

Physical Science

Chapter 4

Work & Machines

Section 4-1: What is Work?

- Work is force exerted on an object that causes the object to move some distance
- Force without moving a distance yields **NO WORK!!**



Work = Force x Distance
SI Unit for work is the **Joule**
1 Joule = 1 Newton x 1 Meter
 $J = Nm$

Word Problems

- Word problems can be confusing; but w/ some practice they're not that bad. Here are a few hints to make them easier
- 1. Be sure you remember the "Need-to-Know" formulas
 $S = d/t$; $A = \frac{V_f - V_i}{\text{Time}}$; $F = MA$; $W = F \times D$; Power = Work/Time
- In the word problem be sure you know the units for each of the variables in the particular formula being discussed.
 - Distance $\rightarrow$ Meter; Force $\rightarrow$ Newton; Volume $\rightarrow$ cm^3 or Liter
- 2. In the word problem, all but one of the variables is told to you in one way or another. Identify what variable is being asked to solve, then plug in the remaining variables to the formula
- Solve it!! Make sure you also keep track of the units

[illegible]

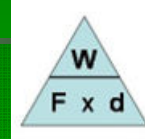
How much work performed:

- How much work is performed if you apply **85 newtons** of force on a box causing it to move **3 meters**:

$$W = F \times D$$

$$W = 85\text{N} \times 3\text{m} = 255 \text{ Nm}$$

$$255 \text{ J} = 255 \text{ Nm}$$



- How much work is performed if you apply 37 newtons of force and move a wagon 4.3 meters?

$$W = F \times D$$

$$W = 37\text{N} \times 4.3\text{m} = 159.1 \text{ Nm}$$

$$159.1 \text{ J} = 159.1 \text{ Nm}$$

- How much work is performed if you apply 118 newtons of force on a car that is stuck in the mud and doesn't move?:

$$W = F \times D$$

$$W = 118\text{N} \times 0\text{m} = 0 \text{ Nm}$$

0J = 0Nm You might be tired from pushing but no work was done!!

How much force required:

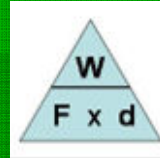
- How much force was required to move an object 3 meters if 75 Joules of work were expended?
- Formula: **Work = Force x Distance**
- Need to solve for force, $w = 75 \text{ J}$ & $D = 3\text{M}$

$$75 \text{ J} = F \times 3\text{M}$$

$$75 \text{ NM} / 3\text{M} = F$$

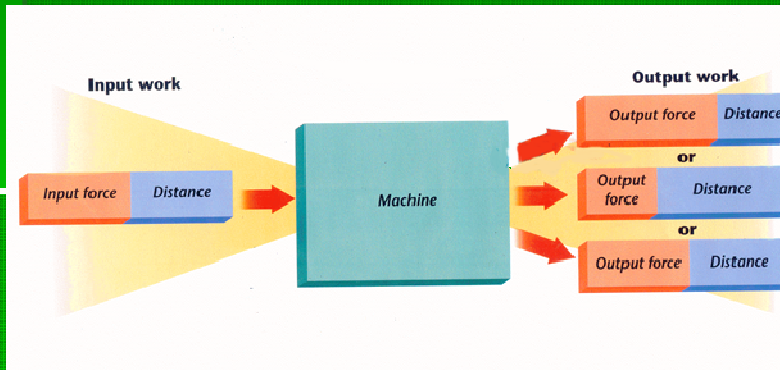
$$75 \text{ NM} / 3\text{M} = F$$

$$25\text{N} = F$$



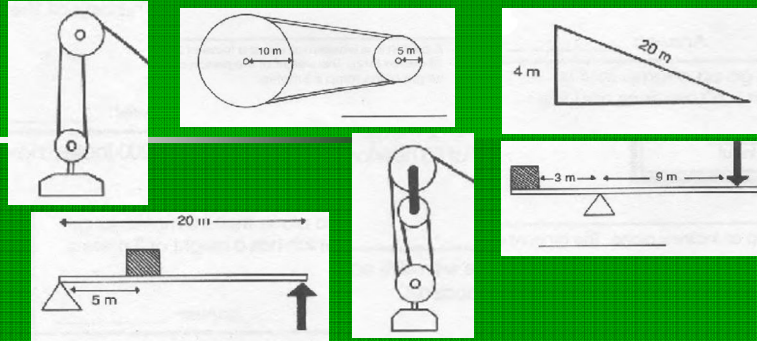
What is a Machine?

- A device that makes work easier or more effective
- A machine makes work easier by changing the amount of force, the distance covered or by changing the direction of the force



Section 4-2 Mechanical Advantage

- A machine's **Ideal Mechanical Advantage** is the number of times a force exerted on a machine is multiplied.
- $\text{IMA} = \text{output force} / \text{input force}$



Section 4-2 Efficiency of a Machine

- The amount of work obtained from a machine is always less than the amount of work put into it. This is ~~because work is lost to friction.~~
- **Efficiency = output work / input work x 100**

$$\text{percent efficiency} = \frac{\text{work output}}{\text{work input}} \times 100$$

Remember that
work = force x distance

A boy pushes a lever down 2 meters with a force of 75 newtons. The box at the other end with a weight of 50 newtons moves up 2.5 meters.

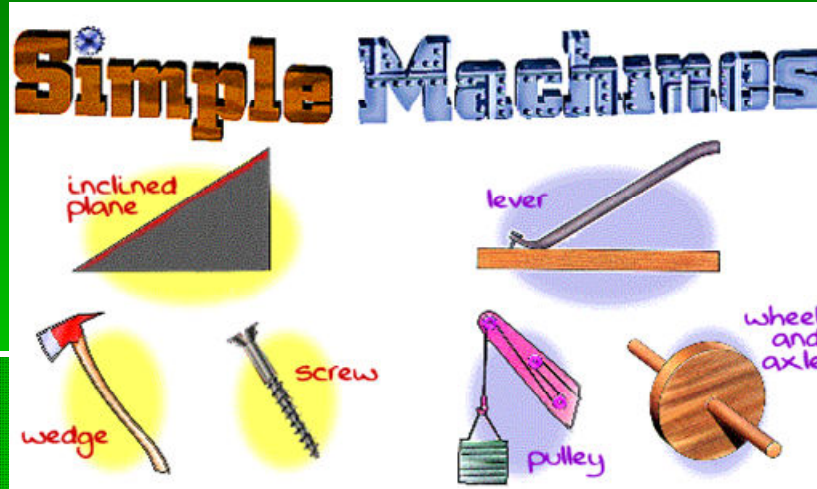
Answer: _____

A box weighing 100 newtons is pushed up an inclined plane that is 5 meters long. It takes a force of 75 newtons to push it to the top, which has a height of 3 meters.

Answer: _____

[illegible]

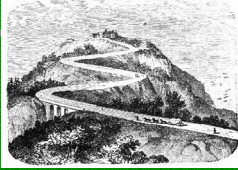
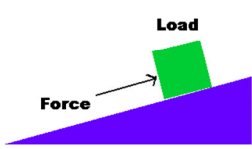
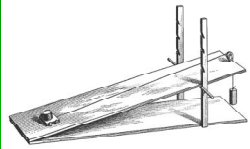
Section 4-3 Simple Machines



Inclined Plane



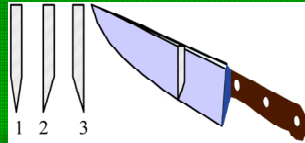
- A plane is a flat surface. When that plane is inclined, or slanted, it can ~~help you move objects across distances. And, that's work!~~ A common inclined plane is a ramp. Lifting a heavy box onto a loading dock is much easier if you slide the box up a ramp—a simple machine.



IMA = length of incline / height of incline

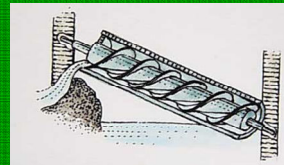
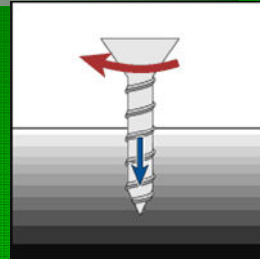
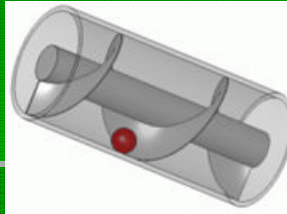
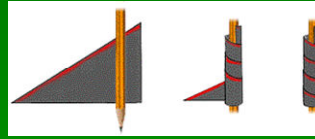
Wedge

- you can use the edge of an inclined plane to push things apart. Then, the inclined plane is a wedge. So, a wedge is actually a kind of inclined plane.
- An axe blade is a wedge. Think of the edge of the blade. It's the edge of a smooth slanted surface.



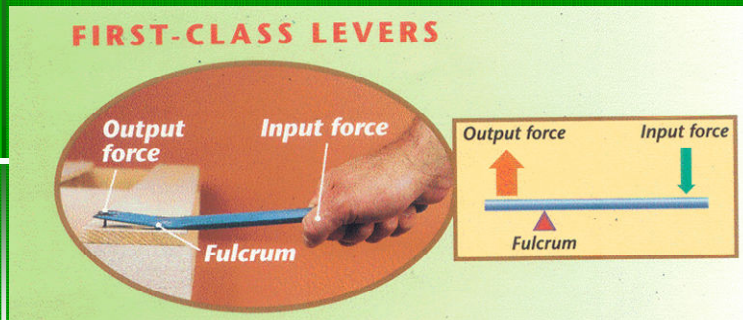
Screw

- an inclined plane wrapped around a cylinder
- A screw can convert a rotational force (**torque**) to a linear force and vice versa.



1st Class Levers

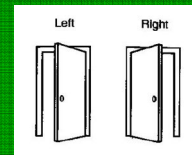
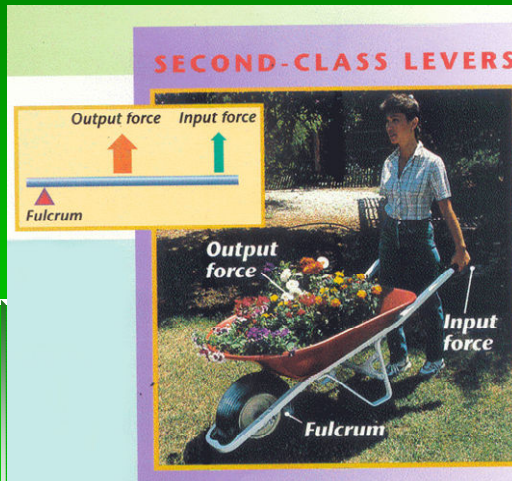
- Notice how
 - The input & output forces are in opposite directions
 - The fulcrum is between the input & output forces
- Examples include nail remover, paint can opener, scissors, seesaw



2nd Class Levers

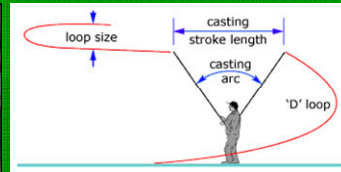
- Notice how:

- The input & output forces are in the same direction
- Input force is farther away from the fulcrum than the output force
- Examples include: wheel barrow, door, nutcracker

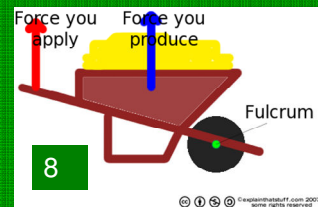
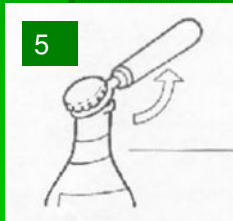
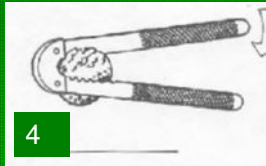
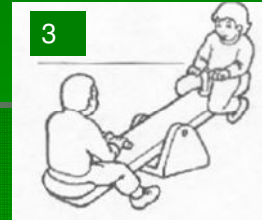


3rd Class Lever

- Notice how:
 - The input & output forces are in the same direction
 - The input force is closer to the fulcrum than the output force
 - Examples include rake, shovel, baseball bat and fishing pole



What Class of Lever?



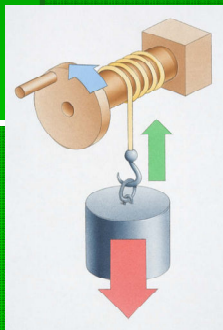
1. 3rd Class 2. 1st Class 3. 1st Class 4. 2nd Class

5. 2nd Class 6. 3rd Class 7. 1st Class 8. 2nd Class

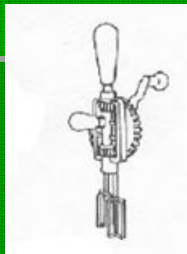
Wheel and Axle



- two circular objects attached together about a common axis
- Wheel is the large cylinder
- Axle is the small cylinder



IMA = Radius of the wheel /
Radius of the axle



Pulley

- In a pulley, a cord wraps around a wheel. As the wheel rotates, the cord moves in either direction. Now, attach a hook to the cord, and you can use the wheel's rotation to raise and lower objects.
- IMA of a pulley system = the number of ropes that support the weight of the object

