CHEM 205 section 03

LECTURE #2 Tues., Jan.08, 2008

ASSIGNED READINGS:

TODAY'S CLASS: continue Ch.1

NEXT CLASS: finish Ch.1, start Ch.2

(1)

Quantitative observations

Properties with numerical values not necessarily reflect the sample's size.

Intrinsic properties ***vs.*** **extrinsic properties**

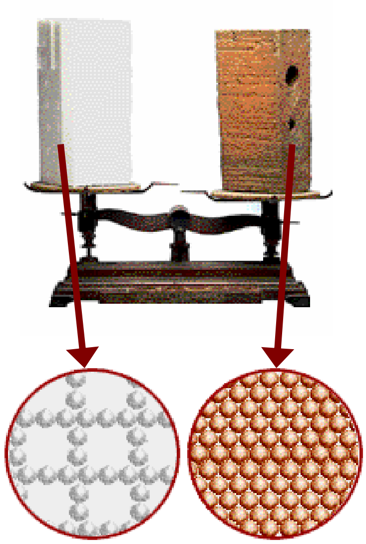
(intensive) (extensive)

Characteristics of the substance itself, not the quantity • Density • Melting point • Boiling point • Viscosity *etc…*	Properties that depend on the quantity of substance present: • Mass • Volume • Length, width, height…

(2)

1.4 Physical properties: DENSITY

$$d = \frac{mass}{volume}$$



(3)

How heavy is a given volume of a substance?

Depends on:

1.) mass of individual particles (atoms/ions/molecules)

2.) how tightly packed together they are in the structure

= a characteristic, *intrinsic*, physical property of any pure substance

A very useful intrinsic property: DENSITY IS AN 'IDENTIFICATION TAG'

TABLE 1.5 Densities of Various Common Substances* at 20°C

Substance	Physical State	Density (g/cm^3)
Oxygen	Gas	0.00133
Hydrogen	Gas	0.000084
Ethanol	Liquid	0.789
Benzene	Liquid	0.880
Water	Liquid	0.9982
Magnesium	Solid	1.74
Salt (sodium chloride)	Solid	2.16
Aluminum	Solid	2.70
Iron	Solid	7.87
Copper	Solid	8.96
Silver	Solid	10.5
Lead	Solid	11.34
Mercury	Liquid	13.6
Gold	Solid	19.32

*At 1 atmosphere pressure

From Zumdahl's Chemistry, 6th Edition

Density is affected by temperature

FOR MOST SUBSTANCES: density ↑ as temperature ↓

WHY?

→ attractive forces between particles are more significant when particles' kinetic energy decreases

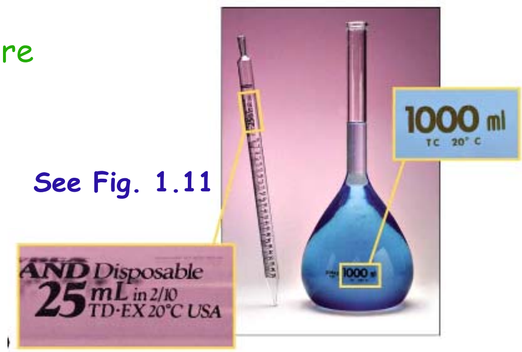
⇨ particles move closer together

⇨ volume decreases

Must specify temperature when discussing:

- density
- volume

See Fig. 1.11



(5)

$H_2O(s)$ is strange: most solids sink in their liquids

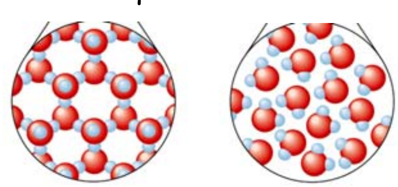
Temperature (°C)	Density of H_2O (g/mL)
0 (solid)	0.917
0 (liquid)	0.99984
2	0.99994
4	0.99997
10	0.99970
25	0.99707
100	0.95836

Ice is less dense than liquid water at same temp…

Most dense at 4°C

WHY?

When locked in ideal geometry for interaction (as in solid), H_2O molecules are a bit farther apart than in liquid!



SOLID (ice) **LIQUID (water)**

From Zumdahl's *Chemistry* 6th Ed.

(6)

Problem: Density & jewelry…

You find a silver-coloured ring at a pawn shop and hope to buy it for a reasonable price. You want to know if it silver, or white gold, or platinum, or lead. How could you identify the metal?

Strategy:

1.) Look up densities of metals.

Pt	21.5 g/cm^3
Au	19.3 g/cm^3
Pb	11.5 g/cm^3
Ag	10.5 g/cm^3

2.) Gather data:

Measure the ring's mass.

Measure the ring's volume.

3.) Calculate its density: $d = m/v$

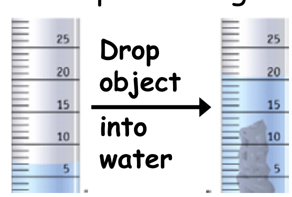
(7)

Data collection & solution:

MASS: using balance

- mass of ring = 3.84 g

VOLUME: by displacement, since shape is irregular



- initial volume = 13.00 mL
- water + ring = <u>13.20 mL</u>

➔ ring volume = 0.20 mL

CALCULATIONS & ANALYSIS:

Density of ring = mass / volume

= 3.84 g / 0.20 mL

= 19.2 g/mL

But, 1 mL = 1 cm^3… = 19.2 g/cm^3

Pt	21.5 g/cm^3
Au	19.3 g/cm^3
Pb	11.5 g/cm^3
Ag	10.5 g/cm^3

(8) *Closest match is gold…*

1.6-7 Units of measurement & using numerical information

OBSERVING PHYSICAL & CHEMICAL CHANGES:

1. Qualitative observations: descriptive
2. Quantitative observations: numerical

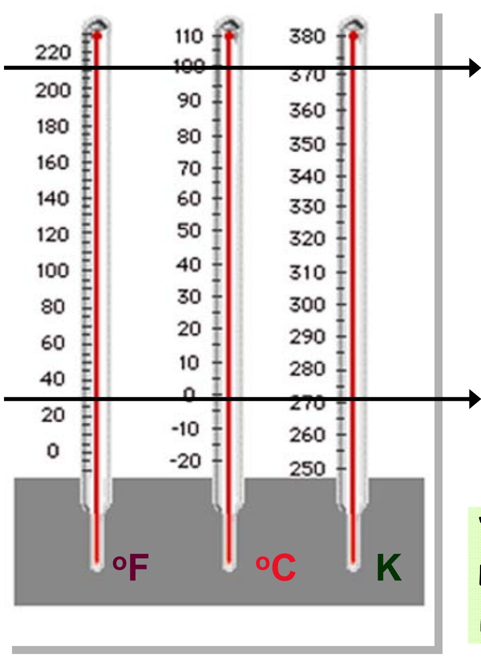
- A *measurement* = a quantitative observation consisting of TWO parts

NUMBER + UNIT

20 grams (g)
6.63×10^{-34} Joule seconds (J·s)
6.02×10^{23} atoms
93 students

A NUMBER WITHOUT A UNIT IS MEANINGLESS!

Temperature: Fahrenheit, Celsius & Kelvin scales



Water boils:
212 °F = 100 °C = 373.15 K

For Celsius & Kelvin scales, the units are the same size… they are simply offset:

$$T_K = T_C \times \frac{1\ K}{1\ °C} + 273.15\ K$$

Water freezes:
32 °F = 0 °C = 273.15 K

"Absolute zero" = 0 K = ___ °C
Liquid N_2 boils at 77 K = ___ °C
Body temperature = 37 °C = ___ K

SI system: a metric (decimal-based) system of units

- base units: gram (g), meter (m), Liter (L), second (s)…
- use prefixes to denote larger/smaller than base units

From Zumdahl's *Chemistry* 6th Ed. --- see Kotz Table 1.3

Prefix	Symbol	Meaning	Exponential Notation*
exa	E	1,000,000,000,000,000,000	10^{18}
peta	P	1,000,000,000,000,000	10^{15}
tera	T	1,000,000,000,000	10^{12}
giga	G	1,000,000,000	10^{9}
mega	M	1,000,000	10^{6}
kilo	k	1,000	10^{3}
hecto	h	100	10^{2}
deka	da	10	10^{1}
—	—	1	10^{0}
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	μ	0.000001	10^{-6}
nano	n	0.000000001	10^{-9}
pico	p	0.000000000001	10^{-12}
femto	f	0.000000000000001	10^{-15}
atto	a	0.000000000000000001	10^{-18}

common (mega, kilo)

common (deci through pico)

Dimensional analysis or Unit analysis

Proper use of "unit conversion factors" leads to proper units in your answer } …helps guide your attack of problems!

Ex.: Interconverting metric units…

The Vehicle Assembly Building at the Kennedy Space Center in Florida has a volume of 3 666 500 m^3 (the world's largest building). Convert this volume to liters and express the result in scientific notation.

Remember fundamental metric system definitions… some that may be useful here:

1 cm^3 = 1 mL
1 L = 1 dm^3

ANS: $V = 3.6665 \times 10^9$ L

Ex: Counting by weighing – common in chemistry

For a pharmacist dispensing pills or capsules, it is often easier to weight the medication to be dispensed rather than to count the individual pills. If a single antibiotic capsule weighs 0.65 g, and a pharmacist weighs out 15.6 g of capsules, how many capsules have been dispensed?

ANS: 24 capsules

(13)

ASSIGNED READINGS

- BEFORE NEXT CLASS:

  Read Ch. 1 (all) & work on exercises

  & learn to use your calculator: see Kotz p.37

- **LABS & TUTORIALS START THIS WEEK.**

  ARRIVE PREPARED: lab coat, safety glasses
  lab manual
  completed Expt. #1 prelab.
  completed tutorial homework

- **CHEM 101 SEMINARS NEXT WEEK.**

  SIGN UP AT CHEMISTY MAIN OFFICE: SP-201.01

(14)