A Standard Measurement System

The International System of Units (SI)

Measurement

- Must have a standard.
- A standard is an exact quantity people agree to use for comparison.
- A standard means two people using the same object should get close to the same results.

Measurement

- Using a standard system of measurement allows scientists to compare data and communicate with each other about their results.

- Using a standard system of measurement allows experiments to be repeated and most importantly achieve a desired result.

Standards of the Past

- People used parts of their body to determine the length of something.
  - Inch:
    - At first an inch was the width of a man's thumb. In the 14th century, King Edward II of England ruled that 1 inch equaled 3 grains of barley placed end to end lengthwise.
  - Hand:
    - A hand was approximately 5 inches or 5 digits (fingers) across. Today, a hand is 4 inches and is used to measure horses (from the ground to the horse's withers, or shoulder).

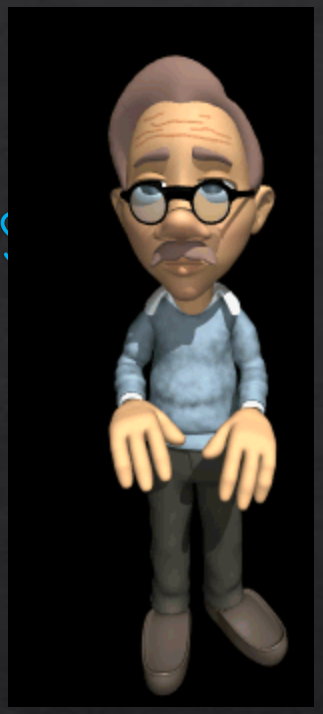
Standards of the Past

- Span:
  - A span was the length of the hand stretched out, about 9 inches.
- Lick:
  - A Lick was used by the Greeks to measure the distance from the tip of the thumb to the tip of the index finger.
- Yard:
  - A yard was originally the length of a man's belt or girdle, as it was called. In the 12th century, King Henry I of England fixed the yard as the distance from his nose to the thumb of his out-stretched arm. Today it is 36 inches.

Standards of the Past

- Foot:
  - In ancient times, the foot was
  - Today it is 12 inches, the leng
    foot.

Measurement



- Scientists give the English system the thumbs down.

- 1 U.S. gallon = 231 cubic inches = 128 U.S. fluid ounces = 256 tablespoons = 768 teaspoons = 16 cups = 8 U.S. fluid pints = 4 U.S. fluid quarts = 1/31.5 U.S. federal barrel = 1/42 oil barrel = 1/55 drum

Measurement

- Examples of the English system.
  - Length
    - 1 foot = 12 inches
    - 1 yard = 3 feet = 36 inches
    - 1 mile = 1,760 yards = 5,280 feet = 63,360 inches
  - Mass
    - 1 pound = 16 ounces
    - 1 Ton = 2,000 pounds = 32,000 ounces
  - Liquid Volume
    - 1 Gallon = 4 quarts = 8 pints = 16 cups= 128 fluid ounces

Le Système International d'Unités

The International System of Units

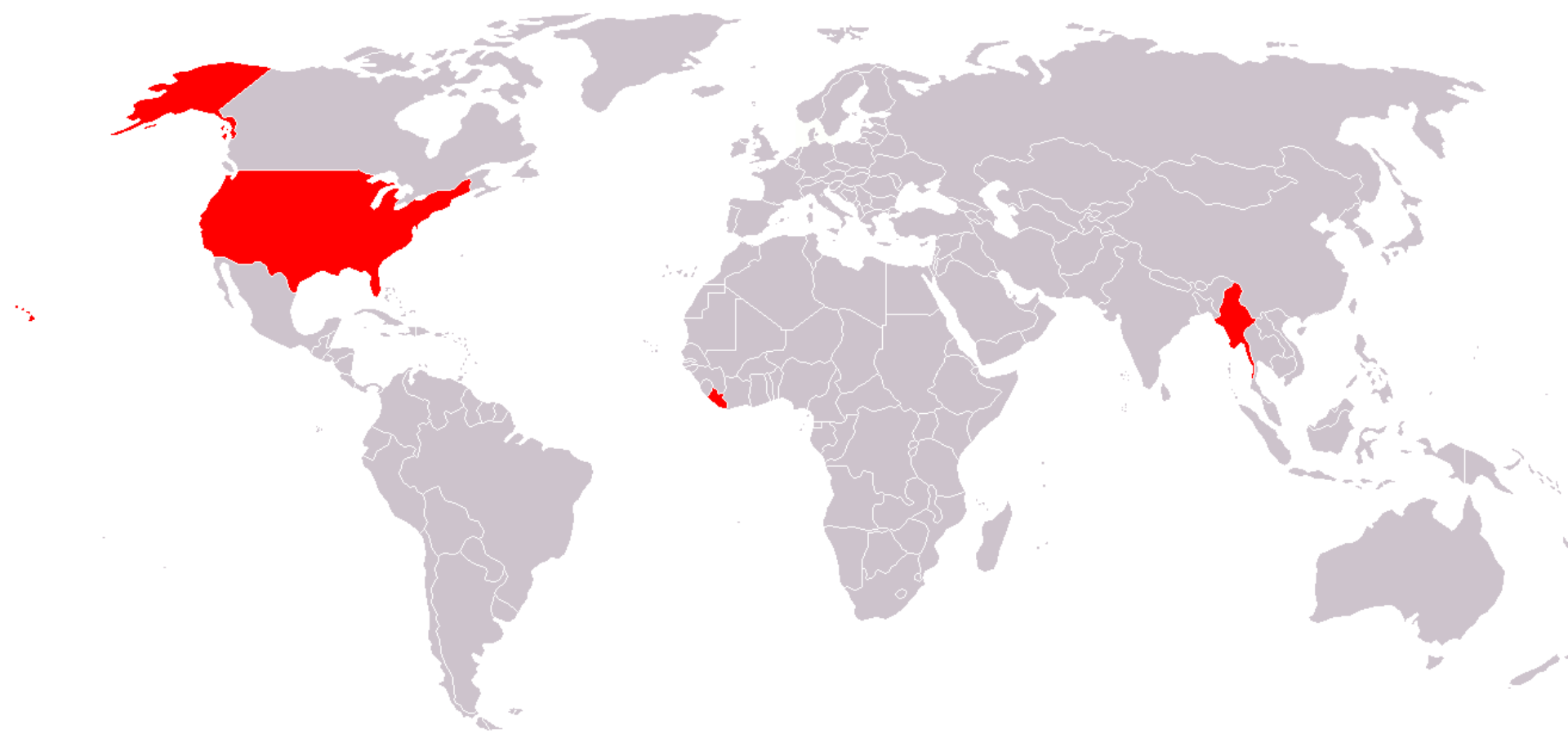
SI

International System of Units

- Developed by the French in the late 1700's.
- Based on powers of ten, so it is very easy to use.
- Used by almost every country in the world.
- Especially used by scientists.
- Invented because countries were using many different systems of measurement causing confusion and lack of consistency.

International System of Units

- Almost all other countries are using the International System of Units.
- Other countries' companies are refusing to buy products from the U.S. if not labeled in metric units
- Scientists need a universal way to communicate data (SI Units).



Three countries use non-metric measurement systems: Liberia, Myanmar (Burma), and the United States. ..the rest of the world uses the international system of units.

The Mistake

- MARS

Two groups of scientists (California and Colorado) worked on the calculations to send the Climate Orbiter to Mars.

One team did their calculations in the English standard and the other team calculated using the International System of Units - OOPS!

The Mistake

The software calculated the force the thrusters needed to exert in *pounds* of force. A separate piece of software took in the data assuming it was in the metric unit: *newtons*.

The $125 million satellite was supposed to be the first weather observer on another world. But as it approached the red planet to slip into a stable orbit Sept. 23, 1999, the orbiter vanished.

- This made scientists very upset.

- It cost the space program 125 million dollars
- It cost the scientists their time

Scientists all over the world use the International System of Units to measure:

- Length
- Volume
- Mass
- Density
- Temperature
- Time

In Science, we will use the International System of Units to measure.

Most Used SI Units (in middle school☺)

- The gram measures mass.
- The liter measures liquid volume.
- The meter measures the length of an object or the distance from place to place.

- Meter- Measures length
  - Length is the distance between two points
- Liter –Measures Volume
  - Volume is how much space an object takes up
- Gram- Measures mass
  - Mass is how much matter is in an object

Prefixes

- Kilo means thousand (1000)
- Hecto means hundred (100)
- Deca means ten (10)
- Deci means one-tenth (1/10)
- Centi means one-hundredth (1/100)
- Milli means one-thousandth (1/1000)

The METER

- One ten-millionth of the distance from the North Pole to the equator?
- Originally defined as one ten-millionth of the distance between a Pole and the Equator as measured from 1792 along a meridian from Dunkirk to Barcelona across Paris

Measuring Length

- Meter- Measures length
  - Length is the distance between two points


MILES PER GALLON
1
½ + ¼ =
Cookies
Ruler in Inches
2
11
6

Measuring Length

- Meter- Measures length
  - Length is the distance between two points

Object	cm	mm	m
Glue stick			
Width of lab table			
Height of planner			
New pencil w/eraser			

Mass

- The measure of the amount of matter an object contains.

- **Matter**: The material that all objects and substances are made up of.
  - Anything that has mass and takes up space is matter.

Mass

- Gram- Measures mass
  - Mass is how much matter is in an object

Mass

- Mass is the amount of matter that makes up an object.
- A golf ball and a ping pong ball are the same size, but the golf ball has a lot more matter in it. So the golf ball will have more mass.
- The SI unit for mass is the gram.
- A paper clip has a mass of about one gram.
- The mass of an object will not change unless we add or subtract matter from it.

Mass

The Difference Between Mass and Weight

- If you were to travel to the moon your weight would be less.
- Your weight would be less because the force of gravity is less.
- Your mass would stay the same if you were to travel to the moon because mass is the amount of matter that an object contains.
- Since you are still made up of the same amount of "stuff", your mass would not change.

Mass

- Scientists prefer to use an objects mass instead of its weight because mass does not change when the force of gravity does.

Mass

- The basic unit of mass in the SI system is the **kilogram**.

Mass Conversions

1 kg = _____ g

1 g = _____ mg

Mass Conversions

1 kg = 1,000 g

1 g = _____ mg

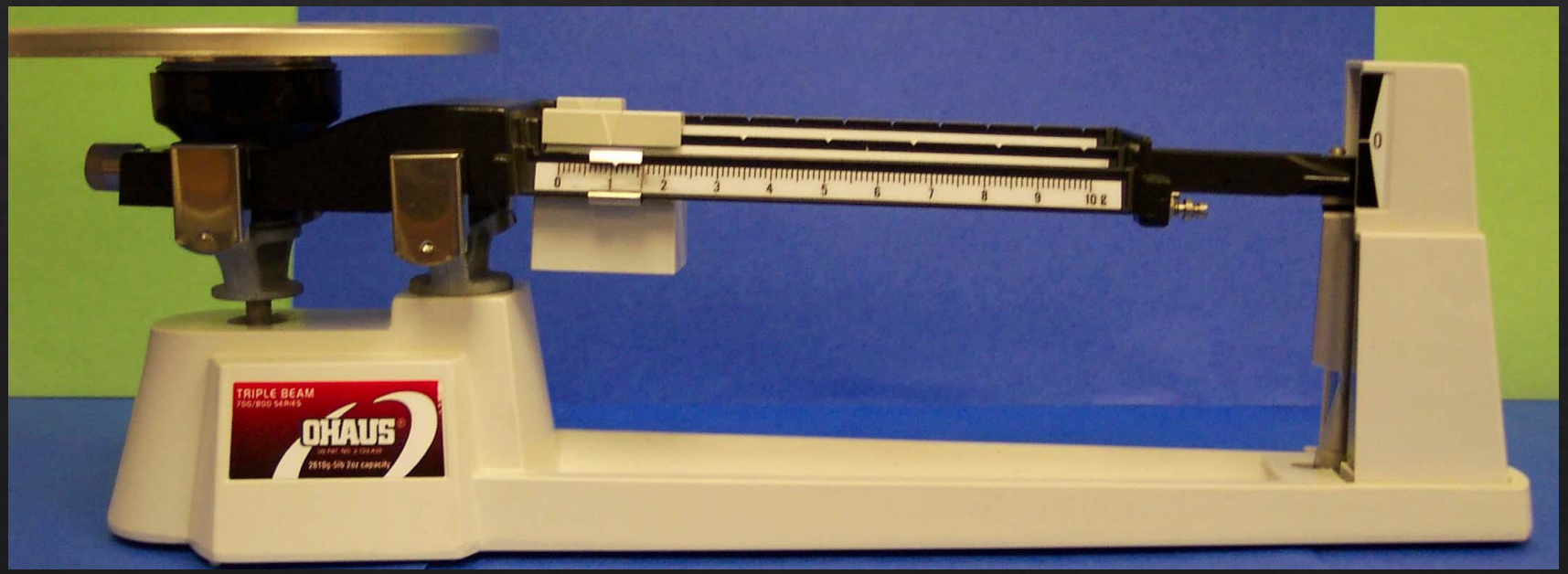
Mass Conversions

1 kg = 1,000 g

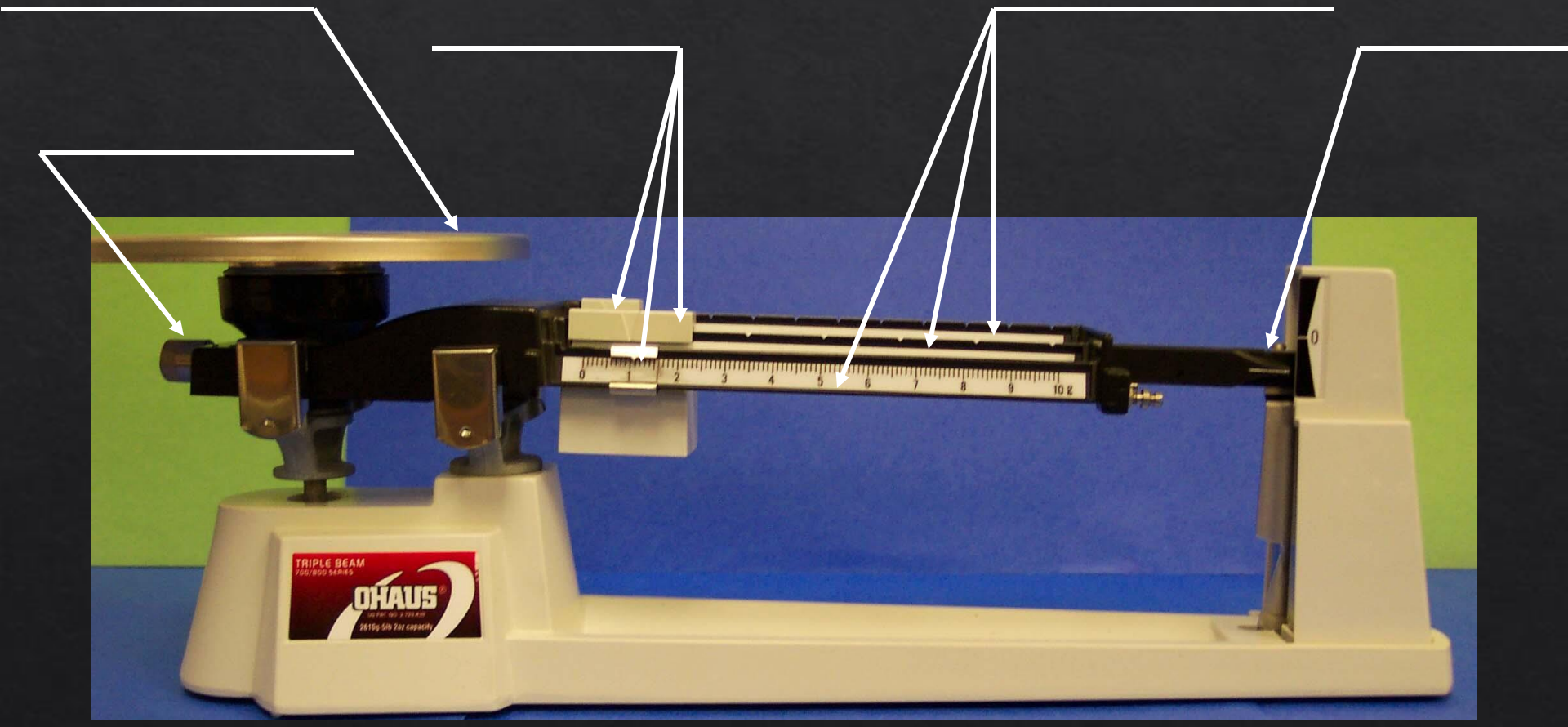
1 g = 1,000 mg

Measuring Mass

- We use a triple beam balance to measure mass.



Label the parts of the triple-beam balance.



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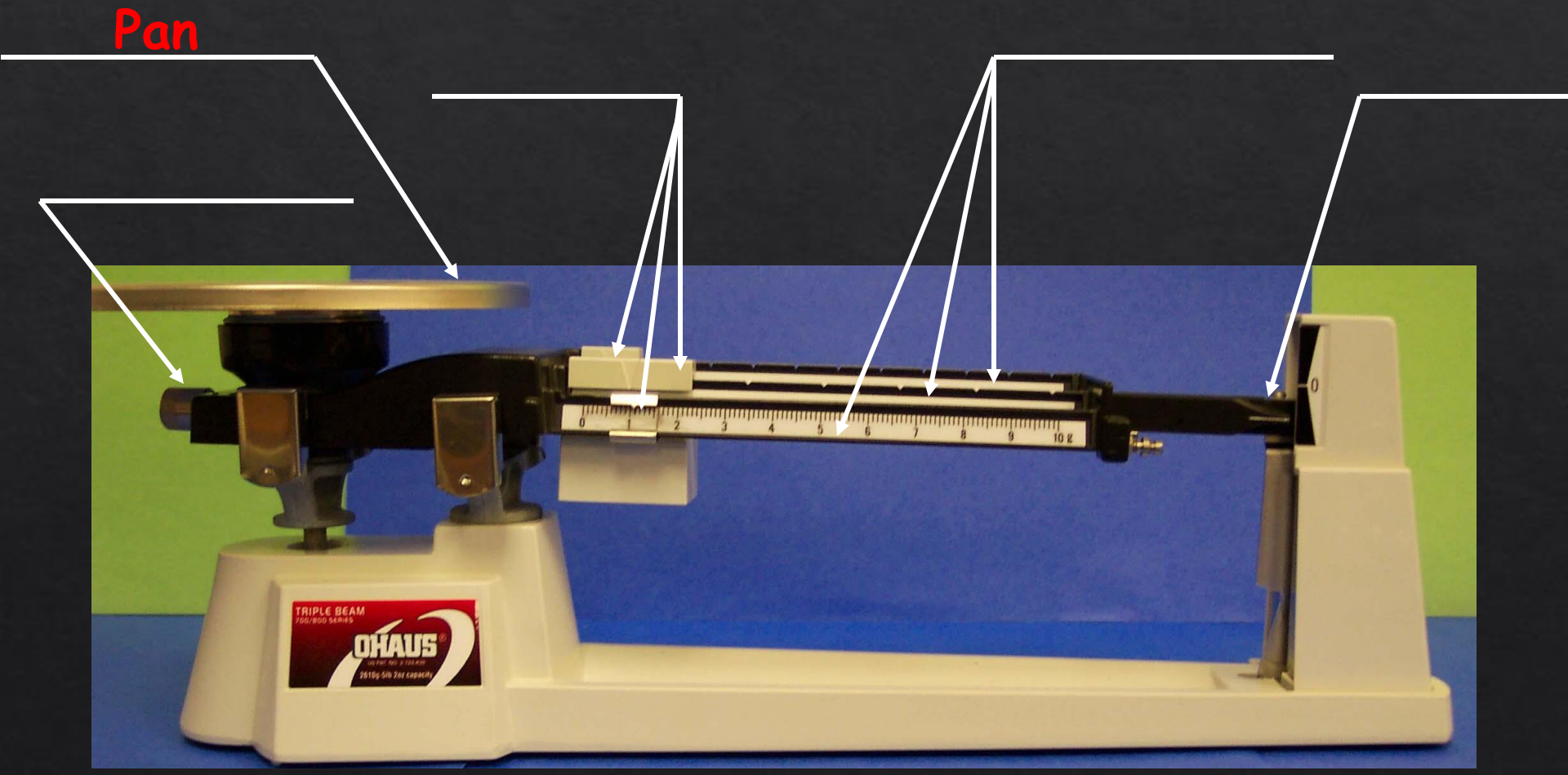

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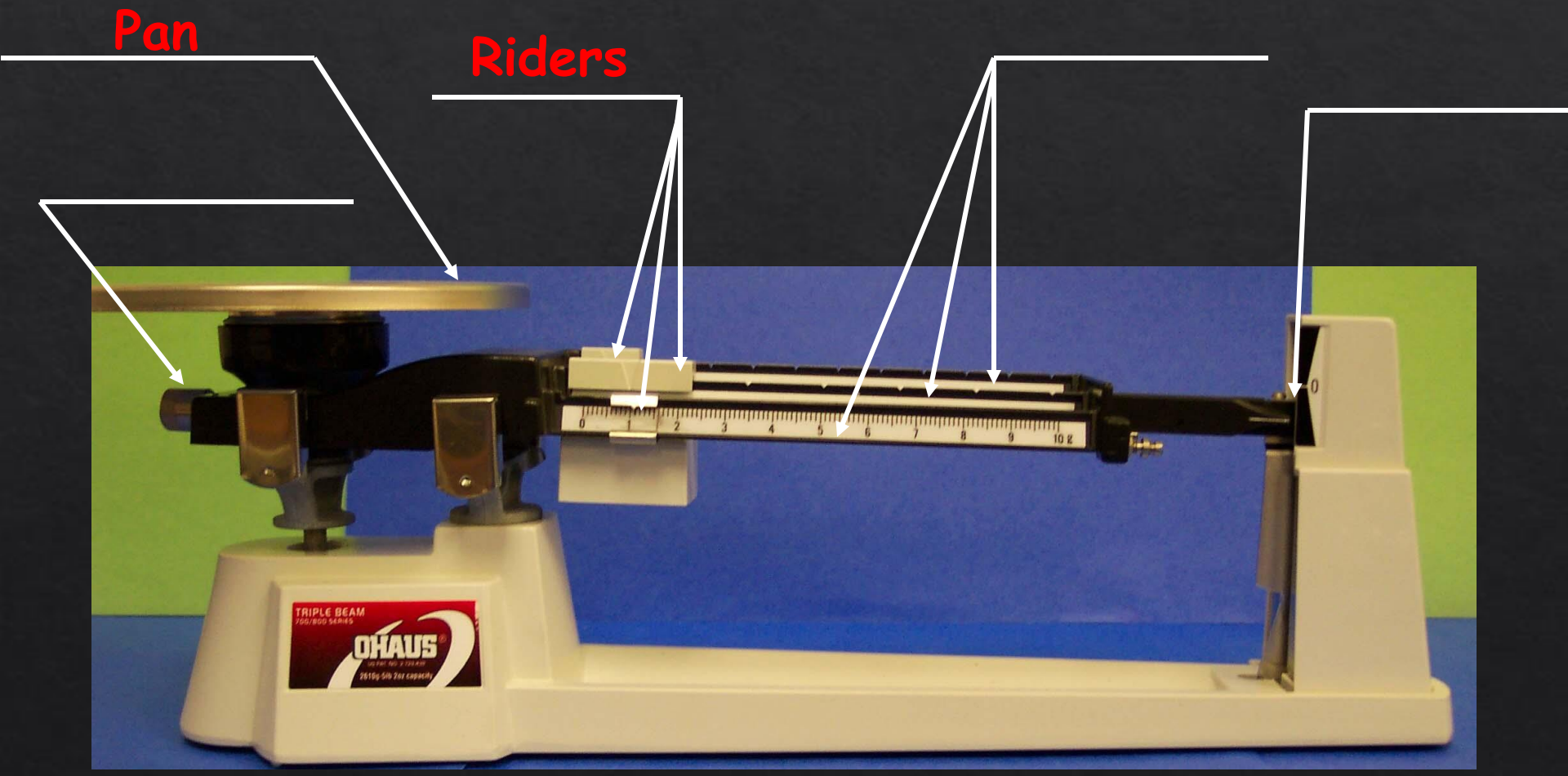

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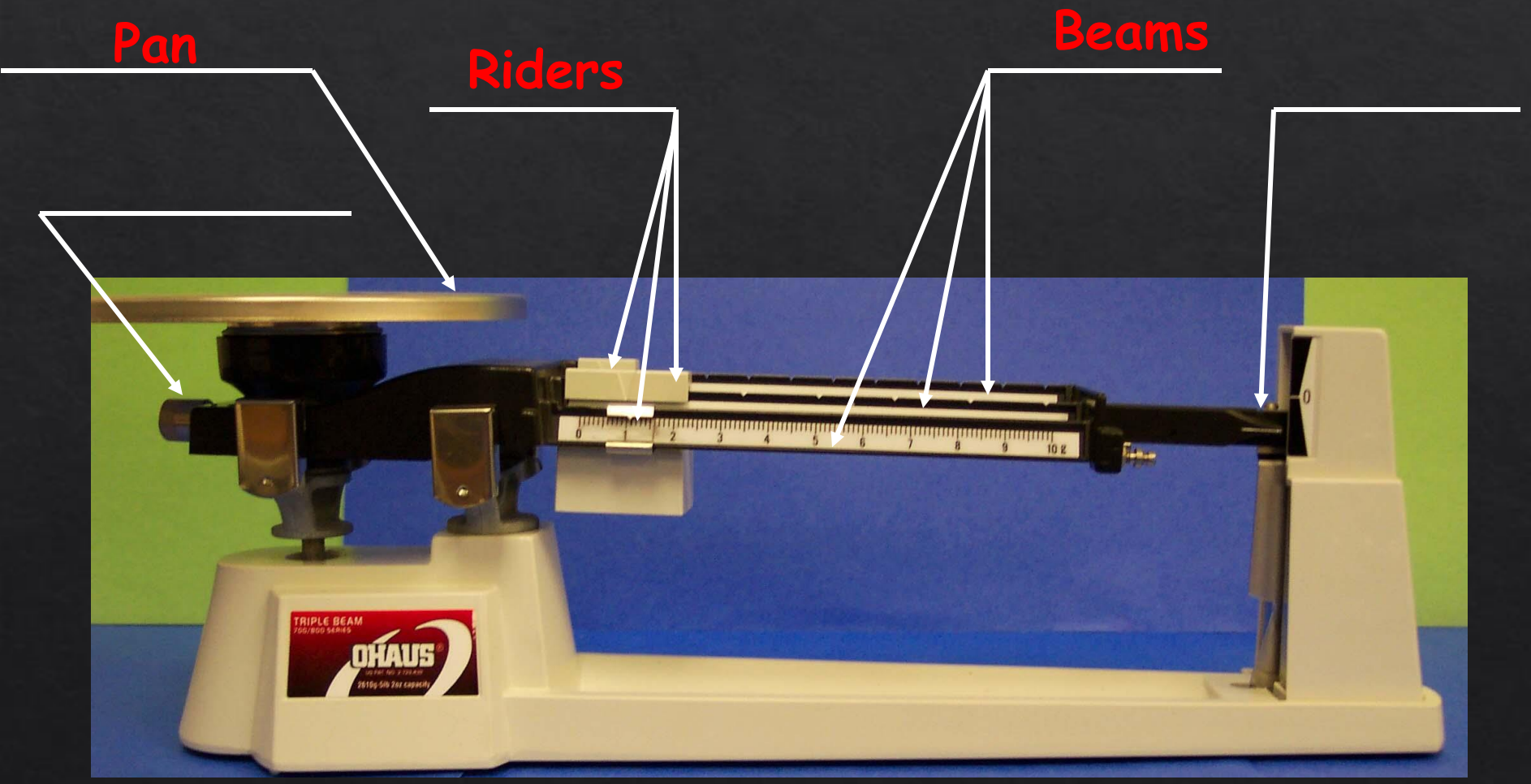

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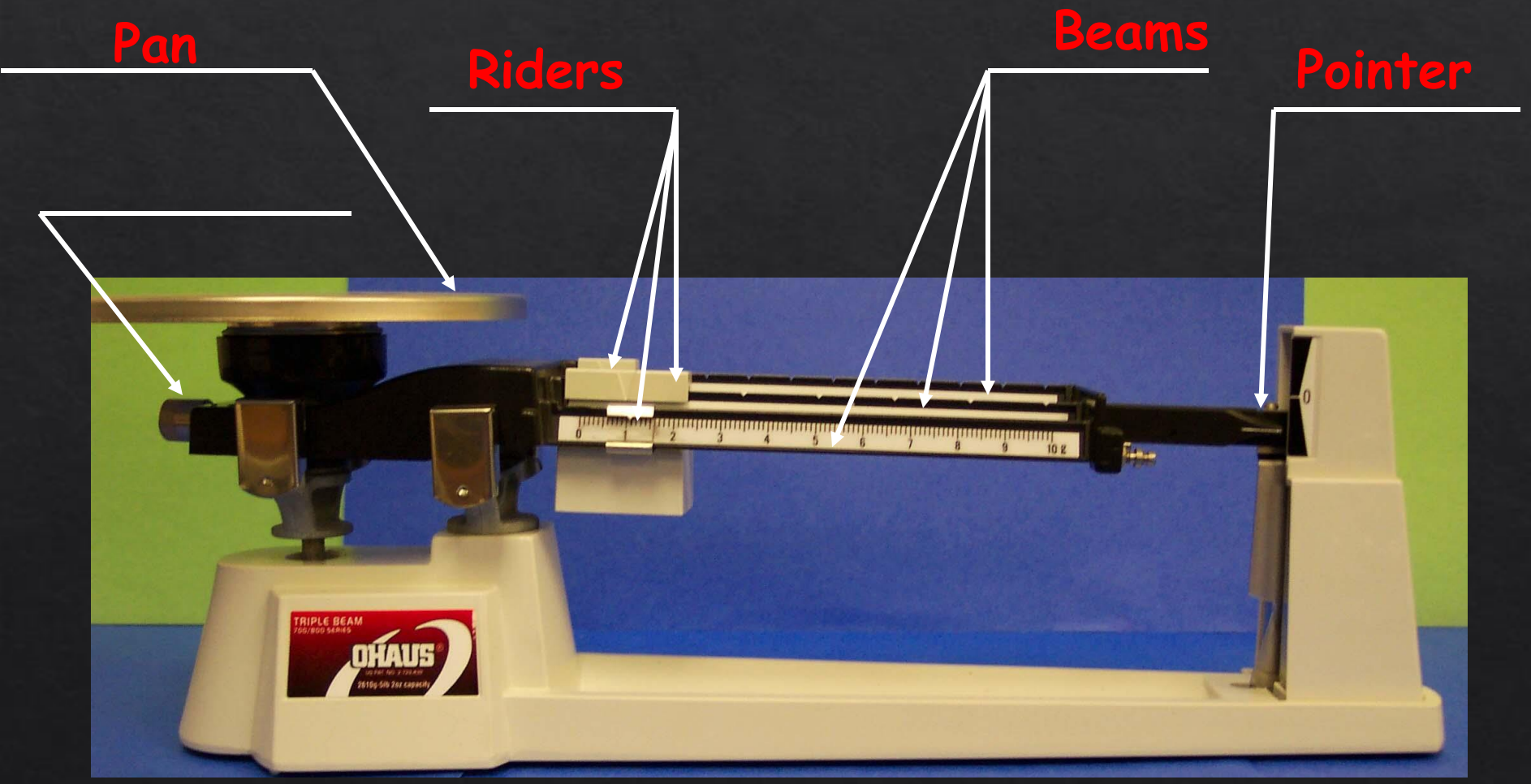
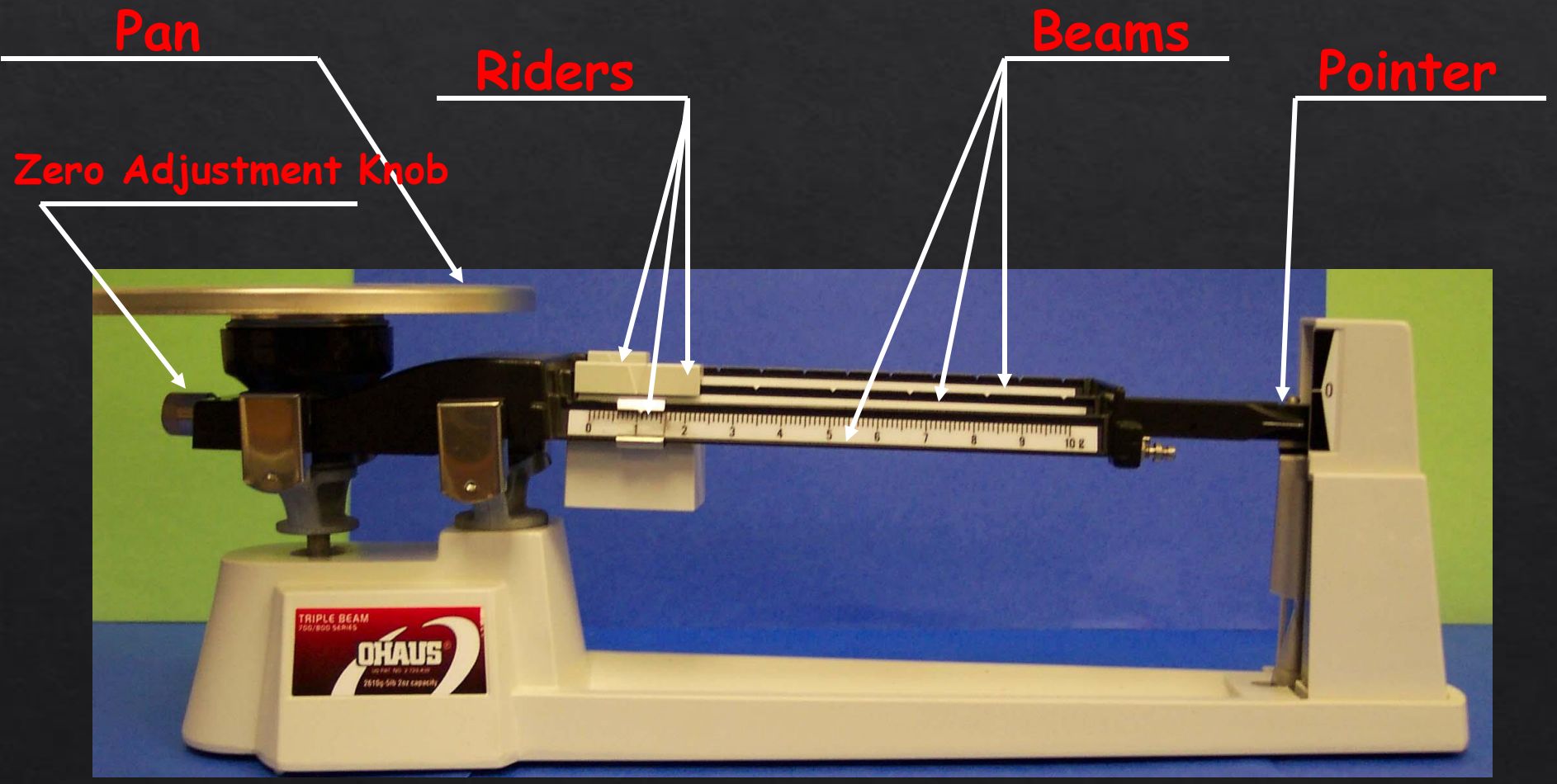


Label the parts of the triple-beam balance.



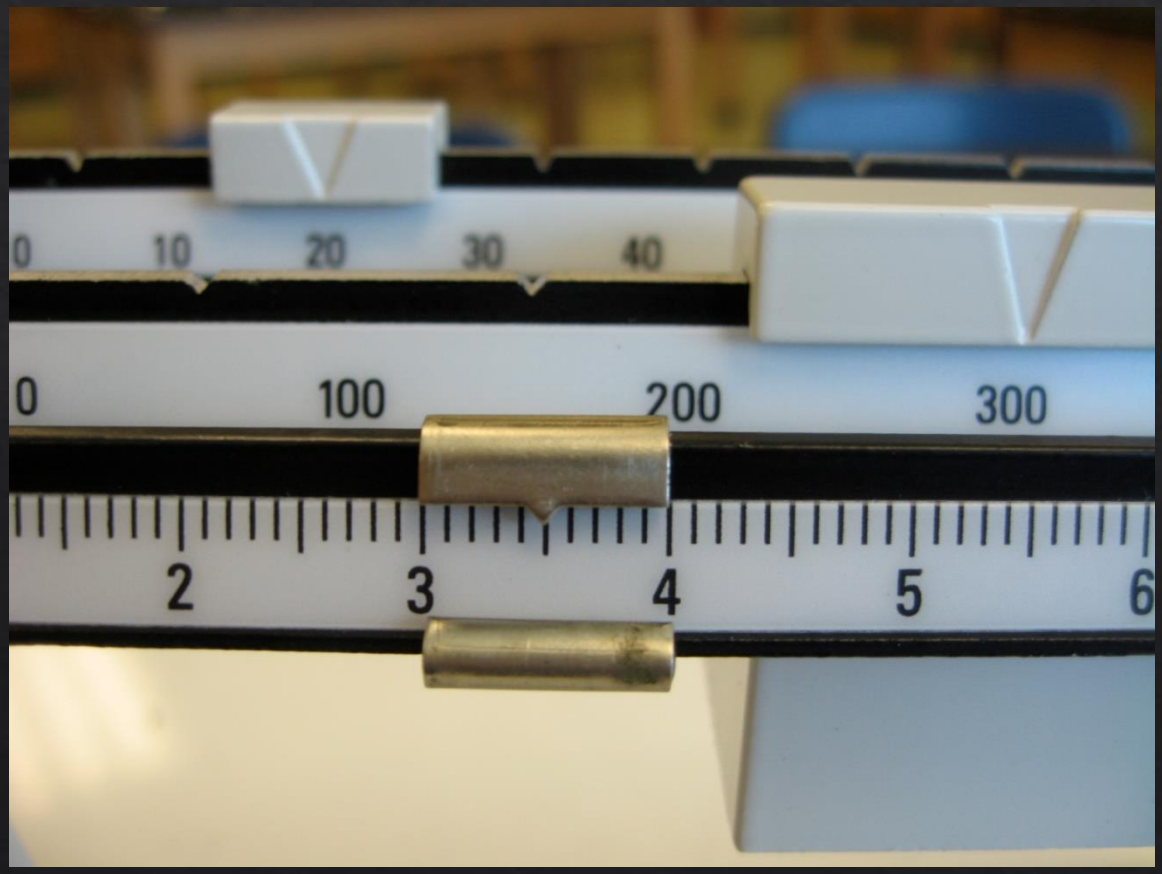
Calibrate or Zero Out

- Before using a triple-beam balance, **calibrate** (set) the balance to zero.

Using a triple-beam balance…

- When you use a triple-beam balance, you:
  1. Place the object on the pan
  2. Shift the riders on the beams until them balance the mass of the object
     - Start with the large rider (increments of 100)
     - Next, the medium sized rider (increments of 10)
     - Lastly, the small rider (increments of 1)

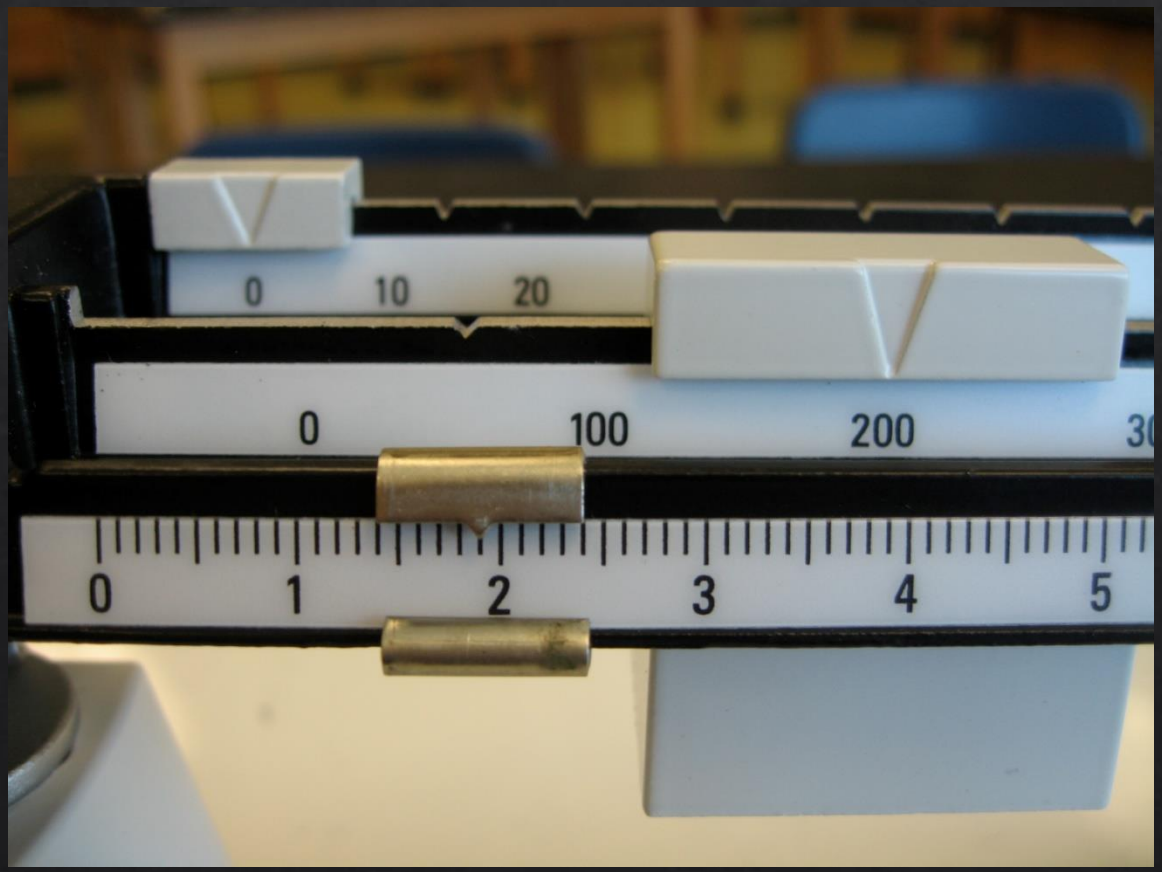
Reading the Triple-Beam Balance



What does this balance read?

- 323.5 grams

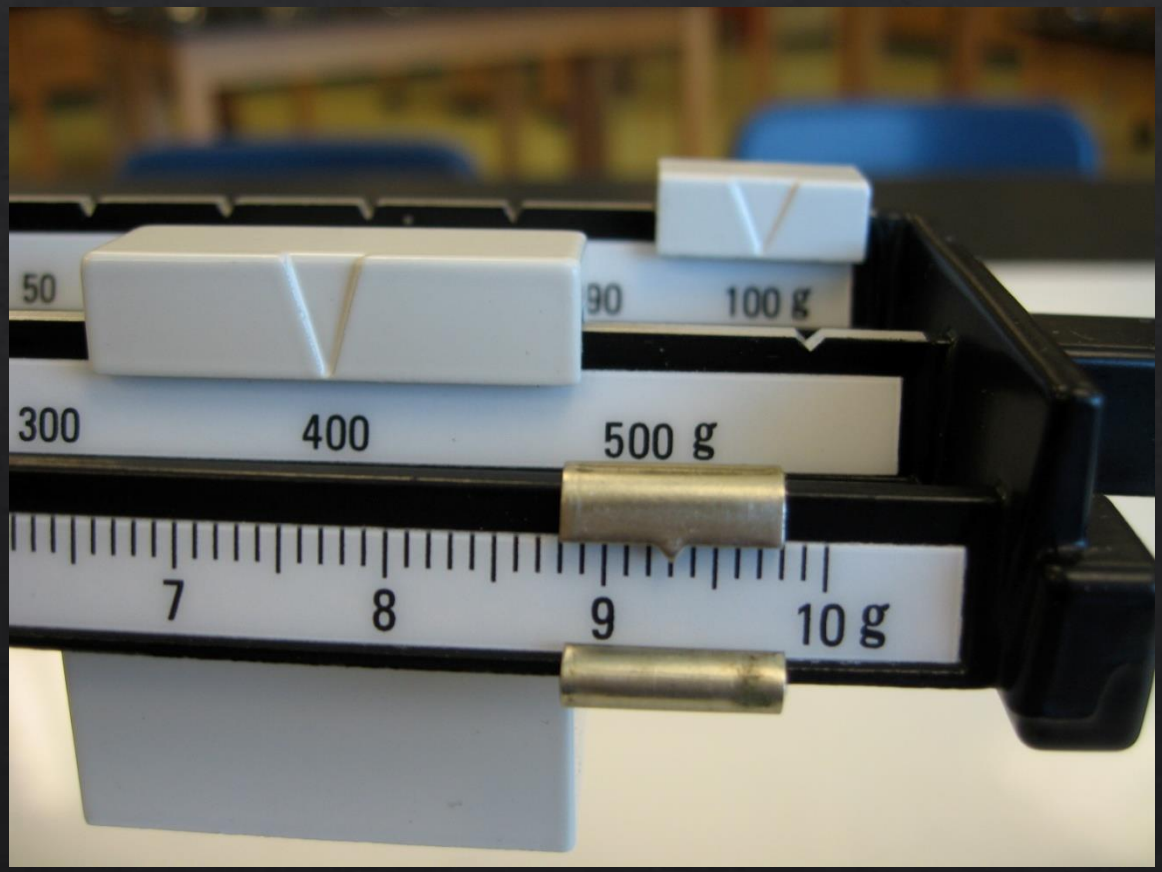
Reading the Triple-Beam Balance



What does this balance read?

- 201.9 grams

Reading the Triple-Beam Balance



What does this balance read?

- 509.3 grams

Metric Mania

Metric Conversions
Ladder Method

T. Trimpe 2008 http://sciencespot.net/

The Story of King Henry

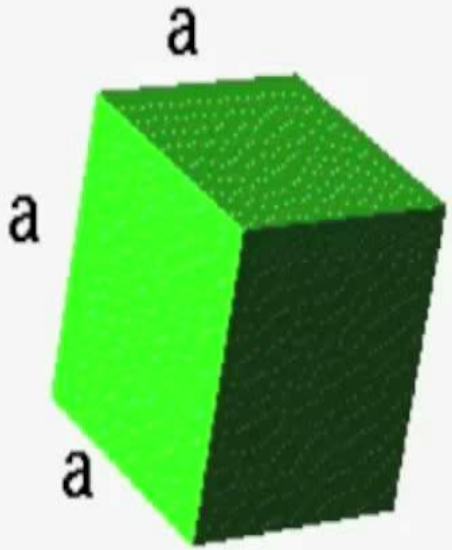
Remember?
Metric Conversion Mnemonic

- King (kilo, 1,000)
- Henry (hecto, 100)
- Died (deka, 10)
- Unexpectedly (Basic Unit)
- Drinking (deci 1/10)
- Chocolate (centi 1/100)
- Milk (milli, 1/1,000)

Sphere

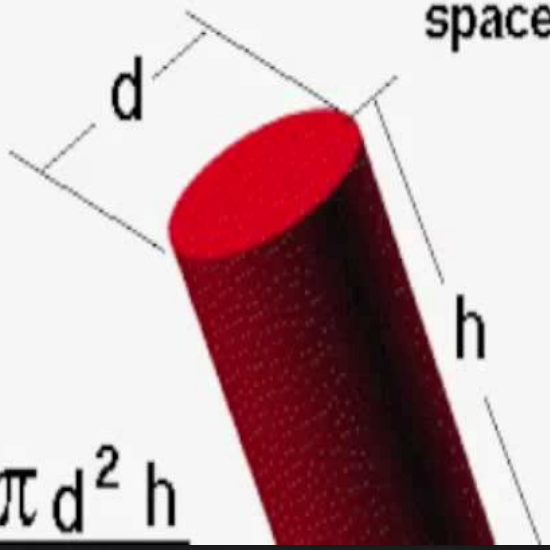
$$V = \frac{\pi d^3}{6}$$

Cube



$$V = a^3$$

Volume is the three-dimensional space occupied by an object.

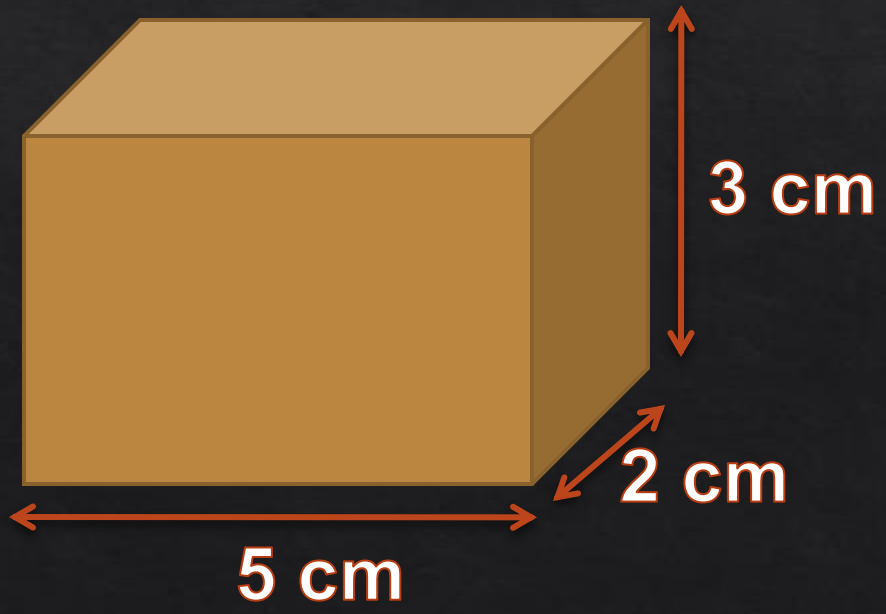


$$V = \frac{\pi d^2 h}{}$$

$$V = a\,b\,h$$

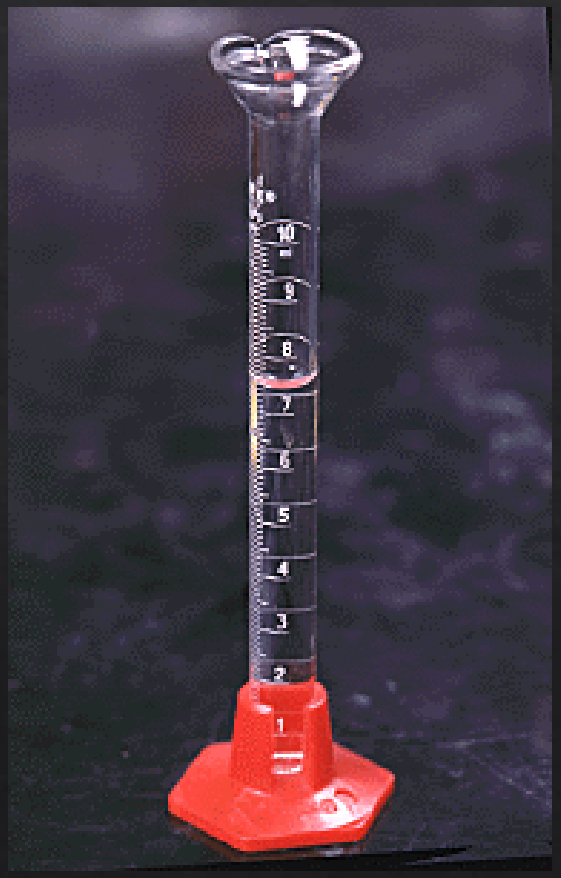
Volume

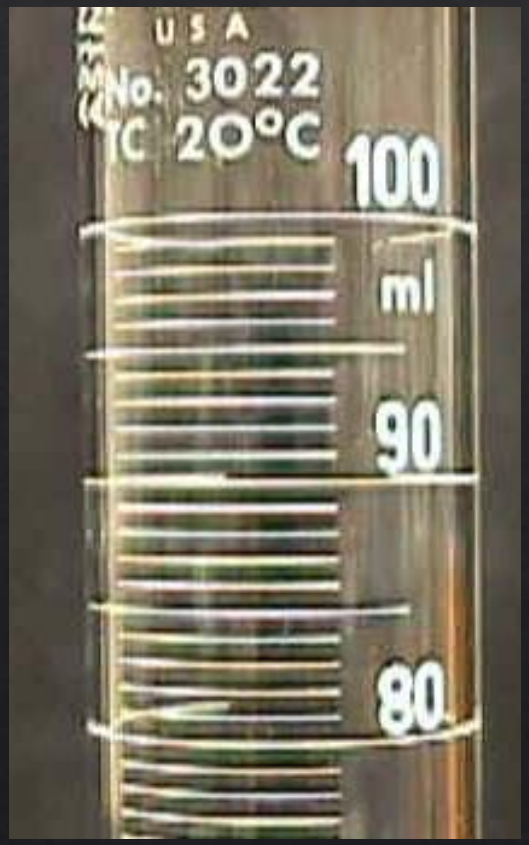
- Volume is the amount of space an object takes up.
- We can find the volume of box shapes by the formula Volume = length x width x height
  - In this case the units would be cubic centimeters (cm^3).
  - So a box 2 cm x 3 cm x 5 cm would have a volume of 30 cm^3



Volume

- The base unit for liquid volume is the Liter.
- We measure liquid volume with a graduated cylinder.





Liquid Volume

- When the metric system was created, scientists decided that 1 cm^3 of water would equal 1 milliliter of water and that 1 mL of water would have a mass of one gram.
- 1 cm^3 of water = 1 mL of water = 1 gram

Temperature

- Water boils at 100 degrees Celsius or 212 degrees Fahrenheit.
- Water freezes at 0 degrees Celsius or 32 degrees Fahrenheit.

Why Mrs. Bartels LOVES the metric system...

- No numbers to memorize.
- No fractions.
  - Decimals only.
- Easy conversions.
  - Only one unit for each quantity.
- Easy to divide and multiply.
  - It's a system of ten.
- More accurate.

REVIEW

- In science, SI is always used.
- Base units in the metric system are meter, liter, gram
- Metric system is based on powers of 10
- For conversions within the metric system, each "step" is 1 decimal place to the right or left