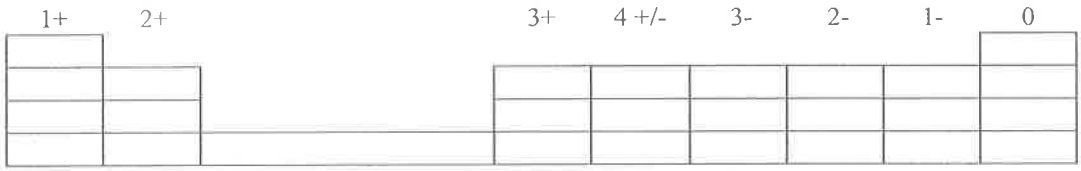
SCH 3U- Nomenclature

Binary Compounds with Elements having one valence (charge) value

- Binary compounds contain **two** elements only.
- They are usually ionic compounds
- When naming compounds the least electronegative element is usually written first.

Rules for Binary Compounds

- The name of the binary compound always ends in **"ide"**.
- The first mentioned element uses its name as it appears on the Periodic table
- Elements have a valence value determined by their group on the Periodic table



N.B. see the periodic table for valences of the transitions metals

Zero Sum Rule: For neutral chemical formulas containing ions, the sum of the positive and negative ions must equal zero.

Cross-over-rule for writing Formulas

1. Write down the symbols of the elements in the order given in the name
2. Write valences above elements symbol
3. Determine if valences are balanced (e.g, 1+, 1-). If they are, formula stays as is. NaCl
4. If valences do not balance (e.g, 3+, 2-), cross-over valences. Al_2O_3
5. Drop all 1's and unnecessary brackets

Examples:

sodium (1+) oxide (2-) Na_2O calcium (2+) sulfide (2-) CaS magnesium (2+) bromide(1-) $MgBr_2$

Exercise:
For all exercises you will give the name if formula provided and the formula if the name is provided.

1) calcium nitride _____

2) aluminum carbide _____

3) silver sulphide _____

4) sodium fluoride _____

5) barium iodide _____

6) LiCl _____

7) K_2S _____

8) silicon oxide _____

9) aluminum bromide _____

10) zinc oxide _____

11) potassium bromide _____

12) magnesium chloride _____

13) BaO _____

14) Mg_3P_2 _____

Binary Compounds with Elements having multiple valence values

Rules for Binary Compounds

- The name of the binary compound always ends in **"ide"**.

- Whenever the first mentioned element has more than one valence value, this must be indicated in the name. It will always be the first element. The second element has a valence value equal to the value for its group on the periodic table.

Certain valence values of transition metals can be determined from the Periodic Table.
On the Periodic table, above each symbol are a number of values which the legend calls oxidation states. In many cases these also correspond to valence values.

There are three ways of naming compounds containing elements that can have multiple valences, The different methods must not be mixed.

Method 1 - Roman numeral method (IUPAC) *** (preferred method)

- The valence value to be used is indicated by using uncrossed Roman numerals
- It is placed in brackets immediately following the name of the first element.

Examples:

iron(III) chloride	$FeCl_3$	tin(IV) iodide	SnI_4
nickel (III) sulfide	Ni_2S_3	mercury(II) oxide	HgO

Exercise:
For all exercises you will give the name if formula provided and the formula if the name is provided.

1) iron(III) chloride _____
2) lead(IV) oxide _____
3) phosphorus(V) chloride _____
4) copper(I) bromide _____
5) antimony(V) sulphide _____
6) arsenic(III) oxide _____
7) mercury(I) sulphide _____
8) Pb_3N_2 _____
9) NiI_2 _____
10) Co_2Se_3 _____
11) SnO_2 _____
12) copper(II) sulphide _____
13) arsenic(V) iodide _____
14) gold(I) fluoride _____
15) sulphur(VI) oxide _____
16) bismuth(v) phosphide _____
17) mercury(II) chloride _____
18) gold(III) chloride _____
19) SbF_3 _____
20) MnO_2 _____
21) BiF_5 _____
22) PtO _____

Method 2 - "ous' and "ic" method

- When the first written element has two valences only, the name of the element ending with "ous" denotes the lower valence value
- The name of the element ending with an "ic" denotes the higher valence values.

1. In some cases, the latin name for the element is used:

iron:	ferrous	(valence = 2+)	and	ferric	(valence = 3+)
gold:	aurous	(valence = 1+)	and	auric	(valence = 3+)
copper:	cuprous	(valence = 1+)	and	cupric	(valence = 2+)
tin:	stannous	(valence = 2+)	and	stannic	(valence = 4+)
lead:	plumbous	(valence = 2+)	and	plumbic	(valence = 4+)
cobalt	cobaltous	(valence = 2+)	and	cobaltic	(valence = 3+)
nickel	nickelous	(valence = 2+)	and	nickelic	(valence = 3+)
mercury	mercurous	(valence = 1+)	and	mercuric	(valence = 2+)
platinum	platinous	(valence = 2+)	and	platonic	(valence = 4+)

2. Some elements having more than two valence values or oxidation states use specific values for the "ous" and the "ic".

nitrogen	ous = 1- ic = 2-	chromium	ous = 2+ ic = 3+
manganese	ous = 2+ ic = 3+	phosphorus	ous = 3- ic = 5-
bismuth	ous = 3+ ic = 5+	arsenic	ous = 3+ ic = 5+

Examples:

stannous chloride $SnCl_2$ manganous fluoride MnF_2 nitric oxide NO

Exercise:

For all exercises you will give the name if formula provided and the formula if the name is provided.

1) ferric oxide _____

2) phosphoric sulfide _____

3) cuprous fluoride _____

4) stannic fluoride _____

5) antimonous sulfide _____

6) cupric bromide _____

7) NiI_2 _____

8) HgBr _____

9) $CoCl_3$ _____

10) As_3N_5 _____

11) stannic oxide _____

12) arsenous nitride _____

13) nickelous fluoride _____

14) cuprous nitride _____

15) auric chloride _____

16) cupric sulfide _____

17) PtO_2 _____

18) As_4C_5 _____

19) Au_2S _____

20) $PbCl_4$ _____

Method 3 - Greek prefix method-*** Binary Covalent Compounds only***

- This method **does not use** the valence values.
- The Greek prefix is placed in front of the element name to indicate how many atoms of the element to place in the formula.
- The word "mono" is usually omitted only if it applies to the **first** element.

Prefixes:	mono = 1	di = 2	tri =3	tetra = 4	penta = 5
	hexa = 6	hepta = 7	octa = 8	nona = 9	deca = 10

Examples:	diphosphorus pentoxide	P_2O_5	arsenic trichloride	$AsCl_3$
	carbon monoxide	CO	xenon tetrafluoride	XeF_4

Exercise:

For all exercises you will give the name if formula provided and the formula if the name is provided.

1) xenon hexafluoride _____
2) sulphur trioxide _____
3) carbon disulphide _____
4) silicon dioxide _____
5) nitrogen monoxide _____
6) nitrogen dioxide _____
7) carbon tetrachloride _____
8) dichlorine monoxide _____
9) OF_2 _____
10) $SeCl_2$ _____
11) NF_3 _____

12) sulfur dioxide _____
13) carbon dioxide _____
14) diphosphorus trisulfide _____
15) silicon tetrachloride _____
16) manganese dioxide _____
17) nitrogen tetroxide _____
18) xenon hexafluoride _____
19) diphosphorus pentasulphide _____
20) ICl _____
21) ICl_7 _____
22) P_2S_5 _____

Formula of elements:

- Most elements are written as single entities:
- Metals (solids in their standard state except mercury)
- Noble gases
- Diatomics - **H O F Br I N Cl (all are gasses except Br and I)**

Eg: hydrogen $H_{2(g)}$; oxygen $O_{2(g)}$; nitrogen $N_{2(g)}$; bromine $Br_{2(l)}$; iodine $I_{2(s)}$

- two other non-metals exceptions: sulphur S(s) & $S_{8(s)}$; phosphorus P(s) & $P_{4(s)}$

Polyatomic ions (Radicals)

- Is an ion made up of two or more atoms
- You were **list of polyatomic ions** to use along with their **valences**.
- These polyatomic ions behave as if they were a single entity and follow the cross-over rule in the same manner as other single elements.
- Brackets are used in the formula, only if it turns out that there are 2 or more of the polyatomic ion indicated in the formula: Eg. Brackets are used in $Al_2(SO_4)_3$ but not in Na_3PO_4
- The only polyatomic cation to be studied is NH_4^+
- The others are polyatomic anions. i.e. they carry a negative charge

radical name	formula	radical name	formula
thiocyanate	SCN^-	nitrate	NO_3^-
cyanide	CN^-	nitrite	NO_2^-
cyanate	CNO^-	carbonate	CO_3^{2-}
hypochlorite	ClO^-	thiosulfate	$S_2O_3^{2-}$
chlorite	ClO_2^-	sulfate	SO_4^{2-}
chlorate	ClO_3^-	sulfite	SO_3^{2-}
perchlorate	ClO_4^-	phosphate	PO_4^{3-}
hydroxide		ammonium	NH_4^+

****See earlier handouts for other common polyatomics.**

"Nick the Camel had a Clam for Supper in Phoenix."

_____ _____ _____ _____ _____

Examples:

calcium hydroxide	$Ca(OH)_2$	iron (II) nitrite	$Fe(NO_2)_2$
magnesium cyanide	$Mg(CN)_2$	ammonium hydroxide	NH_4OH
sodium phosphate	Na_3PO_4	sodium hypochlorite	$NaClO$

1) potassium hydroxide _____
2) barium hydroxide _____
3) copper(II) sulphate _____
4) ammonium bromate _____
5) nickel(III) cyanide _____
6) cobalt(II) cyanate _____
7) gallium dichromate _____
8) $Sn(CN)_4$ _____
9) $KMnO_4$ _____
10) $Cu(NO_3)_2$ _____
11) iron(III) cyanate _____
12) ammonium chloride _____
13) ammonium dichromate _____
14) ferrous hydroxide _____
15) auric bromide _____
16) zinc hydroxide _____
17) potassium chromate _____
18) $Al(OH)_3$ _____
19) $CsCN$ _____
20) $Ca(SCN)_2$ _____

Hydrates:

Greek prefixes are used to indicate how many water molecules are associated with the crystal. A dot separates the ionic compound from the attached water molecule(s).

Examples:	copper(II) sulfate pentahydrate	$CuSO_4 \cdot 5H_2O$	(penta = five water)
	chlorine octahydrate	$Cl_2 \cdot 8H_2O$	(octa = eight water)

1) calcium sulfate dihydrate _____
2) magnesium sulfite heptahydrate _____
3) sodium carbonate decahydrate _____
4) aluminum oxide monohydrate _____
5) ferric chloride hexahydrate _____
6) calcium nitrate trihydrate _____
7)cadmium bromide tetrahydrate _____
8) chromium(III) nitrate nonahydrate_____
9) barium hydroxide octahydrate _____
10) cobalt(II) perchlorate pentahydrate_____
11) barium chloride dihydrate _____
12) aluminum nitrate monohydrate _____
13) bromine decahydrate _____
14) iodine tetrahydrate _____
15) copper(II) sulfite hexahydrate _____
16) ferrous iodide tetrahydrate _____
17) lithium chloride monohydrate _____
18) beryllium nitrate tetrahydrate _____

Peroxides:

These are binary oxides, which contain an extra oxygen atom. (O_2^{2-} = peroxide radical)

Rule:

1. Write the formula as if the regular oxide	Na_2O	H_2O	CaO
2. Add on one extra oxygen atom	Na_2O_2	H_2O_2	CaO_2

Do not at this stage cancel any of the subscripts.

1) zinc peroxide _____
2) calcium peroxide _____
3) cesium peroxide _____
4) copper(II) peroxide _____
5) magnesium peroxide _____
6) potassium peroxide _____
7) strontium peroxide _____
8) hydrogen peroxide _____
9) barium peroxide _____
10) aluminum peroxide _____

Thio Compounds

The prefix thio in the name indicates that an oxygen atom has been replaced by a sulphur atom.

Examples:	potassium sulphate	K_2SO_4	potassium thiosulphate	$K_2S_2O_3$
	sodium carbonate	Na_2CO_3	sodium thiocarbonate	Na_2SCO_2
	potassium cyanate	KCNO	potassium thiocyanate	KSCN

1) ammonium thiocyanate _____
2) sodium monohydrogenthiosulphate _____
3) CaS_2O_2 _____
4) potassium thiosulfate _____
5) aluminum thiocarbonate _____
6) $AlSPO_3$ _____

NOMENCLATURE 4

ACIDS:

There are three groups of acids: - binary acids
- oxy acids
- derived oxy acids

Binary Acids

1. All have the prefix *hydro* and end with *ic.*
2. All must contain hydrogen as the first element.
3. Use the normal cross-over-rule to determine the formula.
4. All are dissociated in water and must be so indicated by using (aq) behind the formula.
5. Have no oxygen in their formula

Examples:		
	hydrochloric acid	HCl(aq)
	hydrosulfuric acid	H_2S(aq)
	hydrocyanic acid	HCN(aq)

Exercise:

For all exercises you will give the name if formula provided and the formula if the name is provided.

hydrobromic acid	_____	hydroselenic acid	_____
hydroiodic acid	_____	hydrophosphoric acid	_____
hydrofluoric acid	_____	hydrofluoric acid	_____
hydrotelluric acid	_____	hydrosulfuric acid	_____

Oxy acids

1. All contain H, O and at least one other non-metal element
2. The name of the acid ends in *ic.*
3. The name of the associated radical ends in *ate.*
4. The valence value of the associated radical is equal to the number of acidic hydrogen atoms in the acid. Hydrogen proton(s) (H^+) will be used to balance the charge of the anion (radical).

e.g. $2\ H^+$ and SO_4^{2-} $\rightarrow H_2SO_4$ H^+ and NO_3^{1-} $\rightarrow HNO_3$

Name of the Acid	Formula of the Acid	Name of the associated radical	Formula of the associated radical	valence value for the associated radical
chromic acid	$H_2CrO_{4(aq)}$	chromate	CrO_4^{2-}	2
nitric acid	$HNO_{3(aq)}$	nitrate	NO_3^{1-}	1
fluoric acid	$HFO_{3(aq)}$	fluorate	FO_3^{1-}	1
carbonic acid	$H_2CO_{3(aq)}$	carbonate	CO_3^{2-}	2
sulfuric acid	$H_2SO_{4(aq)}$	sulfate	SO_4^{2-}	2
phosphoric acid	$H_3PO_{4(aq)}$	phosphate	PO_4^{3-}	3

NOTE:
Use (aq) to indicate an aqueous solution.

"ate" ion = "ic" acid e.g, Chlorate ClO_3^{1-} = Chloric Acid $HClO_{3(aq)}$
"ite" ion = "ous" acid e.g, Chlorite ClO_2^{1-} = Chlorous Acid $HClO_{2(aq)}$

Using the periodic table it is possible to write the names and formulas for a number of other oxy acids using the fact that members of the same chemical family have similar chemical properties.

Elements of the same chemical family (group) follow the pattern of the oxy acid immediately above the oxy acid in the same group.

Example: $HFO_{3(aq)}$ Fluoric acid
therefore: $HClO_{3(aq)}$ - Chloric acid $HIO_{3(aq)}$ - iodic acid and $HBrO_{3(aq)}$ - bromic acid.

*****Exercise: On a separate piece of paper complete the following chart for the acids listed.*****

Name of the acid	Formula of the acid	Name of the associated radical	Formula of the associated radical	Valence value of the associated radical

bromic acid telluric acid dichromic acid iodic acid silicic acid

manganic acid selenic acid chromic acid cyanic acid arsenicacid

NOMENCLATURE 5

Salts

- Salts are compounds which can be formed when an acid and a base neutralize each other.
- Most of the compounds in the section on binary compounds could be considered to be salts formed from a base and a binary acid.
- Salts can also be formed from a base and an oxy acid or derived oxy acid.

Examples:

sodium sulphate	Na_2SO_4	calcium phosphate	$Ca_3(PO_4)_2$
aluminum carbonate	$Al_2(CO_3)_3$	zinc perchlorate	$Zn(ClO_4)_2$
copper (II) nitrite or cupric nitrite	$Cu(NO_2)_2$	tin (II) hypoiodite or stannous hypoiodite	$Sn(IO)_2$

Acid Radicals

- The oxy acids which have more than one acidic hydrogen are able to lose the hydrogens, one at a time.
- This gives rise to radicals, with acidic hydrogens still attached
- These radicals are referred to as acid radicals:

$H_3PO_4 \longrightarrow H^{1+} + H_2PO_4^{1-}$
$H_2PO_4^{1-} \longrightarrow H^{1+} + HPO_4^{2-}$
$HPO_4^{2-} \longrightarrow H^{1+} + PO_4^{3-}$

Radical	Name	Valence value
PO_4	phosphate	3
HPO_4	monohydrogen phosphate	2
H_2PO_4	dihydrogen phosphate	1

* Valence value = Valence of the non-acid radical - # H's still attached.

For the following give the formula and valence value of the radicals listed:

phosphite _____ _____
monohydrogenphosphite _____ _____
dihydrogenphosphite _____ _____
hypophosphite _____ _____
monohydrogenhypophosphite _____ _____
dihydrogenhypophosphite _____ _____
sulphate _____ _____
monohydrogensulphate _____ _____
suphite _____ _____
monohydrogensulphite _____ _____
carbonate _____ _____
monohydrogencarbonate _____ _____
chromate _____ _____
monohydrogechromate _____ _____

Acid Salts:

The acid radicals are treated just like any other radical:

Examples:

calcium dihydrogenhypophosphite	$Ca(H_2PO_2)_2$
potassium monohydrogen carbonate	$KHCO_3$
aluminum hydrogensulphite	$Al(HSO_3)_3$ Note: mono is understood

Note: In some old texts, the prefix "bi" is sometimes used instead of monohydrogen. Its use is very selective and should not be considered to name compounds, but know how to write the formulas when the prefix "bi" is used.
Examples: sodium bicarbonate $NaHCO_3$ potassium bisulphite $KHSO_3$

sodium monohydrogenphosphate	_____	ferric monohydrogensulphate	_____
magnesium dihydrogenphosphat	_____	ammonium hydrogencarbonate	_____
aluminum dihydrogenphosphite	_____	chromium(III) hydrogensulphite	_____
chromium(III) hydrogenphosphite	_____	nickel(II) monohydrogensilicate	_____
cupric monohydrogenarsenate	_____	cadmium monohydrogenselenate	_____
stannic dihydrogenhypophosphite	_____	potassium monohydrogenselenite	_____

K_2HPO_3	_____	$Bi_2(HPO_3)_5$	_____
$Ba(HSO_3)_2$	_____	$Pb(H_2PO_2)_2$	_____

NOMENCLATURE 6

Derived Oxy acid and Salts worksheet

Exercise:

*****Complete the following table for the acids listed on a separate piece of paper. *****

phosphorous acid	bromic acid	iodous acid
hypophosphorous acid	bromous acid	hypoiodous acid
phosphoric acid	hypobromous acid	selenic acid
sulfuric acid	periodic acid	selenous acid
sulfurous acid	iodic acid	telluric acid
nitric acid	perbromicacid	tellurous acid

Name of the acid	Formula of the acid	Name of the associated radical	Formula of the associated radical	Valence value of the associated radical

(A) salts from oxy acids

potassium chlorate _____

sodium nitrate _____

iron(III) acetate _____

aluminum silicate _____

magnesium phosphate _____

aurous sulfate _____

ammonium chlorate _____

zinc nitrate _____

potassium acetate _____

lithium chromate _____

sodium carbonate _____

ferric sulfate _____

gold(I) phosphate _____

magnesium chlorate _____

ammonium nitrate _____

K_2CO_3 _____

Na_3PO_4 _____

$Fe(ClO_3)_2$ _____

$Al(C_2H_3O_2)_3$ _____

$Zn_3(PO_4)_2$ _____

(B) Salts from derived oxy acids

sodium perchlorate _____

aluminum sulfite _____

cobalt(III) chlorite _____

tin(IV) hypochlorite _____

sodium phosphite _____

aluminum nitrite _____

cobalt(II) hypophosphite _____

stannic perchlorate _____

sodium sulphite _____

aluminum chlorite _____

nickel(III) hypochlorite _____

tin(IV) phosphite _____

magnesium phosphite _____

copper(I) permanganate _____

ammonium hypophosphite _____

mercuric perchlorate _____

magnesium sulfite _____

cuprous chlorite _____

ammonium hypoiodite _____

gold(III) chromate _____

$Ga(BrO_4)_3$ _____

$Pt(ClO)_4$ _____

WORKSHEET: NAMING AND WRITING FORMULAS FOR COMPOUNDS

PART 1: Naming Ionic Compounds

1. MgS	
2. KBr	
3. Ba_3N_2	
4. Al_2O_3	
5. NaI	
6. SrF_2	
7. Li_2S	
8. $RaCl_2$	
9. CaO	
10. AlP	

PART 2: Naming compounds with multivalent cations (transition metals).

	Stock or IUPAC method	Classical method
1. CuS		
2. $PbBr_4$		
3. PbN_2		
4. FeO_3		
5. FeI_2		
6. SnP_4		
7. Cu_2S		
8. $SnCl_2$		
9. HgO		
10. Hg_2F_2		

PART 3: Name Compounds (polyatomic + multivalent). Name both ways where possible.

1. $AlPO_4$	
2. KNO_2	
3. $NaHCO_3$	
4. $CaCO_3$	
5. $Mg(OH)_2$	
6. $Sn(NO_3)_2$	
7. $FePO_4$	
8. Cu_2SO_4	
9. $Ni(C_2H_3O_2)_2$	
10. $HgCO_3$	

PART 4 Naming Covalent Compounds

1. As_4O_{10}	
2. BrO_3	
3. BN	
4. N_2O_3	
5. NI_3	
6. SF_6	
7. XeF_4	
8. PCl_3	
9. CO	
10. PCl_5	

PART 5: Writing formula for ionic compounds

1. magnesium oxide	
2. lithium bromide	
3. calcium nitride	
4. aluminum sulphide	
5. potassium iodide	
6. strontium chloride	
7. sodium sulphide	
8. radium bromide	
9. magnesium sulphide	
10. aluminum nitride	

PART 6: Writing formula for compounds with multivalent cations.

1. iron (II) chloride	
2. ferric bromide	
3. tin(II) fluoride	
4. mercuric oxide	
5. manganese(II) nitride	
6. plumbous bromide	
7. chromium(III) oxide	
8. aurous nitride	
9. gold (I) iodide	
10. lead(IV) iodide	

PART 7: Writing formula for covalent compounds

1. chlorine monoxide	
2. oxygen difluoride	
3. boron phosphide	
4. dinitrogen monoxide	
5. nitrogen trifluoride	
6. sulphur tetrachloride	
7. xenon trioxide	
8. carbon dioxide	
9. diphospherous pentoxide	
10. phosphorous trichloride	