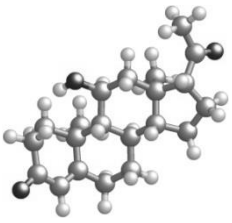

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Name: …… **( )**

Class: ……

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Chemical Symbols and Formulae

Chemists use *symbols* and *formulae* as a concise way of describing chemical elements and compounds. The symbols of some chemical elements are derived from the first letter (or letters) of its English name, *e.g.* C is the symbol for carbon and Br is the symbol for bromine. The symbols of other chemical elements are derived from their Latin or German names, *e.g.* Au is the symbol for gold (from the Latin word *Aurum*) and W is the symbol for tungsten (from the German word *Wolfram*).

If the symbol of a chemical element is composed of a *single* letter then it is always written as a *capital letter*, *e.g.* N is the symbol for nitrogen. If the symbol of a chemical element is composed of *two* letters then the *first* letter is written as a *capital* and the *second* letter is written in *lowercase*, *e.g.* Co is the symbol for cobalt (care should be taken not to write the symbol for cobalt as CO, because this is actually the formula for the compound carbon monoxide).

The *formula* of a compound is constructed using the symbols of the chemical elements that the compound is made of. The names and symbols of all known chemical elements can be found in the Periodic Table. Some chemical elements also have formulae, *e.g.* the *diatomic* element oxygen has the formula O_2 (**Note**: A diatomic molecule is a molecule composed of only *two* atoms).

Question 1: Which other chemical elements are diatomic? Write their names and formulae below:

……..

……..

……..

……..

The formula of a compound is written by combining together the symbols of the chemical elements that it is made-up of. Numbers – written as *sub-scripts* directly after the symbol of an element – specify the number of atoms / ions of the element that are present in one unit of the compound (**Note:** For *simple covalent* compounds, a single unit of the compound is a *molecule*). For example, water has the formula H_2O, indicating that two atoms of hydrogen have combined with a single atom of oxygen. Ammonia has the formula NH_3, indicating that one atom of nitrogen has combined with three atoms of hydrogen. Magnesium chloride has the formula $MgCl_2$, indicating that a single atom of magnesium has combined with two atoms of chlorine.

Chemical formulae therefore tell us two important pieces of information:

1. The elements that are present in a compound.
2. The number of atoms / ions of each element that make-up a single unit of the compound.

It is possible to learn the symbols of all the chemical elements, but it is impossible to learn the formulae of all the known chemical compounds, there are simply too many of them. Because of this, the formula of a compound must be calculated from the *valencies* of the elements that are present. The valency of a *metal* is equal to the number of valence electrons that a single atom of the metal must *lose* in order to obtain a complete valence shell. The valency of a *non-metal* is equal to the number of electrons that a single atom of the element must *gain* in order to obtain a complete valence shell.

The valencies of some common elements and polyatomic ions are given below:

Sodium: valency = 1
Potassium: valency = 1
Magnesium: valency = 2
Calcium: valency = 2
Aluminium: valency = 3
Copper(II): valency = 2
Iron(II): valency = 2
Iron(III): valency = 3
Silver: valency = 1
Zinc: valency = 2
Ammonium group (NH_4^+): valency = 1

Chlorine: valency = 1
Bromine: valency = 1
Hydrogen: valency = 1
Oxygen: valency = 2
Sulfur: valency = 2
Nitrogen: valency = 3
Carbon: valency = 4
Carbonate group (CO_3^{2-}): valency = 2
Sulfate group (SO_4^{2-}): valency = 2
Sulfite group (SO_3^{2-}): valency = 2
Nitrate group (NO_3^-): valency = 1
Nitrite group (NO_2^-): valency = 1
Hydroxide group (OH^-): valency = 1

Note: Some metals, *e.g.* copper and iron, have more than one valency. For these metals, the valency of the chemical element is given in Roman numerals directly after its symbol. For example, copper(II) literally means "*copper with a valency of two*."

The table below shows how valency changes across the Groups of the Periodic Table:

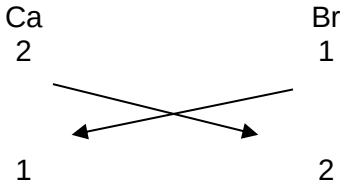
Group Number	1	2	13	14	15	16	17	18
Valency of the Elements Within that Group	1	2	3	4	3	2	1	0

Rules for Writing Chemical Formulae:

- When writing the formula of an ionic compound, the symbol of the *metal* is normally written before the symbol of the *non–metal*.
- To calculate the formula of a compound, determine the valencies of the elements or polyatomic ions that are present and then *swap the valencies* to give the ratio of elements in that compound. Where possible, ratios should be simplified (see example 3).
- When writing the chemical formula of a compound, all numbers should be written as *subscripts*, for example, H_2O, Na_2SO_4 and K_2CO_3.
- Charges present on ions should *not* be included in the formula, for example, the formula of calcium carbonate is written $CaCO_3$ and *not* as $Ca^{2+}CO_3^{2-}$.
- If a polyatomic ion needs to be represented in a formula two or more times then the formula of the polyatomic ion is placed in brackets and the number of times that it is required is written as a subscript immediately to the right of the brackets. For example, the formula of aluminium nitrate is written as $Al(NO_3)_3$ and *not* as $AlNO_{33}$ and the formula of ammonium sulfate is written as $(NH_4)_2SO_4$ and *not* as $NH_{42}SO_4$ (see example 4).

Example One: What is the formula of calcium bromide?

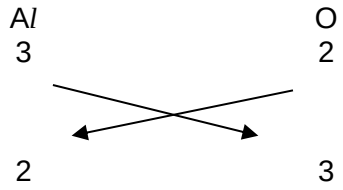
Calcium bromide is composed of the two elements calcium (valency 2) and bromine (valency 1). Swap the valencies to give the ratio of the elements present in the compound and hence the formula:



The ratio of calcium to bromine is 1:2, so the formula of calcium bromide is written as $CaBr_2$.

Example Two: What is the formula of aluminium oxide?

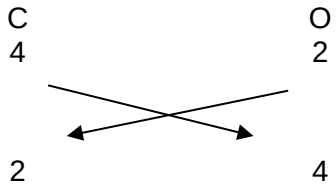
Aluminium oxide is composed of the two elements aluminium (valency 3) and oxygen (valency 2). Swap the valencies to give the ratio of the elements present in the compound and hence the formula:



The ratio of aluminium to oxygen is 2:3, so the formula of aluminium oxide is written as Al_2O_3.

Example Three: What is the formula of carbon dioxide?

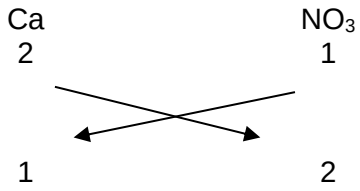
Carbon dioxide is composed of the two elements carbon (valency 4) and oxygen (valency 2). Swap the valencies to give the ratio of the elements present in the compound and hence the formula:



The ratio of carbon to oxygen in carbon dioxide is therefore 2:4. Before writing the formula for this particular example it should be noted that a ratio of 2:4 can be simplified to a ratio of 1:2, so the formula of carbon dioxide is written as CO_2.

Example Four: What is the formula of calcium nitrate?

Calcium nitrate is composed of the element calcium (valency 2) chemically bonded to the polyatomic nitrate ion (NO_3^-, valency 1). Swap the valencies to give the ratio of calcium ions to polyatomic nitrate ions present in the compound and hence the formula:



The ratio of calcium ions to polyatomic nitrate ions in calcium nitrate is therefore 1:2. Care should be taken when writing the formula of this compound because simply writing $CaNO_{32}$ indicates that the compound contains *one* atom of calcium, *one* atom of nitrogen and *thirty–two* atoms of oxygen which is incorrect. The formula must clearly show that calcium nitrate is only composed of *one* calcium ion bonded to *two* polyatomic nitrate ions. This is easily achieved by writing the formula of the nitrate group in *brackets* and writing the number of nitrate groups required as a sub-script immediately outside the brackets. The formula of calcium nitrate is therefore written as $Ca(NO_3)_2$.

Question 2: Write the formulae of the following compounds:

a) Sodium bromide ……

b) Magnesium chloride ……

c) Magnesium oxide ……

d) Aluminium chloride ……

e) Aluminium oxide ……

f) Copper(II) nitrate ……

g) Iron(II) sulfate ……

h) Iron(III) chloride ……

i) Sodium nitrate ……

j) Potassium carbonate ……

k) Ammonium chloride ……

l) Ammonium sulfate ……

m) Aluminium sulfate ……

n) Zinc sulfite ……

o) Silver nitrate ……

p) Water ……

q) Ammonia ……

r) Methane ……

s) Carbon dioxide ……

t) Iron(III) sulfate ……

u) Silver oxide ……

v) Zinc nitrate ……

w) Carbon disulfide ……

x) Hydrochloric acid ……

y) Nitric acid ……

z) Sulfuric acid ……

- Scan the QR code below for the answers to this assignment.

http://www.chemist.sg/formulae_equations/writing_formulae_ans.pdf