**INORGANIC NOMENCLATURE I**

1. **Periodic table** 
   1. **What elements do these symbols stand for?**

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

- **Mn** – manganese

- **B** – boron

**- Mg**- magnesium

**- W** – tungsten

**- Pb** – lead

**- Sb** – antimony

**- I** – iodine

- **Sn** – tin (stannum)

**- K** – potassium

**- Au** – gold

**- Fe** – iron

**- Ag** - silver

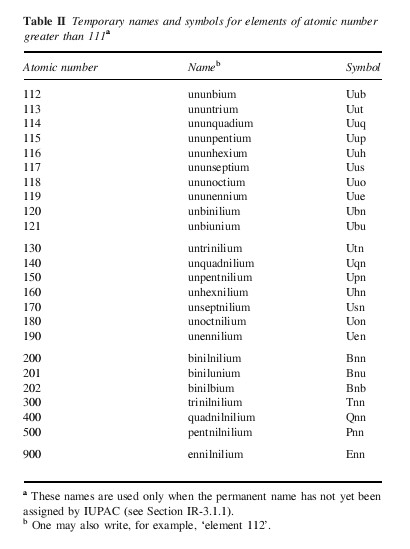
* 1. **Listening exercises**

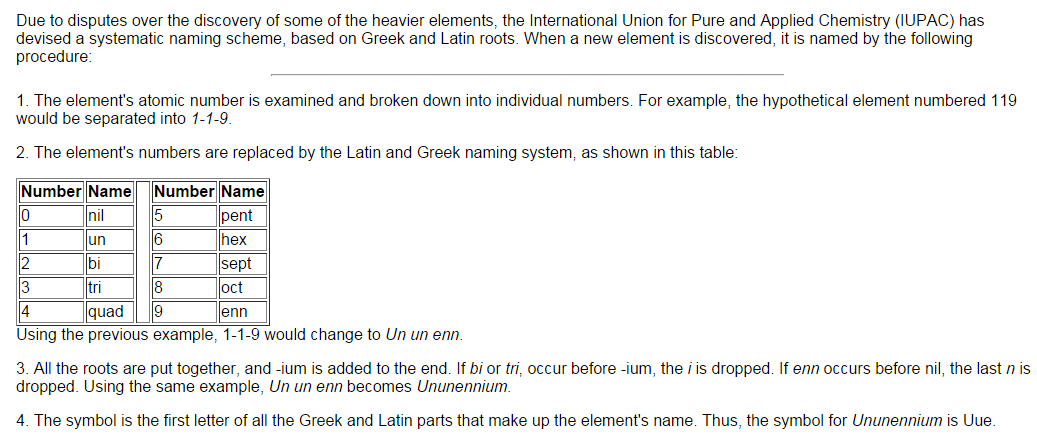
Explain the symbols below:

* + - What do they stand for?
    - What do they mean?
    - What is an alternative way of using them? (e.g. element 112)

Uub Uut Uuq Uup Uuh Uus Uuo

**Answers:**

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Watch the first video and answer the following questions:

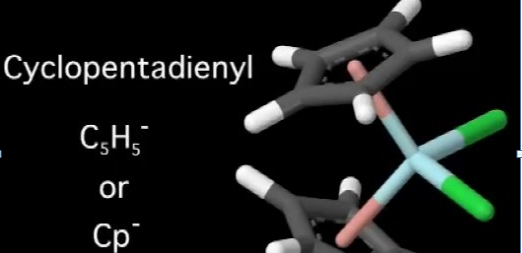
***Source:*** <http://www.periodicvideos.com/videos/112.htm>

1. What element is the professor speaking about?

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

**Answers:**

* 1. Copernicium / Cn
  2. Originally - symbol Cp, but it is used for cyclopentadienyl by organic chemists



Plus the scientists realized that many years ago (in some older books and papers), the symbol Cp was used as an alternative symbol for Lutetium which was in some countries called Cassiopeium) – old books are being digitized, it could cause confusion

* 1. IUPAC – International Union of Pure and Applied Chemistry
  2. The principle of synthesis: atoms of lighter elements are bound together to get 112, i.e. Pb (82) + Zn (30) – Zn atoms are accelerated in a high speed accelerator towards Pb atoms, 2 nuclei fuse together as a result
  3. It does not blow into parts, it starts to decay by steps (112 – 110 – 109 - 107… until it gets to a number below the mass of Uranium 92 (which is stable)

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

***Source:*** <http://www.periodicvideos.com/videos/114.htm>

Stop after the introductory part in which the scientist speaks Russian – question:

***What language does he speak? Why?***

(Element 114 got its official name (Flerovium) and symbol (Fl), excitement, his father was born in Russia)

The rest of the video

**114 December 2011 Plutonium Fljorov**

**30th May 2012 Dubna memorial**

**Russian discussion period bombardment**

**114** – element 114, its atomic number

**December 2011** - the name Flerovium for element 114 suggested to IUPAC

**Plutonium** – Pu (94) + Ca (20) – synthesis of the element

**Fljorov** – Russian scientist, founder of Dubna, the element named after him

**30th May 2012** – the element´s name officially adapted

**Dubna** – Russian research centre north of Moscow

**memorial** – the fact that the element was named after Fljorov is kind of his memorial

**discussion period** – when a new name of an element is suggested to IUPEC, people are allowed to point out if there are any problems connected to it

**bombardment** – superheavy new artificial elements are synthesized by taking a nucleus of a heavy element and binding into it an element that is lighter – Ca atoms are accelerated rapidly and plutonium is bombarded with millions of atoms, one will eventually fuse with one atom of Pu

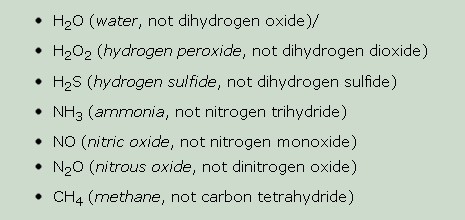
Follow up question:

***Why does such an element need a symbol?***

Not useful for day-to-day chemistry, but for physics (unstable element decay – see explanation using his tie)

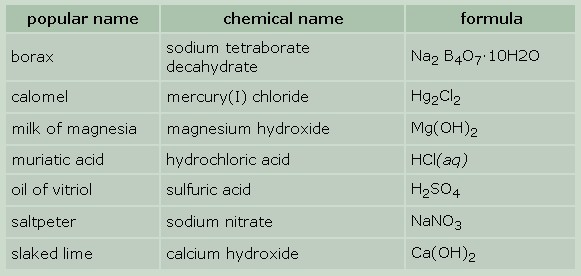
1. **Types of chemical nomenclature**
2. **Trivial names**

HG2Cl2 – mercurous chloride (systematic - mercury (II) chloride)



1. **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.



1. **Systematic nomenclature:** 
   1. **compositional**
   2. **substitutive**
   3. **additive**

Example: **PCl 3**

- compositional: **phosphorus trichloride**

- substitutive: **trichlorophosphane**

- additive: **trichloridophosphorus**

1. **Chemical nomenclature of** 
   1. ions
   2. binary compounds
   3. ternary compounds
2. **IONS**
   1. **CATIONS**
      1. **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,

**Cu2+** copper (2+), /c u two plus/, copper ion, divalent positive

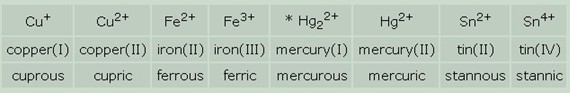
copper ion, copper (II) ion

**Cr3+** 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:



**Fe2+** /Fe two plus/, iron (2+), iron (II), ferrous ion, divalent positive iron ion  
                    **Fe3+** /Fe three plus/, iron (3+), iron (III), ferric ion, trivalent positive iron ion

* + 1. **homopolyatomic:**

**Hg22+** /h g two two plus/, mercury (I) ion, mercurous ion,

**O2+** **di**oxygen (1+)

**S42+** **tetra**sulphur (2+)

**Bi54+** **penta**bismuth (4+)

**H3+** **tri**hydrogen (1+)

**Li22+** **di**lithium (1+)

**N5+** **penta**nitrogen (1+)

**Na2+** **di**sodium (1+)

**P2+** **di**phosphorus (1+)

**Si2+** **di**silicon (1+)

* + 1. **heteropolyatomic:** can follow rules for substitutive nomenclature, or non-systematic names; frequent suffix ***-ium***

**NH4+** ammon**ium** (non-systematic)

**H3O+** oxidan**ium** (substitutive) or oxon**ium** (non-systematic)

**PH4+** phosphan**ium** (substitutive)

* 1. **ANIONS**
     1. **compositional nomenclature (*-ide*)**

**I3-** triiodide (1-)

**O22-** dioxide (2-)

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

**MeNH-** methanamin**ide**

* + 1. **additive** (end in ***–ate***)

**PS43-**  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 – **sulphide/sulfide** phosphorus – **phosphide**

iodine - **iodide** calcium - **calcide** hydrogen – **hydride**

bromine -  **bromide** arsenic - **arsenide** helium – **helide**

tungsten - **tungstide** mercury - **mercuride**

1. 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 \_\_\_ **Ca2+ ; calcium (2+)**  
b) The chemical symbol for the fluoride ion is \_ **F- ; fluoride (1**-) (**cation****F+** **fluorine (1+) )**  
c) The chemical symbol for the ammonium ion is\_\_\_\_ **NH4+**   
d) The chemical symbol for the magnesium ion is\_\_\_\_\_ **Mg+ ; magnesium (1+)** also **Mg2+** **; magnesium (2+)** ( **anion: magneside**: **Mg -**  ; **magneside (1-)** )   
e) The chemical symbol for the sodium ion is\_ **Na+** ; **sodium (1+)** **(anion**: **Na-** ; **sodide (1-) )**  
f) The chemical symbol for the aluminium ion is\_\_ **Al+ ;aluminium (1+)** also **Al3+ ;aluminium (3+) (anion Al- aluminide (1-) )**

1. **BINARY COMPOUNDS**
2. **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***                       
ZnCl2                  zinc chlor***ide***  
CaC2                   calcium carb***ide***                       
MgS                    magnesium sulph***ide***                 
Ca3N2                  calcium nitr***ide***                      
K2O                  potassium ox***ide***  
ZnO                 zinc ox***ide***  
CaO                 calcium ox***ide***

***Write the chemical formulae of the following compounds:***

a) sodium fluoride **NaF**

b) silicon carbide **SiC**

c) aluminium chloride  **AlCl3**

d) calcium nitride  **Ca3N2**

e) zinc oxide **ZnO**

***Write the names of these compounds:***  
a) Na2C \_\_\_\_\_\_\_\_\_\_ **sodium carbide**  
b) BaS *\_\_\_\_\_\_***barium sulphide**  
c) CaCl2 \_\_\_\_\_\_\_**calcium chloride**  
d) Mg3N2 \_\_\_\_\_\_**magnesium nitride**  
e) CaF2 \_\_\_\_\_\_**calcium fluoride** f) CaO \_\_\_\_**calcium oxide**

1. **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***   
Fe2O3             iron **(III)** ox***ide***  
Cu2S              copper **(I)** sulf***ide***  
CuS               copper **(II)** sulf***ide***FeCl2 iron **(II)** chlor***ide***  FeCl3 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)   
Fe2O3          ferr***ic*** oxide  **(higher** oxidation state)   
Cu2S           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:

NO2 nitrogen **di**oxide = nitrogen (IV) oxide (1 atom of nitrogen, 2 atoms of oxygen)

N2O4 **di**nitrogen **tetr**oxide = dimer of Nit. (IV) oxide

N2O5 **di**nitrogen **pent**oxide = nitrogen (V) oxide

CO     carbon **mono**xide

CO2    carbon **di**oxide

P2O3    **(di)**phosphorus **tr**ioxide

OsO4    osmium **tetro**xide

P2O5    **di**phosphorus **pent**oxide

PCl3     phosphorus **tri**chloride

CCl4    carbon **tetra**chloride

CS2      carbon **di**sulfide

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

H2O2               hydrogen peroxide                Na2O2             sodium peroxide

***Write the formulae of the following binary molecular compounds:***

nitrogen monoxide\_\_\_\_**NO** dichlorine monoxide \_\_\_ **Cl2O**  
dinitrogen monoxide\_\_\_\_ **N2O**  tetraphosphorus decoxide\_\_\_\_ **P4O10**  
sulfur trioxide\_\_\_\_ **SO3** oxygen difluoride \_\_\_\_\_**OF2**  
iron (II) sulphide\_\_\_\_**FeS** sodium peroxide \_\_\_ **Na2O2**  
iron (III) sulphide \_\_\_ **Fe2 S3**

***Write the names for the following formulae:***

PI3  **phosphorus triiodide, phosphorus (III) iodide**

SbF5 **antimony pentafluoride**

P2O5 **diphosphorus pentoxide**

SO3 **sulphur trioxide**

FeCl3 **iron (III) chloride, ferric chloride**

CaO  **calcium oxide**

ZnCl2 **zinc chloride**

FeCl2 **iron (II) chloride, ferrous chloride**

H2O2  **hydrogen peroxide**

SCl2 **sulphur dichloride**