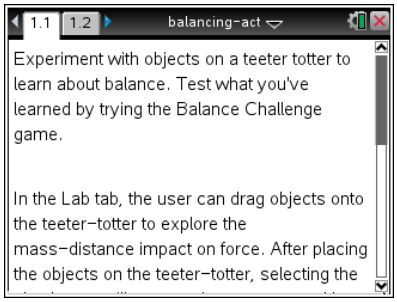
Science Objectives

- Students will be able to balance different masses on a teeter-totter
- Students will solve equations for balancing different masses on a teeter-totter



Vocabulary

- fulcrum
- lever
- torque
- 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 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

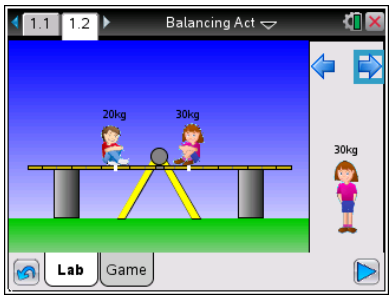
- Balancing_the_Plank_Student.doc
- Balancing_the_Plank_Student.pdf
- Balancing_Act.tns

Discussion Points and Possible Answers

Allow students to read the background information on their student activity sheet.

Move to page 1.2.

Part 1: Balancing Two Different Masses



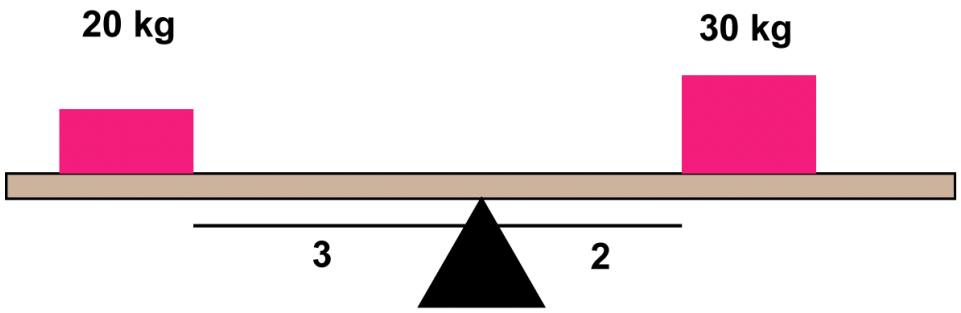
In this part of the lesson students learn about torque and use this concept to balance two different masses on the teeter-totter.

1. Start the simulation. Place a 20-kg person on the left and a 30-kg person on the right.

Q1. Select the Play button. Describe what happened.

Answer: The teeter-totter is balanced. (Check students' work if they don't have a balanced lever.)

Mathematically, placing the 20-kg mass at position 3 and the 30-kg mass at position 2 achieves balance.



$$m_1 \bullet d_1 = m_2 \bullet d_2$$
$$20 \bullet 3 = 30 \bullet 2$$
$$60 = 60$$

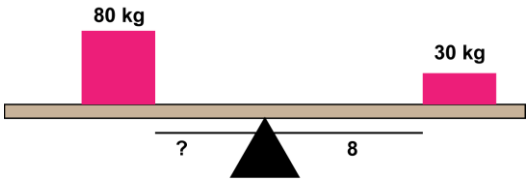
Q2. Complete the table shown below. For each set of masses and distances, determine if this arrangement will result in a balanced teeter-totter or not. Calculate the torques, determine if balance will be achieved, then test your prediction using the simulation.

m_1	d_1	Torque$_1$	m_2	d_2	Torque$_2$	Predicted Result	Actual Result
20	6	*120*	30	4	*120*		*Balance*
20	5	*100*	30	3	*90*		*No balance*
60	3	*180*	80	2	*160*		*No balance*
60	4	*240*	80	3	*240*		*Balance*
30	1	*30*	5	6	*30*		*Balance*
30	2	*60*	5	9	*45*		*No balance*

Tech Tip: It may be helpful for students to view directional arrows representing the forces that each mass exerts on the lever. To view the forces, 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 2: Solving Equations

In this part of the lesson, students calculate the position of one of the masses, given the size and position of the other mass.



A worked-out example is provided, so that students can see how to set up the equation.

$$m_1 \bullet d_1 = m_2 \bullet d_2$$
$$80 \bullet d_1 = 30 \bullet 8$$
$$d_1 = \frac{30 \bullet 8}{80}$$
$$d_1 = \frac{30}{10}$$
$$d_1 = 3$$

Teacher Tip: Plan on going over these steps, since students may need a refresher on solving equations.

Q3. Confirm the results of this equation using the simulation. Describe your results.

Answer: The teeter-totter is balanced. (Check students' work if they don't have a balanced lever.)

Q4. Complete the table below. Calculate the value for d_1 using the equation shown earlier.

m_1	d_1	m_2	d_2
80	1	20	4
60	1	30	2
30	1	5	6
80	1	10	8
80	1.5	60	2
60	1.5	30	3

Q5. Use the simulation to verify your results from the table in Q4. Describe any limitations to the simulation.

Answer: The teeter-totter is balanced, except when d_2 is a decimal value. The simulation doesn't allow you to place the mass at half-values. (Check students' work if they don't have a balanced lever.)

TI-Nspire Navigator Opportunities

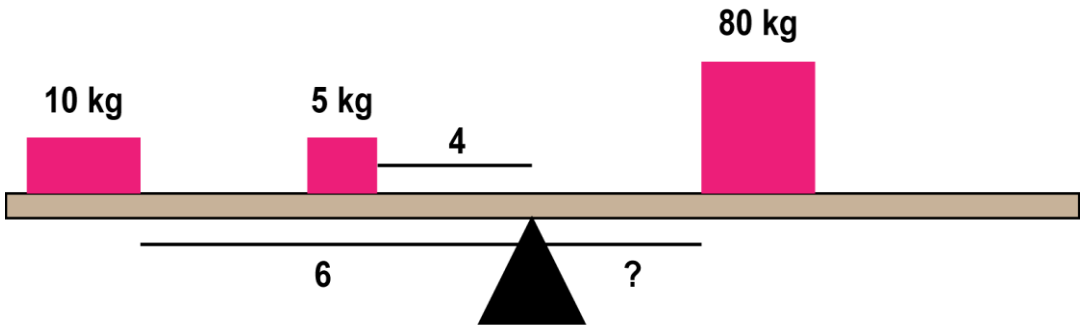
Allow students to volunteer to be the Live Presenter and demonstrate how to help the class understand how to fill out the two tables. Use Quick Poll to check for understanding during the course of the activity.

Part 3: Solving Equations When There are Three Masses

In this part of the lesson, students calculate the position of the mass on the right, given the sizes and positions of two other masses on the left. A worked-out example is provided, so that students can see how to set up the equation. This is a more elaborate equation, but it still is similar to the previous.

Teacher Tip: Plan on going over these steps, since students may need a refresher on solving equations.

$$m_1 \bullet d_1 + m_2 \bullet d_2 = m_3 \bullet d_3$$
$$10 \bullet 6 + 5 \bullet 4 = 80 \bullet d_3$$
$$80 = 80 \bullet d_3$$
$$\frac{80}{80} = d_3$$
$$1 = d_3$$



Q6. Confirm the results of this equation using the simulation. Describe your results.

Answer: The teeter-totter is balanced. (Check students' work if they don't have a balanced lever.)

Q7. Complete the table below. Calculate the value for d_3 using the equation shown earlier.

m_1	d_1	m_2	d_2	m_3	d_3
10	6	60	1	60	2
5	6	30	3	60	2
30	2	10	2	80	1
30	9	10	5	80	4
80	1	10	4	60	2

Q8. Use the simulation to verify your results from the table in Q7. Describe any limitations to the

simulation.

Answer: The teeter-totter is balanced. (Check students' work if they don't have a balanced lever.)

Wrap Up

When students are finished with the activity, retrieve the .tns file using TI-Nspire Navigator. Save grades to Portfolio. Discuss activity questions using Review.

Assessment

- Analysis questions are written into the student worksheet.
- In groups, have students work through the Game mode of the simulation, which has students balancing different masses and positions.