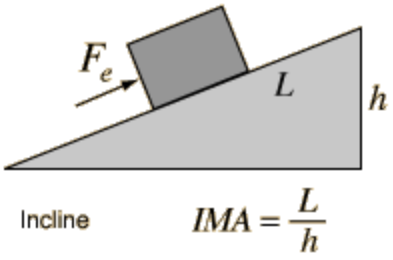
Name_____

Unit 1- Simple Machine Four & Five
Inclined Planes and Wedges

Simple Machine #4 - The Inclined Plane

An inclined plane is a simple machine that is used when trying to lift a heavy object to some height. Often people reference an inclined plane as a "ramp" because a ramp allows a person to lift a heavy object using less force. The **output force (F_{out})** for an inclined plane is the weight of the object you are trying to lift. The input force is how much force a person/object is capable of applying to life the load up the ramp.

The **output distance (d_{out})** is the height that you are trying to lift the load, whereas the length of the ramp is your **input distance (d_{in})** because it is the distance you are physically moving the object.

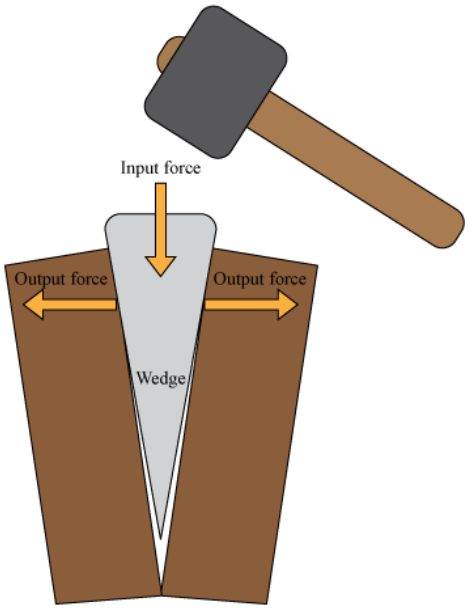


Incline $\quad IMA = \frac{L}{h}$

Inclined Plane Example: If the ramp in the picture to the left is 12 feet long, but the height of the incline is only 2 feet tall calculate the **mechanical advantage (MA)** of the inclined plane. (not to scale)

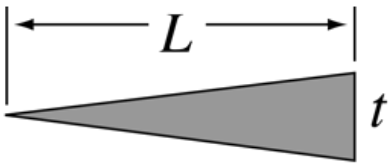
B. A person pushes a 520 pound All- Terrain Vehicle (ATV) up the ramp, What is the minimum force they need to exert on the ATV to push it up the ramp?

Simple Machine #5- The wedge



The wedge is a simple machine that is used to separate an object. An example of this is an axe, which is used to split a piece of wood into two parts. The input force is the force at which your wedge begins to interact with an object (how hard an axe hits a piece of wood.) The output force (F_{in}) is applied *perpendicular* to both of the sloped surfaces with equal force on each side.

The <u>input distance</u> (L) for a wedge is the length of your wedge and the <u>output distance</u> is the thickness (*t)* for the wedge



Wedge $IMA = \frac{L}{t}$

L = depth of penetration

t = separation of wedged surfaces

Wedge Example

The head of an axe is a wedge. Draw a picture for the head of an axe that has a length of 27cm and a width of 9cm.

What is the ideal mechanical advantage of this wedge?

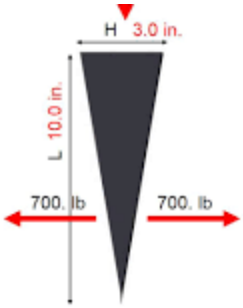
If this axe strikes a piece of wood with 200 pounds of force, how much force is applied to split the wood?

Homework

1. A loading dock uses a ramp to help its work move a heavy refrigerator from the ground to the bed of a truck that is 45 inches above the ground. If this particular ramp has an MA of 10:1, what is the length of the inclined plane measured in feet? *Hint: 1 ft = 12 inches*

B. The loading dock employee loads a 300 pound refrigerator onto a dolly and wheels it up the ramp. What is the minimum amount of force the employee will need to exert on the dolly to pull the refrigerator up the ramp?

2. An axe is used to break a log into two pieces of wood. If the axe head is 10 inches long with a maximum width of 3 inches, what is the **mechanical advantage?**



B. Assuming that no energy is lost, it takes 700 pounds of force to break a log apart. Using this axe head, how much force must a person use to break a log into two pieces?

3. ADA Ramp Guidelines

The Americans with Disabilities Act (ADA) has a distinct set of guidelines that everyone who is building a wheelchair ramp should pay attention to. Safety is the primary concern and these will help you design a useful and safe ramp.

> The ramp should not exceed a 1:12 ratio.
> Any ramp that is longer than 6 inches should have handrails on both sides.
> They should be between 34 and 38 inches from the ramp's surface.
> Ramps that are longer than 30 feet should have a platform to break up the sections.
> Non-skid surfaces should be used and the ramp designed to prevent water accumulation.

a.) What is the required minimum **mechanical advantage** for a ramp to help someone with a disability? What does this mean?

B. What is the tallest a ramp can be without being required to have a platform? *Hint: you may use 30 feet as the maximum value BEFORE you need to have a platform.*