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| **Lesson Title/Focus** | **Work input/output & mechanical advantage** | **Date** | Wednesday, March 19 2014 |
| **Subject/Grade Level** | Science 8 | **Time / Duration** | 80 mins |
| **Unit** | Unit D: Mechanical Systems | **Teacher** | Koreen Klassen |

| **OUTCOMES FROM ALBERTA PROGRAM OF STUDIES** | |
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| **General Learning Outcomes:** | 3. Investigate and describe the transmission of force and energy between parts of a mechanical system |
| **Specific Learning Outcomes:** | 3.3 identify work input and work output in joules for a simple machine or mechanical system |

**LEARNING OBJECTIVES**

**Students will:**

1. Define mechanical advantage in terms of work input and output
2. Describe how a machine provides a mechanical advantage
3. Calculate mechanical advantage using work input and output

| **ASSESSMENTS** | |
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| **Observations:** | • Lab procedure |
| **Key Questions**: | • **Why might there be discrepancies between ideal and actual force ratios?**<br>• **How are work input and output values determined?** |
| **Products/Performances:** | • **Guided notes, lab worksheet, practice problems.** |

| **LEARNING RESOURCES CONSULTED** | **MATERIALS AND EQUIPMENT REQUIRED** |
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| • Alberta Programs of Study<br>• Science Focus 8 Textbook & Teacher Resource<br>• | • **Lab: spring scale (as many as possible), toy cars (15 ish), string for cars, tape (attach string to car), flat boards for inclined planes, meter sticks, books (to prop up boards)**<br>• **Guided notes with practice problems notes**<br>• **Video https://www.youtube.com/watch?v=QrmSJN3uQfY**<br>• **PPT for mini-lecture** |

**PROCEDURE**

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| ***Prior to lesson*** | • **Lab materials ready**<br>• **Video queued up**<br>• **Photocopy guided notes** | |
| **Introduction** | | **Time** |
| ***Attention Grabber*** | Lab setup | |
| ***Assessment of Prior Knowledge*** | Why do we use machines? How do they make our lives easier?<br>How do we know they make work easier? | 5 min |
| ***Expectations for Learning and Behaviour*** | • Spring scales – be nice to them!<br>• Read instructions carefully and ask questions if you aren't sure what to do<br>• Cooperation with peers | |
| ***Advance Organizer/Agenda*** | 1. Video & guided notes<br>2. Practice Problems<br>3. Lab | |
| ***Transition to Body*** | | |
| **Body** | | **Time** |
| ***Instructional Approach #1*** | **Video 5 & Mini Lecture – Mechanical Advantage**<br>1. Students will complete guided notes as they watch the video (0:00 – 8:20) https://www.youtube.com/watch?v=QrmSJN3uQfY<br>2. PowerPoint to reinforce ideas and calculate mechanical advantage using distances instead of forces and introduce ideal vs actual | *20 min* |

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| | mechanical advantage (demo) – discuss possible reasons for discrepancies<br>3. <u>BRAIN BREAK - Thumb Peace:</u> Lock your fingers together. You will try to work together to outline the numbers 0-9 with your thumbs one at a time. Your thumbs will need to work together while making each number. So you will have to decide who will be writing the number forwards and who will write it backwards. | |
| *Assessments/ Differentiation:* | Guided notes response | |
| ***Instructional Approach #2*** | **<u>Practice Problems</u>**<br>Students will attempt a couple problems individually and then we'll go over them as a class<br>Students will complete the rest of the worksheet individually | *15 min* |
| *Assessments/ Differentiation* | Observation/discussion of practice problem responses | |
| ***Instructional Approach #3*** | <u>Brain Break: Ear and Nose Switch</u><br>1. Stand up.<br>2. Take your right hand and grab your left ear. Keep your right arm close to your body.<br>3. Now take your left hand and touch your nose.<br>4. Uncross your arms and move your left hand to your right ear and your right hand to your nose. Your left arm should now be closest to your body.<br>5. Switch back and forth as fast as you can.<br><br>**<u>Lab – Mechanical Advantage & Inclined Planes</u>**<br>Students will get into pods for this activity<br>Students will vary the height of an inclined plane while measuring effort force, load force, work input, work output, and mechanical advantage.<br>Students will then answer questions to analyze and interpret their data. | *30 min* |
| *Assessments/ Differentiation* | Lab data table, calculations, & analyzing questions | |
| **Closure** | | **Time** |
| ***Assessment of Learning:*** | What did we learn today?<br>How do we determine what the work input and work output are for a particular situation?<br>Why do we calculate mechanical advantage and what does it mean?<br>Why is there a difference between ideal and actual values?<br><br>Exit slip: Do you like the videos with guided notes at the beginning of class? Why or why not? | *5 min* |
| ***Feedback From Students*** | | |
| ***Feedback To Students (if applicable)*** | | |
| ***Transition To Next Lesson*** | | |

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| **Sponge Activity/Activities** | Mark practice problems in class;<br>Mrs. Kurpjuweit will go over math test |

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| **Reflections from the lesson** | |

Mechanical Systems – Video 5 (Mechanical Advantage)

Guided Notes

*Learning Target: What is the advantage to using a mechanical device?*

Machines can make work easier for us by _____

_____

but without _____.

**Definition:** When a machine increases the force that you exert on an object, we say that the machine creates a _____.

Force YOU apply = _____ Force MACHINE applies =_____

Mechanical advantage is comparing_____

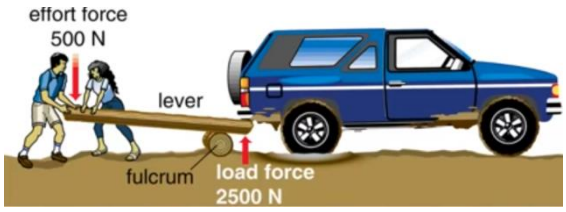
(size of the _____ compared to the size of the _____)

In this picture, should the fulcrum be closer to the load (vehicle) or closer to the effort force (man) to get the best mechanical advantage? _____

A lever will give you a _____.

This means that the LEVER will do _____ work than YOU will.

**Formula:** Mechanical Advantage (MA) = _____




**Example:** Write the equation and calculation for this scenario:

The branch lever has exerted a force that is _____times greater than the force you exerted on the branch itself. In other words, the branch has a mechanical advantage of _____.

**Example:** Justin uses a wheelbarrow to lift a load of bricks. The bricks weigh 600N, which is more than Justin could normally carry. However, with the wheelbarrow, Justin can lift the bricks with as little as 120N. What is the mechanical advantage of the wheelbarrow?

**Note:** A mechanical advantage GREATER THAN 1 means the machine is applying _____ force than you; a mechanical advantage LESS THAN 1 means the machine is applying _____ force than you. What would be the advantage of using a machine if you're applying more force than it?

_____

_____

_____

## Practice Questions – Mechanical Advantage

1. If you exert a force of 100N on a hockey stick, and the stick exerts a force of 20N on the puck, what is the mechanical advantage of the stick?

2. Kisha applied 20N of force to turn an ice cream freezer crank. The crank's resistance was 60 N. What was the mechanical advantage of the crank?

3. A pulley is used to raise a heavy crate. The pulley is such that an input force of 223 N is needed to provide an output force of 1784 N. What is the mechanical advantage of this pulley?

4. To pull a weed out of a garden, you apply a force of 50N to a shovel. The shovel applies a force of 600N to the weed. What is the mechanical advantage of the shovel?

5. To pry a nail out of the wall, you apply a force of 55N to the hammer. The hammer applies a force of 650N to the nail. What is the mechanical advantage of the hammer

6. To lift a block on a movable pulley, you apply a force of 75N to a rope. The rope applies a force of 750N to the block. What is the mechanical advantage of the rope?

# Lab – Work, Mechanical Advantage, & Inclined Planes

**Mechanical advantage** is the comparison of force produced by a machine to the force applied to the machine. In other words, it is the comparison of the size of the load to the size of the effort force. The smaller the effort force compared to the load, the greater the mechanical advantage.

Mechanical Advantage: $\frac{\text{Output force (load force)}}{\text{Input force (effort force)}}$

An **inclined plane** is one of the six types of simple machines. It is sometimes called a ramp or slope and it reduces the force you need to exert to lift something.
This lab will demonstrate how inclined planes can provide a mechanical advantage when doing work.

Materials: spring scale, wooden block, lunch tray (as a ramp), stack of books

Procedure:

1. Hook the wooden block to the spring scale. Measure and record the force (N) required to lift the block without using an inclined plane. This measurement is the LOAD FORCE – the total amount of force required to lift the block.
2. Make an inclined plane using the lunch tray and textbooks to prop it up. The number of books will be the independent variable; you will add books to the stack as indicated by the chart below. Measure and record the height of the inclined plane for each stack of books. The height measurements will be the distances used for your calculations of WORK OUTPUT.
3. Measure the length of the tray (this will be the distance used for your calculation of WORK INPUT.)
4. Drag the spring scale and block up the inclined plane. Measure and record the force (N) required to pull the block up the inclined plane. This measurement is the EFFORT FORCE – the force required to be put in by the person dragging the block up the inclined plane.
5. Calculate the mechanical advantage that the inclined plane provides for each of the different heights of the inclined plane.

Data Table

| Height of inclined plane (cm) | Effort Force (N) | Length of inclined plane (m) | Work Input (J) (W = F x D) | Load Force (N) | Work Output (J) (W = F x D) | Mechanical Advantage (Load Force ÷ Effort Force) |
|---|---|---|---|---|---|---|
| (1 book) | | | | | | |
| (3 books) | | | | | | |
| (5 books) | | | | | | |
| (7 books) | | | | | | |

Table 1. Mechanical advantage produced as a result of varying heights of an inclined plane

Analyzing & Interpreting

1. Which took more force, lifting the car straight up or using the inclined plane?

   _____

   _____

2. Write a statement explaining how the force needed to pull the car up the ramp relates to the length of the ramp. _____

   _____

   _____

3. Write a statement explaining how the effort force needed to pull the car up the ramp relates to the length of the ramp. _____

   _____

   _____

4. If you had a ramp that was twice the length of your ramp, would your input force be more or less? Why?

   _____

   _____

   _____

5. Write a statement explaining how inclined planes relate to mechanical advantage.

   _____

   _____

   _____

   _____

6. Describe and compare work input and work output

   _____

   _____

   _____

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