

Formula of Ionic Compounds

Work out the following salts

Ionic Compounds consist of a Cation (Positive Ion) and Anion (Negative ion)

Step 1: Determine the charges of the cation and anion in the ionic compounds

Hint: For Single element ions, refer to the periodic table and predict the charge.

Hint: For multiple element ions (complex ions), you need to memorise these (those with *).

From ACS Notes

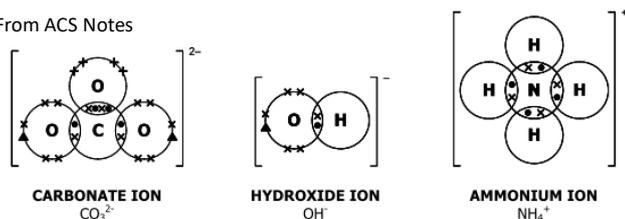
CATIONS	ANIONS
Sodium, Na ⁺ Potassium, K ⁺ Magnesium, Mg ²⁺ Calcium, Ca ²⁺ Barium, Ba ²⁺ Aluminium, Al ³⁺	Fluoride, F ⁻ Chloride, Cl ⁻ Bromine, Br ⁻ Iodide, I ⁻ Oxide, O ²⁻ Sulfide, S ²⁻ Nitride, N ³⁻ Phosphide, P ³⁻
Copper(II), Cu ²⁺ Iron(II), Fe ²⁺ Iron(III), Fe ³⁺ Lead(II), Pb ²⁺	Carbonate, CO ₃ ²⁻ Hydroxide, OH ⁻ Nitrate, NO ₃ ⁻ Sulfate, SO ₄ ²⁻ Sulfite, SO ₃ ²⁻ Phosphate, PO ₄ ³⁻ Dichromate, Cr ₂ O ₇ ²⁻ Permanganate, MnO ₄ ⁻
Hydrogen (Acid), H ⁺ Silver, Ag ⁺ Zinc, Zn ²⁺	
Ammonium, NH ₄ ⁺	

NH ₄ ⁺	Cl ⁻
NH ₄ ⁺	O ²⁻
NH ₄ ⁺	N ³⁻
NH ₄ ⁺	CO ₃ ²⁻
NH ₄ ⁺	OH ⁻
Mg ²⁺	OH ⁻
K ⁺	OH ⁻
Al ³⁺	OH ⁻
Cu ²⁺	CO ₃ ²⁻
H ⁺	CO ₃ ²⁻

- Aluminium iodide
- Barium nitrate
- Calcium phosphate
- Copper(II) hydroxide
- Iron(III) oxide
- Lithium sulfate
- Lithium sulfide
- Lithium sulfite
- Potassium carbonate
- Silver sulfate
- Sodium fluoride
- Zinc dichromate

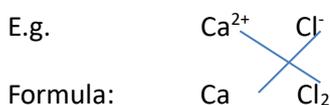
Complex ions are formed when simple molecules gain or lose electrons to form ions.

From ACS Notes



The ions will form electrostatic forces of attraction (ionic bonding) with each other, but within the complex ions itself, covalent bonds are holding the atoms together (e.g. C and O atoms are covalently bonded in the CO₃²⁻ ion)

Step 2: CrissCross the charges (1s do not get shown in the formula)



Formula of Acids

As we know Acids are solutions with H^+ ions

The anion depends on the type of acid.

Acids with 'Hydro-' Prefix contain the monoatomic anion ("-ide") of the respective element

- E.g. Hydrochloric Acid, Hydrobromic Acid, Hydrofluoric Acid

Acids that have no prefix and contain a '-ic' suffix will contain the molecular ions ("-ate") of the respective element

- E.g. Sulfuric acid, Nitric Acid, Carbonic Acid, Phosphoric Acid

Acids that have no prefix and contain a '-ous' suffix will contain the molecular ion ("-ite") of the respective element

- E.g. Sulfurous Acid, Nitrous Acid

Write down the chemical formula for the following acids:

Hydrochloric Acid

Sulfuric Acid

Nitric Acid

Carbonic Acid

Sulfurous Acid

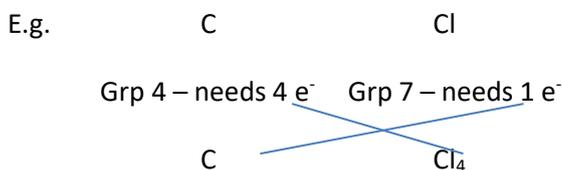
Formula of Covalent Compounds

Not very easy to predict but you can follow these steps for most covalent compounds:

Step 1. Look at the groups of the atoms involved

Step 2. Find how many electrons does the atoms need to get a full octet structure

Step 3. CrissCross



From ACS Notes

ELEMENTS		COMPOUNDS	
Hydrogen, H ₂	Bromine, Br ₂	Water, H ₂ O	Nitrogen Monoxide, NO
Oxygen, O ₂	Iodine, I ₂	Ammonia, NH ₃	Hydrogen Peroxide, H ₂ O ₂
Nitrogen, N ₂	Ozone, O ₃	Methane, CH ₄	Hydrogen Chloride, HCl
Carbon, C	Phosphorus, P ₄	Carbon Dioxide, CO ₂	Hydrogen Fluoride, HF
Chlorine, Cl ₂	Sulfur, S ₈	Sulfur Dioxide, SO ₂	Ethanol, CH ₃ CH ₂ OH

Write down the chemical formula for the following compounds:

Carbon Monoxide

Carbon Tetrachloride

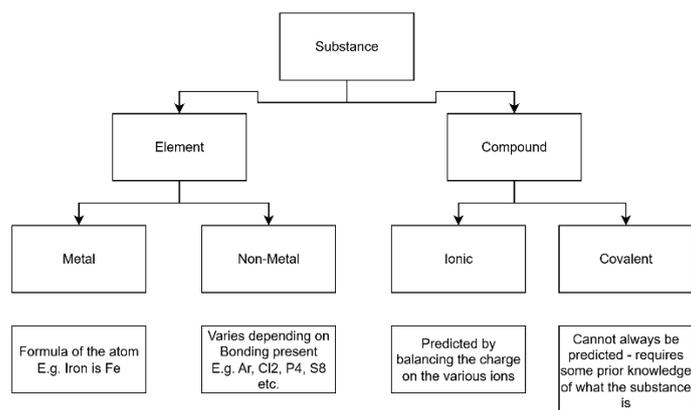
Dichlorine Monoxide

Dinitrogen Trioxide

Phosphorus Tribromide

Sulfur Trioxide

Summary of Chemical Formula



State symbols

In a chemical equation, physical state is indicated by writing (s), (l), (g), (aq) in brackets after each substance

Hint: Metals are solid at room temperature. Ionic Compounds are either solid or aqueous, depending if dissolved in water. Covalent substances can occur in any state.

Refer to the solubility table for Ionic Compounds to determine the state symbol:

Soluble	Insoluble
All Grp I & NH ₄ ⁺	
All NO ₃ ⁻	
All Cl ⁻ , Br ⁻	Ag ⁺ , Pb ²⁺
All SO ₄ ²⁻	Pb ²⁺ , Ba ²⁺ , Ca ²⁺
Grp I, NH ₄ ⁺	All CO ₃ ²⁻ , OH ⁻ , O ²⁻ except (look at left)

E.g. from ACS Notes

Some calcium carbonate powder was allowed to react with dilute hydrochloric acid in a test tube.

Effervescence was observed and a temperature change was recorded. A solution of Calcium Chloride was produced together with Water and Carbon Dioxide.

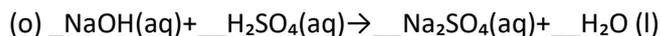
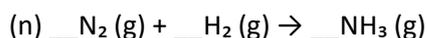
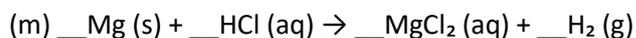
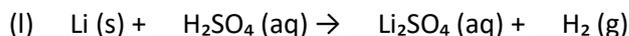
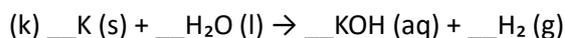
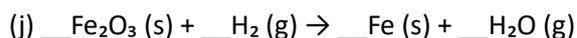
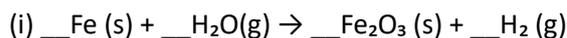
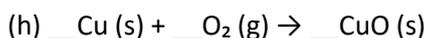
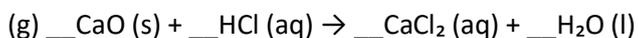
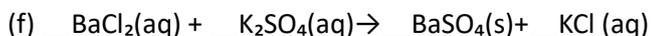
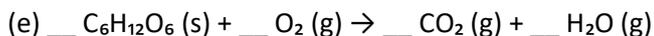
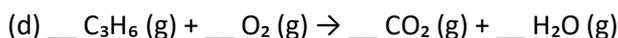
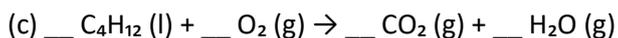
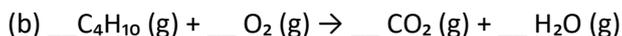
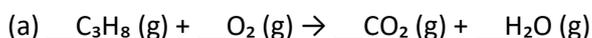
Write the equation for the reaction with state symbols:

Balancing Chemical Equations

For any chemical reaction, number of atoms that go in a reaction must equal the number of atoms that come out from reaction. This is the principle of conservation of mass – atoms can't just disappear like magic.

Hint: Do not alter the chemical formula during balancing.

Balance the equations below:



Constructing Chemical Equations

Step 1: Interpret the chemical reaction

Step 2: Write down the chemical formulae of all reactants and products

Step 3: Balance the Equation

Step 4: Add in state symbols if necessary

E.g from ACS notes

Gaseous hydrogen and Gaseous chlorine combine directly under bright sunlight to produce a third gas, hydrogen chloride

Word Equation:

Chemical Equation:

Chemical Equation with state symbols:

A sample of aluminium foil is allowed to burn in bromine vapour to produce a solid sample of aluminium bromide

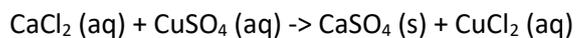
Word Equation:

Chemical Equation:

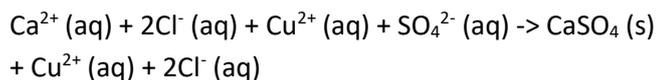
Chemical Equation with state symbols:

Constructing Ionic Equations

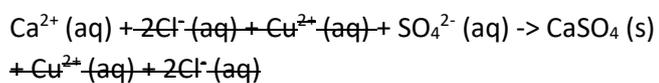
Step 1: Write the balanced chemical equation for the reaction



Step 2: Ionic Compounds that are in aqueous state are written as ions



Step 3: Remove all the spectator ions (Hint: Know the key players within a reaction, every type of reaction has a type of key player)



Review Questions from ACS Notes

Construct balanced chemical equations, including state symbols, for the reactions as described below. Remember – not all information is relevant.

(a) A piece of magnesium oxide reacts with hydrochloric acid to form aqueous magnesium chloride and water.

(b) A piece of sodium is placed into a beaker of water. Effervescence of hydrogen gas was observed, and a solution of aqueous sodium hydroxide was left remaining.

(c) In an industrial process, carbon monoxide is used to convert iron(III) oxide into molten iron, producing carbon dioxide in the process.

(d) Solid calcium nitrate decomposes on heating to become solid lumps of calcium oxide, nitrogen dioxide gas and oxygen.

(e) Calcium carbonate powder reacts with a solution of phosphoric acid to produce solid calcium phosphate, carbon dioxide and water.

(f) Two solutions of ammonium nitrate and calcium hydroxide react to produce aqueous calcium nitrate, ammonia gas and water.