INORGANIC NOMENCLATURE I[1]

1. Periodic table

a. What elements do these symbols stand for?

Mn	B	Mg	W	Pb	Sb	I	Sn	K	Au	Fe	Ag

b. Listening exercises

Explain the symbols below:

- What do they stand for?
- What do they mean?
- What is an alternative way of using them?

Uub	Uut	Uuq	Uup	Uuh	Uus	Uuo

Watch the first video and answer the following questions:

1. What element is the professor speaking about?
2. He has mentioned a controversy that was linked to the symbol of the element. What was the controversy based on?
3. Who/What institution made the final decision regarding the symbol?
4. According to the professor, what role did lead play in the element synthesis?
5. Could you describe the process of the element decay as explained in the video?

Watch the second video and try to explain the meaning of the following facts / dates / expressions within the context of the talk:

114	**December 2011**	**Plutonium**	**Fljorov**
30th May 2012	**Dubna**	**memorial**	
Russian	**discussion period**	**bombardment**	

Follow up question: Why does such an element need a symbol?

2. Types of chemical nomenclature

A. Trivial names

HG_2Cl_2 – mercurous chloride (systematic - mercury (II) chloride)

- H_2O (*water*, not dihydrogen oxide)/
- H_2O_2 (*hydrogen peroxide*, not dihydrogen dioxide)
- H_2S (*hydrogen sulfide*, not dihydrogen sulfide)
- NH_3 (*ammonia*, not nitrogen trihydride)
- NO (*nitric oxide*, not nitrogen monoxide)
- N_2O (*nitrous oxide*, not dinitrogen oxide)
- CH_4 (*methane*, not carbon tetrahydride)

B. Popular names

Chemical substances that are employed in the home, the arts, or in industry have acquired traditional or "popular" names that are still in wide use.

popular name	chemical name	formula
borax	sodium tetraborate decahydrate	$Na_2B_4O_7 \cdot 10H2O$
calomel	mercury(I) chloride	Hg_2Cl_2
milk of magnesia	magnesium hydroxide	$Mg(OH)_2$
muriatic acid	hydrochloric acid	$HCl(aq)$
oil of vitriol	sulfuric acid	H_2SO_4
saltpeter	sodium nitrate	$NaNO_3$
slaked lime	calcium hydroxide	$Ca(OH)_2$

C. Systematic nomenclature:

a. **compositional**
b. **substitutive**
c. **additive**

Example: **PCl_3**

- compositional: **phosphorus trichloride**

- substitutive: **trichlorophosphane**

- additive: **trichloridophosphorus**

3. Chemical nomenclature of

a. ions
b. binary compounds
c. ternary compounds

4. IONS

a. CATIONS

i. monoatomic: name of the element and charge

Na^+ sodium (1+), /n a plus/, sodium ion, univalent positive sodium ion,

H^+ hydrogen (1+), /h plus/, hydrogen ion, univalent positive hydrogen ion,

Cu^{2+} copper (2+), /c u two plus/, copper ion, divalent positive copper ion, copper (II) ion

Cr^{3+} chromium (3+), /c r three plus/, chromium ion, trivalent positive chromium ion,

Some of the metallic ions are multivalent, meaning that they can exhibit more than one electric charge. For these there are systematic names that use Roman numerals and endings ***–ous*** and ***–ic*** to denote the lower and higher charges, respectively. In cases where more than 2 charge values are possible, the systematic names are used.
Examples:

Cu^+	Cu^{2+}	Fe^{2+}	Fe^{3+}	* Hg_2^{2+}	Hg^{2+}	Sn^{2+}	Sn^{4+}
copper(I)	copper(II)	iron(II)	iron(III)	mercury(I)	mercury(II)	tin(II)	tin(IV)
cuprous	cupric	ferrous	ferric	mercurous	mercuric	stannous	stannic

Fe^{2+} /Fe two plus/, iron (2+), iron (II), ferrous ion, divalent positive iron ion
Fe^{3+} /Fe three plus/, iron (3+), iron (III), ferric ion, trivalent positive iron ion

ii. homopolyatomic:

Hg_2^{2+} /h g two two plus/, mercury (I) ion, mercurous ion,

O_2^+ **di**oxygen (1+)

S_4^{2+} **tetra**sulphur (2+)

Bi_5^{4+} **penta**bismuth (4+)

H_3^+ **tri**hydrogen (1+)

Li_2^{2+} **di**lithium (1+)

N_5^+ **penta**nitrogen (1+)

Na_2^+ **di**sodium (1+)

P_2^+ **di**phosphorus (1+)

Si_2^+ **di**silicon (1+)

iii. **heteropolyatomic:** can follow rules for substitutive nomenclature, or non-systematic names; frequent suffix ***-ium***

NH_4^+ ammon**ium** (non-systematic)

H_3O^+ - oxidan**ium** (substitutive) or oxon**ium** (non-systematic)

PH_4^+ phosphan**ium** (substitutive)

b. ANIONS

i. compositional nomenclature (*-ide*)

I_3^- triiodide (1-)

O_2^{2-} dioxide (2-)

ii. substitutive (anions based on the removal of hydrogen (1+), end ***in -ide***

MeNH$^-$ methanamin**ide**

iii. additive (end in ***–ate***)

PS_4^{3-} tetrasulfidophosphate (3-)

Rules for adding sufix ***–ide:***

1. added directly to the name of the element (xenon***ide***, nickel***ide***, argon***ide***…)
2. original ending in the name of the element is substituted with ***–ide:***

chlorine – chlor***ide***	carbon – carb***ide***	sodium – sod***ide***
nitrogen – nitr***ide***	boron – bor***ide***	astatine – astat***ide***
silicon – silic***ide***	sulphur -	phosphorus –
iodine -	calcium -	hydrogen –
bromine -	arsenic -	helium –
tungsten -	mercury -	

3. ending ***-ide*** is added to a Latin-based word

silver – argent***ide***	gold – aur***ide***	copper – cupr***ide***
iron – ferr***ide***	lead – plumb***ide***	tin – stann***ide***

Complete these sentences.

a) The chemical symbol for the calcium ion is _____

b) The chemical symbol for the fluoride ion is _____

c) The chemical symbol for the ammonium ion is_____

d) The chemical symbol for the magnesium ion is_____

e) The chemical symbol for the sodium ion is_____

f) The chemical symbol for the aluminium ion is_____

5. BINARY COMPOUNDS

a) METALS WITH A FIXED CHARGE (just one oxidation state)

Salts of oxo-acids, metal oxides and other binary compounds.

- metal + nonmetal with -ide [aid]

Examples: **NaCl - sodium chloride** (Czech equivalent chlorid sodný – notice the difference in order of elements)

NaCl	sodium chlor***ide***
$ZnCl_2$	zinc chlor***ide***
CaC_2	calcium carb***ide***
MgS	magnesium sulph***ide***
Ca_3N_2	calcium nitr***ide***
K_2O	potassium ox***ide***
ZnO	zinc ox***ide***
CaO	calcium ox***ide***

Write the chemical formulae of the following compounds:

a) sodium fluoride

b) silicon carbide

c) aluminium chloride

d) calcium nitride

e) zinc oxide

Write the names of these compounds:

a) Na_2C _____

b) BaS _____

c) $CaCl_2$ _____

d) Mg_3N_2 _____

e) CaF_2 _____

f) CaO _____

b) METALS WITH A NON-FIXED CHARGE (occur in more than one oxidation state)

Metal oxides and other binary compounds with a non-fixed charge.

2 methods of nomenclature:

- **IUPAC nomenclature,** Roman numeral expresses **oxidation state**

FeO	iron **(II)** ox***ide***
Fe_2O_3	iron **(III)** ox***ide***
Cu_2S	copper **(I)** sulf***ide***
CuS	copper **(II)** sulf***ide***
$FeCl_2$	iron **(II)** chlor***ide***
$FeCl_3$	iron **(III)** chlor***ide***

- **trivial names**

- suffix *-ous* - indicates **lower** oxidation state
- suffix *–ic* - indicates **higher** oxidation state

Example:

FeO	ferr***ous*** oxide	**(lower** oxidation state)
Fe_2O_3	ferr***ic*** oxide	**(higher** oxidation state)
Cu_2S	cupr***ous*** sulfide	
CuS	cupr***ic*** sulfide	

mercuric chloride and mercurous chloride are chlorides of mercury
arsenic oxide and arsenous oxide are oxides of arsenic
plumbic iodide and plumbous iodide are iodides of lead
stannic bromide and stannous bromide are bromides of tin, etc

Important note: These suffixes have no absolute meaning. They just indicate the lower and the higher valence. Thus e.g. -ic means a valence of 2 in the case of copper and 3 in the case of iron. It is for this reason that Roman numerals are used.

c) NON-METALS (trivial names)

Greek prefixes indicate the number of atoms of the element in the compound:

mono-, di-[dai], tri-[trai], tetra-, penta-, hexa-, hepta-, octa-, nona-, deca-

+ *-ide*

Examples:

NO_2	nitrogen **di**oxide = nitrogen (IV) oxide	(1 atom of nitrogen, 2 atoms of oxygen)
N_2O_4	**di**nitrogen **tetr**oxide = dimer of Nit. (IV) oxide	
N_2O_5	**di**nitrogen **pent**oxide = nitrogen (V) oxide	
CO	carbon **mono**xide	
CO_2	carbon **di**oxide	
P_2O_3	**(di)**phosphorus **tr**ioxide	
OsO_4	osmium **tetro**xide	
P_2O_5	**di**phosphorus **pent**oxide	
PCl_3	phosphorus **tri**chloride	
CCl_4	carbon **tetra**chloride	
CS_2	carbon **di**sulfide	

c) PEROXIDES (An oxide containing more oxygen than some other oxide of the same element).

H_2O_2 hydrogen peroxide Na_2O_2 sodium peroxide

Write the formulae of the following binary molecular compounds:

nitrogen monoxide_____
dinitrogen monoxide_____
sulfur trioxide_____
iron (II) sulphide_____
iron (III) sulphide _____

dichlorine monoxide _____
tetraphosphorus decoxide_____
oxygen difluoride _____
sodium peroxide _____

Write the names for the following formulae:

PI_3
SbF_5
P_2O_5
SO_3
$FeCl_3$

CaO
$ZnCl_2$
$FeCl_2$
H_2O_2
SCl_2

Sources: 1. Adapted from Andrea Rozkošná´s lesson plan.