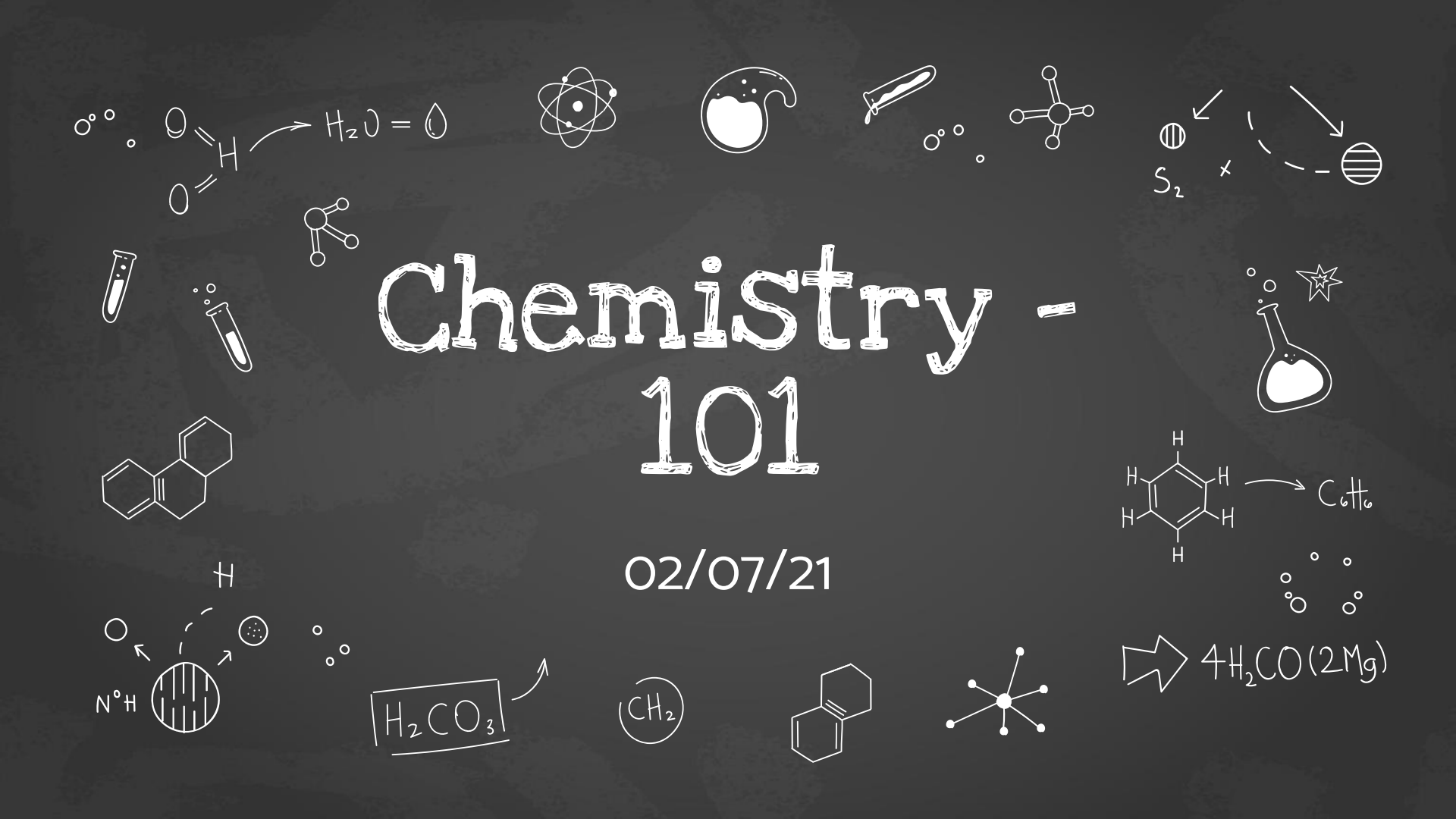
Chemistry - 101
02/07/21
H_2O
S_2
C_6H_6
H_2CO_3
CH_2
$4H_2CO(2Mg)$

The equation's coefficients let us find relative masses of products and reactants.

The calculation uses a unit called **Mole.**

One mole of a substance is the amount whose mass equals **the molecular or atomic weight** of the substance **expressed in grams**

	"MOLECULAR" WEIGHT	MOLAR WEIGHT
O_2	32 AMU	32 GRAMS
SiO_2	60 AMU	60 GRAMS
$Al_2Si_2O_5(OH)_4$	258 AMU	258 GRAMS
Fe	56 AMU	56 GRAMS
PROTON	1 AMU	1 GRAM

Periodic Table of the Elements

1 IA												13 IIIA 3A	14 IVA 4A	15 VA 5A	16 VIA 6A	17 VIIA 7A	8A
1 H Hydrogen 1.008	2 IIA 2A																2 He Helium 4.003
3 Li Lithium 6.941	4 Be Beryllium 9.012											5 B Boron 10.811	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998	10 Ne Neon 20.180
11 Na Sodium 22.990	12 Mg Magnesium 24.305	3 IIIB 3B	4 IVB 4B	5 VB 5B	6 VIB 6B	7 VIIB 7B	8	9 VIII 8	10	11 IB 1B	12 IIB 2B	13 Al Aluminum 26.982	14 Si Silicon 28.086	15 P Phosphorus 30.974	16 S Sulfur 32.066	17 Cl Chlorine 35.453	18 Ar Argon 39.948
19 K Potassium 39.098	20 Ca Calcium 40.078	21 Sc Scandium 44.956	22 Ti Titanium 47.88	23 V Vanadium 50.942	24 Cr Chromium 51.996	25 Mn Manganese 54.938	26 Fe Iron 55.845	27 Co Cobalt 58.933	28 Ni Nickel 58.693	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.631	33 As Arsenic 74.922	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 84.798
37 Rb Rubidium 84.468	38 Sr Strontium 87.62	39 Y Yttrium 88.906	40 Zr Zirconium 91.224	41 Nb Niobium 92.906	42 Mo Molybdenum 95.95	43 Tc Technetium 98.907	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.906	46 Pd Palladium 106.42	47 Ag Silver 107.868	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.711	51 Sb Antimony 121.760	52 Te Tellurium 127.6	53 I Iodine 126.904	54 Xe Xenon 131.249
55 Cs Cesium 132.905	56 Ba Barium 137.328	57-71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.948	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.085	79 Au Gold 196.967	80 Hg Mercury 200.592	81 Tl Thallium 204.383	82 Pb Lead 207.2	83 Bi Bismuth 208.980	84 Po Polonium [208.982]	85 At Astatine 209.987	86 Rn Radon 222.018
87 Fr Francium 223.020	88 Ra Radium 226.025	89-103	104 Rf Rutherfordium [261]	105 Db Dubnium [262]	106 Sg Seaborgium [266]	107 Bh Bohrium [264]	108 Hs Hassium [269]	109 Mt Meitnerium [268]	110 Ds Darmstadtium [269]	111 Rg Roentgenium [272]	112 Cn Copernicium [277]	113 Uut Ununtrium unknown	114 Fl Flerovium [289]	115 Uup Ununpentium unknown	116 Lv Livermorium [298]	117 Uus Ununseptium unknown	118 Uuo Ununoctium unknown

Making pottery and bricks

mullite

$$3Al_2Si_2O_5(OH)_4(s) \xrightarrow{\Delta} Al_6Si_2O_{13}(s) + 4SiO_2(s) + 6H_2O(g)\uparrow$$

Kaolinite from the lake

The castaways mixed clay with sand, molded 3000 bricks in 2 days and baked them by the heat of fire.

NOW SUPPOSE I START WITH 100 kg OF CLAY. HOW MANY KILOGRAMS OF POTTERY WILL I GET? WE START WITH THE BALANCED EQUATION:

$$3\,Al_2Si_2O_5(OH)_4\,(s) \xrightarrow{\Delta} Al_6Si_2O_{13}(s) + 4SiO_2(s) + 6H_2O(g)\uparrow$$

THE CLAY

THE POTTERY

Mass balance table

reactants	Molar weight	products	Molar weight
3 MOL $Al_2Si_2O_5(OH)_4$	3 x	1 MOL $Al_6Si_2O_{13}$	426 g
		4 MOL SiO2	4 x
		6 MOL H2O	6 x
TOTAL	774 g	TOTAL	

Atomic mass (amu):
Al – 27
Si – 28
O – 16
H - 1

The table says that 774 g of kaolin clay makes 426 + 240 = 666 g of pottery

So 1 g kaolin makes (666/774) g = 0.86 g of pottery

And 100 kg makes (0.86) (100 kg) (1000 g/kg) = 86,000 g = 86 kg

We can equally well work backward. If we want 100 kg of pottery, how much wet clay should we mix up?

Molar gas volume. Avogadro's law

$1\ amu = 1.67 \times 10^{-24}\ g$

$N_{particles} = 1\ g$

$N = 6 \times 10^{23}$ particles (Avogadro's number)

$6 \times 10^{23}\ amu = 1\ g$

One mole of anything contains 6.02×10^{23} particles

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

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?

$$pV = nRT$$

$$n = PV/RT$$

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

$$273^{o}C + 26^{o}C = 299\ K$$

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”
http://school-collection.edu.ru (experiments)