CURRICULUM ALIGNMENT

Overview

The PCS Academy of Engineering was developed and aligned to several different science and technology standards. The emphasis of accountability in the classroom requires that lessons are presented in accordance with standards. To assist the educator, PCS offers the following sample benchmarks that are associated with this unit's projects and challenges. These examples are by **no means conclusive** or **definitive**, but are included as a resource tool for the educator.

For the purposes of the PCS AOE Simple Machines Series text, samples will be provided from the American Association for the Advancement of Science's **Benchmark for Science Literacy Project 2061** (grades 6-8), the **Core Knowledge Sequence**, the International Technology Education Association's **Standards for Technological Literacy: Content for the Study of Technology**, and attainment standards from the **National Curriculum** of the UK.

Examples of Standard Alignment

AAAS, BENCHMARK 2061

"Thinking about things as systems means looking for how every part relates to other. The output from one part of a system (which can include material, information or energy) can become the input to other parts." p265

ITEA TECHNOLOGY CONTENT STANDARDS

Standard 2: Core Concepts of Technology
"Tools are used to design, make,use, and assess technology." p35

CORE KNOWLEDGE SEQUENCE (SCIENCE):

"Identify simple machines (e.g. lever, pulley, incline plane, wedge, gears)." (Taken from Correlation of Core Knowledge Sequence and Colorado Grade Level Expectations, p54) Science Biographies: "Explain the significance of the achievements of individual scientists and inventors from many cultures (e.g....the impact of the printing press on who had access to books)." p115

NATIONAL CURRICULUM

Design and Technology, Level 7
"They investigate form, function and production processes before communicating ideas, using a variety of media."

BACKGROUND

Terms

BICYCLE
COMPLEX MACHINE
COMPOUND MACHINE
RUBE GOLDBERG
SIMPLE MACHINE

About Compound Machines

A simple machine is a device that has one function, a minimum of moving parts, and makes work seem easier by overcoming some resistance such as gravity or friction. Examples of simple machines are levers, inclined planes, wheels and axles, pulleys, screws, and wedges.

Often, simple machines are used together in a larger machine. A compound machine is a device made of two or more simple machines that work together to make a task easier.

Simple machines can be thought of as the building blocks of compound machines.

Examples of Compound Machines:

Can Opener: The handles of a can opener are levers, a wheel and axle turn the blade (a wedge), which cuts into the can.

Wheelbarrow: Although the wheelbarrow is often used as an example of a second class lever, the fulcrum is a wheel and axle, and the bucket is an example of an inclined plane, allowing a person to carry and dump a load of gravel.

Bicycle: There are many simple machines integrated in a bicycle. The handlebars are levers, the pedals are inclined planes and the machine depends on two sets of wheels and axles.

Many modern devices are complex machines. A complex machine is a device made of many simple and compound machines. An automobile which relies on many different simple and compound machines would be an example of a complex machine.

"Wow"

The following is a class project that allows students to explore simple and compound machines

1. Students will need a pencil and some paper.

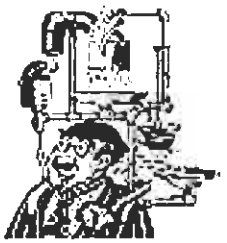
2. Ask students to write the definition of at least three different simple machines, and draw an example of each machine

3. Instruct students to sketch a compound machine, identifying the different simple machines. This compound machine may be one of the examples, or one identified by the instructor.

4. Ask students to sketch a Rube Goldberg machine

Rube Goldberg (1883-1970) was a Pulitzer Prize winning cartoonist, who invented absurd and complicated machines that work in roundabout ways to perform a simple task

His devices used household objects and simple machines that achieved an objective in some sort of progression. For example, a mouse trap switches on a fan, which blows on a sail attached to a toy car, which will move forward and bump a weight off a table, which in turn will fall and flip a switch.



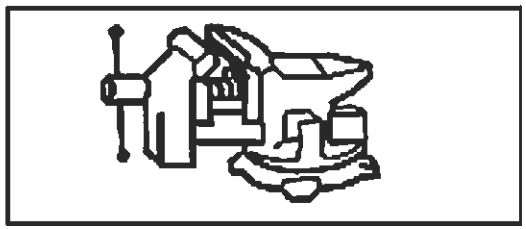
Project 2: Workshop Vice #0028

Make sure you have:

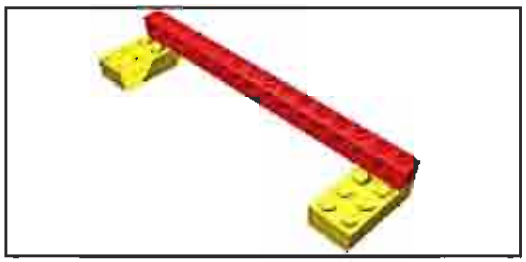
- 1 - #12 axle
- 3 - #4 beams
- 2 - #12 beams
- 6 - 2x4 bricks
- 2 - rack gears
- 2 - friction pegs
- 4 - 1x4 plates
- 1 - medium pulley
- 2 - #2 beams
- 2 - #10 beams
- 2 - #16 beams
- 4 - bushings
- 1 - worm gear
- 9 - connector pegs
- 2 - 1x2 plates
- 1 - 2x4 plate
- 1 - O ring

Build...

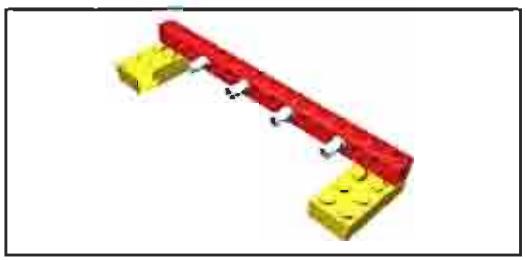
1. In this project, you will build a model of a workshop table vice. It is a compound machine that integrates a worm gear, a wheel and axle, and inclined planes.



2. Connect two 2x4 bricks with a #16 beam. The ends of the beam should be flush with sides of the bricks.

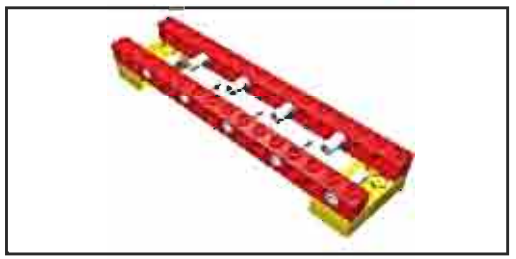


3. Insert connector pegs into the fourth, seventh, tenth, and thirteenth beam holes.



4. Collect a second #16 beam, and insert connector pegs into the far side of the beam and into the third, sixth, ninth, twelfth, and fifteenth holes.

5. Connect the other end of the 2x4 bricks with the second #16 beam. The two sets of connector pegs should face each other.



6. Add a 1x4 plate to each end of two #10 beams, and place the beams on the near end of the #16 beams. Add a 2x4 brick connecting the ends of the #16 beams.

Name:

Date:

Project 2: Workshop Vice

7. Center two #2 beams on the 1x4 plates at the near end of the model. Connect the 1x4 plates on the other end of the #10 beams with two #4 beams. Cover the #4 beams with a 2x4 brick. Set the model aside.

8. Connect two #12 beams side by side with two friction pegs at each end.

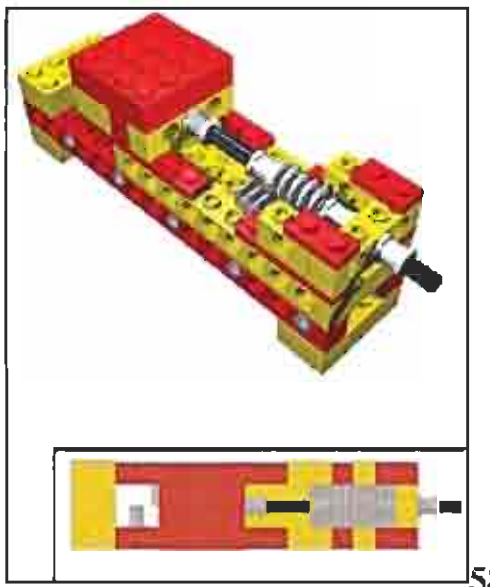
9. Add two rack gears one stud over from one end of the beams.

10. On the opposite end of the #12 beams, place a 2x4 plate covered by two 2x4 bricks. Place it flush with the end of the #12 beams.

11. Slide the #12 beam assembly onto the model, resting the beams on the connector pegs that extend from the #16 beams. You should have to temporarily remove the #4 beams and 2x4 brick.

12. Place a #4 across the #12 beams so it is touching the #2 beams. Cover the cracks by adding a 1x2 plate to each side.

13. Slide a #12 axle into the center hole of the #4 beam. As it is sliding through, add a bushing, a worm gear, and two more bushings. Once it is in place add a fourth bushing to fix it into place. Slide the worm gear so that it connects with the rack gears and is fixed in place with two bushings. The #12 axle should extend slightly into the pair of #4 beams.

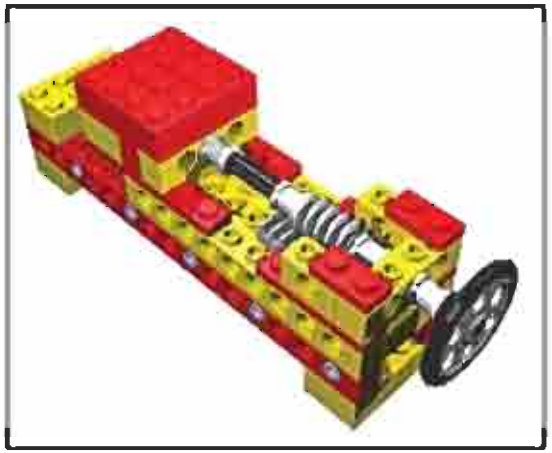


Name:

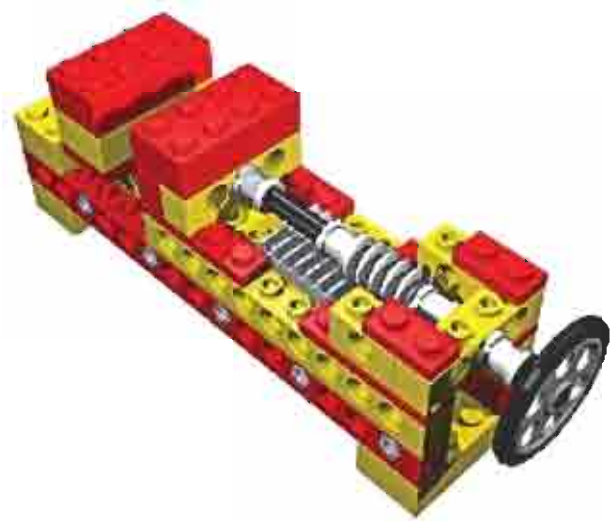
Date:

Project 2: Workshop Vice (Cont'd)

14. Add a medium pulley with an O ring to the extended end of the #12 axle.



15. Your finished model should look like this:



Try this...

1. Turn the medium pulley counterclockwise until the vice jaw opens all the way.

2. Turn the pulley clockwise until the vice closes. As the jaw is closing, try inserting a piece of paper. Can the vice close tight enough to hold the paper?

   Yes ☐ No ☐

3. Sketch your model and identify at least two simple machines that make up this compound machine.

Name:

Date:

Academy of Engineering

ME201: Modification and Application of Simple Machines
UNIT 6: Compound Machines

UNIT QUIZ

Name:

Date:

MULTIPLE CHOICE: Circle the best answer.

1. A simple machine is a device that...
   a) Has one function
   b) Has a minimum of moving parts
   c) Makes work seem easier by overcoming some resistance
   d) All of the above

2. A device made of two or more simple machines that work together to make a task easier is called...
   a) Simple Machine
   b) Secret Machine
   c) Double Machine
   d) Compound Machine

3. A device made of many simple and compound machines is referred to as a...
   a) Complex Machine
   b) Simple-Compound Machine
   c) Compounded Machine
   d) Extreme Machine

MATCH: Write the letter on the line that represents the matching word.

Lettuce	____	**A.** Simple Machine
Wheelchair Ramp	____	**B.** Compound Machine
Wheelbarrow	____	**C.** Complex Machine
Bicycle	____	**D.** This is not a machine

SHORT ANSWER:

1. What is a compound machine? Give an example

2. Identify at least three simple machines incorporated into a common hand-held can opener:

3. Sketch an example of a compound or complex machine and label the simple machines.

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Academy of Engineering: Simple Machines Series

Alignment with the National Science Education Standards

Introduction:

The Third International Mathematics and Science Study found the students in the United States to be below average in Science and Mathematics scores when compared with other nations. This was especially telling in the area of Physics where U.S. high school students scored last of the 22 countries taking the test. It is important for our students to improve their understanding of the physical sciences and especially basic physics principles in order to be competitive in today's world. Understanding simple machines provides an introduction to the study of physics and engineering.

The National Science Education Standards were presented in 1996 to provide a framework for programs to evaluate their progress in helping all students achieve scientific literacy. The following rubric will help teachers identify which Standards this Academy of Engineering program addresses.

National Standards met when using this program:

The following will provide a guide for teachers to easily evaluate which standards the Simple Machines lessons will meet. It will also attempt to evaluate the extent to which each of these applicable Standards (and sub-units of Standards) is met. The age group for which this program was written falls between the K-4 and 5-8 grade divisions of the National Science Education Standards, therefore both divisions are evaluated. Each of the Standards has sub-units, which better define each grade level's content and examples of how each goal might be met. If a Standard is fully met with all sub-units addressed, a +++ is assigned to that Standard. If the Simple Machines program meets most of the sub-units' goals, a ++ is assigned. If only some of the sub-units are met, a + is given. The sub-units listed under each Standard are especially pertinent to the Simple Machines program.

Content Standard	Grade K-4	5-8
A. Science as Inquiry Abilities necessary to do scientific inquiry Understandings about scientific inquiry	+++	+++
B. Physical Science Position and motion of objects Motions and forces Transfer of energy	+++	+++
E. Science and Technology Abilities of technological design Understandings about science and technology Abilities to distinguish between natural objects and objects made by humans	+++	+++
F. Science in Personal and Social Perspectives Science and technology in local challenges Risks and benefits Science and technology in society	++	++
G. History and Nature of Science Science as a human endeavor Nature of science	+	+

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Academy of Engineering: Simple Machines Series

Alignment with the Project 2061 Benchmarks for Science Literacy

Introduction

The American Association for the Advancement of Science constructed benchmarks for measuring student progress toward scientific literacy. These benchmarks were published before the National Science Education Standards were completed. At about the same time individual states were undertaking systemic reform efforts in mathematics, science, and technology. Because they preceded the Standards, they were used as models of progress by a number of schools and programs. They are included as a helpful resource for those schools using benchmarks as a measure of competency in science literacy.

+ + + = met all sub-units addressed
+ + = met most sub-units addressed
+ = met some sub-units addressed

NA means there are no benchmarks for that level.

Benchmark	Sub-unit of Benchmark	Grade K - 2	Grade 3 - 5	Grade 6 - 8
1. The Nature of	1.A The scientific world view	+ +	+ +	+
Science	1.B Scientific inquiry	+ +	+ +	+ +
	1.C The scientific enterprise	+ +	+ +	+ +
2. The Nature of	2.A Patterns and relationships	+ + +	+ + +	+ + +
Mathematics	2.B Mathematics science and technology	NA	NA	+ + +
	2.C Mathematics inquiry	+ +	+ +	+ +
3. The Nature of	3.A Technology and science	+ + +	+ + +	+ + +
Technology	3.B Design and systems	+ + +	+ +	+ +
	3.C Issues in technology	+ +	+ + +	+ +
4. The Physical	4.F Motion	+ +	+ + +	+ +
Setting	4.G Nature of forces	+ +	+	+
11. The Common	11.A Systems	+ + +	+ + +	+ + +
Themes	11.B Models	+ + +	+ + +	+ +
	11.D Scale	+ +	+	+ +
12. Habits of Mind	12.A Values and attitudes	+ + +	+ + +	+ +
	12.B Computation and estimation	+ +	+ +	+ + +
	12.C Manipulation and observation	+ + +	+ +	+ + +
	12.D Communications	+ + +	+ + +	+ +
	12.E Critical-response skills	+ + +	+	+