

Unit 4

Structures and Forces

Notes Part 1



Structures

- Structure comes from the latin word, “structura”, which means ‘to put things together’.
- Structural Strength refers to its ability to hold itself up on its own as well as hold itself up when weights are added to it...aka. Its strong.
- Structural stability refers to its ability to avoid losing its balance and falling over.

Types of Structures

1. Frame Structure
2. Shell Structure
3. Mass Structure
4. Frame and Shell Structure

Frame Structure

- Long pieces of material that are joined end-to-end.
- Think door frame, human skeleton, house frame, chair, the hopefully soon-to-be completed museum at the back of my class 😊.



Advantages

- Super light and cost effective.
- Super strong when all the pieces are connected properly.

Disadvantages

If a piece is not connected properly, the entire structure weakens.

-

Shell Structure

- Thin-Solid outer surface (flat or rounded).
- Hollow inner surface.
- Think helmet, water bottle, CD case, cup, bowl, car body.
- Rounded shells are stronger than flat shells but also more expensive.
- Rounded shells are stronger because the curve spreads the force.



Advantages

Extremely Strong



Disadvantage

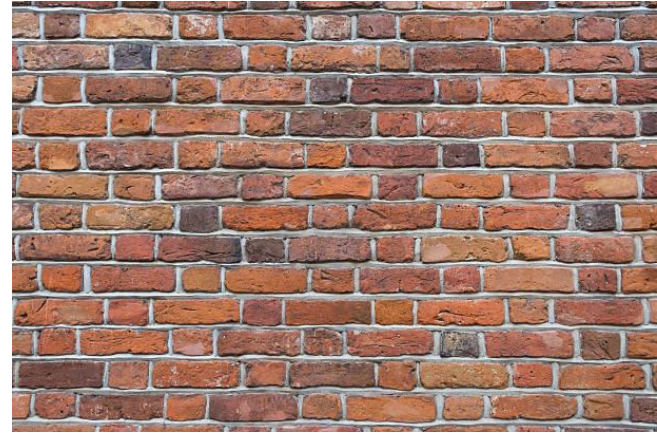
Curved shells are expensive to make

A small crack in a shell will make the structure very weak.



Mass Structure

- Things are stacked or mashed together.
- Little to no space inside.
- Think hockey pucks, walls, concrete tile.



Advantages

Strongest of all the types.

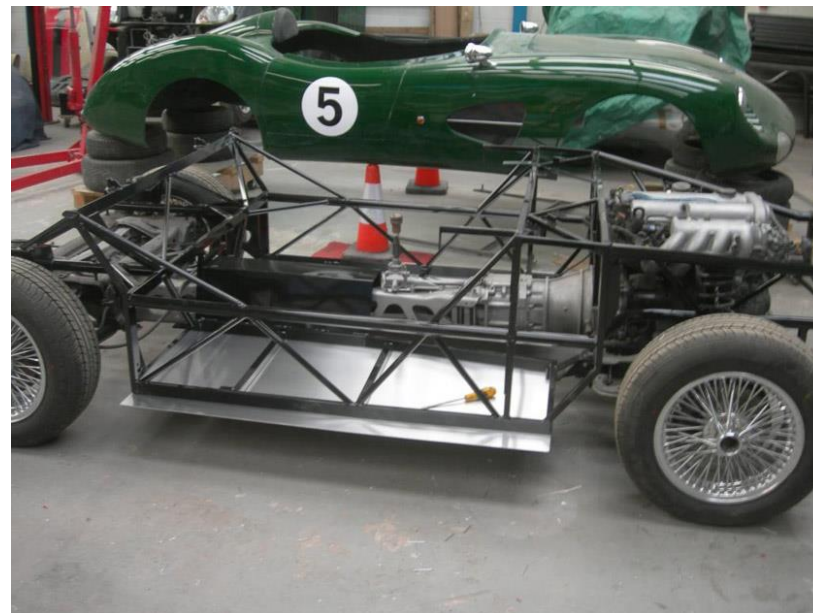
Disadvantages

Extremely heavy and hard to move.



Shell and Frame Combo Structure

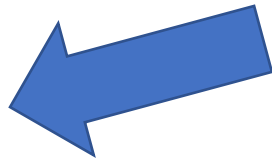
- A lot of Shells have Frames underneath.
- For example, your car is built out of a frame, but then it is clothed with a shell.
- A typical plastic chair is built out of a frame but then topped off with a plastic shell seat.



Same Function...but Different Design

Roof Tops

1. Flat Adobe Roof
2. Gable Roof
3. Dome Roof



They all have the same function, which is to protect your living area from the sky.

The difference is in their design.

1. Gabled Roof

- Slope adds strength (Triangle shapes are strong)
- Slope also allows snow and rain to runoff. This is excellent for snowy and rainy climates. The steeper the slope the better it knocks off rain/snow.
- You can have an attic which will insulate your house, because attics are full of air and insulation material...both of which are great insulators.
- Expensive to build and replace.
- Bad for windy areas because they have a large surface to catch wind and blow off.



2. Flat Roof

- Advantages
 - Easy to install and replace
 - Good for hot climates because they don't insulate well.
 - You can use the roof for storage, grow a garden or have a tan.
-
- Disadvantages
 - Snow builds up and cause it to collapse.
 - Not strong.
 - Water can build up causing moss and fungus to grow.



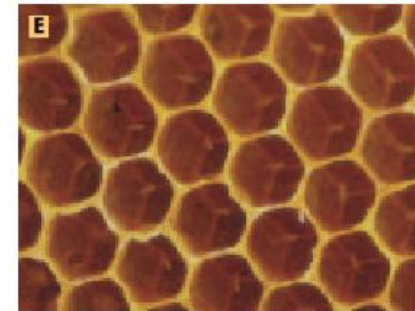
3. Dome Roof

- Creates Echo. Used in religious buildings such as churches and mosques to create inspiring sounds when religious services take place.



Same Function...Different Design? No Way Bro...

- Match up the items that have the same Function but different design.



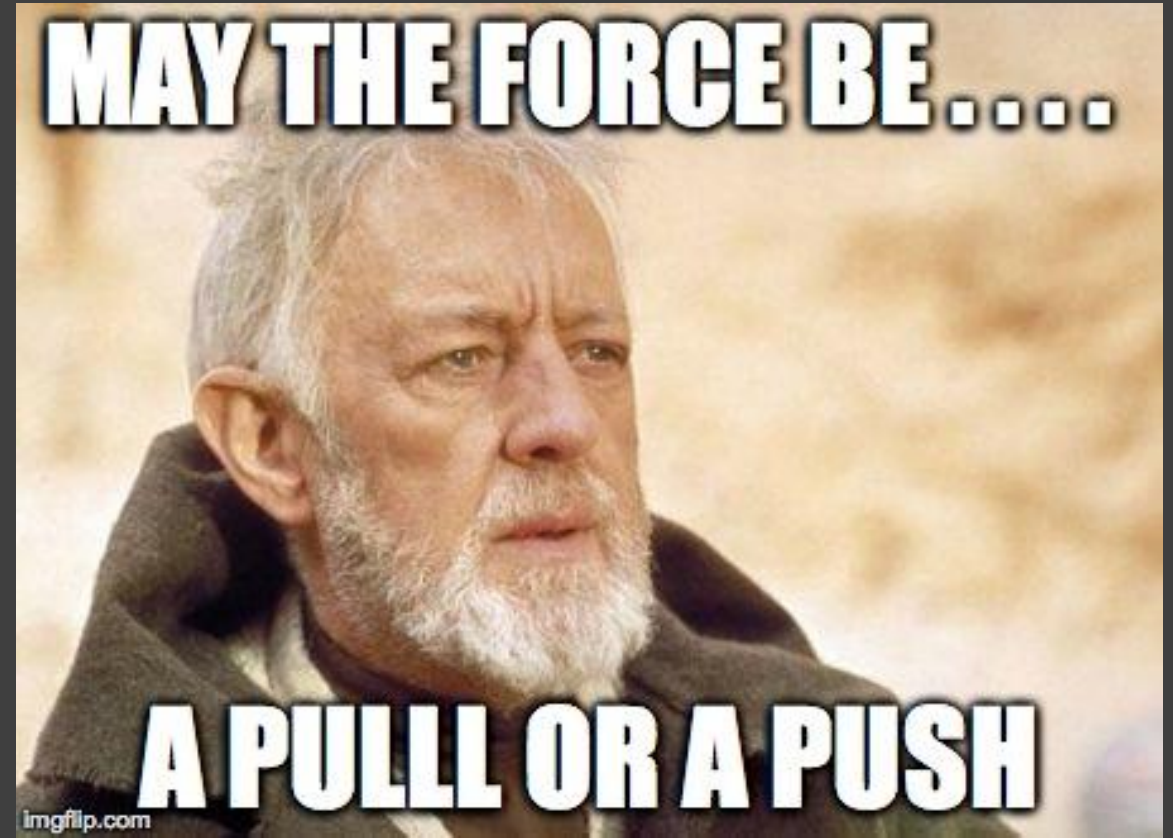
Same Function...Different Design? No Way Bro...

- Igloos, yurts(Siberia), tents, and teepees have all been used as homes for thousands of years. They all serve the same purpose, but have different designs based on culture and climate. Another thing in common is their stability. What do you think makes them stable?



Yurt in Siberia





What is a Force?

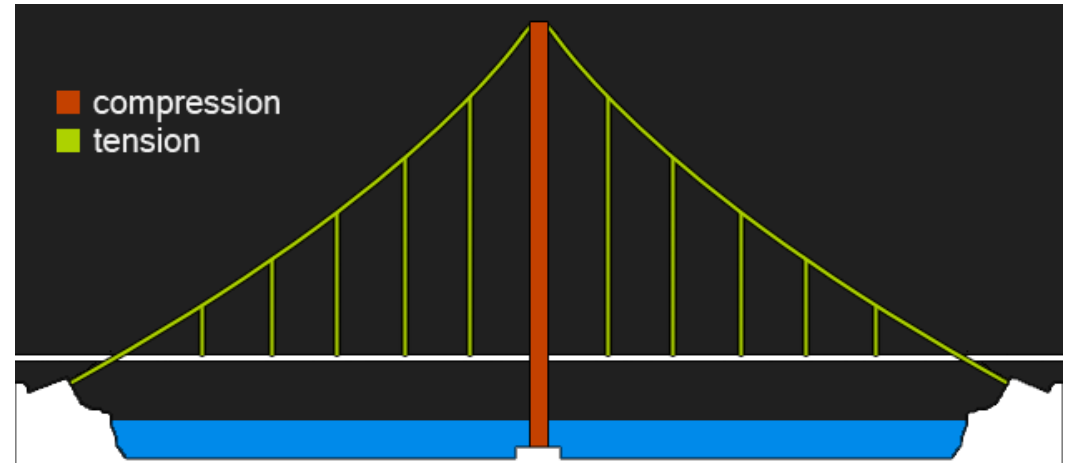
A Force is a Push or Pull.

Types of Push and Pull Forces

- Compression
- Tension
- Bending
- Shear
- Torsion

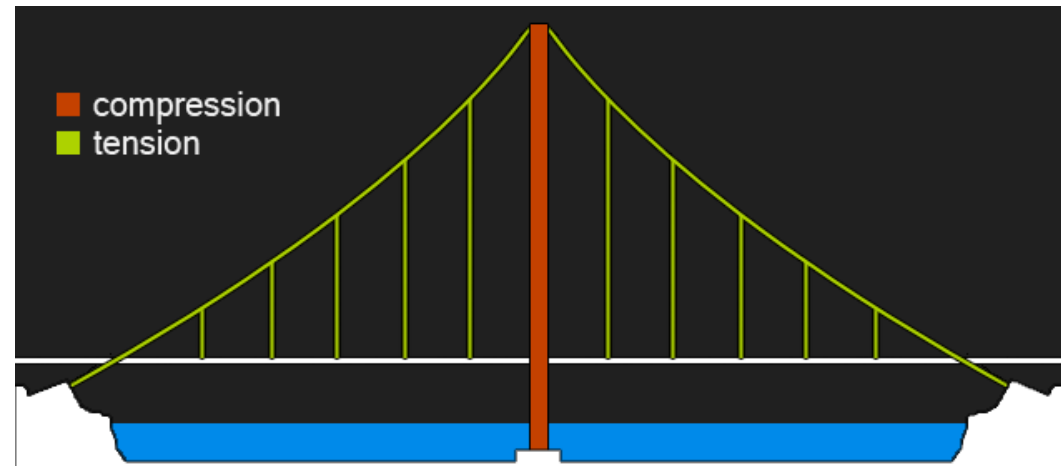
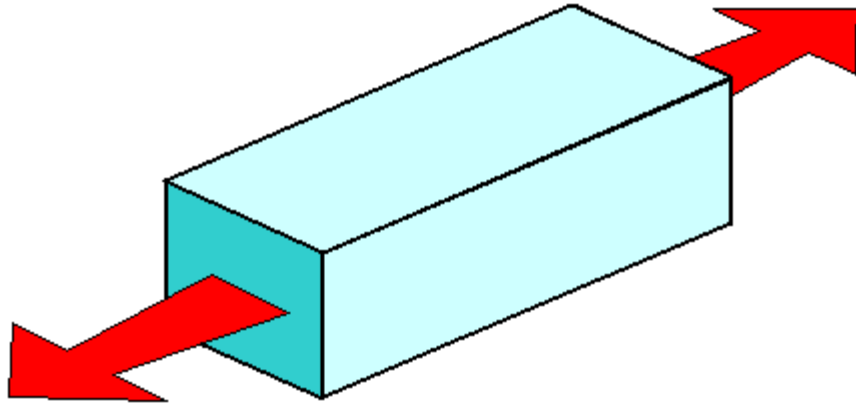
Compression

- Both ends are pushed together.



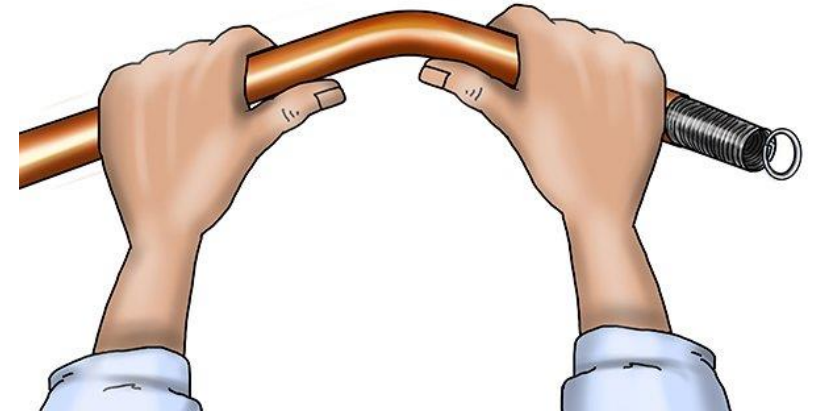
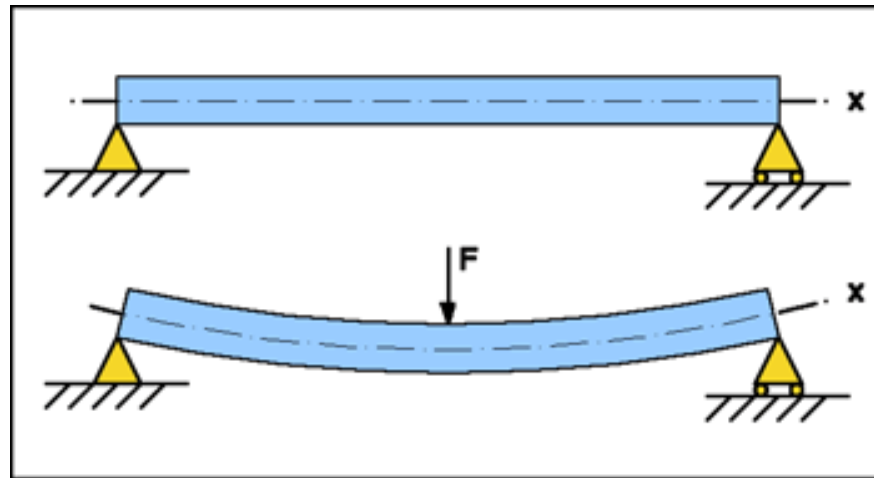
Tension

- When you stretch something you are applying tension.
- There are no pushing forces. Both ends get “pulled”



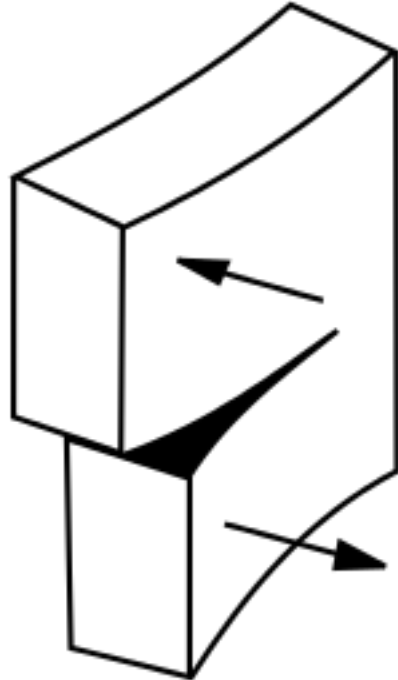
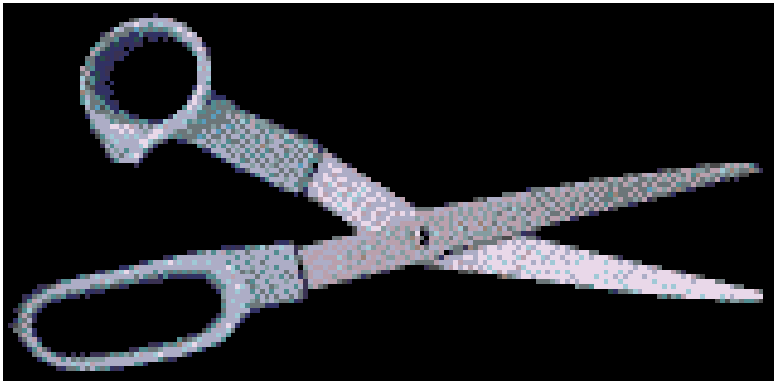
Bending

- During any bend, one side gets compressed and the other side gets stretched (tension).
- Can you figure out which side does what in the gif on the left and the pictures below?



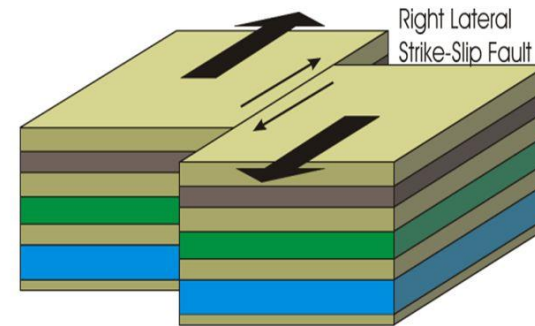
Shear Force

One end gets pushed, while the other end gets pulled. Opposite forces.



Strike-slip Fault

Strike-Slip Fault – Shearing forces two parts of Earth's crust past each other with NO vertical movement.



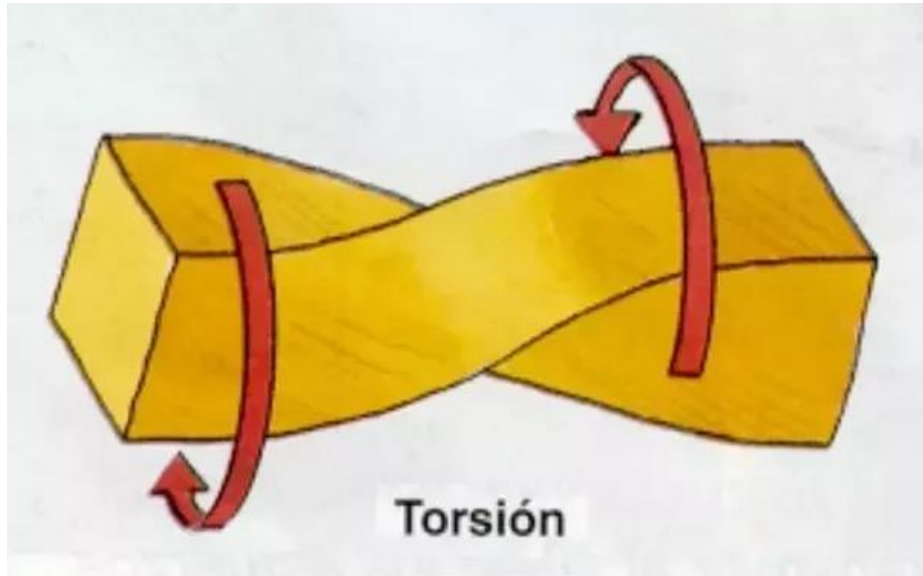
[Strike-Slip Animation](#)

Explain Where Shear Force Is Happening

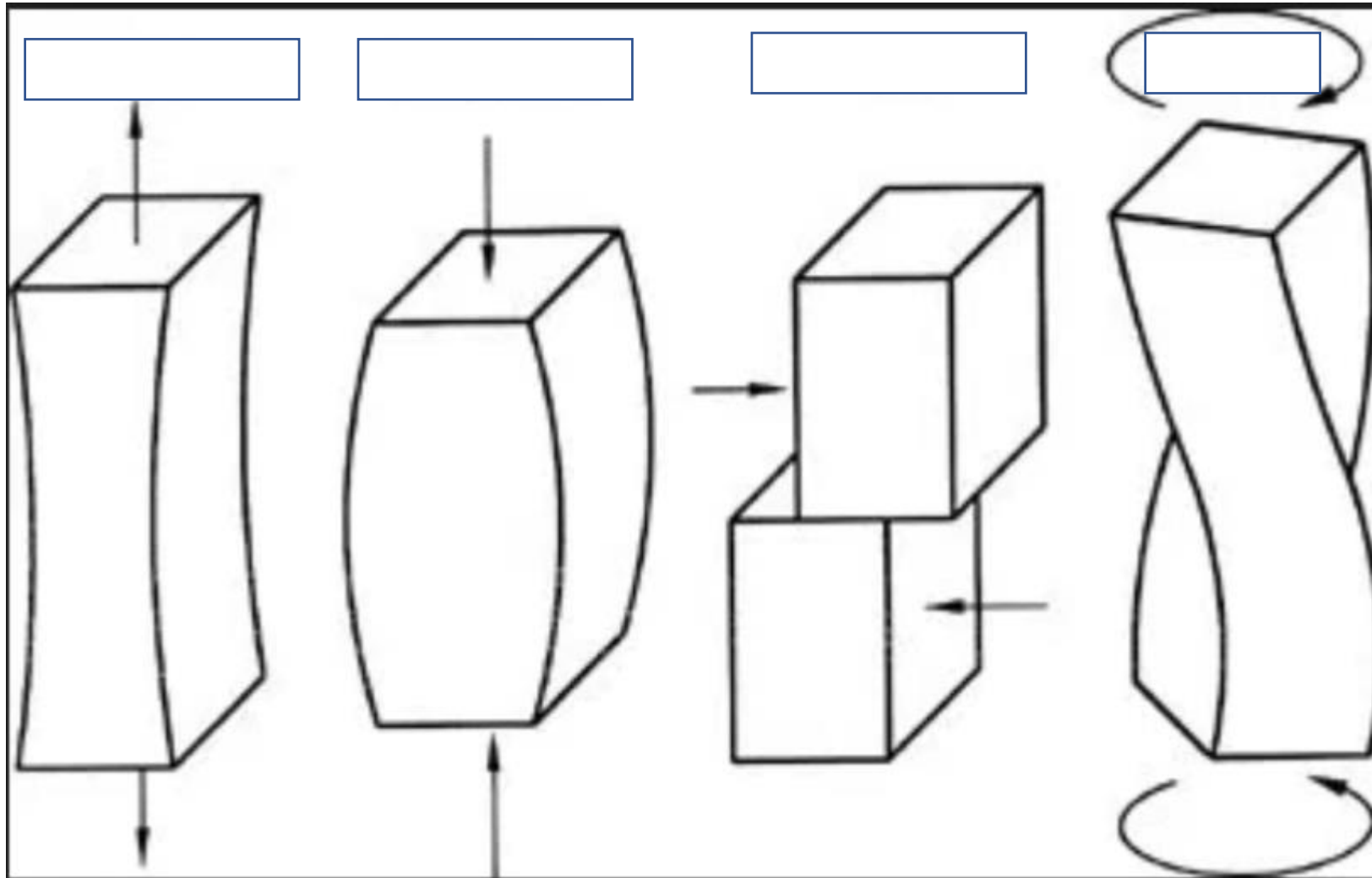


Torsion

- Twisting Action.



Label The Forces That Are Being Exerted



What is Mass?

- Mass is how much stuff a structure consists of.
- Measured in pounds (U.S) and in Kilograms (Kg) and Grams (g) in Canada.
- If you want to increase a mass, you must add more stuff.
- If you want to decrease a mass, you must remove stuff.

Ways To Increase & Decrease Your Mass

Increase Mass (Add more particles)

Eat More Food.

Wear More Clothing

Carry Stuff in your hands.

Take a big gulp of air (yes, air is made of particles, so it has mass)

Decrease Mass (Remove particles)

Vomit.

Remove clothing

Burn off body fat.

Breathe out air.

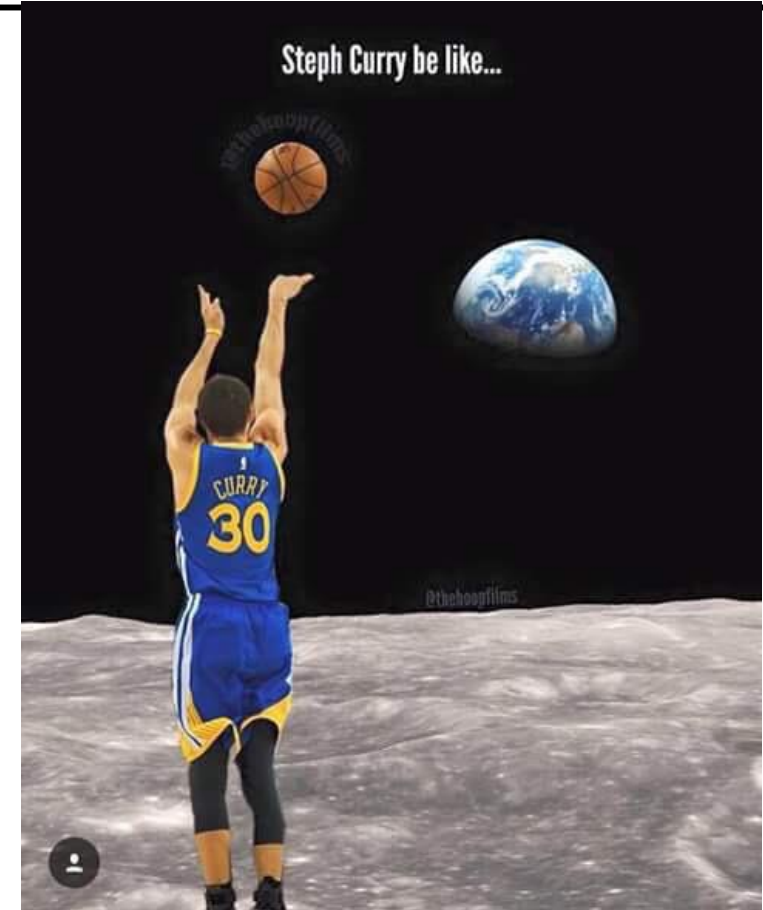
Send a #1 or #2 in the toilet.

Does Going To the Moon Change Your Mass?

- No!!!.... your mass does not change just by going to the moon.
- Why not? Because you still have the same amount of stuff in your body.
- So why do you feel lighter on the moon?
- Answer: You feel lighter because there is less gravity on the moon.

So Then, Why Do You Feel Lighter On The Moon?

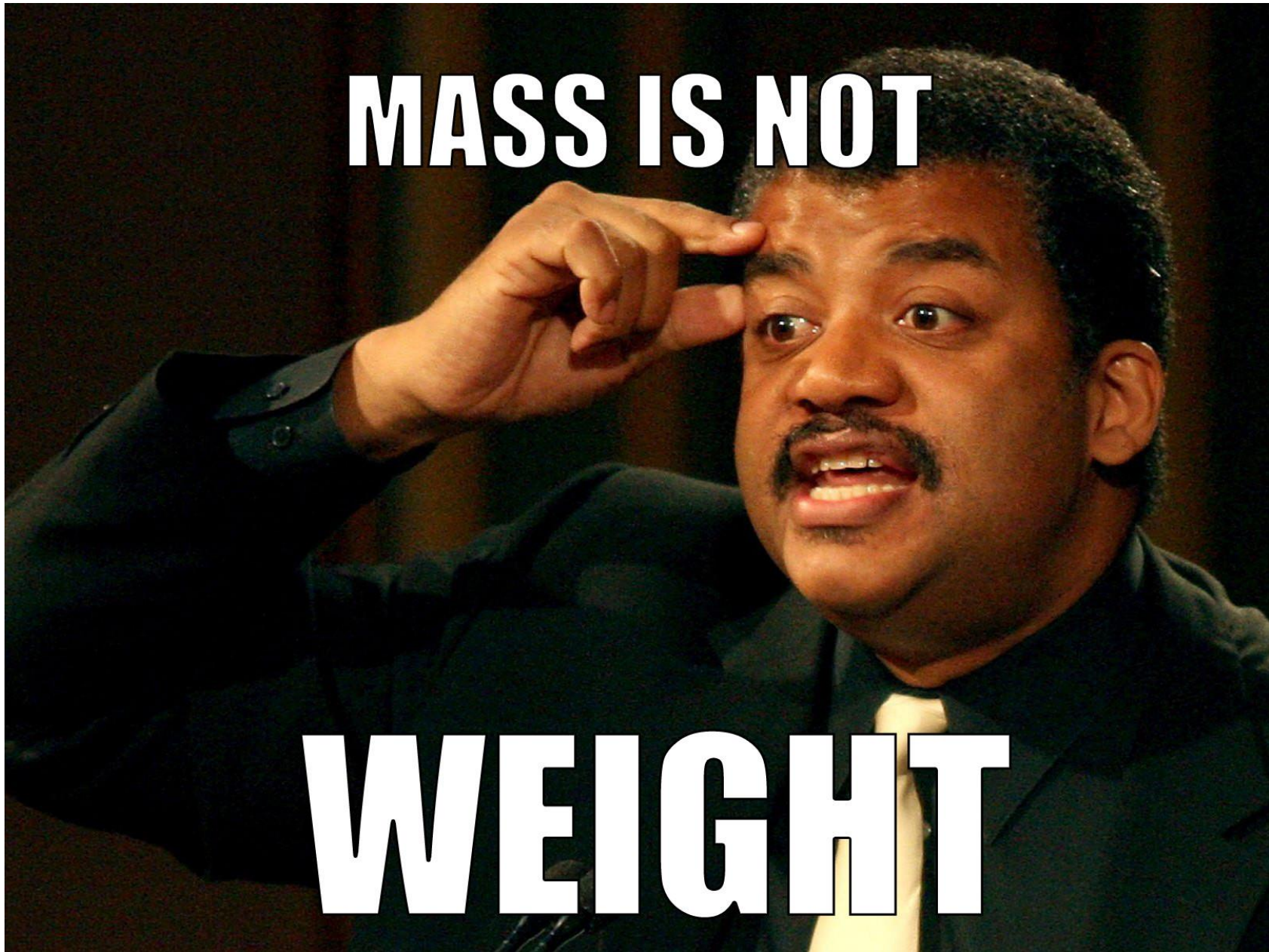
- Because there is less gravity on the moon.
- Gravity effects your Weight.
- What? Weight? Don't Weight and mass mean the same thing?
- No, they don't.
- Weight is the force that gravity exerts on a mass.



Recap: Mass is how much stuff is in a structure. (measured in Kg, g, pounds)

Weight is the Force that gravity pulls you with. (measured in Newtons)

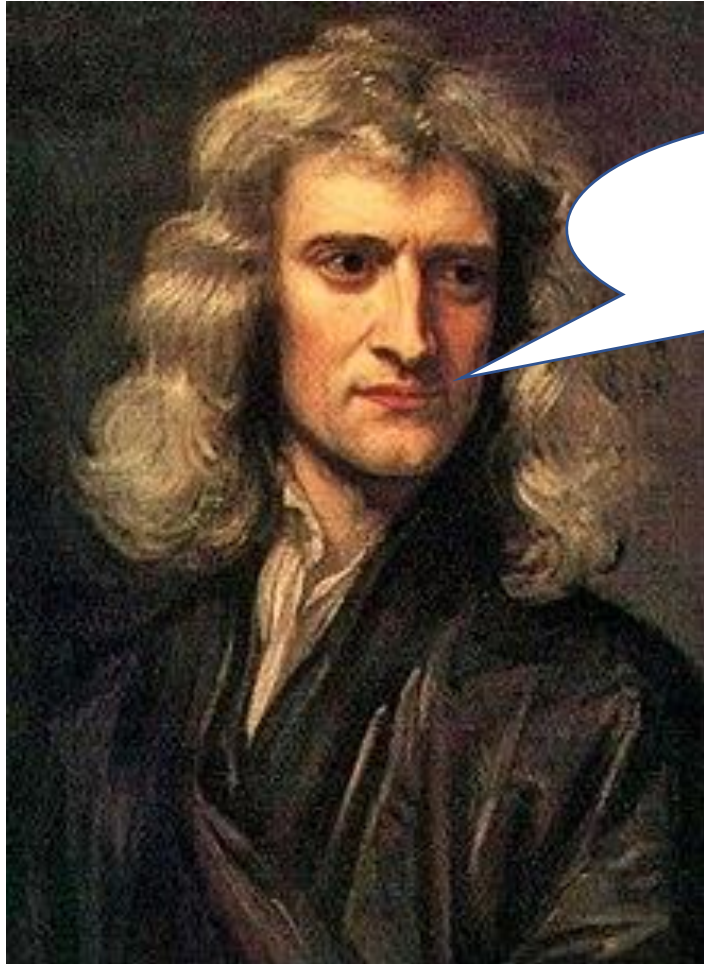
Your mass stays the same when you go to the moon, but your weight will change because there is less gravity.



MASS IS NOT

WEIGHT

Isaac Newton

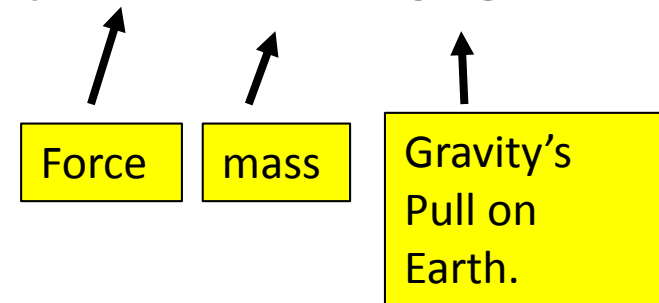


I recommend Pert Plus
for great looking hair.
#myhairgotbounce

One of the greatest scientists of all time.

Experimented with Light, Forces, and gravity.

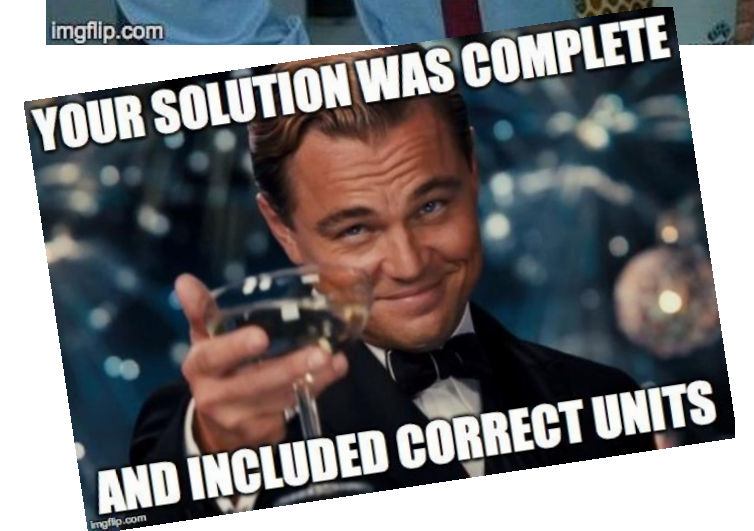
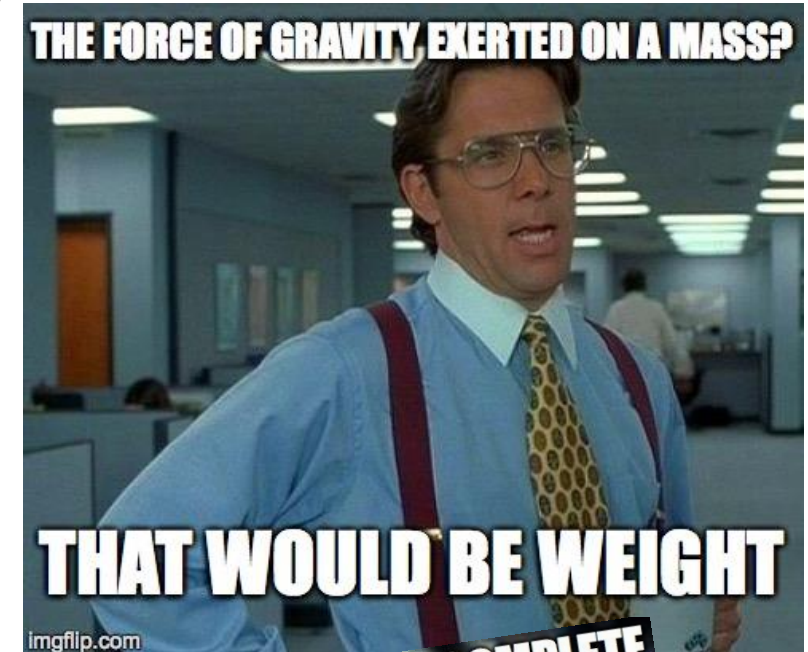
Designed a formula to convert mass into Weight. $W = m \times 9.81$



Force is measured in Newtons (N)
...named after him.

How To Calculate The Force Gravity Exerts on You.

- Multiply the mass of an object (make sure its in Kg) by 9.81 (that is the value of the acceleration that gravity pulls with on earth).
- $F = m \times 9.81$
- We shall round to 10 for simplicity.
- Ex. What is the Weight of a 9 Kg object?
 - $F = m \times 10$
 - $F = 9 \text{ Kg} \times 10$
 - $F = 90 \text{ N}$



MASS IS NOT

WEIGHT

**YEAH, IF YOU COULD JUST
MULTIPLY MASS TIMES GRAVITY**

THAT'D BE WEIGHT

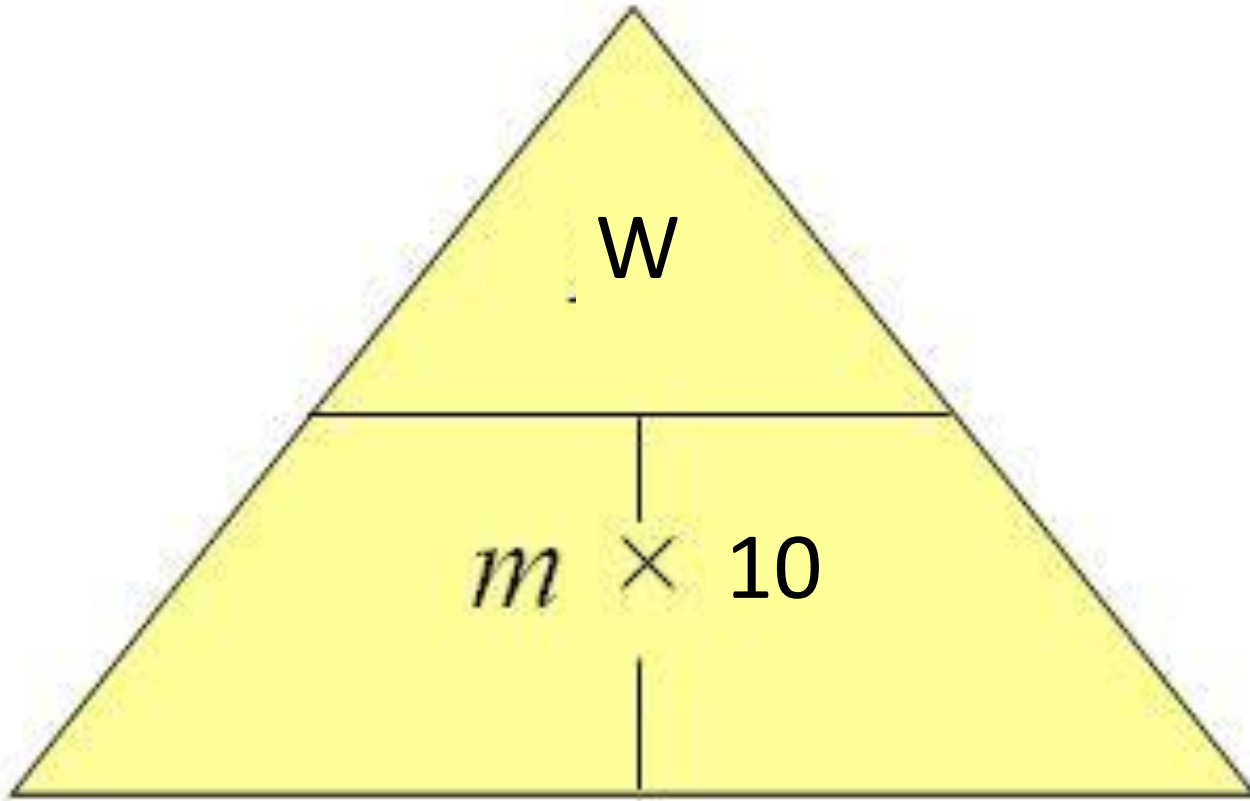
BRO, DO YOU EVEN

**RAISE HEAVY OBJECTS AGAINST
THE FORCE OF GRAVITY?**

**WANNA LOSE WEIGHT?
GO TO THE MOON.**

**GOING ON A DIET
MAKES YOU LOSE MASS.**

Magic Triangle



$$W = m \times 10$$

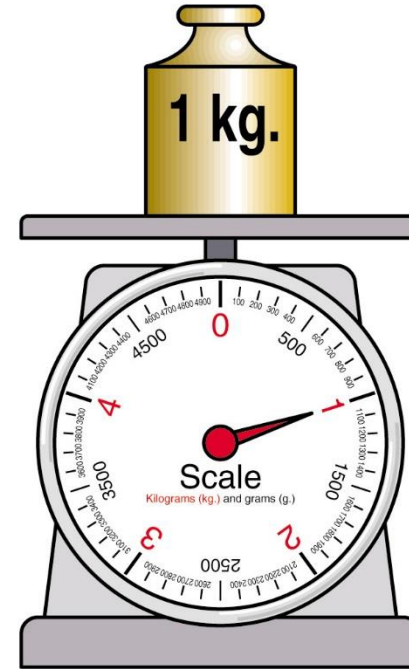
$$m = W \div 10$$

What if the mass is in Grams?

- Then you **MUST** convert it into Kg.
- To Do so, divide by 1000.

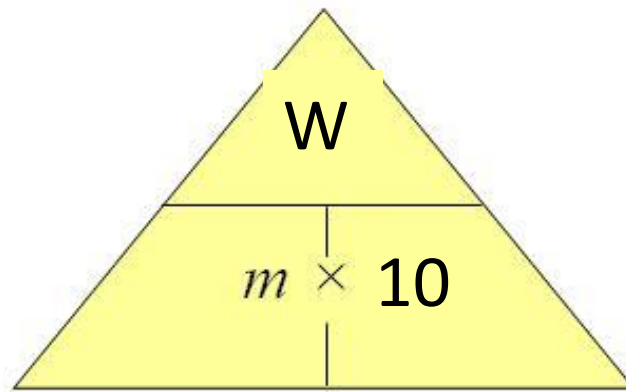
- Convert 2000 g into Kg.
 - $2000 \text{ g} \div 1000 = 2 \text{ Kg}$

- $500 \text{ g} = \underline{\hspace{2cm}} \text{ kg}$
 - $500 \text{ g} \div 1000 = 0.500 \text{ Kg}$

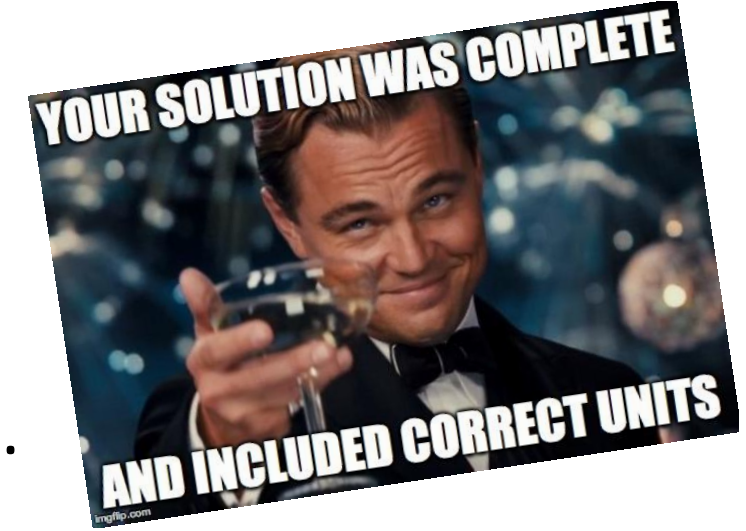


1 kilogram = 1000 grams

Practice

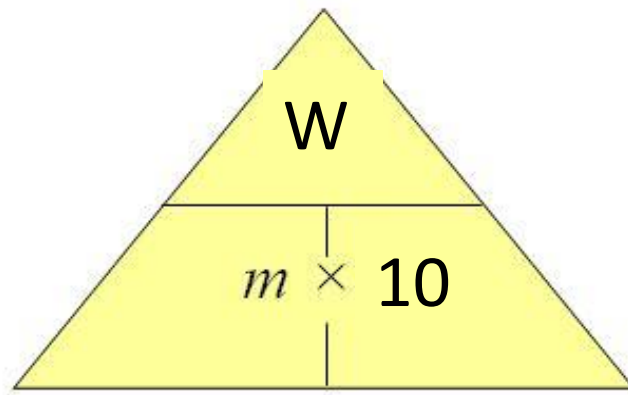


A structure has a mass of 3 Kg? Calculate its Weight.



A structure has a mass of 200g. Calculate its Weight.

Practice

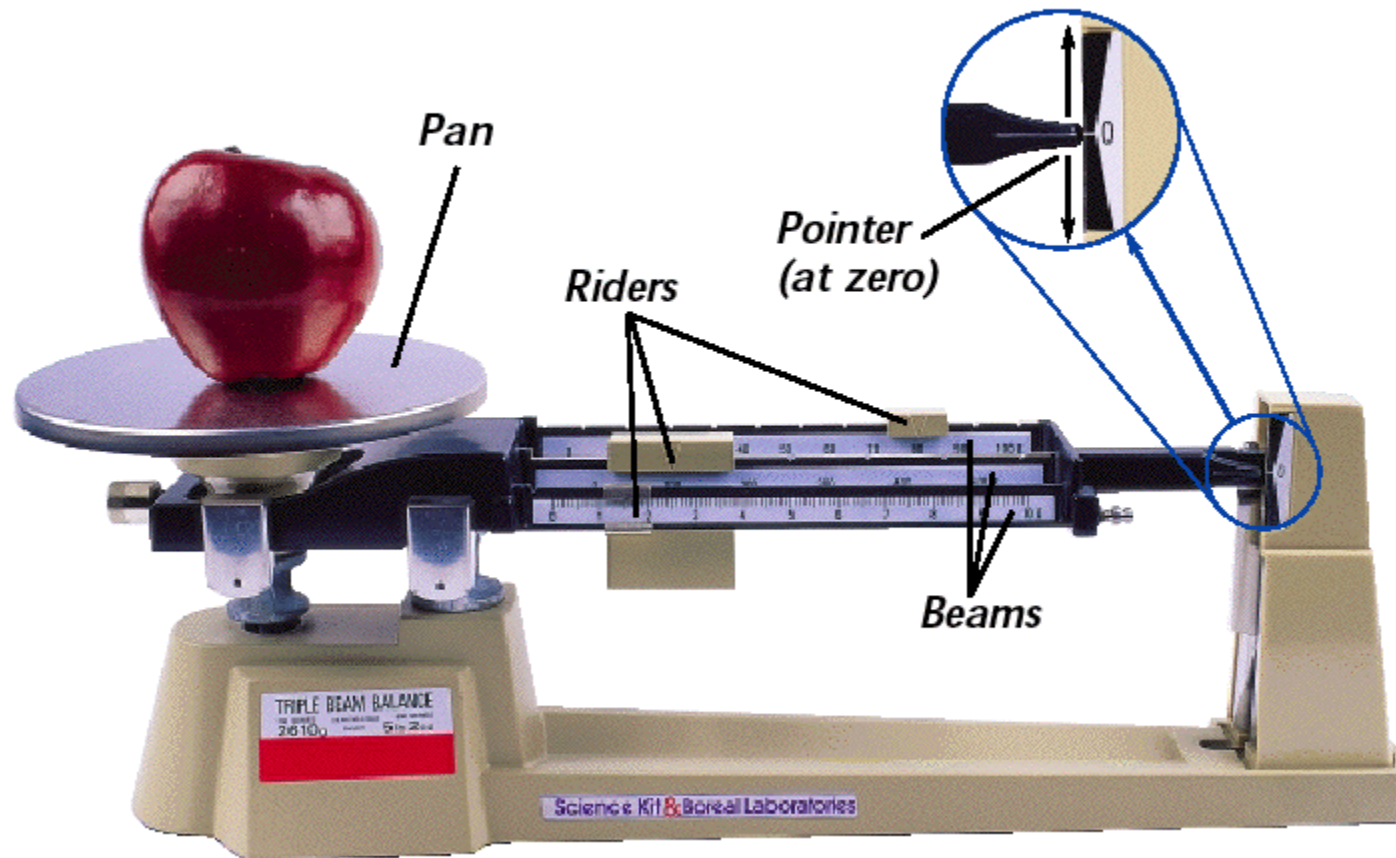


What is the mass of an object that has a Weight of 20N?

What is the mass of an object that has a Weight of 3N?

Measure Mass Using A Triple Beam Balance

Triple-Beam Balance



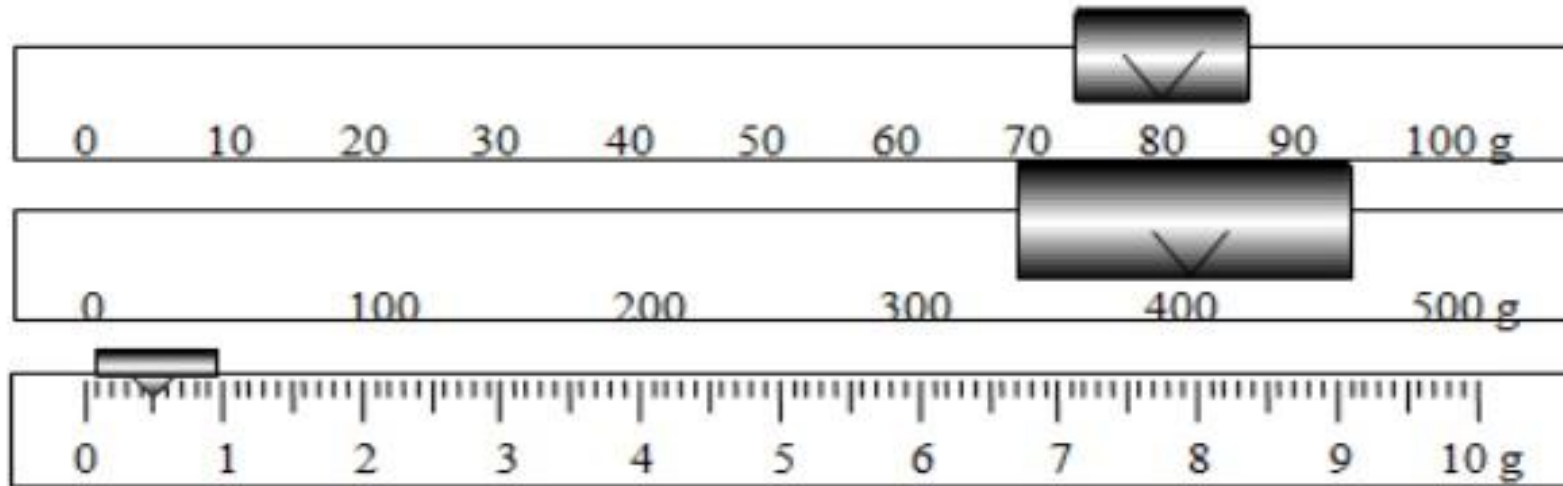
Super Sensitive to mass. Very Accurate.

Adjust the Riders until the side bar Pointer points at the 0.

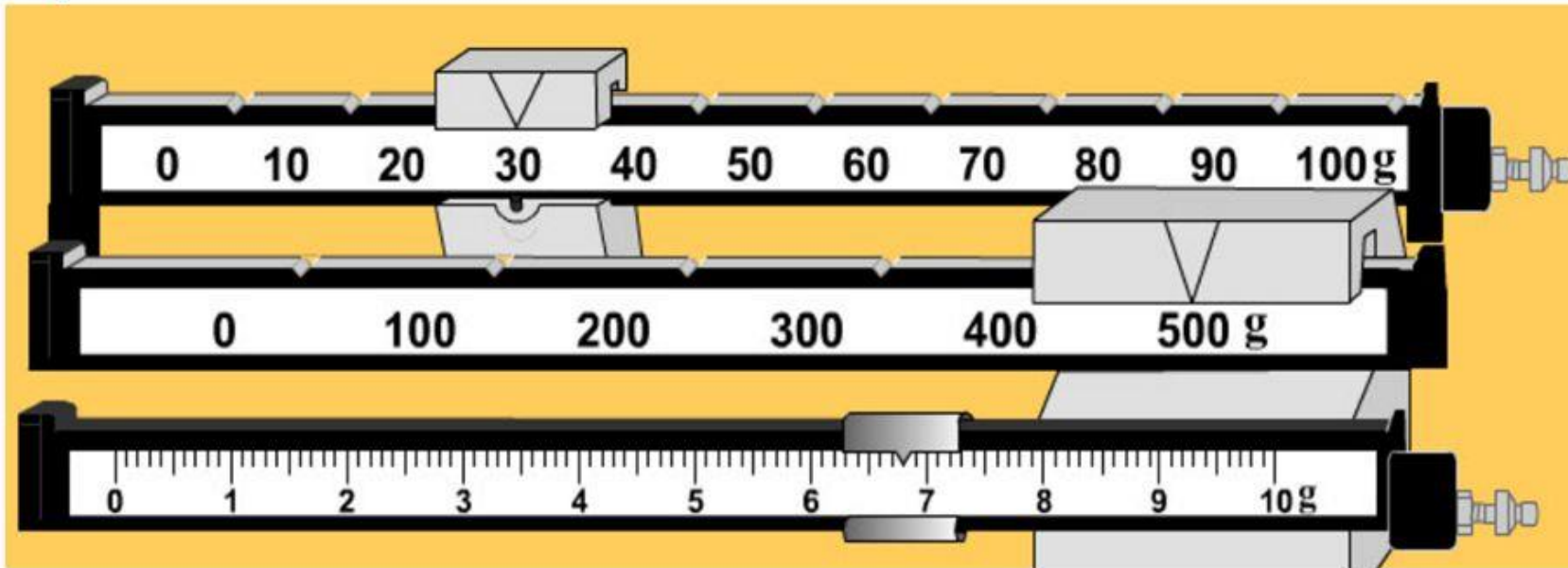
Then add the values that the Riders are pointing at.

How To Read A Triple Beam Balance

What's the mass shown?



c) Calculate the mass for each triple beam balance below

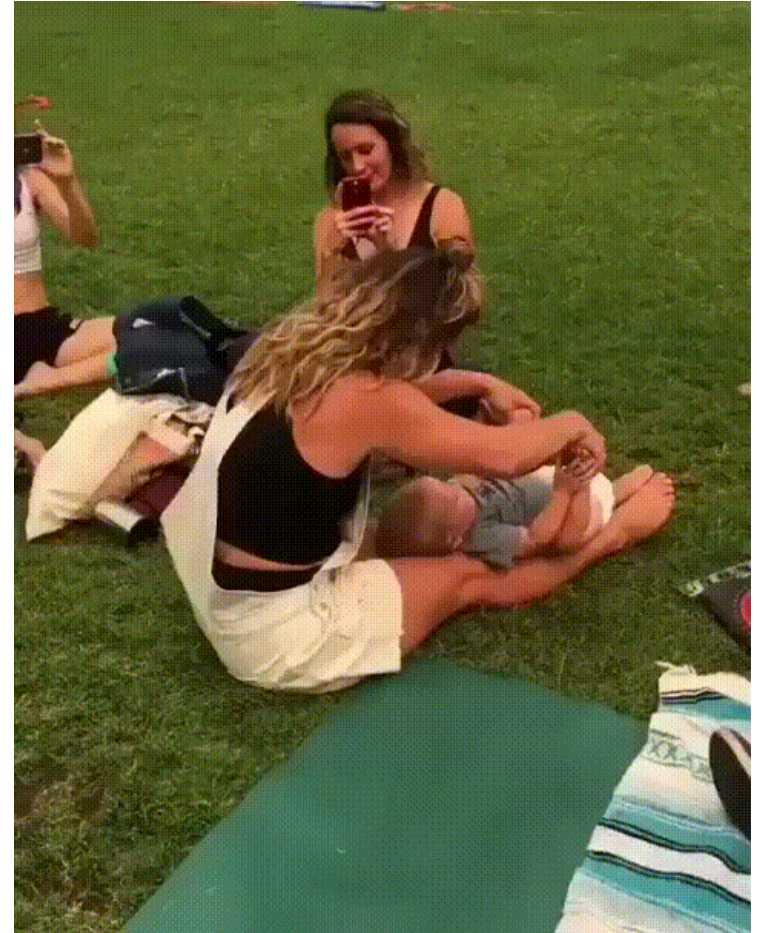


Then
Convert the
mass into
Weight.

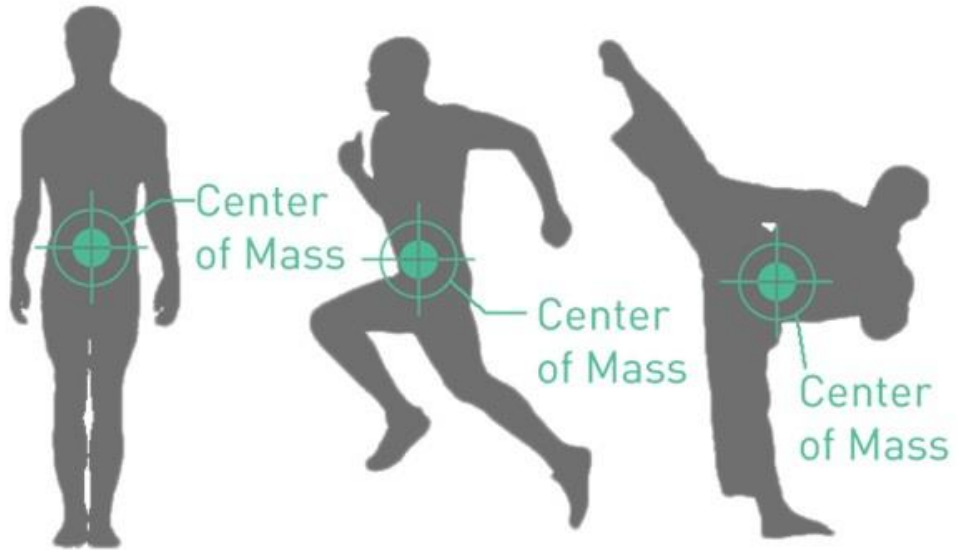
Mass:

What makes an object stable?

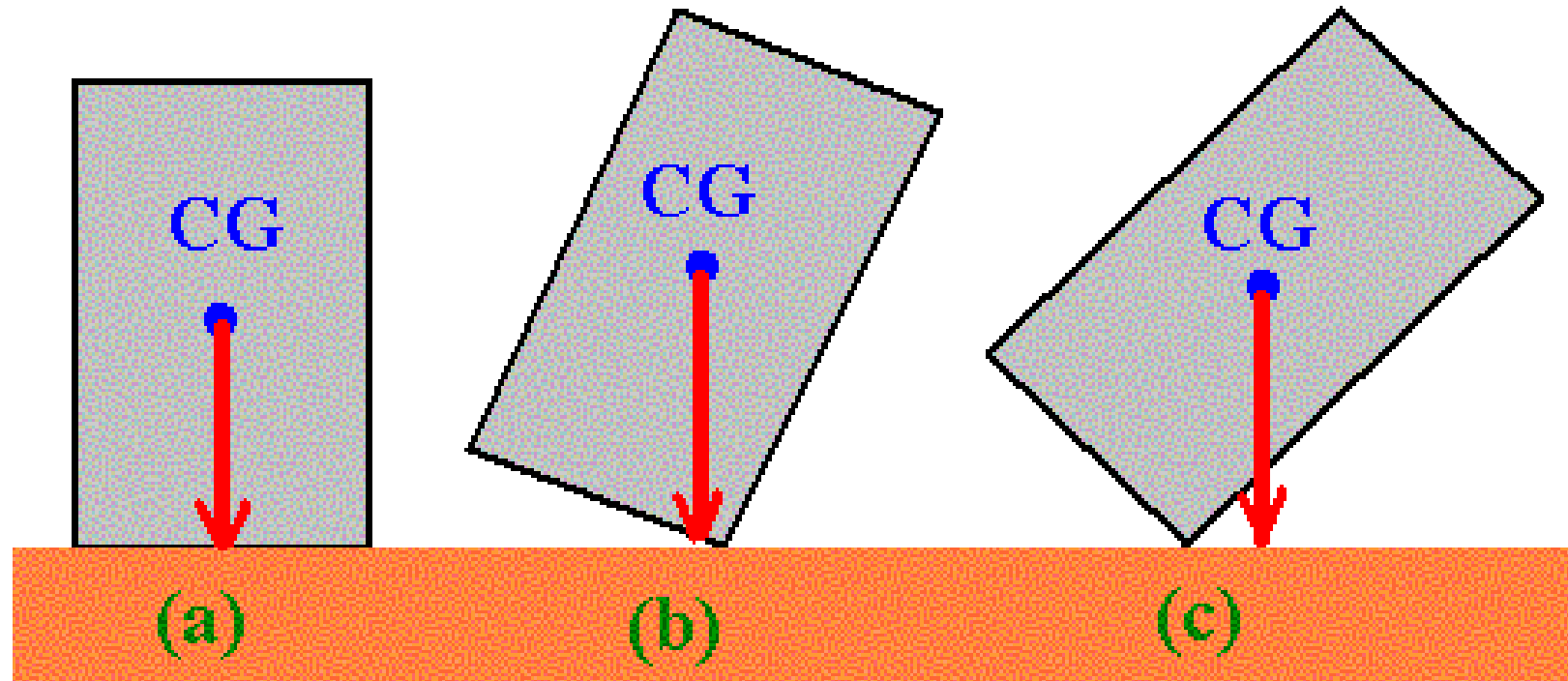
- Stability refers to a structure that is balanced.
- Objects are most stable when the point of contact is directly below the center of mass.
- What is the center of mass?
- The center of mass is the point where there is equal amount of mass in each direction.
- If you hold an object immediately below the center of mass, it will remain balanced.



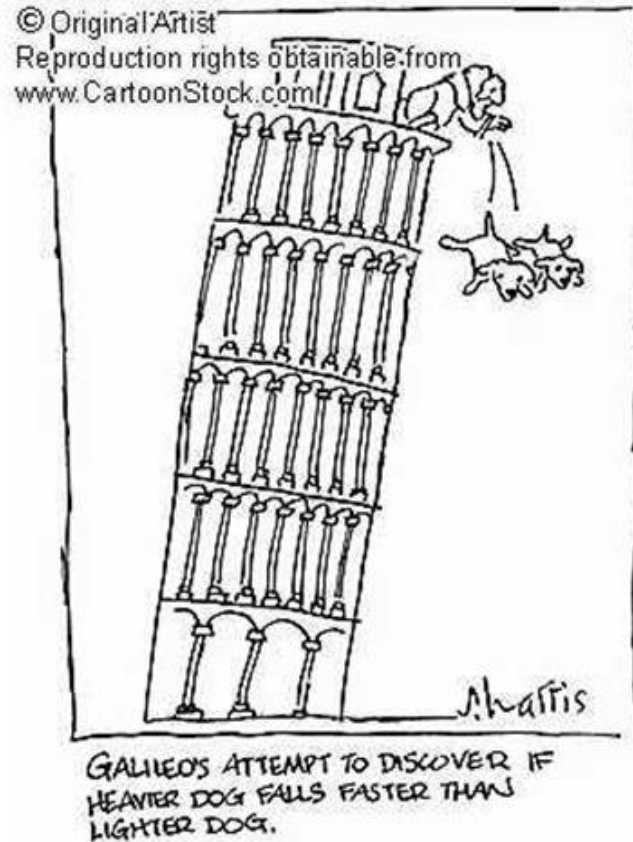
Point of Contact vs. Center of Mass



Which one falls over? Why?

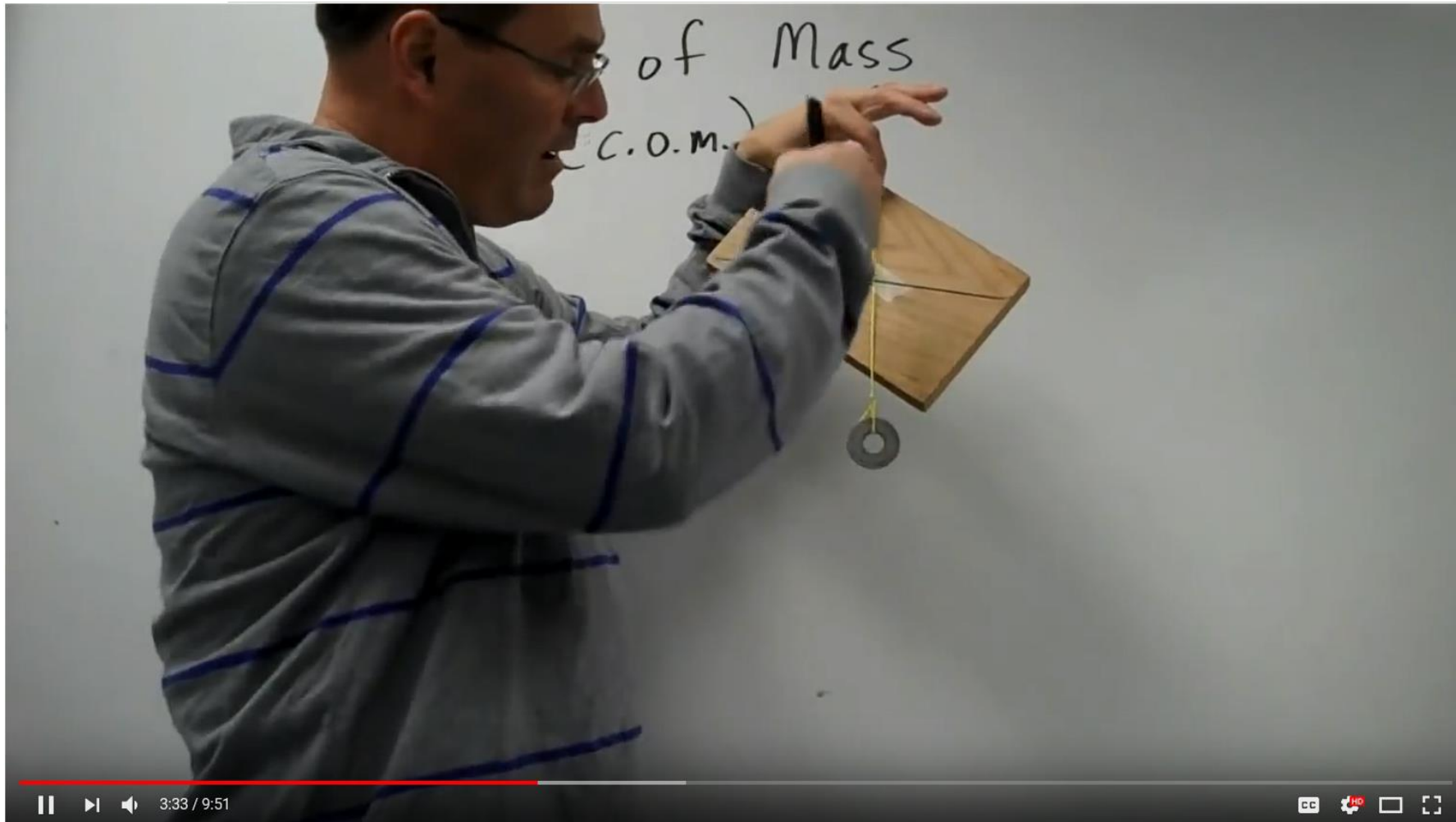


Leaning Tower of Pisa



- If the leaning tower of Pisa is not toppling over, where must the c.g. be located?
- The c.g. must be over the base.

How To Locate Center of Mass (Spinning Top)



You Can Also Increase Stability By....

- Making the object bottom-heavy and bottom-wide.
- Making the bottom heavy also lowers the center of mass. **A Low center of mass creates high stability.**
- The things below are called footings because they look like large feet.
- They are super heavy and really wide.

