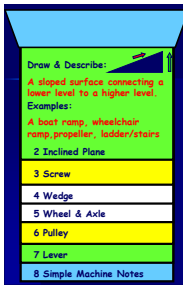
Simple Machines
(Making work easier…phew!)

Simple Machines Foldable

- Line up your papers about 1-2 cm apart, so that you see "5, 6, 7, 8" along the bottom.
- Fold the papers over so you see all 8 numbers in a row.

Simple Machines Foldable



Use your textbook (pg. 716-727) & websites to research simple machines:

- On each tab, draw and describe that type of simple machine.
- Then give 2-3 examples.

What are MACHINES?

- Most people think of complex, technical, or electronic gadgets with motors…, but machines can be much SIMPLER.
- A machine is any device that lets you do **WORK** in an ***EASIER*** or ***BETTER*** way.
- Basically:
  Simple machines make work EASIER.

How do machines do work?

- Machines make work easier by changing 3 things about the FORCE you exert to do work:
  - AMOUNT OF FORCE you exert
  - DISTANCE over which you exert force
  - DIRECTION in which you exert force

What are SIMPLE MACHINES?

- There are only 6 basic simple machines that make work easier:
  - Inclined Plane
  - Wedge
  - Screw
  - Lever
  - Wheel & Axle
  - Pulley

COMPOUND MACHINES

- Compound Machines – are made of **combinations** of two or more simple machines.
- For example, a simple can opener is a combination of 3 simple machines:
  - Lever
  - Wheel & axle
  - Wedge

WORK & SIMPLE MACHINES

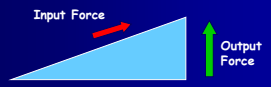
- Simple machines DON'T change the amount of WORK done!
  (They change the size, distance or direction of your FORCE!)

WORK IN = WORK OUT*

(*usually machines lose a bit of work due to FRICTION…)

INCLINED PLANE

- An inclined plane is a flat, sloped surface. It connects a lower level to a higher level.
- You use less force over a longer distance to raise a load to a higher level.

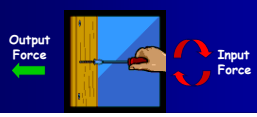


INCLINED PLANE: Examples

- Ramps (Boat ramps, wheelchair ramps)
- Propeller
- Ladders/Stairs

SCREW

- A screw has a "thread" or "groove" wrapped around a central cylinder.
- While turning, it converts a twisting force into a forward or backward force.

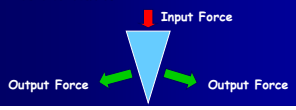


SCREW: Examples & Uses

- Screws can holds things together or lift materials.
- Screws
- Screw top lids for jars/bottles
- Light bulb
- Swivel stools/chairs

WEDGE

- A wedge has slanting slides that meet at an edge – it splits material apart.
- It changes force in one direction into a splitting force that acts at right angles to the blade.



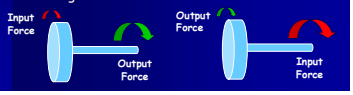
WEDGE: Examples & Uses

- Ax, Knife, etc.
- Zippers

- Used in all cutting machines (to split materials apart)

WHEEL & AXLE

- The wheel is locked to the central axle – when one turns, so does the other one.
- A short powerful force at the axle, will move the wheel's edge a long distance.
- A long motion at edge of wheel, moves the axle with great force.

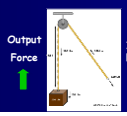


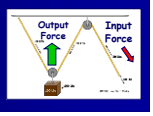
WHEEL & AXLE: Examples & Uses

- Screwdriver
- Windmill
- Cars/Bicycles
- Rolling Pin
- Door Knob
- Fan

PULLEY

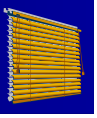
- A pulley is a grooved wheel with a rope, used to raise/lower/move a load.
- Pulley systems change the direction and/or decrease the input force so you can move heavier loads.





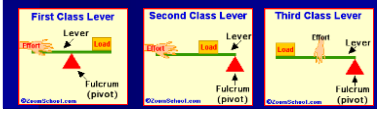
PULLEY: Examples & Uses

- Cranes
- Raising a flag on a pole
- Window Blinds
- Raising a sail on a boat
- Clothesline



LEVER

- A lever is a bar that pivots or rotates on a point (called a fulcrum).
- Levers may change the size, distance or direction of the force.



LEVERS: Examples & Uses

- First Class Levers:
  - Scissors, See-saws, Pliers
- Second Class Levers:
  - Staplers, Nutcrackers, Wheelbarrows
- Third Class Levers
  - Shovels, baseball bats, tweezers

Machines make work easier by changing 3 things about the FORCE:

- The amount of force
- The distance of the force
- The direction of the force

Machines make work easier by changing 3 things about the FORCE:

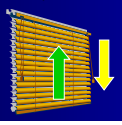
- The amount of force
  (eg. A ramp lets you lift a heavy object with LESS force)

Machines make work easier by changing 3 things about the FORCE:

- The distance of the force
  (eg. A baseball bat lets you move your arms a short distance, but move the end of the bat a large distance).

Machines make work easier by changing 3 things about the FORCE:

- The direction of the force
  (eg. The pulley on a set of window blinds lets you move the blinds UP with a DOWNWARD pull.



How do machines make work easier?

In your science notebook, write the following questions:

- When you add pulleys to a system what happens to the force you need to do work?
- How can we change a lever to make it easier to lift a heavy weight?

What is the *mechanical advantage* of a machine?

- A machine's mechanical advantage is the number of times a machine increases a force exerted on it.
- Mechanical Advantage = $\frac{\text{Output Force}}{\text{Input Force}}$

What is the *mechanical advantage* of a machine?

You exert 10 N of force on a can opener. The can opener exerts 30 N of force on the can. What is the mechanical advantage?

Mechanical Advantage = $\frac{\text{Output Force}}{\text{Input Force}} = \frac{30\text{ N}}{10\text{ N}}$

Mechanical Advantage = 3

What is the *efficiency* of a machine?

- The EFFICIENCY compares:
  - the work you put IN to
  - the work the machine puts OUT.
- An IDEAL machine is 100% efficient.

  INPUT WORK = OUTPUT WORK
- In the real world, some input work is always lost due to FRICTION between the moving parts of the machine.

What is the *efficiency* of a machine?

$$\text{EFFICIENCY} = \frac{\text{Output Work}}{\text{Input Work}} \times 100\%$$

You mow the lawn with a rusty lawn mower. You do 50,000 J of work on the lawn mower but only 25,000 J go to cutting the lawn. What is the efficiency of the lawn mower?

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$$\text{EFFICIENCY} = \frac{\text{Output Work}}{\text{Input Work}} \times 100\%$$

$$\text{Efficiency} = \frac{25{,}000\ \text{J}}{50{,}000\ \text{J}} \times 100\%$$

Efficiency = 50%

Try the rest of the practice problems on your own…

$$\text{Mechanical Advantage} = \frac{\text{Output Force}}{\text{Input Force}}$$

$$\text{EFFICIENCY} = \frac{\text{Output Work}}{\text{Input Work}} \times 100\%$$