

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 **hydrochloric** acid HCl
HF **hydrofluoric** acid
HCN **hydrocyanic** acid

OXYACIDS (OXOACIDS): polyatomic ion + acid

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

H₃BO₃ **boric** acid
H₄SiO₄ **silicic** acid

- two oxyacids with different oxygen content:

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

H₂SO₄ sulphuric acid (higher oxygen content)
H₂SO₃ sulphurous acid (lower oxygen content)
H₂S₂O₇ **disulphuric** acid
H₃PO₄ phosphoric acid
H₃PO₃ phosphorous acid
HNO₃ nitric acid
HNO₂ nitrous acid

- more than two oxyacids:

prefix	suffix	Examples	
<i>per</i> (more than)	<i>-ic</i>	<i>HClO₄</i>	<i>perchloric acid</i>
	<i>-ic</i>	<i>HClO₃</i>	<i>chloric acid</i>
	<i>-ous</i>	<i>HClO₂</i>	<i>chlorous acid</i>
<i>hypo</i> (less than)	<i>-ous</i>	<i>HClO</i>	<i>hypochlorous acid</i>

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

$HCl \rightarrow NaCl$ sodium chloride (salt)

Note: H_2S hydrogen sulphide

SALTS OF OXOACIDS (ternary compound containing oxygen)

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

Na_2CO_3	sodium carbonate, (no carbonite is known)
Na_3BO_3	sodium borate, (no borite is known)
Na_4SiO_4	sodium silicate, (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

$NaNO_2$	sodium nitrite
Na_3PO_3	sodium phosphite
Na_3AsO_3	sodium arsenite
Na_2SO_3	sodium sulphite

higher oxygen content

$NaNO_3$	sodium nitrate
Na_3PO_4	sodium phosphate
Na_3AsO_4	sodium arsenate
Na_2SO_4	sodium sulphate

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	
<i>per</i> (more than)	<i>-ate</i>	$NaClO_4$	<i>sodium perchlorate</i>
	<i>-ate</i>	$NaClO_3$	<i>sodium chlorate</i>
	<i>-ite</i>	$NaClO_2$	<i>sodium chlorite</i>
<i>hypo</i> (less than)	<i>-ite</i>	$NaClO$	<i>sodium hypochlorite</i>

$KMnO_4$ - potassium *permanganate*

Corresponding nomenclature of acids and their salts:

acids		salts (ions)	
<i>perchloric acid</i>	$HClO_4$	<i>perchlorate ion</i>	ClO_4^-
<i>chloric acid</i>	$HClO_3$	<i>chlorate ion</i>	ClO_3^-
<i>chlorous acid</i>	$HClO_2$	<i>chlorite ion</i>	ClO_2^-
<i>hypochlorous acid</i>	$HClO$	<i>hypochlorite ion</i>	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 *trioxosulfate* (IV) – 3 oxygens, oxidation number IV
 Na_2SO_4 sodium *tetraoxosulfate* (VI)

sodium salts:

$NaClO_4$ sodium *tetraoxochlorate* (VII)
 $NaClO_3$ sodium *trioxochlorate* (V)
 $NaClO_2$ sodium *dioxochlorate* (III)
 $NaClO$ sodium *oxochlorate* (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. $\text{Ca}(\text{NO}_3)_2$ _____
2. $\text{Ca}(\text{NO}_2)_2$ _____
3. BaSO_4 _____
4. NaClO_3 _____
5. NaClO_2 _____
6. NaHSO_4 _____

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

NaOH	sodium hydroxide
$\text{Ca}(\text{OH})_2$	calcium hydroxide
$\text{Mg}(\text{OH})_2$	magnesium hydroxide
$\text{Fe}(\text{OH})_2$	iron (II) hydroxide = ferrous hydroxide
KOH	potassium hydroxide
$\text{Fe}(\text{OH})_3$	iron (III) hydroxide = ferric hydroxide
$\text{Ba}(\text{OH})_2$	barium hydroxide

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:

<i>Example:</i>	HCl	+	NaOH	→	NaCl	+	H₂O
<i>We spell as:</i>	H Cl	plus	Na OH	gives	Na Cl	plus	H ₂ O
<i>We read as:</i>	hydrochloric acid reacts with sodium hydroxide to form sodium chloride and water						

Reading chemical formulae:

+	<i>reacts with, combines with, plus, and or together with</i>
=	<i>give, form, pass over to, yield or go to</i>
-->	<i>give, pass over to or lead to</i>
<-->	<i>forms and is formed from</i>
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
C₃H₂	<i>c three h two</i>
2 CO₂	<i>two molecules of c o two</i>
CO₂ + CaO → CaCO₃	<i>c o two plus c a o give c a c o three</i>
Ca(OH)₂	<i>c a o h twice</i>

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

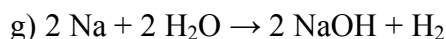
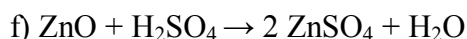
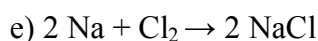
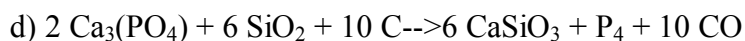
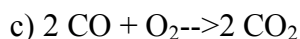
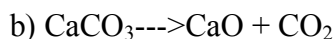
When we mix _____ with _____, we will get _____.

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.



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% k³ y² -70°F x
 1,203.4 10°C 3a⁴ :
3.14 0.631 = 30.7° 0.002

Text: read out the expressions in bold

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



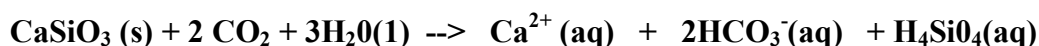
During the first five years of life whales gain **75 kg** of mass per day by feeding on krill. The whale must consume ten times this mass of krill each day. The whale must consume **10.0 kg** of diatoms to produce 1.0 kg of krill.

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 **CO₂** 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 **CO₂** per 1 sea water (at **24 °C** and **101 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 **9.1.10⁴ kg** adult whale is nitrogen. What is the maximum mass of **NH₄⁺** that can become available for other marine organisms if one adult whale dies?

d) **18%** of a adult whale's mass is carbon which can be returned to the atmosphere as **CO₂** being removed from there by weathering of rocks containing calcium silicate.



What is the maximum number of grams of **CaSiO₃** 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:

$2 \text{H}_2 + \text{O}_2 \rightarrow 2 \text{H}_2\text{O}$
$\text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O}$
$2 \text{Na} + 2 \text{H}_2\text{O} \rightarrow 2 \text{NaOH} + \text{H}_2$
$\text{Ca} + 2 \text{H}_2\text{O} \rightarrow \text{Ca(OH)}_2 + \text{H}_2$
$2 \text{NaBr} + \text{Cl}_2 \rightarrow 2 \text{NaCl} + \text{Br}_2$
$\text{AgNO}_3 + \text{KCl} \rightarrow \text{AgCl}\downarrow + \text{KNO}_3$
$2\text{AgNO}_3 + \text{CaBr}_2 \rightarrow 2 \text{AgBr}\downarrow + \text{Ca(NO}_3)_2$
$\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{CO}_2\uparrow + \text{H}_2\text{O}$