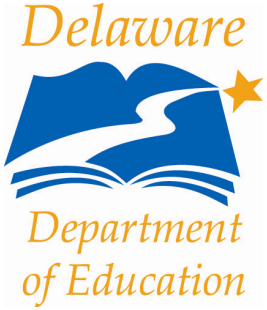
Delaware Science Coalition

Grade 6 Simple Machines Unit Template



Preface: This unit has been created as a model for teachers in their designing or redesigning of course curricula. It is by no means intended to be inclusive; rather it is meant to be a springboard for teacher thought and creativity. The information we have included represents one possibility for developing a unit based on the Delaware Science Content Standards, the Delaware Science Coalition units, and the Understanding by Design framework and philosophy.

Unit Summary:
Simple machines are devices used to transfer energy to accomplish tasks that would otherwise be more difficult or impossible to complete without the use of the simple machine. Simple machines typically operate by decreasing the amount of effort force that the used must supply, however the trade-off is that the user must exert this force over a larger distance. This relationship is also a focus of the Simple Machines unit. Examples of simple machines include the lever, pulleys, and inclined planes.

Stage 1: Desired Results
Delaware Science Content Standards

This course focuses on the Delaware Science Content Standards and Grade Level Expectations in Standards 1 and 3 found on the following web site: http://www.doe.k12.de.us/programs/ci/content_areas/science.shtml

Standard 1: Nature and Application of Science and Technology
Understandings and Abilities of Scientific Inquiry
Students should know and be able to:

1. Understand that: Scientific investigations involve asking testable questions. Different kinds of questions suggest different scientific investigations. The current body of scientific knowledge guides the investigation.
    - Be able to: Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.
2. Understand that: A valid investigation controls variables. Different experimental designs and strategies can be developed to answer the same question.
    - Be able to: Design and conduct investigations with controlled variables to test hypotheses.
3. Understand that: In a scientific investigation, data collection involves making precise measurements and keeping accurate records so that others can replicate the experiment.

- Be able to: Accurately collect data through the selection and use of tools and techniques appropriate to the investigation. Construct tables, diagrams and graphs, showing relationships between two variables, to display and facilitate analysis of data. Compare and question results with and from other students.

4. Understand that: There is much experimental and observational evidence that supports a large body of knowledge. The scientific community supports known information until new experimental evidence arises that does not match existing explanations. This leads to the evolution of the scientific body of knowledge.
    - Be able to: Form explanations based on accurate and logical analysis of evidence. Revise the explanation using alternative descriptions, predictions, models and knowledge from other sources as well as results of further investigation.
5. Understand that: Evaluating the explanations proposed by others involves examining and comparing evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations. Conflicting data or conflicting interpretations of the same data suggest the need for further investigation. Continued investigation can lead to greater understanding and resolution of the conflict.
    - Be able to: Communicate scientific procedures, data, and explanations to enable the replication of results. Use computer technology to assist in communicating these results. Critical review is important in the analysis of these results.
6. Understand that: Scientific habits of mind and other sources of knowledge and skills are essential to scientific inquiry. Habits of mind include tolerance of ambiguity, skepticism, openness to new ideas, and objectivity. Other knowledge and skills include mathematics, reading, writing, and technology.
    - Be able to: Use mathematics, reading, writing, and technology when conducting scientific inquiries.

Standard Three: Energy and Its Effects

Forces and the Transfer of Energy

Students should know that:

1. When the forces acting on an object are balanced, its motion will not change. Unbalanced forces will cause the object's motion to change. Changes in motion depend upon the size and direction of the total unbalanced force exerted on the object.

Students should know that:

2. Gravity is a force that acts between masses over very large distances. Near the Earth's surface, gravity pulls objects and substances vertically downward.

Students should know that:

3. Forces can be used to transfer energy from one object to another. Simple machines are used to transfer energy in order to simplify difficult tasks.

Students should be able to:

- Conduct investigations using simple machines to demonstrate how forces transfer energy. Explain that simple

machine may change the direction of an applied force (directional advantage) or the size of the force that is applied (mechanical advantage) but that the amount of energy transferred by the simple machine is equal to the amount of energy transferred to the simple machine.

- Design a device that relies on the directional and/or mechanical advantage of a simple machine to perform a task (e.g., lift a weight, move a heavy object). Identify the forces and motions involved, the source of the energy used to complete the task, and how the energy is used by the simple machine.

Big Ideas

- Simple machines are used to transfer energy in order to complete a task.
- Simple machines may change the direction of an applied force (directional advantage) or the size of the force that is applied (mechanical advantage) but that the amount of energy transferred *by* the simple machine is equal to the amount of energy transferred *to* the simple machine
- The effort force and the effort distance form an inverse relationship (sometimes described in terms of "trade-off"). This relationship stems from the fact that it takes a specific amount of energy to complete a given task.

Unit Enduring Understandings

- Changes take place because of the transfer of energy. Energy is transferred to matter through the action of forces. Different forces are responsible for the transfer of the different forms of energy.

Unit Essential Question(s)

- What makes a question scientific?
- What constitutes evidence? When do you know you have enough evidence?
- Why is it necessary to justify and communicate an explanation?
- How can energy be transferred from one material to another? What happens to a material when energy is transferred to it?

Knowledge & Skills
Students will know….

- All simple machines operate on the fact that the input energy is equal to the output energy, but the effort force and effort distance are most likely different from the load/resistance force and load/resistance distance.
- The ratio (comparison) of load/resistance force to the effort force is called the mechanical advantage (MA).

- When using simple machines, the smaller the effort force, the larger the effort distance. This is an inverse relationship.
- The load is not an object, but a force. The "load" in a simple machine system is typically the weight of an object, but it can also be a resistance force such as the force of friction between a nail and a piece of wood.
- A lever is composed of three basic parts. They are the effort force, the load/resistance force, and the fulcrum.
- The placement of the fulcrum, effort force, and the load/resistance force determines the classification of the lever and more importantly how it can be used to transfer energy.
- A pulley can create an advantage to the user simply by changing the direction of the effort force and it may or may not also provide a mechanical advantage as well.
- An inclined plane can also provide a mechanical advantage to its user. The longer the inclined plane, the smaller the effort force needed to move the object up the inclined plane.
- A screw is actually an inclined plane wrapped around an axis.

Students will be able to…

- Determine where to place the effort force and fulcrum in order to lift an object with the least amount of effort force.
- Read a spring scale to measure the amount of effort force.
- Recognize and describe how levers used in daily life.
- Describe the relationship between the effort force and the effort distance.
- Collect data in a single and a double pulley system.
- Make observations of pulley systems and draw conclusions using data.
- Use multiplication skills to complete a data table.
- Draw conclusions about data from previous inquiries to use with present investigations.
- Identify the effort force and effort distance in an inclined plane system.
- Make observations about inclined plane systems, collect data in an inclined plane system, and draw conclusions.
- Apply knowledge of inclined plane systems to practical applications.
- Identify how the screw is an example of an inclined plane.
- Conduct investigations using simple machines to demonstrate how forces transfer energy. Explain that simple machines may change the direction of an applied force (directional advantage) or the size of the force that is applied (mechanical advantage) but that the amount of energy transferred *by* the simple machine is equal to the amount of energy transferred *to* the simple machine.

Stage 2: Assessment Evidence
(Design Assessments To Guide Instruction)

This Simple Machines unit is assessed through the use of an end-of-unit summative assessment. This assessment is intended to uncover student misconceptions which will then direct instruction. Both the student guide and teacher directions and rubrics are included. To access the end-of-unit summative assessment, go to the website listed below. Click on the Delaware Science Comprehensive Assessment Program.

http://www.doe.k12.de.us/programs/ci/content_areas/science.shtml

Key Transfer Ideas:

1. The longer the inclined plane, the smaller the effort force needed to move the object up the inclined plane and vice versa.
2. In a lever and fulcrum system, placement of the fulcrum closer to the load will reduce the amount of effort force needed to lift the load.
3. Directional advantage in a pulley system can create an advantage for the user.
4. Mechanical advantage in a pulley system can create an advantage for the user.
5. Energy input in a pulley system is equal to the effort force multiplied by the effort distance.

Student Expectations:

- Compare the force and distance relationship in terms of energy using the terms effort force, effort distance, and energy.
- Position a fulcrum on a lever to obtain the greatest mechanical advantage.
- Explain mechanical advantage in terms of force and distance.
- Identify the advantages (mechanical or directional) of different pulley systems.
- Compare data to support or refute the conclusions drawn.
- Given a problem, design a solution using at least two simple machines. Illustrate the solution and describe how the solution solves the problem.

Other Evidence

Formative assessment is embedded in each activity under the heading “Investigation Reflection”. This reflection in intended to inform the

teacher of student misconceptions and level of understanding prior to going further.
Example: Activity 1.

1. Diagram a lever system and identify the three parts of the lever.
2. How does the placement of the fulcrum (the pivot point) affect how much effort force is used to complete the task (lift the object)?
3. Where should the user exert his/her effort force in a lever system to maximize the lever's effectiveness?

Formative assessment is embedded in each activity under the heading "Summary of Activity". Students journal their responses to questions regarding the investigation. Questions span cognitive levels.
Example: Activity 1

1. What are the parts of a lever system?
2. How can a lever system be used to accomplish a task such as lifting a large object?
3. Describe how the placement of the fulcrum and the effort force affects how effective the lever is in accomplishing the task.

Transfer tasks and/or questions are found at the end of each activity. These transfer tasks are designed for students to apply learned knowledge and skills to new and different situations.
Example: Activity 1
Two brothers are on a playground after school one day. The older brother weighs twice as much as the younger brother. They both want to use the see-saw on the playground, but with the see-saw pivot in the middle, the younger brother can't get his older brother off the ground. They notice that the see-saw can be adjusted so that the pivot point is not directly in the middle. Describe how the brothers could adjust the pivot point of the see-saw so that the younger brother could get the older brother off the ground.

Student Self-Assessment and Reflection

Students will keep a journal throughout this unit. All notes, questions, data and reflections will be recorded in the journal.

Daily warm ups, bell ringers will be given to self assess and will also be recorded in the student's journal.

Stage 3: Learning Plan
(Design Learning Activities To Align with Goals and Assessments)

Key learning events needed to achieve unit goals

1. Lesson 1: Getting Some Leverage on Simple Machines: Students are introduced to the most common simple machine, the lever, and how it plays a part in everyday life. Students identify the effort force, the fulcrum, and the resistance force in a simple lever system. Students recognize that the placement of the effort force, the fulcrum, and the resistance force will affect the effectiveness of the lever system. Lastly, students are introduced to the effort force & effort distance relationship.

2. Levers Move the World. Students identify the effort force, the fulcrum, and the resistance force in a simple lever system. They investigate the effect of lengthening the effort arm on the effort force and the mechanical advantage of a lever system. Students collect data and draw conclusions about the collected data. Students investigate the effort force & effort distance relationship.

3. Other Lever Systems. Students identify the effort force, the fulcrum, and the resistance force in a 2^{nd} and 3^{rd} class lever systems. They investigate the effect of changing the position of the effort force, resistance force, and the fulcrum. They then use these observations to draw conclusions about the advantages and disadvantages of using various lever systems to transfer energy. Again, students make observations about the effort force & effort distance relationship.

4. Pulleys. Students identify the effort force, the pulley (as either fixed or moveable), and the resistance force in pulley systems. They investigate the effect of using fixed and moveable pulleys on the effort force, effort distance, and the mechanical advantage of a pulley system and distinguish between a mechanical advantage and a directional advantage. Students collect data and draw conclusions about the collected data to investigate the effort force & effort distance relationship in pulleys.

5. Simple Machines and Energy. Students use numerical data from previous activities to prove that an inverse relationship exists between the effort force and the effort distance. They recognize that when a simple machine is used, by applying an effort force over a specific effort distance, energy is transferred from the user to the machine to accomplish this task. Students interpret data from previous activities and draw conclusions about the effort distance, effort force, and the energy transferred during the process and quantify the amount of energy used by a simple machine to accomplish a specific task.

6. Inclined Planes. Students identify the effort force and the effort distance in an inclined plane system. They investigate the effect of lengthening the effort distance on the effort force and the mechanical advantage of a lever system and collect data and draw conclusions about the collected data. Students describe inclined plane systems in terms of the effort force & effort distance relationship using the concept of energy transfer that was discussed in the previous activity.

Resources & Teaching Tips

Full Option Science System (FOSS), Levers and Pulleys (Teacher's Guide and FOSS Science Stories). ©2000
Resource: Delaware Department of Education Unit. Simple Machines. 2006.

Kids Discover magazine "Simple Machines"

Idaho PTV.org: http://www.idptv.state.id.us/dialogue4kids/season7/simplemachines/links.html. Student interactive links and teacher resources for Simple Machines.

Simple Machines. Student interactive web site for Simple Machines. www.Edheads.org

Macauley, David. The New Way Things Work. 1998. Houghton Mifflin Company. ISBN #9780395938478 **(book and video – levers and pulleys)**

- **What tips to teachers of the unit can you offer about likely rough spots/student misunderstandings and performance weaknesses, and how to troubleshoot those issues?**

Bill Nye web site from Disney Educational Products. Simple Machines.
http://dep.disney.go.com/educational/billnye_experiment?id=77A19VL00

Hagley Museum exhibit on simple machines. http://www.hagley.lib.de.us/

Accommodation/Differentiation ideas and tips

1. Use a word wall.
2. 2. When working with compound pulleys, work in groups of 2 rather than 4.

Tip: Emphasize energy.

This unit is the transition point from a force perspective to an energy perspective (that will be used well into the high school curriculum). It will be very important to get good data in the levers (Act. #2) and pulleys (Act. #4) sections as that data will be used in the energy activity following these activities. The emphasis is on how simple machines transfer energy, so do not spend a great deal of time having students memorize the names or classes of levers and/or pulleys. Keep in mind that the main idea is to get students to be able to describe how levers, through the action of forces, transfer energy.