Table 1: Predicting the Products of Some Common Types of Synthesis Reactions

Types of Synthesis Reaction	Example
1. Two different elements form a binary compound	
a. A univalent metal and a non-metal form an ionic compound ➢ Electrons are transferred from the metal to the non-metal so ions are formed ➢ Use the periodic table to determine the ion charge for each element ➢ Predict the product following nomenclature rules ➢ Name the compound formed ends in *-ide*	Write the balanced chemical equation that shows the synthesis reaction between potassium metal and fluorine gas. potassium + fluorine → potassium fluoride $2\ K_{(s)} + F_{2(g)} \rightarrow 2\ KF_{(s)}$
b. A multivalent metal and a non-metal form an ionic compound ➢ Use the periodic table to determine the ion charge for each element ➢ **All** ion charges for the multivalent element must be considered ➢ Two or more equations will be written using nomenclature rules to predict the products ➢ Name of compound formed ends in *-ide*	Write the balanced chemical equation that shows the synthesis reaction between iron and oxygen. Iron can have an ion charge of 3+ or 2+; oxygen has an ion charge of 2- so two different equations can be written. iron + oxygen → iron (III) oxide $4\ Fe_{(s)} + 3\ O_{2(g)} \rightarrow 2\ Fe_2O_{3(s)}$ iron + oxygen → iron (II) oxide $2\ Fe_{(s)} + O_{2(g)} \rightarrow 2\ FeO_{(s)}$
c. **Two** non-metals form a covalent compound ➢ Electrons are shared between these atoms so no ions are formed. So there are no ion charges to determine the products. ➢ Additional information is needed to determine the product as many non-metals can combine in several different ratios ➢ Name of compound formed ends in *-ide*	Write the balanced chemical equation that shows the synthesis reaction between sulfur and oxygen forming sulphur dioxide. sulfur + oxygen → sulfur dioxide $S_{8(s)} + 8\ O_{2(g)} \rightarrow 8\ SO_{2(g)}$
1. An element and a compound form a new compound ➢ Products cannot be predicted with certainty ➢ Products formed during the reaction must be collected and analysed	
	carbon monoxide + oxygen → carbon dioxide $2\ CO_{(g)} + O_{2(g)} \rightarrow 2\ CO_{2(g)}$
2. Two compounds form a new compound ➢ Products cannot be predicted with certainty ➢ Reactants are small, simple compounds	
a. A non-metal oxide with water ➢ Forms an **ACID**	sulphur trioxide + water → sulfuric acid $SO_{3(s)} + H_2O_{(\ell)} \rightarrow H_2SO_{4(aq)}$
b. A metal oxide with water ➢ Forms a **BASE**	calcium oxide + water → calcium hydroxide $CaO_{(s)} + H_2O_{(\ell)} \rightarrow Ca(OH)_{2(aq)}$

Table 2: Predicting the Products of Some Common Types of Decomposition Reactions

Types of Decomposition Reaction	Example
1. A binary compound decomposes into its elements.	magnesium chloride → magnesium + chlorine $MgCl_{2(s)} \rightarrow Mg_{(s)} + Cl_{2(g)}$
2. A hydrate decomposes into an ionic compound and water.	barium hydroxide octahydrate → barium hydroxide + water $Ba(OH)_2 \bullet 8H_2O_{(s)} \rightarrow Ba(OH)_{2(s)} + 8\ H_2O_{(g)}$
3. A metal nitr**ate** decomposes into a metal nitr**ite** and oxygen gas.	potassium nitrate → potassium nitrite + oxygen $2\ KNO_{3(s)} \rightarrow 2\ KNO_{2(s)} + O_{2(g)}$
4. A metal carbonate decomposes into a metal oxide and carbon dioxide.	zinc carbonate → zinc oxide + carbon dioxide $ZnCO_{3(s)} \rightarrow ZnO_{(s)} + CO_{2(g)}$
5. A metal hydroxide decomposes into a metal oxide and water.	potassium hydroxide → potassium oxide + water $2\ KOH_{(s)} \rightarrow K_2O_{(s)} + H_2O_{(\ell)}$