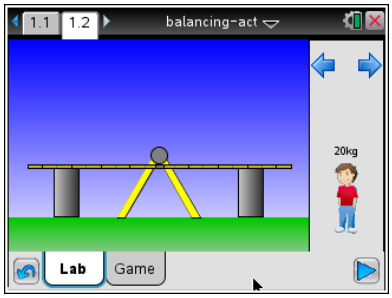
Science Objectives

- Students will describe a lever and fulcrum.
- Students will define force vectors and torque.
- Students will solve proportions for balancing different weights on a teeter-totter balance.



Vocabulary

- acceleration
- force
- fulcrum
- gravity
- lever
- mass
- Newton
- simple machine
- torque

About the Lesson

- This lesson is a simulation of a teeter-totter where people and objects of different masses are placed at either end to test for balance. This provides an opportunity to explore a lever and fulcrum simple machine, as well as to measure torque.
- As a result, students will:
  - Describe a lever and fulcrum.
  - Define weight as a force, as well as the unit of measurements for force.
  - Measure torque and solve equations involving torque.

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 variables 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

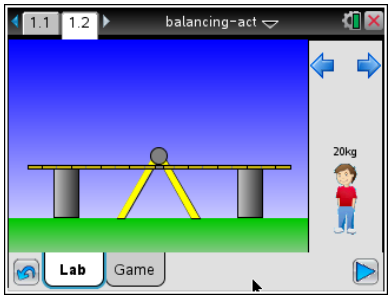
- Balancing_Act_Student_HS.doc
- Balancing_Act_Student_HS.pdf
- Balancing_Act.tns

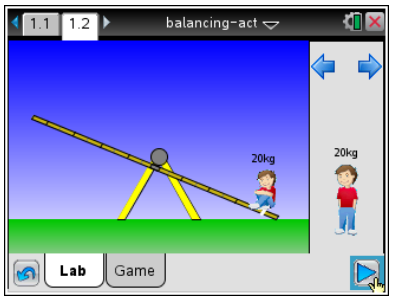
Discussion Points and Possible Answers

Part 1: Exploring Force

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

1. Start the simulation.
2. Place a figure on the teeter-totter before selecting the Play button.
3. Make sure students note the downward movement of the teeter-totter based on the mass of the person on one end of it.
3. Go over the formula for calculating the weight of the person, based on the gravitational force on the mass of the person. Also reinforce that the units of force, called the Newton, are kg-m/s^2.



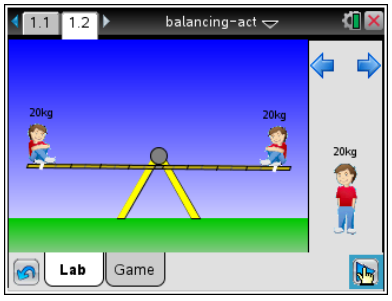


TI-Nspire Navigator Opportunities

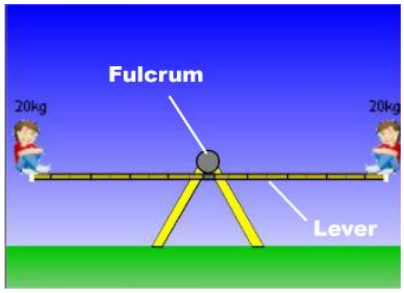
Allow students to volunteer to be the Live Presenter and demonstrate how to adjust the parameters of the simulation.

Part 2: Exploring Balance

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.



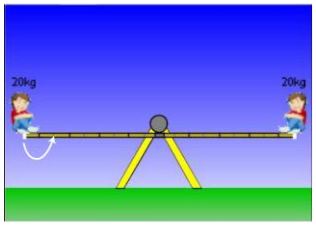
4. Make sure to go over the two key parts of this simple machine. Reinforce that the fulcrum remains stationary, while the lever rotates. Again, students may have an intuitive understanding of this, but anchor this informal knowledge to the key parts of the lever and fulcrum.



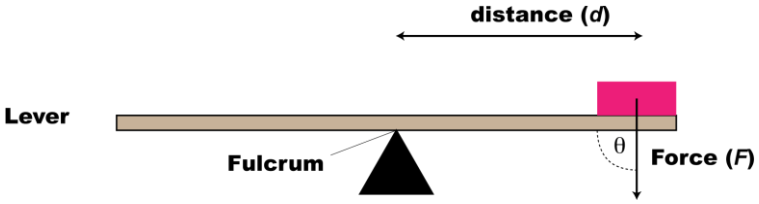
Tech Tip: Press menu or to see various options for turning labels on or off and changing the display options. You may need to back-out to the main Tools Menu to see the desired menu option.

Part 3: Exploring Imbalance

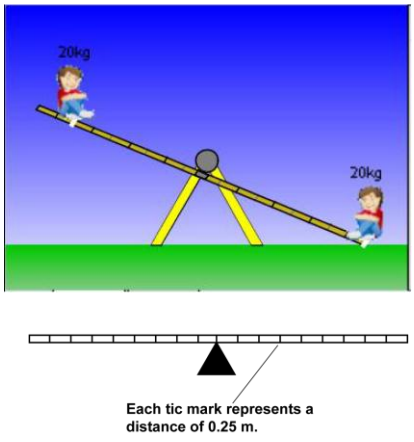
Students should also have an intuitive understanding that placing two people of different weights will usually result in an imbalance. They may not be aware that equal weights on each side can lead to imbalance, while different weights on each side can result in balance.



5. Go over the definition of torque. If possible, create a lever and fulcrum using a shelf and textbooks and show how it is possible to achieve balance with different weights on each side.



6. Have students calculate the torque using the data provided. The units of length provided provide an opportunity for multiplying by decimals. Also, make sure that students display the units in their calculations.



Q1. Calculate the downward force of the person you placed on the teeter-totter. Make sure to keep track of the units.

Answer: To one significant digit, the answer is 2.0×10^2 N.

Q2. Describe what happens when you place the second person on the teeter-totter.

Answer: The teeter-totter is balanced.

Q3. Describe what happens.

Answer: The teeter-totter slants to the right.

Q4. Calculate the torque for each person on the teeter-totter. For distance measures use the units shown in the illustration.

Answer: Torque for the person on the left: 35 N-m. Torque for the person on the right: 45 N-m.

Q5. How does torque help explain why having the same weight on either side of the fulcrum doesn't guarantee balance?

Answer: If the same weight is at different lengths from the fulcrum, the torque will be different. A different in torque will result in an imbalance.

Q6. How far from the fulcrum would you need to place another 20-kg person to have a balanced distribution of weight? Show how you got your answer.

Answer: At position 2

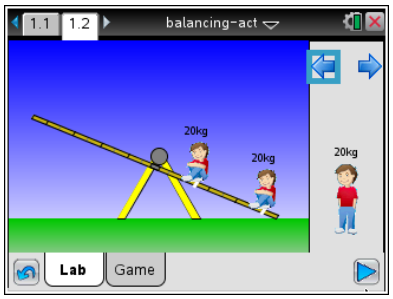
Q7. Use the proportion to calculate where to place the 30-kg person, if the 20-kg person remains in the current position.

Answer: Position 6

Q8. Test the result of the previous question using the simulation. Describe the outcome.

Answer: Check student's work.

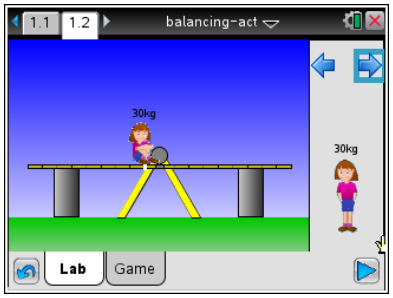
Q9. Select the Reset button. Next, place a 20-kg at farthest end of the teeter-totter and another 20-kg person 3 units away from the fulcrum. Where would you need to place an 80-kg person to balance the lever?



Answer: Position 3

Q10. What is the mass of an object 6 units from the fulcrum that balances a 30-kg person 1 unit from the fulcrum?

Answer: 5 kg



TI-Nspire Navigator Opportunities

Allow students to volunteer to be the Live Presenter and show their solutions to some of the questions, Have them show the calculator page to reveal/verify their solutions. 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

- Analysis questions are written into the student worksheet.
- In groups, have students work through the Game mode of the simulation, which has students working with the torque proportion.