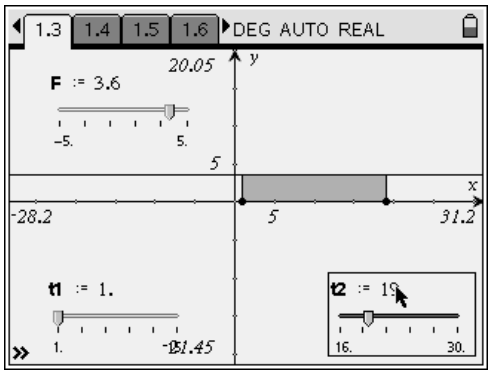
- What is the impulse on an object?
- How does the time over which an object changes speed affect the impact force on the object?

The purpose of this activity is for students to observe the relationships between impulse, impact force, and time. Students will calculate the integral of a force versus time graph to determine the impulse on an object. Then they will manipulate initial velocity and time in a simulation of a car crash to observe how these variables affect the impact force on an object.

**Step 1:** Students should open the file **PhysBR_week17_impulse.tns** and read the first two pages. Page 1.3 shows a graph of a constant force, **F**, acting on an object from time **t1** to **t2**. The total area of the shaded region represents the impulse on the object. It has a minimum *x*-value of **t1** and a maximum *x*-value of **t2**. Students can vary the values of **F**, **t1**, and **t2** using the sliders. (To use the sliders, students should use the NavPad to move the cursor to the slider value located below each variable. They can press ⏺ to select the slider, and then use the NavPad to drag it to change the values. Alternatively, students can use the NavPad to scroll over the text value of the variable. Students should press ⏺ twice to delete the value, and then type a new value.) Students should observe how the impulse on the object changes as the force and collision time change.



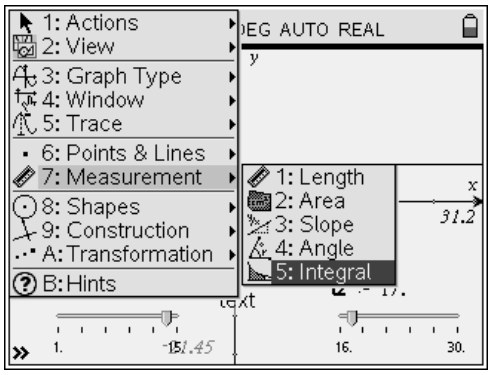



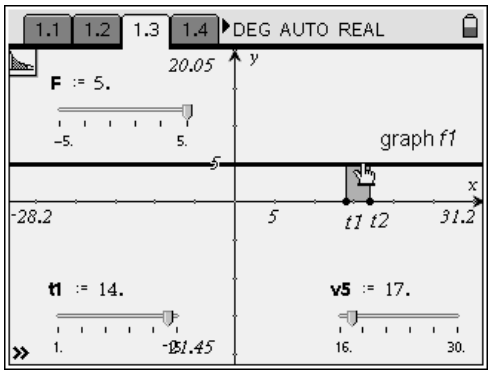



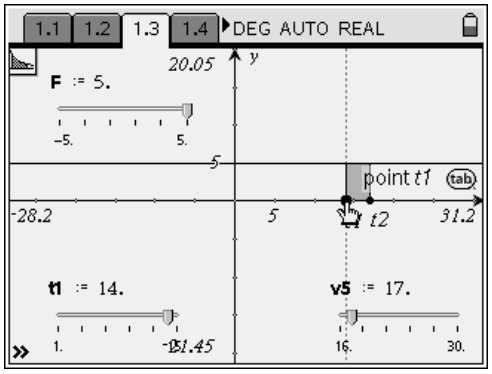
**Step 2:** Next, students should answer question 1 on page 1.5.

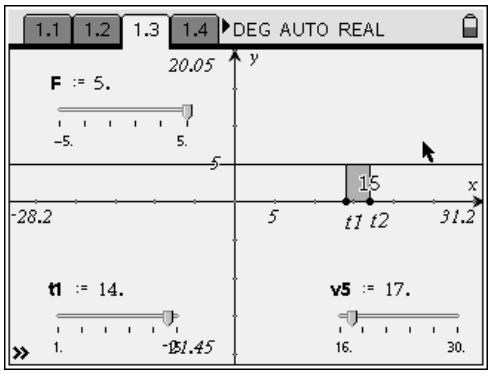
**Q1.** What is the impulse on an object that experiences a force of 1 N for 15 seconds? How does this compare with the impulse on an object that experiences a 5 N force for 3 seconds? Verify your answer by calculating the impulse on page 1.3.

**A.** *Students can set a slider variable to an exact value by clicking on the displayed numerical value of the slider variable. Students should recall that the impulse on an object is the integral of the force acting on an object with respect to the time over which that force acts on the object. For a force that is constant over time, impulse is equal to the product of force and time. To calculate the impulse using the handheld device, students should return to page 1.3 and enter the specified values for force and time. Then, they should select the* ***Integral*** *tool (****Menu > Measurement > Integral****) and click once (press* ⬭ *) on the graph of the function. Then, they should use the NavPad to select the boundaries for the integral. To do this, they should move the cursor over the point at* **t1** *and press* ⬭*, and then they can repeat the process for* **t2***. (To select the point at* **t2***, students may need to press* tab*.) Students will find that the calculated impulse for both scenarios is 15 N·m.*

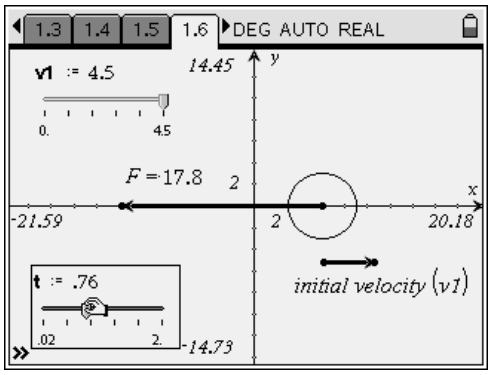


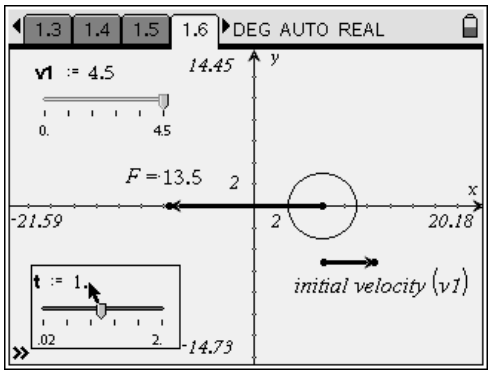
**Step 3:** Next, students should read page 1.5 and then move on to page 1.6. Page 1.6 shows a simulation of a person, represented by the circle, traveling at an initial velocity of *v1* in a vehicle. The vehicle comes to a stop in a time *t*, and the vector *F* represents the force on the person during this time. (The force during this time is assumed to be constant.) Students can vary the initial velocity and time using the sliders to observe how the force on the object changes.




**Q2.** How is the force on the person related to the time over which the force is applied?

**A.** *The force on the object increases as the time over which the force is applied decreases.*

**Q3.** Assume the person is traveling at 4.5 m/s at the time of the collision.




a. If the person is wearing a seatbelt, she comes to a stop in 1 second. What is the force acting on her body?

b. If the person is not wearing a seatbelt, she strikes a hard area on her dashboard and comes to a stop in 0.04 second. What is the force acting on her body?

c. One part of the woman's dashboard is padded. If she strikes this part instead of the harder area, she comes to a stop in 0.08 second. By how much would this reduce the force on her body?

**A.** *a. −13.5 N*

*b. −338 N*

*c. −169 N; This means that the padded dashboard reduced the impact force by 169 N (because 338 − 169 = 169). In other words, when the time over which the force was applied doubled, the force was reduced by half.*

**Suggestions for Extension Activities:** Students can investigate the impulse on an object for non-constant forces by modifying the equation *f1(x)* on page 1.3.

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(Student)TI-Nspire File: *PhysBR_week17_impulse.tns*