Science Objectives

- Students will be able to identify a lever and fulcrum
- Students will solve one-step equations for balancing different masses on a teeter-totter balance

Vocabulary

- force
- fulcrum
- imbalance
- lever
- simple machine
- mass

About the Lesson

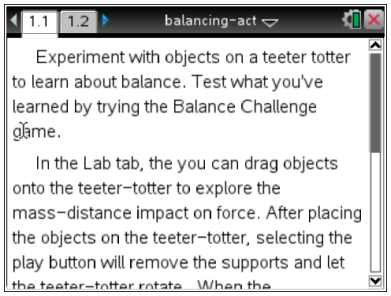
- This lesson is a simulation of a teeter-totter where people and objects of different masses are placed at positions on either side to test for balance. This provides an opportunity for students to gather data and explore the conditions under which the teeter-totter is balanced.
- As a result, students will:
  - Describe a lever and fulcrum.
  - Determine the positions for different mass arrangements to balance on the teeter-totter.

TI-Nspire™ Navigator™

- Send out the *Balancing_Act.tns* file.
- Monitor student progress using Class Capture.
- Use Live Presenter to allow students to show how they manipulate positions that effect results.

Activity Materials

- Compatible TI Technologies: TI- Nspire™ CX Handhelds, TI-Nspire™ Apps for iPad®, TI-Nspire™ Software



Tech Tips:

- This activity includes screen captures taken from the TI-Nspire CX handheld. It is also appropriate for use with the TI-Nspire family of products including TI-Nspire software and TI-Nspire App. Slight variations to these directions may be required if using other technologies besides the handheld.
- Watch for additional Tech Tips throughout the activity for the specific technology you are using.
- Access free tutorials at http://education.ti.com/calculators/pd/US/Online-Learning/Tutorials

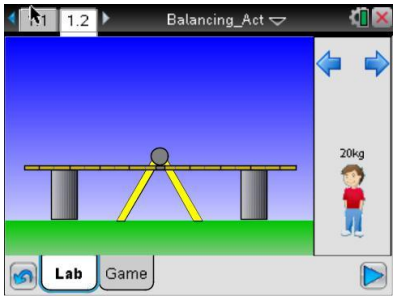
Lesson Files:
Student Activity

- Balancing_Act_Student_MG.doc
- Balancing_Act_Student_MG.pdf
- Balancing_Act.tns

Discussion Points and Possible Answers

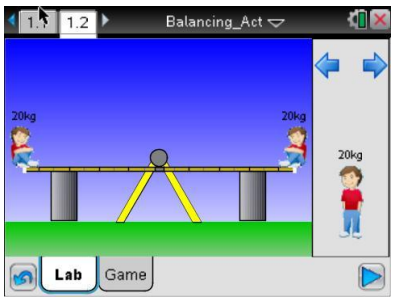
Part 1: Exploring Balance

In this part of the lesson students explore the forces at work in an imbalanced teeter-totter.



1. Start the simulation.
2. Place two 20-kg people on either end of the teeter-totter before selecting the Play button.
3. Make sure students note the balance achieved when the two people are in the same distance from the fulcrum.

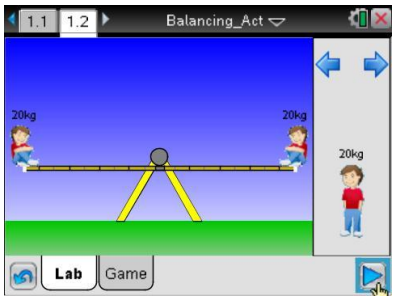
4. Students will be generating data and completing the table. Make sure that students use a systematic approach in gathering data. For example, hold the person on the left in position 9, while the person on the right changes positions from 9 to 1. Then repeat with the person on the left in position 8, and so on. Students can work in groups to gather the data.



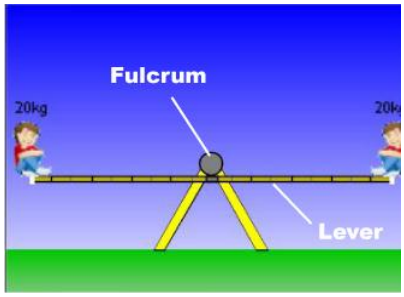
TI-Nspire Navigator Opportunities

Allow students to volunteer to be the Live Presenter and demonstrate how to adjust the positions of different objects of different masses.

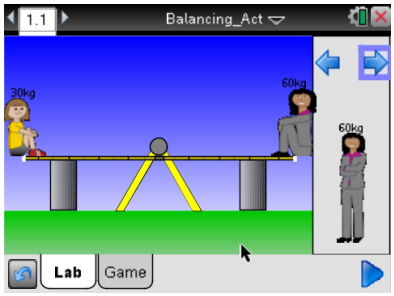
5. Students should have an intuitive understanding that equal masses placed equally far apart on the teeter-totter will achieve balance. However, make sure that students are aware of the white tic marks along the lever. This is what ensures the distance from the fulcrum. Students may inadvertently place one person at position 9 and the other at position 8.
   From their data, students should conclude that the only time that balance is achieved is when the two equal masses are equally apart from each other. If one mass is further to the left or right, then the teeter-totter will tilt in the direction of the person farthest away.



Part 2: Exploring Balance Using Different Masses



6. Make sure to go over the two key parts of this simple machine. Reinforce that the fulcrum remains stationary, while the lever rotates. Again, students may have an intuitive understanding of this, but anchor this informal knowledge to the key parts of the lever and fulcrum.



7. Students will be generating data and completing the table for two people of different masses. As before, make sure that students use a systematic approach in gathering data. For example, hold the person on the left in position 9, while the person on the right changes positions from 9 to 1. Then repeat with the person on the left in position 8, and so on. Students can work in groups to gather the data. Students will see that balance is achieved for certain configurations have students analyze the data for these scenarios to look for a pattern.

Tech Tip: It may be helpful for students to view the forces that each mass exerts on the lever. To display directional arrows representing the force of each mass, have students select **Menu** or > **Show Force** > **Yes**. You may need to back-out to the main Tools Menu to see the desired menu option.

Part 3: Creating Balance

$$d_{left} \times m_{left} = d_{right} \times m_{right}$$

8. From parts 1 and 2, students should now have an intuitive understanding that balance is possible regardless of the mass on either side. In this part, this intuitive understanding is formalized with the formula shown. Remind students the value for distance in the formula is based on the position of the person on the lever. For example, position 1 on the lever is thought of as having a distance of 1.

Q1. Describe what happened.

Answer: The teeter-totter is balanced.

Q2. Complete the table shown below. For example, when the 20-kg people are the same distance apart, the result is B, a balanced lever. These entries in the table have been filled in. Move the people to the different positions and mark the result with an “R” (when the teeter-totter tilts down on the right) or “L” (when the teeter-totter tilts down on the left).

Answer:

	Position on right								
	1	2	3	4	5	6	7	8	9
Position on left									
1	**B**	R	R	R	R	R	R	R	R
2	L	**B**	R	R	R	R	R	R	R
3	L	L	**B**	R	R	R	R	R	R
4	L	L	L	**B**	R	R	R	R	R
5	L	L	L	L	**B**	R	R	R	R
6	L	L	L	L	L	**B**	R	R	R
7	L	L	L	L	L	L	**B**	R	R
8	L	L	L	L	L	L	L	**B**	R
9	L	L	L	L	L	L	L	L	**B**

Q3. Based on your data, write a general statement that describes what happens when you place an equal amount of mass at equal distances on a teeter-totter. Then describe what happens to get an R or an L in the data table.

Answer: When there is an equal amount of mass on each side of the teeter-totter, it will only balance when the two masses are the same distance from the middle of the teeter-totter. An R results when the mass is in a position farther to the right than the comparable position of the mass on the left. An L results when the opposite is true.

Q4. Complete the table shown below for a 30-kg person on the left and a 60-kg person on the right. Use the same symbols—B, R, and L—to indicate the tilt or balance of the lever. Use the right or left icons on the upper right to change your object.

Answer:

	Position on right for 60-kg person								
	1	2	3	4	5	6	7	8	9
Position on left for 30-kg person									
1	R	R	R	R	R	R	R	R	R
2	**B**	R	R	R	R	R	R	R	R
3	L	R	R	R	R	R	R	R	R
4	L	**B**	R	R	R	R	R	R	R
5	L	L	R	R	R	R	R	R	R
6	L	L	**B**	R	R	R	R	R	R
7	L	L	L	R	R	R	R	R	R
8	L	L	L	**B**	R	R	R	R	R
9	L	L	L	L	R	R	R	R	R

Q5. Look at your table. You will see that although the amount of mass on each side of the lever is different, there are some arrangements where the lever is balanced. For those cases, multiply the position on the lever by the mass of the person for each side of the lever. What do you notice?

Answer: The two products are equal.

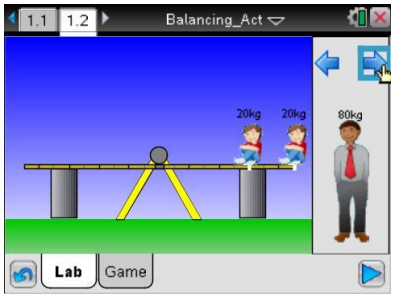
Q6. Why do you think there were some cases where you could not get a Balance?

Answer: Answers may vary. Encourage students to look for number patterns in their data table..

Q7. Use the equation above to calculate the places where the two people can be placed to achieve balance. Verify your results by moving the people to those positions. Describe your results.

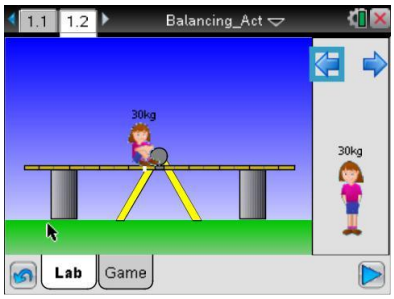
Answer: Place the 20-kg person at position 3 and the 30-kg person at position 2. Or place the 20-kg person at position 6 and the 30-kg person at position 4. Or place the 20-kg person at position 9 and the 30-kg person at position 6.

Q8. Select the Reset button. Next, place a 20-kg at farthest end of the teeter-totter and another 20-kg person, 3 units away, from the fulcrum. Where would you need to place an 80-kg person to balance the lever?



Answer: Position 3

Q9. What is the mass of an object, 6 units from the fulcrum that balances a 30-kg person, 1 unit from the fulcrum on the other side? Use the formula to find the mass, and verify your results using the simulation.



Answer: 5 kg

TI-Nspire Navigator Opportunities

Allow students to volunteer to be the Live Presenter and demonstrate how to help the class understand how to fill out the two tables. Use Quick Poll to check for understanding during the course of the activity.

Wrap Up

When students are finished with the activity, collect students' worksheets.

Assessment

- In groups, have students work through the Game mode of the simulation, which has students balancing different masses and positions.
- Formative assessment will consist of questions embedded in the student worksheet. Analyze questions in the student worksheet with the students. Teacher can also collect scores that students earned in the game.
- Summative assessment will consist of questions/problems on the chapter test.