

Future Changes:

2012–2013 District Grade 5 – revised SIMPLE MACHINES Unit will be implemented district-wide, spring / fall 2013.

CONTENT: SIMPLE MACHINES & RUBE GOLDBERG DESIGN CHALLENGE

STRAND: TECHNOLOGY/ENGINEERING & PHYSICAL SCIENCE

STANDARD #'s Grades 3-5 - #1, #2 - refer to DOE Framework Technology/Engineering Standards Grades 3-5 - #1, #4 – Physical Science Standards

**Concepts: Students need to know:**

- Energy = the ability to do work
  - Law of Conservation of Energy, the total input energy must equal the total output energy.
- Work = force times distance (Work is defined as the result of applying a force to an object in order to move it a certain distance.)
  - The equation for work is  $W = Fd$  (work = Force X distance)
  - Work is measured while the force is being applied.
  - Work is measured in joules. (J - joules a unit of work)
  - Work is kinetic energy
- Force = a push or pull
  - Force is measured in newtons (named after Isaac Newton)
- Acceleration = Change in speed or direction / evidence that a force was applied to the object
- Newton's Laws apply to simple machines.
  - Newton's three laws: 1) An object will stay at rest (or in motion) until acted on by a force, 2) There is a relationship between an object's mass, acceleration and the force applied to it, 3) for every action, there is an equal and opposite reaction
- There is a relationship between force and energy.
- Resistance Force – is a force that causes a moving object to slow down or tends to prevent a stationary object to move.
  - The resistance force acts in a direction opposite to the one that you use to move the object
  - All machines must overcome resistance forces
    - Gravity is a force pulling down on every atom of an object
    - Inertia – Newton's First Law - *Objects tendency to keep doing what it's doing!*
    - Friction - force that resists the motion of a solid object that is in contact with another object or material.
      - Is problematic / resists motion, causes heating, wears things down and wastes energy
      - Is beneficial / necessary for writing, driving etc
- Machines - A machine converts the force provided from an input energy into motion that changes the magnitude or direction of that force. This motion against a resistive force is the work done by the machine.
  - Makes something easier to do but will take you longer or require you to cover more distance while doing it.
  - According to the Law of Conservation of Energy, the total input energy must equal the total output energy. With a machine some of the output energy does not contribute to the output work and is lost as friction and heat. **The efficiency of a machine is the ratio of the input energy to the useful output work.**
- Simple Machine – have no or one moving part

- **A simple machine reduces the amount of effort needed to move something, but you wind up moving it a greater distance to accomplish the same amount of work.**
- Six types of simple machines (Lever Family = lever, wheel, pulley, gear and Incline Plane Family = ramp/incline plane, wedge, and screw)
- Three classes of levers
- Gear ratios
- Fixed and movable pulleys
- Mechanical Advantage – machines perform work with less effort and provide a mechanical advance by
  - Increasing the output force, distance, or speed,
  - Changing the direction
  - Reducing resistive forces - like friction or gravity.
- Complex Machines – two or more simple machines combined to perform a function
- Tools - a device that is used to perform a simple task
  - Multiple simple machines can be put together to make different types of tools (e.g., screwdriver is a wheel & axle and wedge – can be lever when used to pry / hammer is two levers and wedge).
- Engineering Design Process – ask, imagine, plan, create and improve
  - Constraints – limitations to be taken into account during design process
  - Criteria - specification

**Performance Skills: Students will be able to:**

- Label the 6 simple machines in isolation and within a complex machine
- Observe, sketch and analyze a tool or machine to determine the simple machines combined and the function it's intended to perform.
- Demonstrate an ability to measure both the force and distance and calculate the work done in joules.
- Participate in a Rube Goldberg Design Challenge through which they demonstrate an understanding of: the function of the 6 types of simple machines, acceleration, applied and resistance forces, collaboration, the engineering design process and designing with constraints.
- Keep an engineering notebook of the design process their group undertook during the design challenge.

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Grade 5  
STRAND: TECHNOLOGY/ENGINEERING

### VOCABULARY

Force	push or pull
newtons	force is measured in newtons
Energy	ability to do work
Resistance Force	force that causes a moving object to slow down or tends to prevent a stationary object to move
Gravity	a force pulling down on every atom of an object
Inertia	Newton's First Law - <i>Objects tendency to keep doing what it's doing!</i>
Friction	force that resists the motion of a solid object that is in contact with another object or material
Work	defined as the result of applying a force to an object in order to move it a certain distance - The equation for work is <b>W = Fd</b> (work = Force X distance)
Joules	Work is measured in joules. (J - joules a unit of work)
Acceleration	a change in speed or direction / evidence that a force was applied to the object
Machines	convert the force provided from an <u>input energy</u> into motion that changes the magnitude or direction of that force. This motion against a resistive force is the work done by the machine. Makes something easier to do but will take you longer or require you to cover more distance while doing it.
Mechanical Advantage	machines perform work with less effort / increases the output force, distance, or speed, changes the direction and/or reduces resistive forces - like friction or gravity.
Simple Machine	machine with no or only one moving part
Lever	Makes lifting weight easier by using a fulcrum to redirect force over a longer distance
Wheel and axle	is a lever that rotates in a circle around a center point or fulcrum
Gear	wheel with teeth
Gear ratio	the ratio being studied is the physical size relationship of the drive gear (input gear or effort gear) to the driven gear (output gear or the load)
Pulley	is a wheel with a groove
Fixed pulley	stationary pulley – fixed in one spot
Movable pulley	pulley is attached to the load and moves with the load
Complex Machines	two or more simple machines combined to perform a function
Tool	a device that is used to perform a simple task
Engineering Design Process	the process used by engineers when designing - ask, imagine, plan, create and improve
Constraints	limitations to be taken into account during design process
Criteria	specifications of the task to be performed or the design