THE CLEVER LEVER

BENCHMARK and TASKS

SC.C.2.2.1 The student recognizes that forces of gravity, magnetism, and electricity operate simple machines.

- The student demonstrates that work is done every time a force is used to move something.
- The student identifies the six types of simple machines (screw, inclined plane, wedge, pulley, lever, wheel and axle).
- The student demonstrates how simple machines are used to accomplish work.

KEY QUESTION

How will shifting the load on a lever affect the amount of force needed to lift it?

BACKGROUND INFORMATION

Machines are mechanical devices that often permit people to do work more easily. Work is done any time a **force** is used to move an object. There are six types of simple machines: **lever, wheel and axle, inclined plane, pulley**, wedge, and screw**.**

A lever has four parts: a bar or beam, the **fulcrum** (the fixed point around which the bar pivots), the load (the object to be moved), and the effort (the force needed to move the load). Some common examples of a lever are: crowbar, shovel, claw, the hammer when use for prying, hinged door, wheelbarrow, fishing rod, baseball bat, and broom. One of the simplest examples of a lever is the playground seesaw. Levers can be used to decrease the amount of force needed to do a certain amount of work.

MATERIALS

Per pair of students

1 metric ruler
fulcrum (1 thick, round marker)
3 small ceramic tiles (taped)
The Clever Lever record sheet
20 interlocking cubes

Per class

tote bag with a handle
several books
Early Bird Physics Books, Sally M. Walker and Roseann Feldman, Lerner Publications Co., 2002

TEACHING TIPS

1. Instruct students to be careful when pushing on the lever. They should push slowly and gently with the index finger.
2. Washers or pennies could be substituted for the ceramic tiles.

ENGAGE

1. Remind students that there are six types of simple machines: lever, wheel and axle, inclined plane, pulley, wedge, and screw. Refer to the Tree Map the class started in the previous activity when they were investigating inclined planes. Tell students they are going to learn about another simple machine, the lever.
2. Tell students they have their own body levers – their arms and legs! Ask a student volunteer to come forward and hold his arm out straight. Put the tote bag handle on his wrist. Using his shoulder as the fulcrum, he should try to lift the bag without bending his arm.
3. Then move the handle up to his elbow. Have him again lift the bag with a straight arm. Ask if it is easier or harder to lift than when it was hanging from his elbow.
4. Finally, move the handle up toward his shoulder. Have him again lift the bag with a straight arm. Ask if it is easier or harder to lift now.
5. Ask: *At what point was the bag the easiest to lift?* Allow all students to experience that the closer a load is to the fulcrum, the easier it is to lift!

EXPLORE (Part 1)

1. Distribute tiles, a metric ruler, and a marker to each group. Have students tape the marker (fulcrum)to the desk and then place the ruler across the fulcrum so the 15-cm mark is centered on the fulcrum. Have students tape the three tiles together and then place the taped tiles at the 20-cm position on the ruler.
2. Explain that a lever has four parts: a bar or beam (the ruler), the fulcrum or object on which the bar pivots (the marker), the load or the object to be moved (the three taped tiles), and the effort or force needed to move the load (the index finger).
3. Give each group *The Clever Lever* record sheet. Ask students to make a prediction about where it will be the easiest to lift the load – at the 20 cm, 25 cm, or 30 cm mark on the ruler. Predictions should be made by ranking the positions as 1, 2, or 3, with 1 being the position at which the load will be the easiest to lift.
4. Have students take turns lifting the load, using only their index finger at the 1 cm mark to provide a pushing force.
5. Next, have the students place the load at 25 cm and take turns using their index finger to lift the load.
6. Finally, have the students place the load at the 30 cm mark and take turns using their finger to lift the load.
7. Students should then record their results, again ranking the positions 1, 2, or 3, with 1 being the position at which the load was the easiest to lift.

EXPLAIN (Part 1)

At what position was it the easiest to lift the tiles? (20 cm)
At what position did it require more force to lift the tiles? (30 cm)

EXPLORE (Part 2)

1. Students should think about how many interlocking cubes would be needed to lift the 3 tiles at the 20-cm position and then write their prediction in the second table on *The Clever Lever* data sheet.
2. Next, students will find out exactly how many cubes it would take to lift the 3-tile load at the 20 cm position. (Note: Students should predict at only one position and then find the exact

number of cubes needed before moving on to the next position. This will enable them to use the data they are collecting to make more accurate predictions.)

3. Instruct students to repeat Steps 1 and 2 at the 25 cm and then the 30 cm marks.

EXPLAIN (Part 2)

How did the number of cubes needed for lifting the tiles at each position compare to your earlier findings?

Did the load position that was the easiest when you used only your finger also require the fewest number of tiles?

Did the load position that required the most force when you used only your finger also require the most tiles?

Was any work being done? (Yes, the pushing force of our finger was used to lift a load, the tiles.)

What does this investigation teach us about levers? (The closer a load is to the fulcrum, the easier it is to lift.)

What is the purpose of a lever? (A lever can help us pry things loose or lift heavy objects.)

EXTEND/APPLY

1. Ask: *How does a door act as a fulcrum?* Explain that the fulcrum of a door is the hinged part because that's the part the door pivots around. A door is like a large lever with nothing on one side of the fulcrum.
    - Adjust a door so that it is slightly ajar. Have a student volunteer use one finger near the hinges to gently push the door open. (Take care that the student does not place her fingers near the hinged opening!) Then have the student use one finger to gently push the door open near the handle.
    - Ask the student to tell the class which method was easier. (The farther from the fulcrum you push, the more force you create and the easier it is to open and close the door.)
2. Share the *Early Bird Physics Books*. The titles include: *Work, Inclined Planes, Screws, Wedges, Levers, Pulleys, and Wheels and Axles.*

ASSESSMENT

Show the students a manual can opener and a can. Say: *Imagine that you are using this manual can opener. You place the opener on the can like this, and you are about to open it, but stop and think: Would it be easier to puncture the can by squeezing the handle at the halfway mark or at the end? Why do you think so?*

THE CLEVER LEVER

1. Predict at which position the load will be the easiest to lift. Rank order the positions at which the load will be placed as 1, 2, or 3 with 1 being the easiest.
2. Record your findings by again rank ordering the positions as 1, 2, or 3 with 1 being the easiest.

Position of the Load	Load	Force	Prediction (1, 2, or 3)	Result (1, 2, or 3)
20 cm	**3 tiles**	**finger**		
25 cm	**3 tiles**	**finger**		
30 cm	**3 tiles**	**finger**		

3. Predict how many interlocking cubes it will take to lift the 3 tiles at each position.
4. Connect interlocking cubes and find the fewest number of cubes it will take to lift the 3 tiles at each level.

Position of the Load	Load	Force	Prediction (# of cubes to lift the load)	Result (# of cubes to lift the load)
20 cm	**3 tiles**	**finger**		
25 cm	**3 tiles**	**finger**		
30 cm	**3 tiles**	**finger**		

5. Explain how moving the load closer to or farther away from the fulcrum affects the amount of force needed to lift the load.

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