PERIODIC TABLE OF THE ELEMENTS

Group																	
1																	18
1 H Hydrogen 1.008	2											13	14	15	16	17	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	4	5	6	7	8	9	10	11	12	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 83.798
37 Rb Rubidium 85.468	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 131.294
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 183.85	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.967	80 Hg Mercury 200.59	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 [278]	110 Ds Darmstadtium [281]	111 Rg Roentgenium [280]	112 Cn Copernicium [285]	113 Nh Nihonium [286]	114 Fl Flerovium [289]	115 Mc Moscovium [289]	116 Lv Livermorium [293]	117 Ts Tennessine [294]	118 Og Oganesson [294]

57 La Lanthanum 138.905	58 Ce Cerium 140.116	59 Pr Praseodymium 140.908	60 Nd Neodymium 144.243	61 Pm Promethium 144.913	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.925	66 Dy Dysprosium 162.500	67 Ho Holmium 164.930	68 Er Erbium 167.259	69 Tm Thulium 168.934	70 Yb Ytterbium 173.055	71 Lu Lutetium 174.967
89 Ac Actinium 227.028	90 Th Thorium 232.038	91 Pa Protactinium 231.036	92 U Uranium 238.029	93 Np Neptunium 237.048	94 Pu Plutonium 244.064	95 Am Americium 243.061	96 Cm Curium 247.070	97 Bk Berkelium 247.070	98 Cf Californium 251.080	99 Es Einsteinium [254]	100 Fm Fermium 257.095	101 Md Mendelevium 258.1	102 No Nobelium 259.101	103 Lr Lawrencium 174.967

Legend: Alkali Metal · Alkaline Earth · Transition Metal · Basic Metal · Metalloid · Nonmetal · Halogen · Noble Gas · Lanthanide · Actinide

Water, hydrogen bond

Unpaired electrons
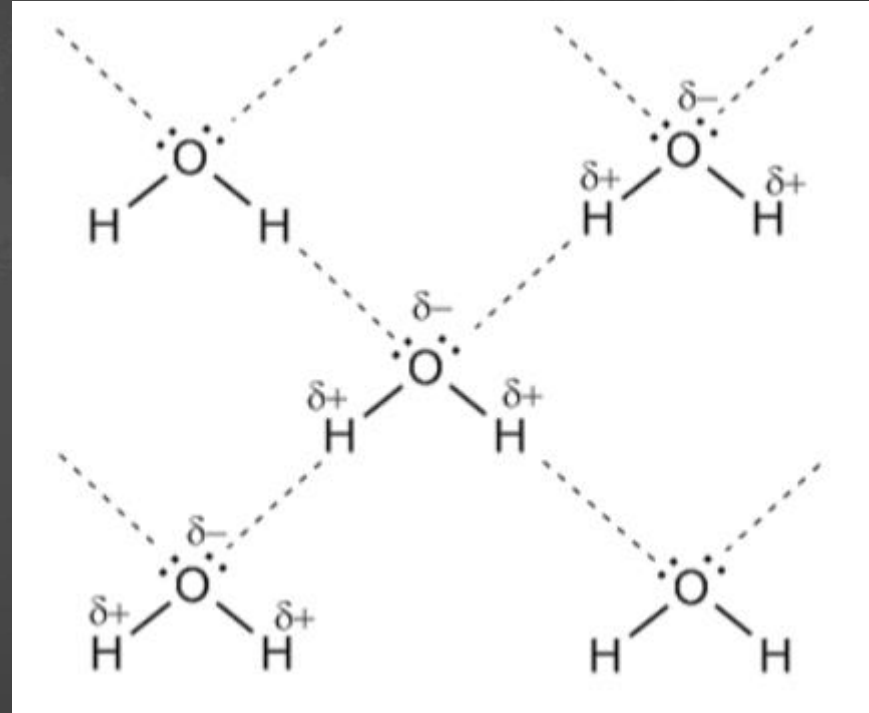
105°

Tetrahedron

7	8	9
N	**O**	**F**
Nitrogen 14.007	Oxygen 15.999	Fluorine 18.998

Chemical properties of water

1. Reactions with metals and non-metals with release of hydrogen

$$2Na + 2H_2O = H_2 + 2\ NaOH$$

$$2K + 2\ H_2O = H_2 + 2\ KOH$$

$$3Fe + 4\ H_2O = 4H_2 + Fe_3O_4\ \text{(when heated)}$$

$$C + H_2O = H_2 + CO$$

$$CH_4 + 2\ H_2O = 4H_2 + CO_2$$

2. Water decomposes into oxygen and hydrogen under electrical current
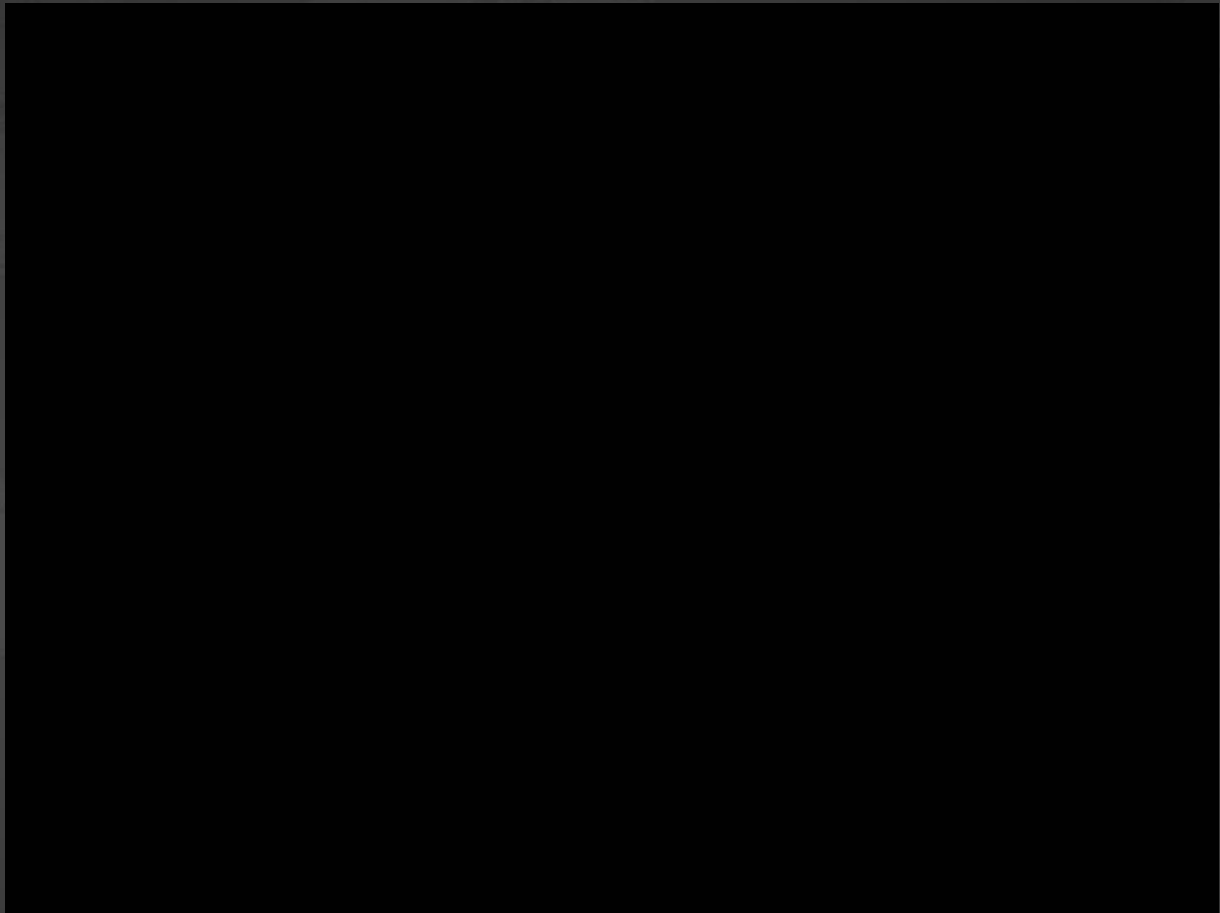
3. Water reactions with non-metal oxides (combination)

$$SO_2 + H_2O = H_2SO_3 \text{ (sulfurous acid)}$$

$$SO_3 + H_2O = H_2SO_4$$

$$CO_2 + H_2O = H_2CO_3 \text{ (carbonic acid)}$$
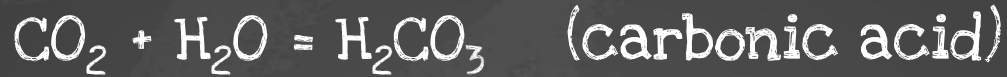
4. Some metal oxides also can react with water (combination)

$$CaO + H_2O = Ca(OH)_2$$

5. Water forms compounds where its molecule does not decompose (hydrates)

$$CuSO_4 + 5H_2O = CuSO_4 \cdot 5 H_2O$$
$$H_2SO_4 + H_2O = H_2SO_4 \cdot H_2O$$
$$NaOH + H_2O = NaOH \cdot H_2O$$

Salt/sugar - solute

Water - solvent

Dissolution, solutions

- Solution is a special type of <u>homogeneous mixture</u> composed of two or more substances. The most common state of solutions is liquid.
- The composition of a solution can change.
- In a solution a solvent is the one that is taken in a larger quantity and has the same aggregate state as the solution.
- The solute is the substance dissolved in a solvent.
- In the case of water – water is always a solvent.

Solutions, dissolution

- Solutions can be solid (hydrogen dissolved in metals)
- There are no gas solutions because there are no interactions between gas molecules.
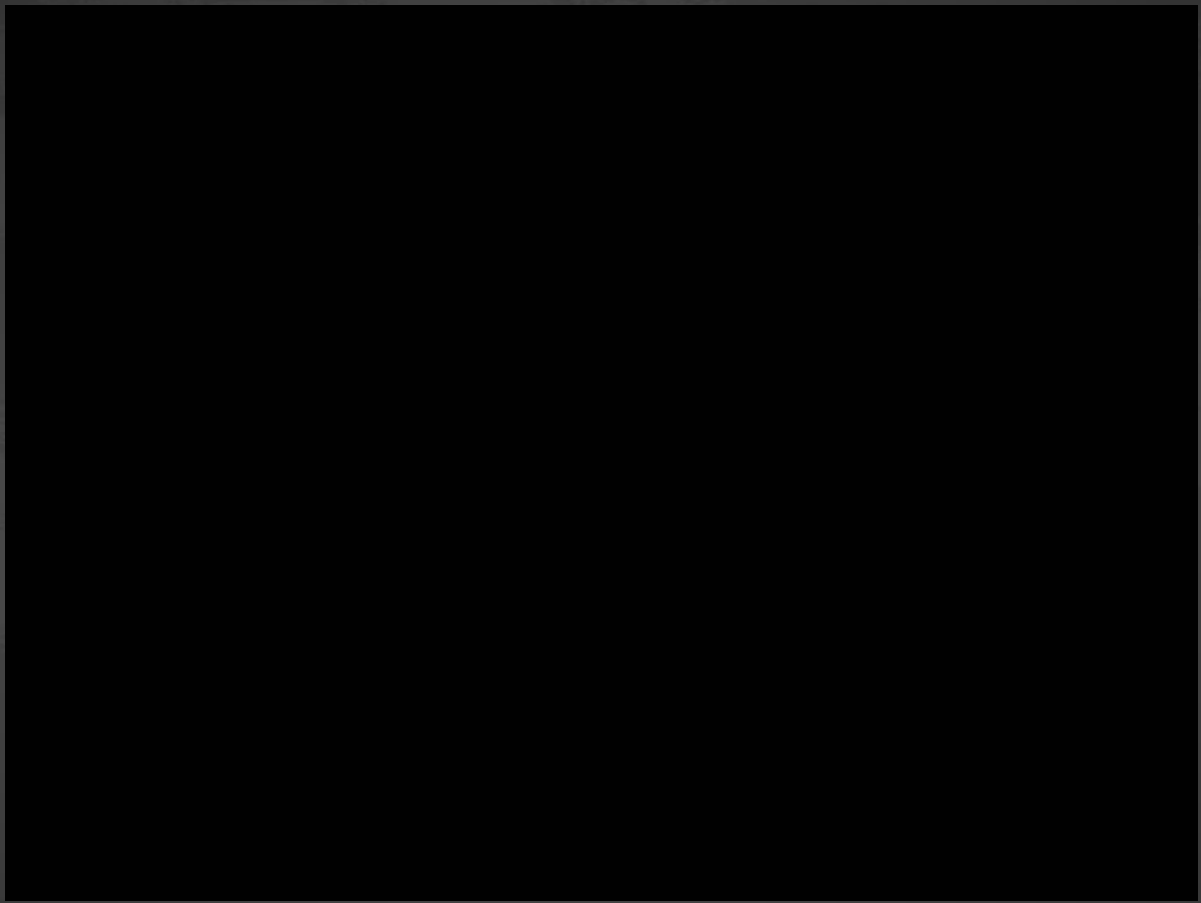
Solutions

- Solution where a given substance cannot dissolve anymore is called **_saturated_** (under the given conditions)
- Solubility is an ability of a substance to dissolve in a solution.
- The measure of solubility is the amount of the substance in its saturated solution
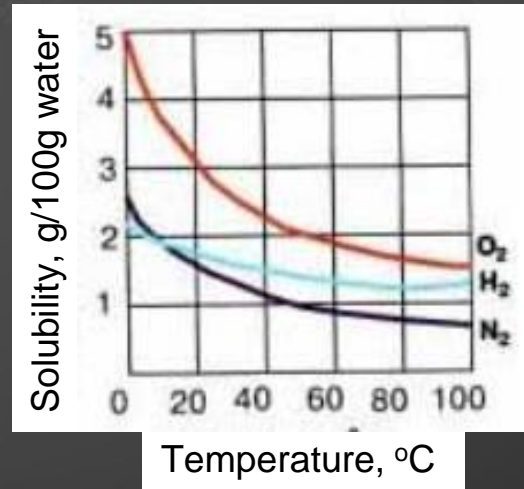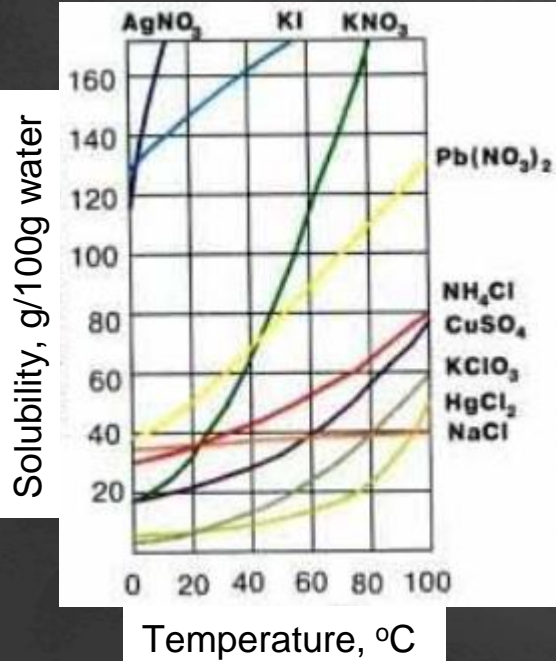
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Solution concentration

- The **mass fraction** is the ratio of the **mass** of a solute to the **mass** of the **solution**.

Concentration is a relative amount of a solute in a solution
Molar concentration is the ratio of amount of solute in moles to the volume in liters

$$3H_2 + N_2 = 2NH_3$$

Hydrogen - H_2 (molecular mass 2x1 = 2g)
Nitrogen - N_2 (molecular mass 2x14 = 28 g)
Ammonia - NH_3 (molecular mass 14 + 3x1 = 17 g)

1 mole of any gas at normal conditions takes up 22.4 L

This class uses the materials from the following books:
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Manyuilov and Rodionov "Chemistry for children and adults"
Kuzmenko, Eremin, Popkov "Beginnings of chemistry"
http://school-collection.edu.ru (experiments)