INORGANIC NOMENCLATURE II

1. WARM UP

- If you could change something in chemistry, what would that be?
- If you were a teacher of chemistry at a primary/secondary school, how would you change the way chemistry is taught there?
- If you could change something in the way chemistry is taught at Masaryk University, what would you do?

2. INORGANIC NOMENCLATURE II

C. TERNARY COMPOUNDS (compounds that consist of a combination of three elements)

ACIDS

HYDROACIDS: hydrogen + non-metal

Hydro + root + *ic* acid

HCl **hydro**chlor***ic*** acid HCl
HF **hydro**fluor***ic*** acid
HCN **hydro**cyan***ic*** acid

OXYACIDS (OXOACIDS) : polyatomic ion + acid

- only one oxyacid**:** **root + *-ic* acid**

H_3BO_3 bor***ic*** acid
H_4SiO_4 silic***ic*** acid

- two oxyacids with different oxygen content:

- **root + *-ic* acid** indicates **higher oxygen content**
- **root + *-ous*** indicates **lower oxygen content**

H_2SO_4 sulphur**ic** acid (higher oxygen content)
H_2SO_3 sulphur**ous** acid (lower oxygen content)
$H_2S_2O_7$ **di**sulphur**ic** acid
H_3PO_4 phosphor**ic** acid
H_3PO_3 phosphor**ous** acid
HNO_3 nitr**ic** acid
HNO_2 nitr**ous** acid

- more than two oxyacids:

prefix	suffix	Examples	
per (more than)	***-ic***	$HClO_4$	***per*chlor*ic acid***
	-ic	$HClO_3$	chlor***ic acid***
	-ous	$HClO_2$	chlor***ous acid***
hypo (less than)	***-ous***	$HClO$	***hypo*chlor*ous acid***

Practise:

- ***Write chemical formulae for:***
  1. phosphorous acid _____
  2. carbonic acid _____
  3. disulfuric acid _____
  4. nitric acid _____
  5. hydrobromic acid _____
  6. iodic acid _____
  7. chromic acid _____
  8. bromic acid _____
  9. hypoiodous acid _____
  10. phosphoric acid _____

- ***Write the names for:***
  1. H_3PO_4 _____
  2. H_2SO_4 _____
  3. H_4SiO_4 _____
  4. HClO _____
  5. H_3BO_3 _____

SALTS

SALTS OF HYDROACIDS

HCl hydrochloric acid

HCl → NaCl sodium chlor***ide*** (salt)

Note: H_2S hydrogen sulph***ide***

SALTS OF OXOACIDS (ternary compound containing oxygen)

- if there is **only one such compound**: **root + *-ate***

Na_2CO_3	sodium carbon**ate**, (no carbonite is known)
Na_3BO_3	sodium bor**ate,** (no borite is known)
Na_4SiO_4	sodium silic**ate,** (no silicite is known)

- if there are **two compounds**, differing only in their oxygen content and oxidation number of the central atom: the one which contains **more oxygen** ends in ***-ate*** and the other, with less oxygen, ends in ***-ite***

Example 1: **sodium salts**

lower oxygen content		**higher oxygen content**	
$NaNO_2$	sodium nitr***ite***	$NaNO_3$	sodium nitr***ate***
Na_3PO_3	sodium phosph***ite***	Na_3PO_4	sodium phosph***ate***
Na_3AsO_3	sodium arsen***ite***	Na_3AsO_4	sodium arsen***ate***
Na_2SO_3	sodium sulph***ite***	Na_2SO_4	sodium sulph***ate***

Example: sodium salts of the oxyacids of chlorine:

- if there are **more than two compounds**, differing only in their oxygen content and oxidation number of the central atom:

prefix	suffix	Examples	
per (more than)	***-ate***	$NaClO_4$	***sodium per***chlor***ate***
	-ate	$NaClO_3$	***sodium*** chlor***ate***
	-ite	$NaClO_2$	***sodium*** chlor***ite***
hypo (less than)	***-ite***	***NaClO***	***sodium hypo***chlor***ite***

$KMnO_4$ - potassium permangan***ate***

Corresponding nomenclature of acids and their salts:

	acids		salts (ions)	
	***per**chlor**ic** acid*	$HClO_4$	***per**chlor**ate** ion*	ClO_4^-
	*chlor**ic** acid*	$HClO_3$	*chlor**ate** ion*	ClO_3^-
	*chlor**ous** acid*	$HClO_2$	*chlor**ite** ion*	ClO_2^-
	***hypo**chlor**ous** acid*	*HClO*	***hypo**chlor**ite** ion*	ClO^-

Since the oxygen-acid nomenclature of ternary compounds does not give the absolute number of oxygens involved, the name must be derived from experience. That´s why the chemists use **rational nomenclature (named according to IUPAC regulations):**

- **prefixes *mono-, di-,* tri-, tetra-, penta-…** express the **absolute number of oxygens**
- **root+ suffix - *ate***
- **Roman numerals** express the **oxidation number**

Examples:

Na_2SO_3 sodium ***tri***oxosulf***ate*** (IV) – 3 oxygens, oxidation number IV
Na_2SO_4 sodium ***tetra***oxosulf***ate*** (VI)

sodium salts:

$NaClO_4$ sodium ***tetra****oxochlor**ate*** (VII)
$NaClO_3$ sodium ***tri****oxochlor**ate*** (V)
$NaClO_2$ sodium ***di****oxochlor**ate*** (III)
NaClO sodium *oxochlor**ate*** (I)

Practise

- ***Write the chemical formulae for:***
  1. sodium tetraoxochlorate (VII) _____
  2. sodium trioxochlorate (V) _____
  3. sodium phosphite _____
  4. sodium phosphate _____
  5. sodium sulphate _____
  6. sodium sulfite _____

- ***Write the name for (use the IUPAC system):***

1. $Ca(NO_3)_2$ _____
2. $Ca(NO_2)_2$ _____
3. $BaSO_4$ _____
4. $NaClO_3$ _____
5. $NaClO_2$ _____
6. $NaHSO_4$ _____

HYDROXIDES - (bases containing the OH group) – the same rules applied

NaOH	sodium hydrox***ide***
$Ca(OH)_2$	calcium hydrox***ide***
$Mg(OH)_2$	magnesium hydrox***ide***
$Fe(OH)_2$	iron **(II)** hydrox***ide*** = ferr***ous*** hydrox***ide***
KOH	potassium hydrox***ide***
Fe(OH)3	iron (III) hydrox***ide*** = ferr***ic*** hydrox***ide***
Ba(OH)2	barium hydrox***ide***

3. LISTENING

Listen and answer the following questions:

1. What compounds are necessary for the chemical experiment?

_____

2. What is the position of the iron nail?

_____

3. What is the mercury drop compared to?

_____

4. What is the role of the dichromate?

_____

5. What compound is formed on the surface of the drop?

_____

6. What do you know about its solubility?

_____

7. Why does the mercury drop flatten?

_____

8. What enables electrons to flow from the nail to the mercury?

_____

9. How does the shape of the drop change due to the electrons?

_____

10. What happens at the end of the process?

_____

4. HOW TO READ CHEMICAL EQUATIONS IN ENGLISH:

Example:	**HCl**	+	**NaOH**	→	**NaCl**	+	**H_2O**
We spell as:	H Cl	**plus**	Na OH	**gives**	Na Cl	**plus**	H_2O
We read as: hydrochloric acid **reacts with** sodium hydroxide **to form** sodium chloride **and** water							

Reading chemical formulae:

+	***reacts with***, ***combines with***, ***plus***, ***and*** or ***together with***
=	***give***, ***form***, ***pass over to***, ***yield*** or ***go to***
-->	***give***, ***pass over to*** or ***lead to***
<-->	***forms and is formed from***
the sign -	designates the bond and is not to be read in the formulae
the sign =	designates two bonds and is not to be read in formulae
C_3H_2	***c three h two***
2 CO_2	***two molecules of c o two***
$CO_2 + CaO \rightarrow CaCO_3$	***c o two plus c a o give c a c o three***
	c o two reacts with c a o to give c a c o three
$Ca(OH)_2$	***c a o h twice***

You can also use time clauses / conditional clauses to describe the reactions:

When we mix_____ with _____, we will get _____.

If _____mixes together with _____, it will lead to _____.

If we mixed _____ and _____, it would lead to _____.

Practise: Read these equations in pairs.

First spell them, then express in words. You can use a time / conditional clause.

a) $CO_2 + H_2O$ ---> H_2CO_3

b) $CaCO_3$--->$CaO + CO_2$

c) $2\ CO + O_2$-->$2\ CO_2$

d) $2\ Ca_3(PO_4) + 6\ SiO_2 + 10$ C-->$6\ CaSiO_3 + P_4 + 10$ CO

e) 2 Na + $Cl_2 \rightarrow 2$ NaCl

f) $ZnO + H_2SO_4 \rightarrow 2\ ZnSO_4 + H_2O$

g) 2 Na + $2\ H_2O \rightarrow 2$ NaOH + H_2

Work in small groups. Write down two or three equations on a piece of paper. Then present the equations to the others.

Reading numbers and measurements:

31% **k^3** **y^2** **-70°F** **x**

1,203.4 **10°C** **$3a^4$** **:**

0.002

3.14 **0.631** **=** **30.7°**

Text: read out the expressions in bold

Diatoms, microscopic organisms, produce carbohydrates from carbon dioxide and water by normal photosynthesis:

6 CO_2 + 6 H20 + solar energy --> $C_6H_{12}O_6$ + 6 O_2

During the first five years of life whales gain **75 kg** of mass per day by feeding on krill. The whale must consume ten times this mass of krill each day. The whale must consume **10.0 kg** of diatoms to produce 1.0 kg of krill.

a) Assuming that the mass gain in the first years of a whale's life is due to the consumption of carbohydrates, calculate the volume of **CO_2** at **0 °C** and **101 kPa** that must be used by the diatoms to produce the carbohydrates consumed by a blue whale in its first five years of life.

b) There is **0.23 ml** of dissolved **CO_2** per 1 sea water (at **24 °C** and **l0l kPa**). If diatoms can completely remove carbon dioxide from the water they process, what volume of water would they process to produce the carbohydrates required by a blue whale during the first five years of life?

c) **3%** of the mass of a **$9.1.10^4$ kg** adult whale is nitrogen. What is the maximum mass of **NH_4^+** that can become available for other marine organisms if one adult whale dies?

d) 1**8%** of a adult whale's mass is carbon which can be returned to the atmosphere as **CO_2** being removed from there by weathering of rocks containing calcium silicate.

$CaSiO_3$ (s) + 2 CO_2 + 3$H_2$0(1) --> Ca^{2+} (aq) + 2HCO_3^-(aq) + H_4Si0_4(aq)

What is the maximum number of grams of $CaSiO_3$ that can be weathered by the carbon dioxide produced from the decomposition of 1000 blue whales, the number estimated to die annually?

Assignment 9:

A. Write equations for the following chemical reactions:

1) When dissolved beryllium chloride reacts with dissolved silver nitrate in water, aqueous beryllium nitrate and silver chloride powder are made.

2) When isopropanol (C_3H_8O) burns in oxygen, carbon dioxide, water, and heat are produced.

3) When dissolved sodium hydroxide reacts with sulfuric acid (H_2SO_4), aqueous sodium sulfate, water, and heat are formed.

4) When fluorine gas is put into contact with calcium metal at high temperatures, calcium fluoride powder is created in an exothermic reaction.

5) When sodium metal reacts with iron (II) chloride, iron metal and sodium chloride are formed.

B. Read out the following equations:

$2\ H_2 + O_2 \rightarrow 2\ H_2O$
$CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$
$2\ Na + 2\ H_2O \rightarrow 2\ NaOH + H_2$
$Ca + 2\ H_2O \rightarrow Ca(OH)_2 + H_2$
$2\ NaBr + Cl_2 \rightarrow 2\ NaCl + Br_2$
$AgNO_3 + KCl \rightarrow AgCl\downarrow + KNO_3$
$2AgNO_3 + CaBr_2 \rightarrow 2\ AgBr\downarrow + Ca(NO_3)_2$
$Na_2CO_3 + 2HCl \rightarrow 2NaCl + CO_2\uparrow + H_2O$