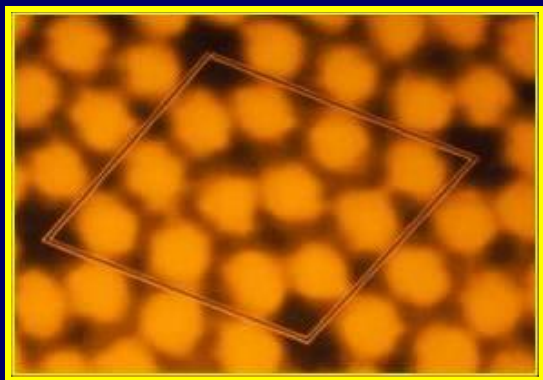


Density



Matter

Matter is anything that has mass and takes up space.



All matter is made up of atoms.

Photo of Silicon Atoms Sample of Silicon

Mass is a measurement of the amount of matter there is in an object.
(Amount & type of atoms present)

Volume

Volume is the amount of space that an object occupies.



Solid



Liquid

Mass and Volume

Two substance
or objects can
have the same
volume but have
different masses.



1 bowling ball has
the same mass as
18 basketballs.



Different Masses?

The type of atoms in the basketball have less mass than the type of atoms in the bowling ball.



Periodic Table of the Elements

1																	18			
1	2											10	11	12	13	14	15	16	17	18
1	2											10	11	12	13	14	15	16	17	18
3	4											10	11	12	13	14	15	16	17	18
11	12											10	11	12	13	14	15	16	17	18
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36			
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54			
55	56	57-71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86			
87	88	89-103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118			
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Cn	Uut	Uuq	Fl	Uup	Lv	Uus	Uuo		
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106	107		
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu						
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr						
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71						
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu						
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103						
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr						
223.02	226.03	227.03	231.04	238.03	237.05	244.06	245.06	247.07	247.07	251.08	252.08	257.10	258.10	262.10	262.10	262.10	262.10	262.10		
Alkali Metal	Alkali Earth	Transition Metal			Basic Metal	Semimetal	Nonmetal	Halogen		Noble Gas		Lanthanide	Actinide							
© 2016 periodic-table.com																				

Basketball – Nitrogen 14 amu

Different Masses?

One of the many elements that make up the core of a bowling ball is bismuth, which is added to give a bowling ball greater mass.



Periodic Table of the Elements

1																	18								
H Hydrogen 1.008																	He Helium 4.002								
3	4											13	14	15	16	17	18								
Li Lithium 6.941	Be Beryllium 9.012											B Boron 10.81	C Carbon 12.01	N Nitrogen 14.01	O Oxygen 16.00	F Fluorine 18.998	Ne Neon 20.18								
11	12											19	20											37	38
Na Sodium 22.99	Mg Magnesium 24.31											K Potassium 39.10	Ca Calcium 40.08											Br Bromine 79.904	Kr Krypton 83.80
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36								
K Potassium 39.10	Ca Calcium 40.08	Sc Scandium 44.96	Ti Titanium 47.88	V Vanadium 50.94	Cr Chromium 51.99	Mn Manganese 54.94	Fe Iron 55.85	Co Cobalt 58.93	Ni Nickel 58.69	Cu Copper 63.55	Zn Zinc 65.38	Ga Gallium 69.723	Ge Germanium 72.64	As Arsenic 74.9216	Se Selenium 78.96	Br Bromine 79.904	Kr Krypton 83.80								
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54								
Rb Rubidium 85.468	Sr Strontium 87.62	Y Yttrium 88.91	Zr Zirconium 91.224	Nb Niobium 92.906	Mo Molybdenum 95.94	Tc Technetium 98.906	Ru Ruthenium 101.07	Rh Rhodium 101.07	Pd Palladium 106.42	Ag Silver 107.868	Cd Cadmium 112.411	In Indium 114.818	Sn Tin 118.710	Sb Antimony 121.757	Te Tellurium 127.6	I Iodine 126.905	Xe Xenon 131.29								
55	56	57-71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86								
Cs Cesium 132.905	Ba Barium 137.327	Lanthanides	Hf Hafnium 178.49	Ta Tantalum 180.948	W Tungsten 183.84	Re Rhenium 186.207	Os Osmium 190.23	Ir Iridium 192.222	Pt Platinum 195.084	Au Gold 196.967	Hg Mercury 200.59	Tl Thallium 204.384	Pb Lead 207.2	Bi Bismuth 208.980	Po Polonium 209	At Astatine 209	Rn Radon 222								
87	88	89-103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118								
Fr Francium 223	Ra Radium 226	Actinides	Rf Rutherfordium 261	Db Dubnium 262	Sg Seaborgium 266	Bh Bohrium 264	Hs Hassium 265	Mt Meitnerium 268	Ds Darmstadtium 271	Rg Roentgenium 272	Cn Copernicium 285	Uut Ununtrium 288	Fl Flerovium 289	Dup Duo-114 289	Lv Livermorium 293	Lus Lutetium 262	Uuo Ununoctium 294								
57	58	59	60	61	62	63	64	65	66	67	68	69	70	71											
La Lanthanum 138.905	Ce Cerium 140.12	Pr Praseodymium 140.908	Nd Neodymium 144.24	Pm Promethium 144.913	Sm Samarium 150.36	Eu Europium 151.964	Gd Gadolinium 157.25	Tb Terbium 158.925	Dy Dysprosium 162.50	Ho Holmium 164.930	Er Erbium 167.259	Tm Thulium 168.934	Yb Ytterbium 173.054	Lu Lutetium 174.967											
89	90	91	92	93	94	95	96	97	98	99	100	101	102	103	104	105	106								
Ac Actinium 227.03	Th Thorium 232.04	Pa Protactinium 231.04	U Uranium 238.03	Np Neptunium 237.05	Pu Plutonium 244.06	Am Americium 243.06	Cm Curium 247.07	Bk Berkelium 247.07	Cf Californium 251.08	Es Einsteinium 252.08	Fm Fermium 257.10	Md Mendelevium 258.10	No Nobelium 259.10	Lr Lawrencium 262											
Alkali Metal Alkaline Earth Transition Metal Block Metal Semimetal Nonmetal Halogen Noble Gas Lanthanide Actinide																									

Bismuth 209 amu

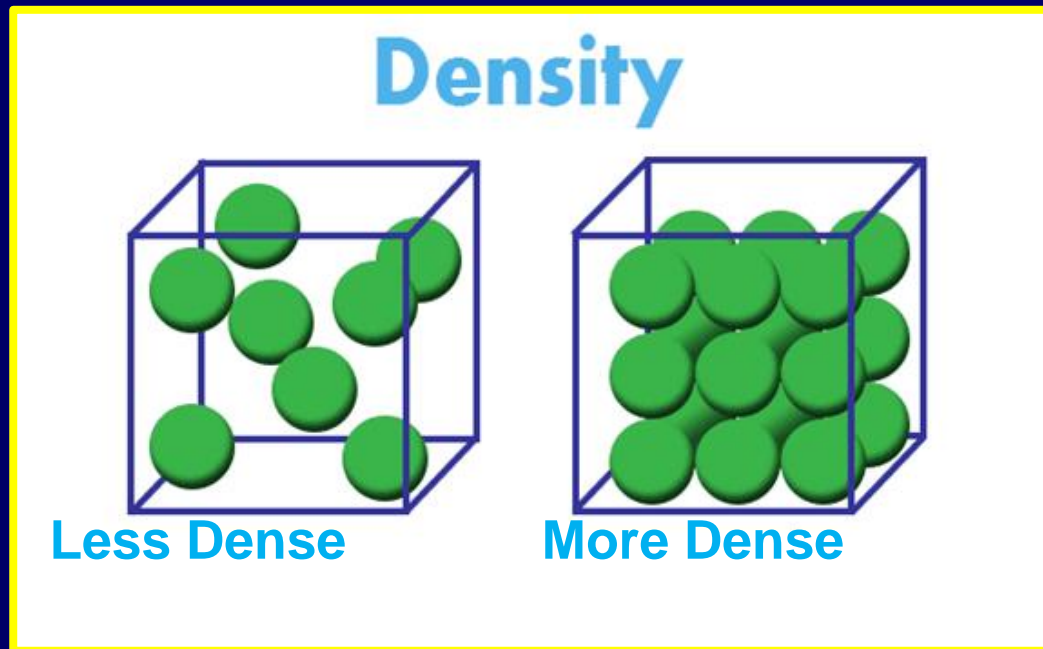
Mass and Volume

Because the volume is the same but the masses are different, the basketball and bowling ball have different densities.



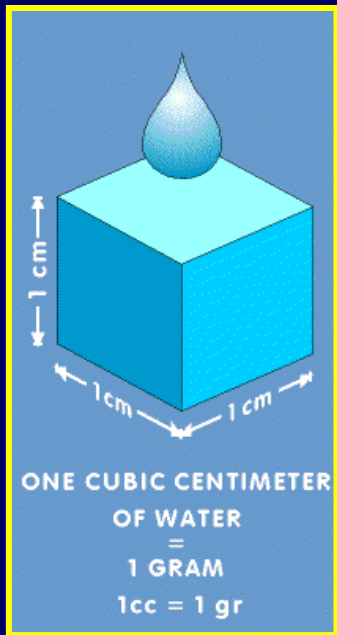
Defining Density

Density is the mass per unit of volume of a substance or object present within a given amount of space.



Density of Water

1 gram of pure water has a volume of 1 cubic centimeter or 1 mL of water. Therefore, Water has a density of 1 g/cm³ or 1 g/mL.

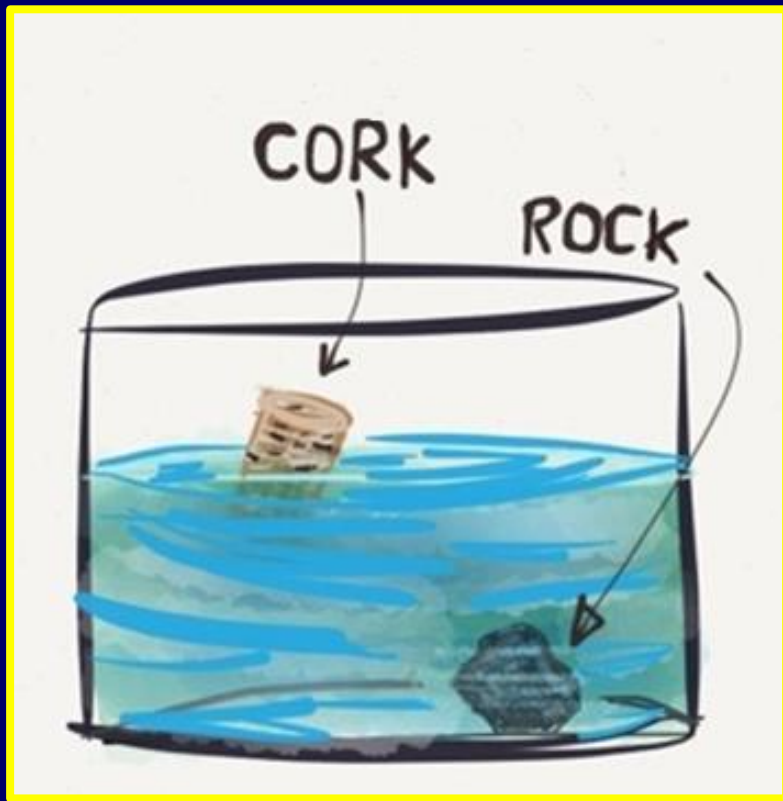


$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\text{Density} = \frac{1 \text{ g}}{1 \text{ cm}^3} = 1 \text{ g/cm}^3$$

Sink or Float?

Objects with a density less than 1 g/cm^3 or 1 g/mL will float.



Objects with a density greater than 1 g/cm^3 or 1 g/mL will sink.

Salt Water

Pure water consists of just water molecules.



The average density of ocean water ranges between 1.02 g/cm^3 and 1.03 g/cm^3 .



The higher density of saltwater makes it easier for large animals to float and move about.

Unique Densities

Most substances have a unique density.



Pyrite

5.01 g/cm³



Gold

19.3 g/cm³

Calculating Density

We can calculate the density of any substance or object by dividing its mass by its volume.

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Scientific Equations

In science, scientific equations show the relationship between various quantities and different symbols are used to represent each quantity.

$$d = m / v$$

Symbols

Density = d

Mass = m

Volume = v

Units

Each variable in a scientific equation also has an associated unit that must be included in the answer.

$$d = m / v$$

Units

Density (D) = g/cm³ or g/mL

Mass (m) = g

Volume (v) = cm³ or mL

Example Problem

0.259 cm³ of gold has a mass of 5 g.

What is the density of gold?

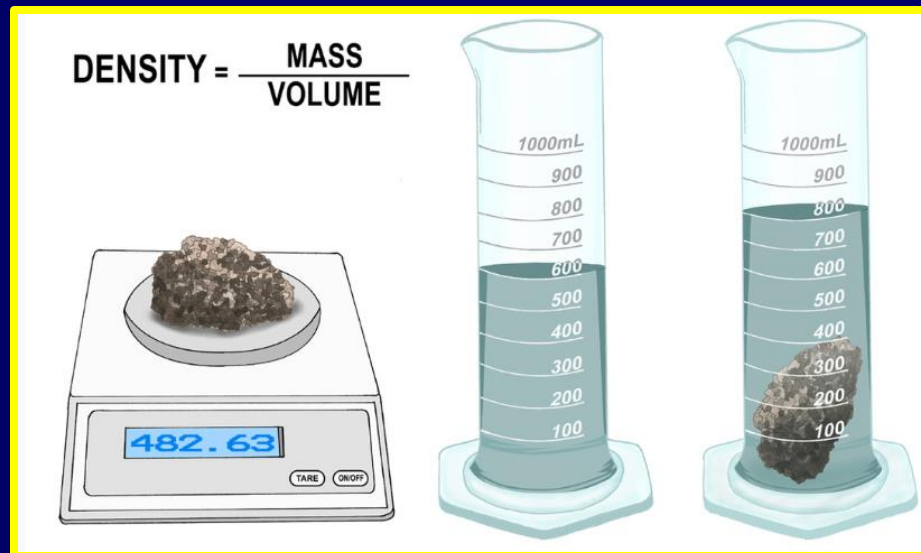
$$m = 5 \text{ g}$$

$$V = 0.259 \text{ cm}^3$$

$$d = m / v = 5 \text{ g} / 0.259 \text{ cm}^3 = 19.3 \text{ g} / \text{cm}^3$$

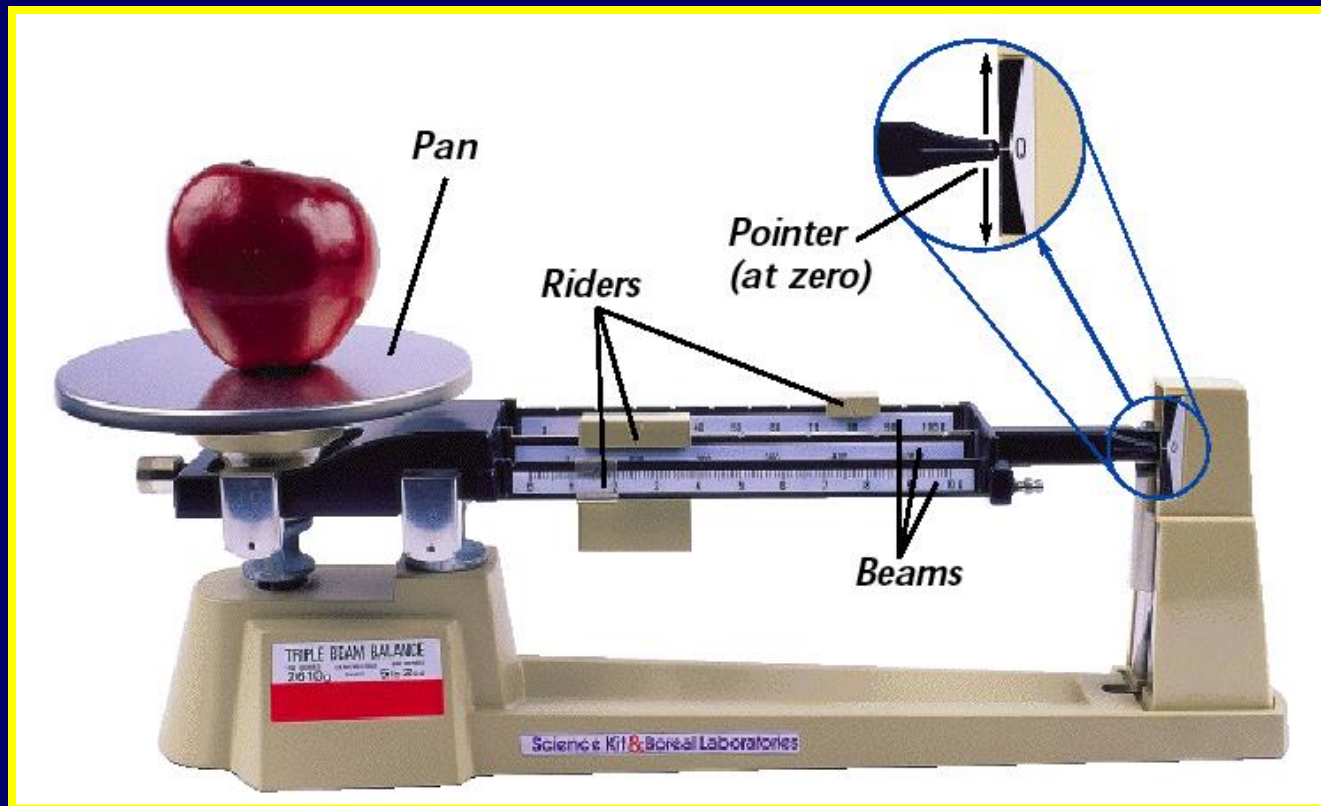
Measuring Density

We can find the density of any substance or object by measuring the mass and volume and then dividing the mass by the volume.






Measuring Mass

We can use the triple beam balance to measure the mass of any object.



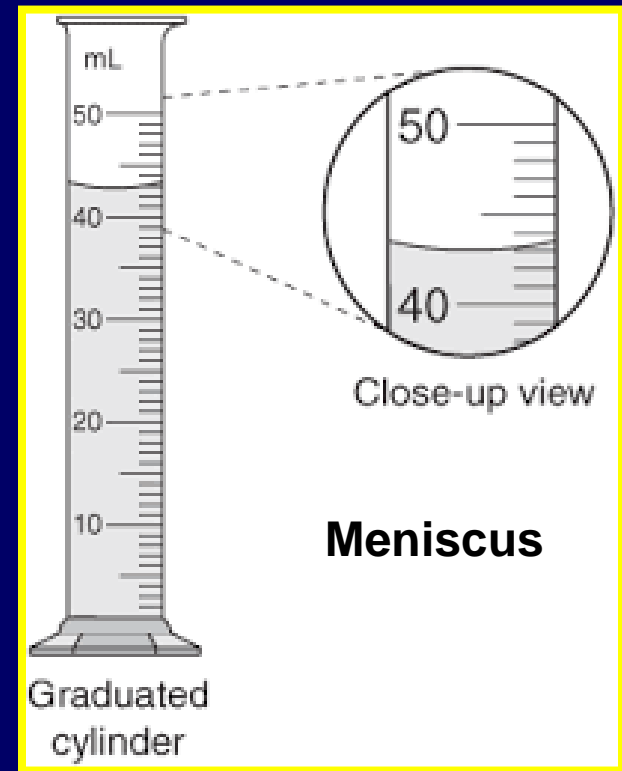
Measuring Liquid Mass

We can measure the mass of a liquid by subtracting the mass of the empty container from the mass of the container with the liquid.

Mass of Beaker with Liquid	-	Mass of Beaker without Liquid	=	Mass of the Liquid
				
10 g	-	3 g	=	7 g

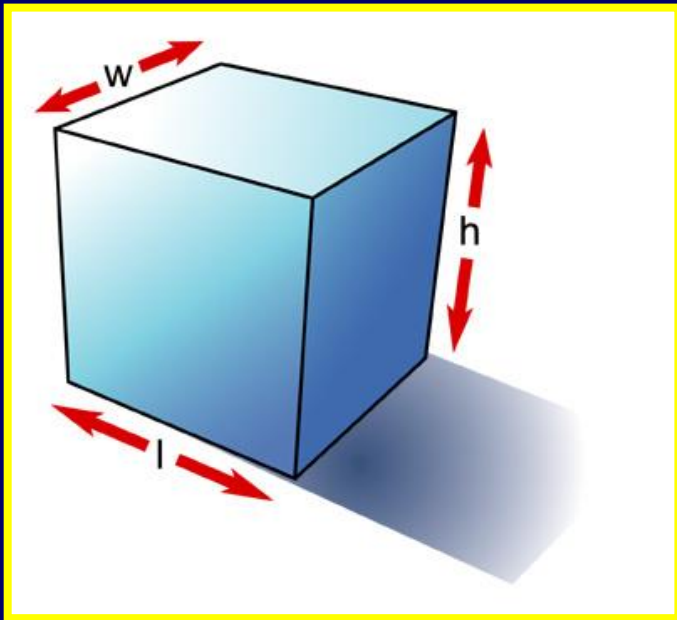
Measuring Liquid Volume

We can measure the volume of liquids using graduated cylinders.



Measuring Cubic Volume

We can measure the volume of a cube using a ruler, then multiplying the length X width X Height.



$$2\text{cm} \times 2\text{cm} \times 2\text{cm}$$

$$8\text{cm}^3$$

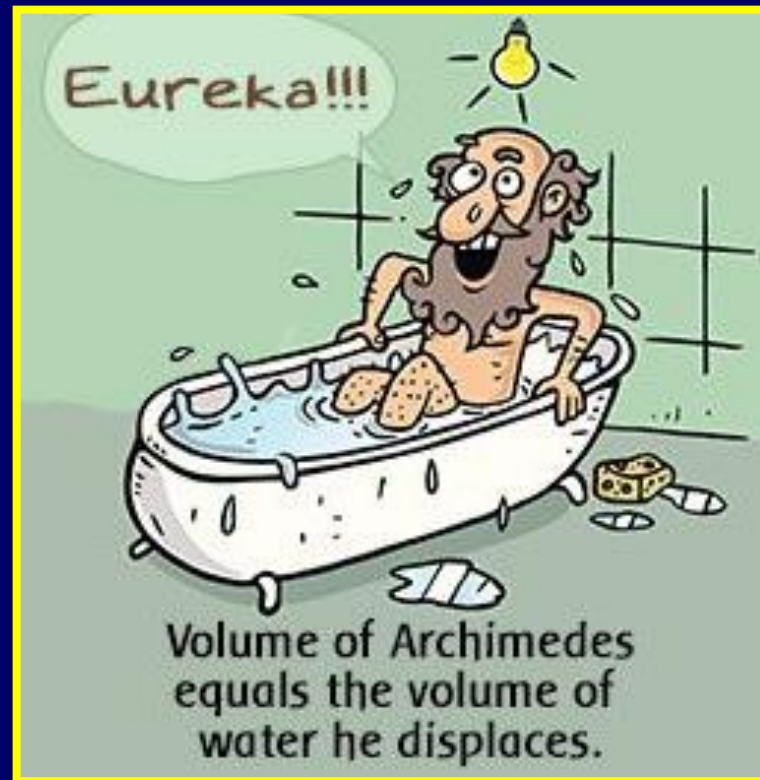
Measuring Irregular Shaped Volume

But how can we measure the volume of an irregular shaped object?



Archimedes Principle

The volume of irregular shaped solids can be measured in graduated cylinders using Archimedes Principle.

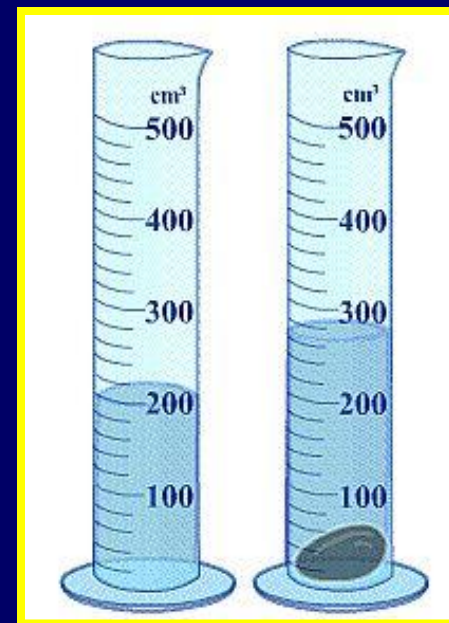


Using Archimedes Principle

1. Determine initial volume

2. Add the Object

3. Determine final volume



4. $\text{Volume} = \text{final volume} - \text{initial volume}$

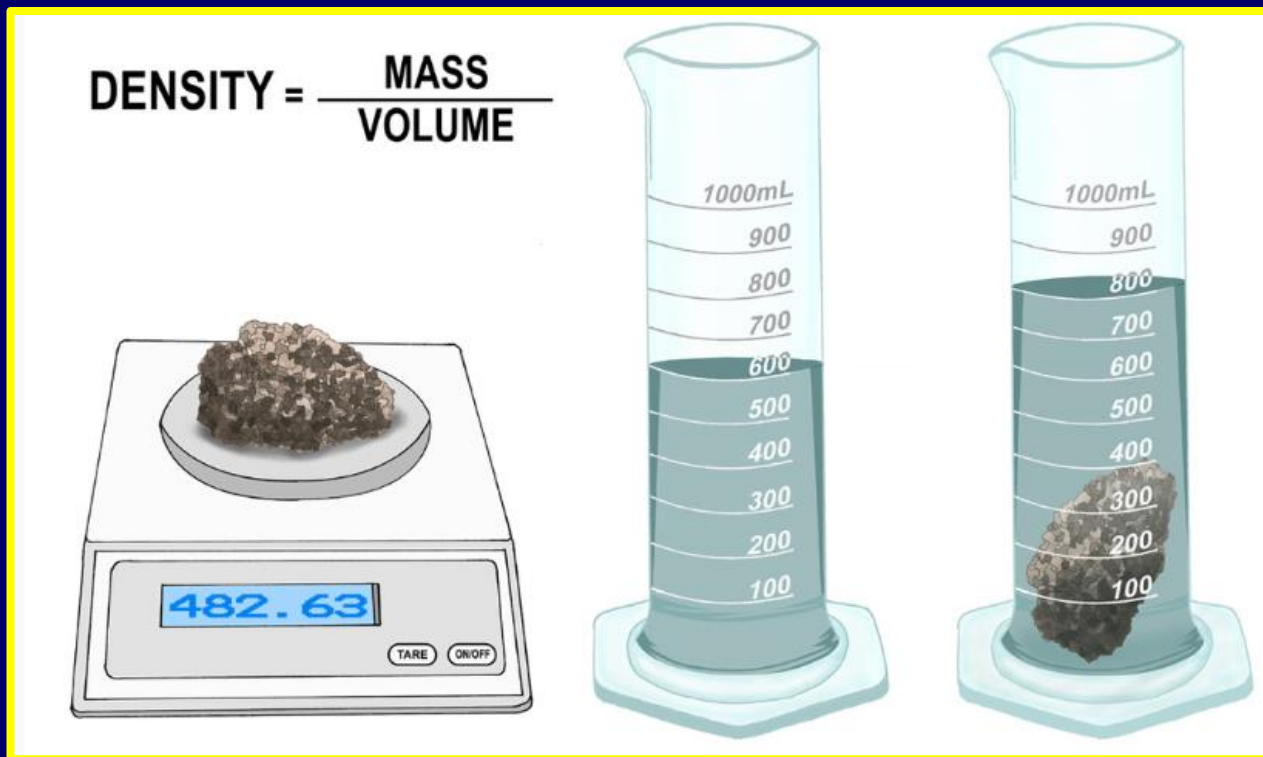
Initial volume = 200 mL

Final volume = 260 mL

$\text{Volume} = 260 \text{ mL} - 200 \text{ mL} = 60 \text{ mL}$

Measuring Density

Measure the mass and volume, using the appropriate technique, then divide the mass by the volume.



The End

