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Simple & Compound Machines [7th grade]

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UNDERSTANDING BY DESIGN

Unit Cover Page

Unit Title: Simple & Compound Machines

Grade Level: 7

Subject/Topic Area(s): Simple Machines, Compound Machines, Pulleys, Levers, Wedges, Inclined Planes, Screws, Wheel & Axles, Force, Motion

Designed By: Roxanne Hammonds

Time Frame: 16 Days

School District: East Central Independent School District

School: Legacy Middle School

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Brief Summary of Unit (Including curricular context and unit goals-Stage 2):

Students will learn about the different types of simple machines including pulleys, levers, wedges, screws, inclined planes, and wheel & axles. They will be able to classify objects as simple or compound machines. They will describe how humans use machines to make everyday tasks easier. They will illustrate their knowledge of simple machines throughout the unit through various science journals, fold books, and flashcards.

As a culminating performance task, the students will use what they have learned to make a Rube Goldberg machine. Students will choose what type of useful work their machine will do. The students will present their machines at the end of the unit and complete a self-assessment on the project.

Skills

Students will be able to…

(TEKS 7.6A) Demonstrate basic relationships between force and motion using simple machines including pulleys and levers

(TEKS 7.6B) Demonstrate that an object will remain at rest or move at a constant speed and in a straight line if it is not being subjected to an unbalanced force

Unit: Simple & Compound Machines
Grade: 7

Stage 1: Desired Results

Understandings

Students will understand that…

* Forces cause objects to move
* There are various types of simple machines that can do different kinds of work
* Humans use simple machines everyday to make work easier

Essential Questions

How do forces affect the movement of an object?
How do machines help humans do work?
How do forces influence the way individual simple machines work?

Knowledge	**Skills**
Students will know… • TEKS7.6 There is a relationship between force and motion. • Newton's 1st, 2nd, and 3rd Laws of Motion	*Students will be able to…* (7.6A) demonstrate basic relationships between force and motion using simple machines including pulleys and levers (7.6B) demonstrate that an object will remain at rest or move at a constant speed and in a straight line if it is not being subjected to an unbalanced force

Stage 2: Assessment Evidence

Performance Task:
Students will have sufficient knowledge to understand that forces affect the movement of objects and that there are six types of simple machines. To demonstrate their knowledge of these ideas, students will be assigned in groups of three to design a Rube Goldberg machine using three out of six types of simple machines. Rube Goldberg machines are named after a famous cartoonist who depicted various objects following a path of motion to perform a simple task. Pre-AP students will decide what the everyday task in their machines will be. The teacher should give other students some options for the everyday task such as getting a marble into a cup at the end of the path of motion. Students must use at least three types of simple machines to make the machine work and at least two compound machines; however, the entire machine must follow seven steps to complete the task. See attached rubric for details.

Other evidence:	**Vocabulary Development:**
(quizzes, tests, academic prompts, self-assessments, etc) Quiz 1- Force & Motion Quiz 2- Levers Quiz 3- Pulleys Exit Slips Self Assessments District Test (Multiple Choice)	Word Wall Frayer Model vocabulary Thinking Maps (Graphic Organizer) Daily Warm-Up Science Investigation Journals

Stage 3: Learning Activities

(Steps taken to get students to answer Stage 1 questions and complete performance task)

Teacher Note: A helpful way for students to remember the six simple machines is simply the use of hand gestures. Decide which hand gestures are appropriate to use and easy to remember. When reviewing the machines every day, have the students go through the hand gestures with you. This is especially important for bodily-kinesthetic learners, but benefits everyone.

Day 1: Daily Warm-Up- *When you hear the word "machine", what do you usually think of*? Discuss answers for a few minutes. Then, tell students that you are about to observe some machines. Pass out various school supplies like a ruler, scissors, pens, etc. In groups of three, tell students to describe how these items might be classified as machines. What do they do? What do they have in common? What purpose do they serve? In Science Journals, have students classify the items in a way that makes sense to them. A prompt might be: "Machines that…." Students should think of at least three categories to place the items in. All objects on the table should be used. Have students share their categories with the class. On an exit slip, write the question: What do all these objects need in order to work? Students will turn in their exit slips before leaving for the day.

Day 2: **How do forces affect the movement of an object?**
Daily Warm-Up: *What kinds of forces allow you to do every day activities?* Discuss student answers after a few minutes. Make sure to address misconceptions about forces. *Introduce Newton's 1st Law of Motion.* Conduct a quick lab about forces using a flat ruler and two pennies on a desk. Place one penny on the edge of the table and one penny on the edge of the ruler. Place the edge of the ruler 2 inches off the edge of the table. The 2-inch mark on the ruler should be lined up with the edge of the desk. Hold the ruler by the end that is on the desk. Move the ruler quickly so that it knocks the penny off the table and the other penny drops. Repeat this several times. Record the observations of both pennies in Science Journals. Before students leave, they will answer and turn in the following question about the lab on an exit slip. How does force affect the direction of the two pennies? (Lesson adapted from Holt Science & Technology Textbook for 7th Grade)

Days 3-4: **How do forces influence the way individual simple machines work?**
Daily Warm-Up- *Describe the relationship between force and motion.*
Students will create a tri-fold book placing two simple machines in each section. This will be added to every day as they continue to learn more about simple machines. It will also serve as a study guide for quizzes. For the next two days, they will learn about levers. Define what a lever is. Students should write both the book definition and also a definition in their own words in the tri-fold book. They should include a picture of what a simple lever looks like. They can make the drawing more detailed as they learn more. The first Levers lab introduces students to three types of levers: 1st class, 2nd class, and 3rd class. Students will complete the lab after the teacher initials each section of the lab. Teachers will grade whether or not the student understands the three basic lever types by reviewing the analysis diagram and analysis/conclusions page. The lab is titled "Learning About Levers" and can be found at http://science-class.net . Once there, click on Physics, then Simple Machines & Work. Then click on Learning Levers.

Day 5: Daily Warm-Up- *Which every day items do you think are classified as 1st class levers*?
Using some of the tools from Day 1, have students identify which types of levers the tools contain. Students should work in pairs. In science journals, students must correctly identify the fulcrum, load, location of input force and output force. Students will then combine with another group and share their findings. Then the class will all come back to a class discussion of their findings. Have students explain their reasoning for their answers. Then, address misconceptions if there are any incorrect answers. At the end of the day, have students answer three questions on an exit slip: 1) List three items that were examples of 1st class levers 2) List three items that were examples of 2nd class levers and 3) List three items that were examples of 3rd class levers.

Day 6: Daily Warm-Up- *List as many types of planes as you can.*
Discuss with students the double meanings in this case. A plane is a flat surface, not something that travels through the air. Pass out note cards. Tell students to write the word "inclined plane" in the middle of the card and circle it. Then draw four lines coming out the circle in the cardinal directions (North, South, East, and West). In the top left section of the card, write the book definition of the word inclined plane. In the top right section, students should write the definition of inclined plane in their own words. In the bottom left section, students will draw or write an example of an inclined plane. In the bottom right section, students will draw or write a non-example such as an airplane or field (plain). After students complete this, they will conduct a simple experiment about inclined planes.

You will need string, a spring scale, blocks of various sizes, a wooden board, and a metric ruler. Each group will use string to attach a block to the spring scale. Students will use the wooden board and the remaining blocks to build a ramp. Students will use the spring scale to pull the block up the ramp to the tops of the supporting blocks and record the force used. Students will then measure and record the distance they pulled the block along the ramp. They should conduct the trials two more times, each time changing only the angle of the ramp. Students will make a chart of their data to compare the force and distance for each trial. They will also calculate the Mechanical Advantage (MA) of the three planes. Mechanical Advantage can be calculated using the following formula: MA= Length of Plane/ Height of Load Lifted. Discuss the results as a class. Responses should include observations of how the simple machine made work easier as the angle was changed. (Lesson from Holt Science & Technology 7th Grade textbook) Students will then describe and draw an inclined plane in their tri-fold books.

Day 7: Daily Warm-Up- *How would you divide a whole object into two equal pieces*?
Allow students to offer their suggestions. Then, as a class demonstration, cut open a whole fruit. Use a fruit with small seeds like a cantaloupe, melon, or watermelon. Large seeds will prevent from cutting all the way through it. Explain to students that as you cut, you are applying more force to the fruit. The further you go, the more force is applied until the fruit splits apart. Ask students to describe why a knife would be considered a simple machine. Answers should include that knives help humans do useful work (cutting things open). Could knives be considered any other type of simple machine? Why or why not? Explain to students that the knife is in fact a simple machine- a wedge. A wedge is a double inclined plane that moves. It applies an output force that is greater than the input force, but the input force is applied over a greater distance. In groups of three, have students observe, describe and draw examples of wedges in their tri-fold books.

Another type of inclined plane is one that is wrapped around a cylinder- a screw. When you rotate a screw, you apply a small force over a long distance along the inclined plane of the screw. The screw applies a large force through the short distance that is pushed at the same time. Other examples of screws are jar lids, soda bottle caps, fasteners such as bolts, and what we typically consider screws to be. Students will observe examples of screws, describe and draw a picture of one in their tri-fold books.

Day 8: Warm-Up-*What are pulleys useful for?*
A pulley is a simple machine that consists of a grooved wheel that holds a cable. A load is attached to one end of the cable or rope and an input is applied to the other end. There are two kinds of pulleys- fixed and movable. Fixed pulleys are attached to stationary objects. Movable pulleys are attached to the moving object and do not change a force's direction. However, they do increase force. The mechanical advantage of a movable pulley is the number of rope or cable segments that support the load. You must make both sides of the rope move in order to lift the load. When fixed and movable pulleys are combined, it makes a block and tackle. An example of a machine that uses block and tackles is a crane, which is used to lift very heavy loads. Students will draw and describe the three types of pulleys.

To demonstrate how the three types of pulleys work, students will conduct the pulleys lab procedure found at the end of this unit.

Day 9: Warm-Up- *Why is a faucet considered to be a simple machine?* **How do machines help humans do work?**
A faucet is a simple machine called a wheel and axle which consists of two circular objects of different sizes. Examples of wheels can be cranks such as the handle on a pencil sharpener or the volume knob on a stereo. Examples of axles are the smaller of the two circular objects such as wrenches, screwdrivers, and steering wheels. To calculate the mechanical advantage of wheel and axles, divide the radius of the wheel by the radius of the axle. Turning the wheel yields a result of greater than 1 because the radius of the wheel is larger than the radius of the axle.

Using the tri-fold book as a resource, students will describe how three of the machines they learned about help make every day activities easier. Tell students that when two or more simple machines are combined, they result in a compound machine. Ask students to think of examples of how the simple machines can be combined to make a compound machine. Then, have students share their ideas with a partner for a few minutes. Then, open up the discussion to the rest of the class. After listening to some ideas, you may choose to give some examples of some compound machines if they are not mentioned in the discussion such as a can opener, pencil sharpener, or zipper on a backpack. Tell students that their ideas will help them on their project for the end of this unit. Introduce the performance assessment.

Day 10-14 Students will build the Rube Goldberg machine in class.

Day 15 Students will present their machines and test to see if the machine actually completes a simple task.

Day 16 Students will take a District multiple choice test.

Pulling Pulleys

Objective: Students will understand how simple pulleys work.

Materials:

Pulley	Kilogram Mass Kit
Crossbar	Spring Scale
Rope	Meterstick

Procedure:

1. Construct a fixed pulley system by hanging a **pulley** from a **crossbar** on a table. Thread a length of **rope** through the pulley.
2. Tie one end of the rope to a 1 kg mass. Tie the other end to a spring scale.
3. Pull the spring scale to lift the mass 1 m. Record the force you used in your Science Journal. Use a meterstick to measure the distance you had to pull the rope. Record the distance in your Science Journal.
4. Now construct a movable pulley system by tying one end of the rope to the crossbar. Thread the rope through the pulley so that the pulley hangs from the middle of the rope. Tie the other end of the rope to the spring scale. Then hang the mass from the pulley.
5. Pull the spring scale to lift the mass 1 m. Record the force you used. Measure and record how far you had to pull the rope.
6. Repeat steps 2-5 using a 2 kg mass.
7. Repeat steps 2-5 using a 3 kg mass kit.

Analysis:

Which pulley system had the greater mechanical advantage?

Which kilogram mass produced the greatest force?

Rube Goldberg Machine Rubric

	Exceeds Expectations +4	Meets Expectations +3	Approaches Expectations +2	Does Not Meet Expectations +1or 0
Machine Blue Print	Blue print is drawn and labeled neatly	Blue print is drawn and labeled, but is not very neat	Blue print is drawn, but a few parts of the machine are missing	Blue print is not drawn
Machine Appearance	Machine is very well assembled neatly labeled	Machine is well assembled and labeled	Machine is assembled, but lacks support	Machine is not assembled
Simple Machines	All six simple machines are used	3 out of 6 simple machines are used	2 simple machines are used	Only 1 simple machine is used
Compound Machines	3 or more compound machines are used	2 or more compound machines are used	1 compound machines are used	No compound machines are used
Machine Performance	Seven or more machine components work properly and **work*** is completed at the end of the course	At least five components of the machine work properly and work is completed at the end of the course	At least three components of the machine work properly, but work is not completed at the end of the course	At least one component of the machine works and work is not completed at the end of the course
Machine Description	Description of the machine structure and function is clear and neatly included in a separate folder	Description of the machine structure and function are included	Little description of machine structure and function are included	No description of machine structure and function are included

* The term **work** means that the machine was useful in completing an everyday task.

Self-Assessment

1) How well did you understand the assignment?
    a. Very Well
    b. Somewhat
    c. Not at All
2) How well did you participate with your group to complete the assignment?
    a. I gave my best effort
    b. I could have contributed a little more
    c. I did not help my group at all
3) What grade would you give yourself for this assignment?
    a. 90-100 I did my best work, understood the assignment, and participated very well with my group
    b. 80-90 I worked hard, understood the assignment, and I participated with my group sometimes
    c. 70-80 I did my part, but did not help my group with anything else
    d. 69 and below I did not participate with my group and did not complete my part of the assignment
4) My group role was: _____

Rube Goldberg Machine
Performance Assessment Information Sheet

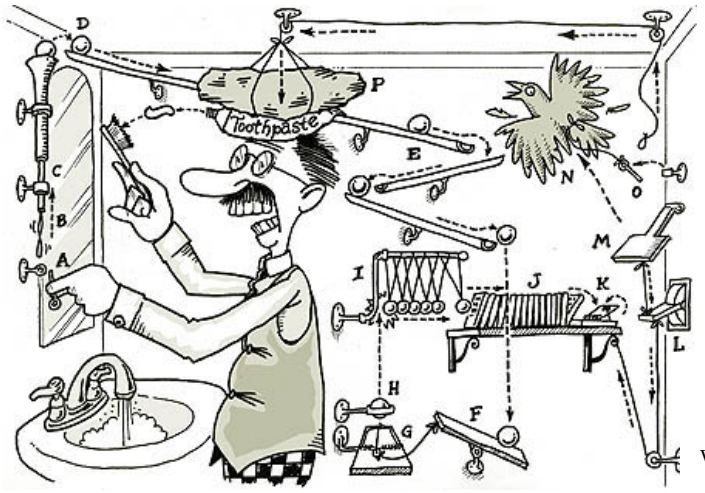
For this project, you will be graded based on how well you perform your group role and how well your machine performs. The purpose of this assignment is to demonstrate your knowledge of how simple and compound machines do useful work for an everyday task. Your groups have already been assigned, but you will choose what your role will be. Everyone in the group must be in agreement of the group roles before you begin. You may not change your group role once your group agrees on it. If there are problems with this, you will be assigned your group roles by your teacher.

You may choose what type of useful work your machine will do or your teacher may assign one to you. Your machine will need to go through 7 steps of simple and compound machines. You must include three simple machines and two compound machines, but in the end you must have completed 7 steps to do work. You may use some simple machines more than once.

The following are group roles for this performance task:

- Designer/Engineer- With the input of the others in the group, the designer will draw a blue print for the machine. After the blue print is finished, help your group build the machine.
- Materials Manager/Engineer- Will make sure that the group has all the necessary materials to build the machine. If the group needs more materials after they start building, it will be the Materials Manager's job to get more. After you gather materials, you may become an engineer to help your group build the machine.
- Persuader/Engineer- Will write a persuasive description convincing the teacher what this machine is useful for and why s/he should buy one. All seven parts of the machine must be described as to how they do work. Include whether each part is a simple machine or a compound machine in the overall machine. When you are finished with this, you may help your group finish building the machine.

This assignment is due on _____. Use the rubric to check what grade you might get. Also, be sure to complete the self-assessment so you can grade yourself on how well you did on this project. Have fun and good luck!



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