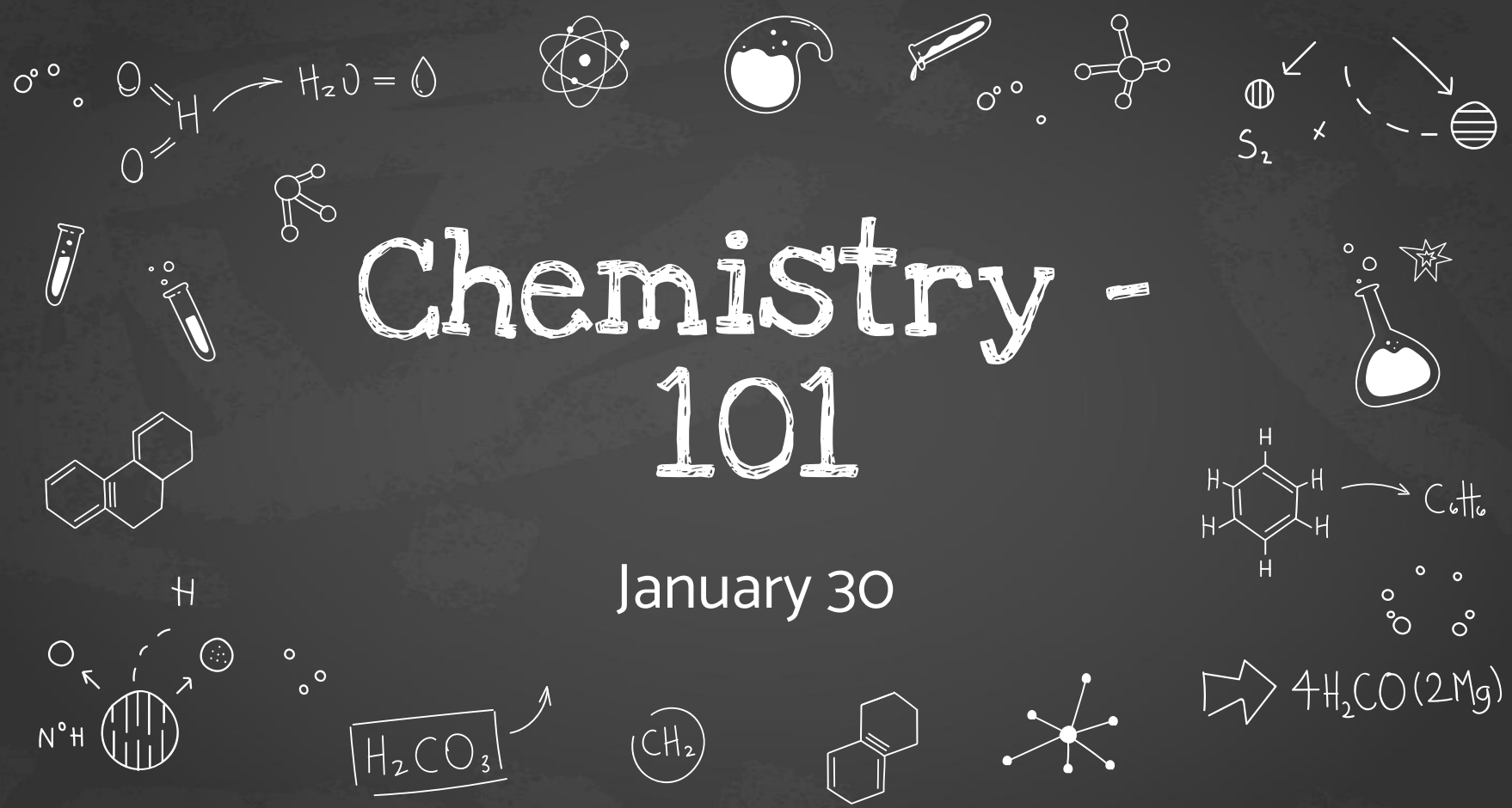
Chemistry - 101

January 30



Moles - unit of counting used in chemistry

Avogadro's number (6.022×10^{23}) represents the number of particles (atoms, ions, formula units, or molecules) in one mole of any substance

Any atom, element, or compound can have its mass expressed in atomic mass units (amu). The average atomic mass (in amu) for atoms of any element can be found on the periodic table.

Mole and amu

The numerical value of the amu of the atoms of a given elements is equal to the mass in grams of one mole of that element.

The mass of a single Na atom is 22.99 amu
One mole of Na has an average mass of 22.99 grams

Conversions of # of particles, # of moles, and the mass

E.g. NaCl has a mass of (22.99 + 35.45) = 58.44 amu
One mole of NaCl has a mass of (22.99 + 35.45) = 58.44 g

Calculations using chemical equations

Calculate how many grams of water and sulfur trioxide is needed to produce 100g of sulfuric acid according to the following chemical reaction:

$SO_3 + H_2O \rightarrow H_2SO_3$

	SO_3	H_2O	H_2SO_3
Molecular weight	80	18	98
Molar weight (g/mole)	80	18	98
Coefficients (moles reacting)	1	1	1
Known	?	?	100g
Number of moles to obtain the product and needed of reagents	1.02	1.02	100/98 = 1.02
Mass needed (g)	1.02(mole)x80(g/mole)=81.6(g)	1.02(mole)x18(g/mole)=18.36 (g)	

- If you need to calculate the volume of SO_3 gas needed you should remember that 1 mole of each gas takes 22.4 L. Then 1.02 moles will take 1.02x22.4 = 22.85L

- If the coefficients of the reactions were different from 1 you would have to calculate the number of moles of the reagents needed for the number of moles of the product using the reactions coefficients. For example, in the following reaction of S and O_2 2 moles of S react with 3 moles of O_2 to produce 2 moles of SO_3. In this case to obtain 1 mole of SO_3 you would need 1 mole of S and 3/2 moles of O_2.

$$2S + 3O_2 \rightarrow 2SO_3$$

$$HCl_{(gas)} + NH_{3(gas)} \rightarrow NH_4Cl_{(solid)}$$
$$2H_{2(gas)} + O_{2(gas)} \rightarrow 2H_2O_{(gas)}$$
$$H_{2(gas)} + Cl_{2(gas)} \rightarrow 2HCl_{(gas)}$$

Equal gas volumes (at equal temperature and pressure) contain the same number of particles

- 1 mole of any gas takes a volume of **22.4 liters** at "normal conditions ". This is a molar gas volume under normal conditions.

- Normal conditions are temperature of 0°C (273 K) and pressure of 1 atm (101 325 Pa)

Clapeyron-Mendeleev equation

$$pV = nRT$$

n - gas mole number

p - gas pressure (atm)

V - gas volume (liters)

T - temperature (K)

R - gas constant (0.0821 l x atm/mole x K)

Example

A closed flask of 2.6 L contains oxygen under the pressure of 2.3 atm and temperature of 26°C.
How many moles of O_2 are there in the flask?

$$pV = nRT$$

$$n = PV/RT$$

$$n = (2.3\ atm \times 2.6\ L)/(0.0821\ (L \times atm/mole \times K) \times 299\ K)$$

$$273°C + 26°C = 299\ K$$

This class uses the materials from the following books:
Larry Gonick and Graig Criddle “The cartoon guide to chemistry”
Manyuilov and Rodionov “Chemistry for children and adults”
Kuzmenko, Eremin, Popkov “Beginnings of chemistry”