Creating compounds

Ions, cations and anions

Ions atoms or molecules with an unbalanced charge (or net electric charge) due to the loss or gain of one or more elections from its outer (valence) shell.

For elements on the periodic table, the charge on their associated ion is the number of electrons in their outer shell for groups 1, 2 and 3 (1+, 2+ and 3+ respectively) – this is due to their desire to lose these valence electrons to become stable. Ions that have a positive charge are known as **cations**.

For elements in groups 15, 16 and 17, the charge on their associated ion is the number of electrons needed to fill their outer shell to become stable. The charges on these ions are 3-, 2- and 1- respectively and are referred to as **anions**.

Ions formed from elements (that is, one chemical species) are known as **monoatomic ions**. Ions formed from molecules are known as **polyatomic ions**.

A list of common ionic charges for cations and anions are listed below.

Cations

1+		2+				3+	
ammonium	NH_4^+	barium	Ba^{2+}	manganese (II)	Mn^{2+}	aluminium	Al^{3+}
cesium	Cs^+	beryllium	Be^{2+}	mercury(I)	Hg_2^{2+}	chromium(III)	Cr^{3+}
gold(I)	Au^+	cadmium	Cd^{2+}	mercury(II)	Hg^{2+}	cobalt(III)	Co^{3+}
hydrogen	H^+	cobalt(II)	Co^{2+}	nickel(II)	Ni^{2+}	gold(III)	Au^{3+}
lead(I)	Pb^+	copper(II)	Cu^{2+}	strontium	Sr^{2+}	iron(III)	Fe^{3+}
Lithium	Li^+	iron(II)	Fe^{2+}	zinc	Zn^{2+}	manganese(III)	Mn^{3+}
Potassium	K^+	lead(II)	Pb^{2+}	tin(II)	Sn^{2+}	**4+**	
Silver	Ag^+	magnesium	Mg^{2+}			tin(IV)	Sn^{4+}
Sodium	Na^+					nickel(IV)	Ni^{4+}
copper	Cu^+					lead(IV)	Pb^{4+}

Roman numeral notation indicates charge of ion when element commonly forms more than one ion. E.g. tin(II) has a 2+ charge where tin(IV) has a 4+ charge.

Anions

1-				2-		3-	
acetate	$C_2H_3O_2^-$	cyanide	CN^-	carbonate	CO_3^{2-}	arsenate	AsO_4^{3-}
amide	HN_2^-	cyanate	OCN^-	chromate	CrO_4^{2-}	arsenite	AsO_3^{3-}
hydrogen carbonate (bicarbonate)	HCO_3^-	fluoride	F^-	dichromate	$Cr_2O_7^{2-}$	citrate	$C_6H_5O_7^{3-}$
		hydride	H^-	oxide	O^{2-}	ferricyanide	$Fe(CN)_6^{3-}$
hydrogen sulfate (bisulfate)	HSO_4^-	hydroxode	OH^-	oxalate	$C_2O_4^{2-}$	nitride	N^{3-}
		hypochlorite	ClO^-	silicate	SiO_3^{2-}	phosphate	PO_4^{3-}
bisulfide	HS^-	iodate	IO_3^-	sulfate	SO_4^{2-}	phosphite	PO_3^{3-}
bisulfite	HSO_3^-	iodide	I^-	sulfide	S^{2-}	phosphide	P^{3-}
bromate	BrO_3^-	nitrate	NO_3^-	sulfite	SO_3^{2-}		
bromide	Br^-	nitrite	NO_2^-	tartrate	$C_4H_4O_6^{2-}$		
chlorate	ClO_3^-	perchlorate	ClO_4^-	tetraborate	$B_4O_7^{2-}$		
chlorite	ClO_2^-	permanganate	MnO_4^-	thiosulfate	$S_2O_3^{2-}$		
chloride	Cl^-	thiocyanate	SCN^-				

There are no common anions with a 4- charge.

Displacement reactions

Some metals *displace* other metals that are part of a salt solution. Based on the reactivity series of metals, metallic zinc (being a metal more reactive) displaces copper in copper sulfate solution.

This is an example of a *single displacement reaction*.

Single displacement reactions take the following general formula:

$$A + BX \rightarrow AX + B$$

Not all metals react in pairs. If, for example, less reactive metallic copper was placed in zinc sulfate solution, no reaction would occur.

Predicting products

Predict the products for the following word equations, and predict the products and balance the equations in the examples with chemical symbols.

1. Zinc + Silver nitrate → _____ + _____
2. Chlorine + Potassium iodide → _____ + _____
3. Zn + H_2SO_4 → _____ + _____
4. Fe + $CuSO_4$ → _____ + _____
5. Fe + $Pb(NO_3)_2$ → _____ + _____
6. Al + H_2SO_4 → _____ + _____

Metals in ores

An **ore** is a mineral from which metals can be extracted. Bauxite is an ore from which Aluminium can be extracted through a range of industrial processes. The table below lists some common ores and their chemical formulae. Complete the table below to identify the metal within the mineral, and identify the chemical name of the ore.

Mineral	Formula	Metal	Chemical name of ore
bauxite	Al_2O_3	aluminium	aluminium oxide
galena	PbS	lead	
hematite	Fe_2O_3		
sphalerite	ZnS		
magnesite	$MgCO_3$		
litharge	PbO		
magnetite	Fe_3O_4		