Regents Chemistry: Dr. Shanzer

Practice Packet

Chapter 7: Formulas & Chemical Equations



Formula Writing and Naming Ionic Substances

Video 7.1



How many atoms are	in a foi	mula?		
$CH_3COOH \rightarrow C=2$	H=4	O = 2	→ 8	
$Mg(NO_3)_2 \rightarrow Mg = 1$	N = 2	O = 6	→ 9	
٠				•

Cation (+)	Anion (-)	Example
metal	nonmetal	NaCl
metal	(-) polyatomic ion	MgSO ₄
(+)polyatomic ion	nonmetal	$\rm NH_4Br$
polyatomic ion	polyatomic ion	NH ₄ NO ₃
Use the periodic table to determine if there is a metal or nonmetal		



	Tal Selected Po	ble E lyatomic	lons	What you see is wha
H ₃ O*	hydronium	CrO ₄ ² -	chromate	you get
Hg22+	dimercury (I)	Cr2072	dichromate	
NH4+	ammonium	MnO ₄	permanganate	
C2H3O2 }	acetate	NO2-	nitrite	
CH ³ COO-1		NO3-	nitrate	
CN	cyanide	0.2-	peroxide	
CO32-	carbonate	OH-	hodewide	
HCO3-	hydrogen carbonate	PO43-	phosphate	
C.0.2	oxalate	SCN-	thiocyanate	
ClO-	hypochlorite	SO3	sulfite	
ClO ₂ -	chlorite	SO4	sulfate	
ClO3-	chlorate	HSO4	hydrogen sulfate	
ClO ₄ -	perchlorate	5.0.2	thiosulfate	

Writing an ionic formula from a name

- Use the periodic table and/or table E to locate the charges for the ions after you have determined the compound is ionic. For nonmetals, select the first charge.
- 2. Write the symbol for each ion, using subscripts when needed, to create the lowest ratio that makes the sum of the charges equal to zero. (+) ion first, (-) ion second.

Remember that many polyatomic ions have subscripts as part of their formula and this is not used as a subscript for creating the ratio that equals zero +1 -1 = 0 Sodium Chloride \rightarrow NaCl 1 to 1 ratio $\begin{array}{c} -1 \\ +2 \\ +2 \\ -1 \end{array}$ Magnesium Nitrite \rightarrow Mg(NO₂)₂ 1 to 2 ratio $\begin{array}{c} +1 \\ +1 \\ +1 \\ -2 \end{array}$ $\begin{array}{c} =0 \\ 2 \text{ to 1 ratio} \end{array}$ Ammonium Sulfate \rightarrow (NH₄)₂SO₃

Writing a name from an ionic formula

- 1. If the (+) ion is a metal, it keeps the same name.
- 2. If the (-) ion is an element, drop the last few letters and change the ending to "ide".
 - ** If it is a polyatomic ion, then use the name **EXACTLY** as it appears on Table E **
- NaBr \rightarrow Sodium Bromide
- $Al_2(SO_4)_3 \rightarrow$ Aluminum Sulfate
- $(NH_4)_3PO_4 \rightarrow Ammonium Phosphate$



Objective:

How do we write the name or formula for an ionic substance whose metal has more than one charge?

The rules are the same as the previous video except for one change. When the metal is located in groups 3-12, it may have multiple charges. Polyatomic ions are still from Table E.









Writing a name from a stock ionic formula 1. If the (+) ion is a metal, it keeps the same name.. 2. Determine the charge of the metal ion by using the negative charges to get a sum equal to 0. The metal's charge will be indicated in the name by using a roman numeral 3. If the (-) ion is an element, drop the last few letters and change the ending to "ide". ** If it is a polyatomic ion, then use the name EXACTLY as it appears on Table E **





Objective:

How do we write the name or formula for a molecular substance?







	Mono-	1
7 1 1	Di-	2
The number	Tri-	3
of each atom	Tetra-	4
of cach atom	Penta-	5
is given by	Hexa-	6
nrofivor	Hepta-	7
prenxes	Octa-	8
	Nona-	9
	Deca-	10

of atoms	prefix	example
1	mone	NO nitrogen monoxide
2	di	NO ₂ nitrogen dioxide
3	tri	N2O3 dinitrogen trioxide
4	tetra	N2O4 dinitrogen tetraoxide
5	penta	N ₂ O ₅ dinitrogen pentaoxide
6	hexa	SF6 sulphur hexa fluoride
7	hepta	IF ₇ iodine hepta fluoride
8	octa	PtOg tetra phosphur decoxide
9	nona	P4 59 tetra phusphur nona sulphide
10	deca	AS ₄ O ₁₀ tetra arsinic decoxide
The pr The se	efix "n cond el	nono" is never used for the first eleme lement always gets s prefix



Writing Molecular Formulas

Sulfur hexachloride SCl₆

Carbon tetrachloride CCl₄

Dinitrogen tetraoxide N₂O₄

At the End of this Lesson – You should be able to:

- Identify molecular substances
- Name molecular substances from formula
- Write the formulas from the names of molecular substances.

Sketch Notes

Sketch Notes

Video 7.1

Create formulas for the following ionic compounds.

IUPAC NAME	FORMULA
Calcium chloride	
Magnesium iodide	
Ammonium Bromide	
Barium phosphate	
Potassium phosphide	
Lithium nitrite	
Aluminum chloride	
Zinc iodide	
Zinc sulfide	
Magnesium nitride	
Ammonium sulfite	
Magnesium hydroxide	

Name the following ionic compounds.

FORMULA	IUPAC NAME
K_2CO_3	
ZnI_2	
$Mg_3(PO_4)_2$	
NH ₄ I	
Al_2O_3	
Ag_2SO_3	
Mg_3P_2	
Be(OH) ₂	
SrS	
Al_2S_3	
MgCl ₂	
Ba(OH) ₂	

Stock System for Ionic Substances

Video 7.2

Create Formulas for the following Ionic substances.

IUPAC NAME	FORMULA
Copper (II) oxide	
Chromium (III) chloride	
Lead (II) nitride	
Copper (I) sulfate	
Chromium (III) nitrite	
Manganese (IV) sulfide	
Lead (II) phosphide	
Nickel (III) oxide	
Gold (III) nitrate	
copper (II) sulfite	
Lead (IV) sulfide	
Titanium (IV) nitride	

Name the following Ionic substances.

FORMULA	IUPAC NAME
CrF_2	
$\mathrm{Cu}_2\mathrm{S}$	
FePO_4	
Co_3N_2	
$Mn(NO_2)_3$	
PbO	
${ m TiI}_4$	
$CoCO_3$	
$Sn_3(PO_4)_2$	
CuCl_2	
$\mathrm{Ni}_3\mathrm{P}_2$	
$\mathrm{Fe}_3\mathrm{N}_2$	

Molecular Compounds

Video 7.3

Create formulas for the following Molecular substances

IUPAC NAME	FORMULA
Carbon dioxide	
Carbon monoxide	
Diphosphorus pentoxide	
Dinitrogen monoxide	
Silicon dioxide	
Carbon tetrabromide	
Sulfur dioxide	
Phosphorus pentabromide	
Iodine trichloride	
Nitrogen triiodide	
Dinitrogen trioxide	

Name the following Molecular Substances

FORMULA	IUPAC NAME
N_2O_4	
SO_3	
NO	
NO_2	
PCl_3	
CCl_4	
H_2O	
${ m SeF}_6$	
As_2O_5	

Compounds: Putting it all Together

The compounds below are of several different types. Use the flow chart to determine the naming system to use and name each compound show below.

Formula	IUPAC Name
1. Fe(NO ₂) ₃	
$2. \operatorname{Na}_2 S_2 O_3$	
3. P ₂ O ₅	
4. BaBr ₂	
5. $Mn_2(Cr_2O_7)_7$	
6. CaCl ₂	
7. (NH ₄) ₂ S	
8. CuF	
9. Br ₂ O	
10. HgSO ₄	
11. Al ₂ O ₃	
12. SCl ₆	
13. IF ₇	
14. Cr(CO ₃) ₃	
15. KNO ₂	

IUPAC Name	Formula
1. antimony tribromide	
2. chlorine dioxide	
3. sodium sulfate	
4. iron (II) oxide	
5. calcium chloride	
6. ammonia	
7. zinc hydroxide	
8. diphosphorus pentoxide	
9. zinc nitrate	
10. iron (III) oxide	
11. potassium nitride	
12. tin (IV) oxide	
13. ammonium phosphate	
14. magnesium hydroxide	
15. carbon monoxide	

Write the correct name for the chemical formulas below. Use the flow chart to help!

Formula Writing & Naming Review

1. In the formula $X_2(SO_4)_3$, the X represents a metal.	9. What is the chemical formula for sodium sulfate?
 This metal could be located on the Periodic Table in 1) Group1 3) Group 13 2) Group 2 4) Group 14 	1) Na ₂ SO ₃ 3) NaSO ₃ 2) Na ₂ SO ₄ 4) NaSO ₄ 10. What is the IUPAC name for the compound ZpO2
 2. Every water molecule has two hydrogen atoms bonded to one oxygen atom. This fact supports the concept that elements in a compound are 1) chemically combined in a fixed proportion 2) chemically combined in proportions that vary 3) physically mixed in a fixed proportion 4) physically mixed in proportions that vary 3) Which element forms a compound with chlorine with 	1) zinc oxide 3) zinc peroxide 2) zinc oxalate 4) zinc hydroxide 11. What is the chemical formula of iron(III) sulfide? 1) FeS 3) FeSO3 2) Fe ₂ S ₃ 4) Fe ₂ (SO ₃) ₃ 12. Which formula represents copper(I) oxide?
the general formula <i>M</i> Cl	1) CuO 3) Cu2O 2) CuO2 4) Cu2O2
1) Rb 2) Ra 3) Re 4) Rn 4. Which formula represents strontium phosphate? 1) SrPO4 3) Sr2(PO4)3 2) Sr3PO8 4) Sr3(PO4)2 5. The compound XCI is classified as ionic if X represents the element	 13. Which formula represents lead(II) chromate? 1) PbCrO4 3) Pb₂CrO4 2) Pb(CrO₄)₂ 4) Pb₂(CrO₄)₃ 14. A compound is made up of iron and oxygen, only. The ratio of iron ions to oxide ions is 2:3 in this compound. The IUPAC name for this compound is
1) H2) I3) Rb4) Br6. What is the chemical formula for iron(III) oxide?1) FeO3) Fe ₃ O2) Fe ₂ O ₃ 4) Fe ₃ O ₂ 7. In which compound is the ratio of metal ions to	1) triiron dioxide 2) iron(II) oxide3) iron(III) oxide 4) iron trioxide15. What is the IUPAC name for the compound FeS?1) iron(II) sulfate 2) iron(III) sulfate3) iron(II) sulfide 4) Iron(III) sulfide
 nonmetal ions 1 to 2? 1) calcium bromide 3) calcium phosphide 2) calcium oxide 4) calcium sulfide 8. Element X reacts with iron to form two different compounds with the formulas FeX and Fe₂X₃. To which group on the Periodic Table does element X belong? 1) Group 8 3) Group 13 2) Group 2 4) Group 16 	16. What is the formula of titanium(II) oxide? 1) TiO 2) TiO ₂ 3) Ti ₂ O 4) Ti ₂ O ₃ 17. Which is a binary compound? 1) CaCl ₂ 3) NaNO ₃ 2) KOH 4) MgSO ₄ 18. What is the correct formula for ammonium carbonate? 1) NH4(CO ₂) ₂ 3) (NH4) ₂ (CO ₂) ₂
	2) NH4CO3 4) (NH4)2CO3

LEQUATION TANTS, SUBSCRIPT, 2012 (20)	\mathcal{SH}_2 How many atoms of Hydrogen are in this formula as shown ²	$2Na_2SO_4$ by atoms of each element are the formula? S = 0 = 0
OMU OF A CHEMICA Lequation using PRODUCT, REACT	d each coefficient. related to each chemical formul CO_2 How many atoms of each esent? C = 0 = 0	$2C_2H_6$ any atoms of each element How man wn in the formula? H = Na =
Chemical Equations The And The Chemica Part A: Label the Chemica Coefficient and YTELD Coefficient and YTELD	Part 8: Parts & Pieces: 1. Circle each subscript 2. Draw a square aroun 3. Answer the questions 0.2 What element does the 0 repr	How m are sho C =

NU	IMBER OF	ATOMS IN A FOR	MUI	A Name)
Det	ermine the nur	mber of atoms in the following	ng ch	emical formula	15.
1.	NaCl		11.	Cu(NO ₃) ₂	
2.	H₂SO₄		12.	KMnO₄	
3.	KNO3		13.	H ₂ O ₂	
4.	CaCl ₂		14.	H ₃ PO ₄	
5.	C ₂ H ₆		15.	(NH₄)₃PO₄	
6.	Ba(OH) ₂		16.	Fe ₂ O ₃	• •••
7.	NH₄Br		17.	NaC2H3O2	
8.	Ca3(bO ⁴⁾⁵		18.	Mg(C ₂ H ₃ O ₂) ₂	
9.	$Al_2(SO_4)_3$	v	19.	Hg ₂ Cl ₂	
10.	Mg(NO ₃) ₂		20.	K2SO3	

XX

TRY THESE Classify each of the following reactions.

$PbCl_2 + AgNO_3 \rightarrow Pb(NO_3)_2 + AgCl$	
$\rm NH_3 + HCl \rightarrow \rm NH_4Cl$	
$\text{AlCl}_3 + \text{Na}_2\text{SO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + \text{NaCl}$	
$Zn + S \rightarrow ZnS$	
$\mathrm{Al}_2(\mathrm{SO}_4)_3 + \mathrm{BaCl}_2 \twoheadrightarrow \mathrm{BaSO}_4 + \mathrm{AlCl}_3$	
$Al_2S_3 \rightarrow Al + S$	
$H_2SO_4 + Fe \rightarrow H_2 + FeSO_4$	
$\mathrm{C}_{12}\mathrm{H}_{22}\mathrm{O}_{11} + \mathrm{O}_2 \twoheadrightarrow \mathrm{CO}_2 + \mathrm{H}_2\mathrm{O}$	
$\mathrm{Mg(OH)_2} + \mathrm{H_2SO_4} \twoheadrightarrow \mathrm{MgSO_4} + \mathrm{H_2O}$	
$NaOH + CuSO_4 \rightarrow Na_2SO_4 + Cu(OH)_2$	
$\mathrm{C_4H_{12}+O_2} \rightarrow \mathrm{H_2O+CO_2}$	
$Fe + O_2 \rightarrow Fe_2O_3$	
$Mg_3(PO_4)_2 + H_2 \rightarrow Mg + H_3PO_4$	
$NH_4NO_3 \rightarrow N_2O + H_2O$	
$H_2O + Na \rightarrow NaOH + H_2$	

Name: _____

Balancing Chemical Equations

We balance chemical equations to confirm the law of conservation of mass. The law of conservation of mass states that the mass of substances produced by a chemical reaction is always equal to the mass of the reactants. Matter is neither created nor destroyed.

RULES FOR BALANCING CHEMICAL EQUATIONS:

- 1. All formulas for molecules and compounds must be correct (No cheating!)
- 2. Add coefficients to balance atoms.
- 3. ONLY change coefficients, NOT formulas or subscripts
- 4. Balance the atoms in the largest compound first
- 5. Balance monatomic and diatomic elements last
- 6. Check to be sure that the number of atoms are the same on both sides of the equation
- 7. Reduce all coefficients to the lowest whole number ratio

Balance the following chemical equations.

1. _____Ca + _____O₂
$$\rightarrow$$
 _____CaO
2. _____Mg + _____HCl \rightarrow _____H₂ + _____MgCl₂
3. _____AgNO₃ + _____Na₂S \rightarrow _____Ag₂S + _____NaNO₃
4. ____HCl + _____Fe₂O₃ \rightarrow _____H₂O + _____FeCl₃

5. ____ AlBr₃ + ____ K₂SO₄ \rightarrow ____ KBr + ____ Al₂(SO₄)₃



10. _____ LiBr + _____ $F_2 \rightarrow ____ Br_2 + ____ LiF$

Balancing Equations

Balance the following chemical equations.

1.	 Fe	+	H_2SO_4	\rightarrow	 Fe ₂ (SO ₄) ₃	+	H ₂
2.	 C_2H_6	+	O ₂	\rightarrow	 H ₂ O	+	CO ₂
3.	 КОН	+	H ₃ PO ₄	\rightarrow	 K ₃ PO ₄	+	H ₂ O
4.	 SnO ₂	+	H_2	\rightarrow	 Sn	+	H ₂ O
5.	 NH_3	+	O ₂	\rightarrow	 NO	+	H ₂ O
6.	 KNO ₃	+	H ₂ CO ₃	\rightarrow	 K ₂ CO ₃	+	HNO ₃
7.	 B_2Br_6	+	HNO ₃	\rightarrow	 B(NO ₃) ₃	+	HBr
8.	 BF_3	+	Li ₂ SO ₃	\rightarrow	 B ₂ (SO ₃) ₃	+	LiF
9.	 (NH ₄) ₃ PO ₄	+	Pb(NO ₃) ₄	\rightarrow	 Pb ₃ (PO ₄) ₄	+	NH ₄ NO ₃
10.	 SeCl ₆	+	O ₂	\rightarrow	 SeO ₂	+	Cl_2

About Chemistry

http://chemistry.about.com

Types of Chemical Reactions

Do atoms rearrange in predictable patterns during chemical reactions?

Why?

Recognizing patterns allows us to predict future behavior. Weather experts use patterns to predict dangerous storms so people can get their families to safety. Political analysts use patterns to predict election outcomes. Similarly, chemists classify chemical equations according to their patterns to help predict products of unknown but similar chemical reactions.

Model 1 – Types of Reactions

Set A $4Fe(s) + 3O_{2}(g) \rightarrow 2Fe_{2}O_{3}(s)$ $N_{2}(g) + 3H_{2}(g) \rightarrow 2NH_{3}(g)$ $2SO_{2}(g) + O_{2}(g) \rightarrow 2SO_{3}(g)$ $MgO(s) + H_{2}O(l) \rightarrow Mg(OH)_{2}(aq)$ $P_{2}O_{5}(g) + 3H_{2}O(l) \rightarrow 2H_{3}PO_{4}(aq)$ $SO_{3}(g) + H_{2}O(l) \rightarrow H_{2}SO_{4}(aq)$

Set C _____

 $\begin{aligned} &2 \text{FeCl}_3(\text{aq}) + 3 \text{Zn}(\text{s}) \rightarrow 2 \text{Fe}(\text{s}) + 3 \text{Zn}\text{Cl}_2(\text{aq}) \\ &2 \text{Al}(\text{NO}_3)_3(\text{aq}) + 3 \text{Ca}(\text{s}) \rightarrow 3 \text{Ca}(\text{NO}_3)_2(\text{aq}) + 2 \text{Al}(\text{s}) \\ &M \text{g}(\text{s}) + \text{CuSO}_4(\text{aq}) \rightarrow \text{MgSO}_4(\text{aq}) + \text{Cu}(\text{s}) \\ &2 \text{Al}(\text{s}) + 6 \text{HCl}(\text{aq}) \rightarrow 2 \text{Al}\text{Cl}_3(\text{aq}) + 3 \text{H}_2(\text{g}) \\ &\text{Cl}_2(\text{g}) + 2 \text{NaBr}(\text{aq}) \rightarrow 2 \text{NaCl}(\text{aq}) + 8 \text{F}_2(\text{l}) \\ &\text{ZnBr}_2(\text{aq}) + \text{F}_2(\text{g}) \rightarrow \text{ZnF}_2(\text{aq}) + 8 \text{F}_2(\text{l}) \end{aligned}$

Set B $MgCO_{3}(s) \rightarrow MgO(s) + CO_{2}(g)$ $8Li_{2}S(s) \rightarrow 16Li(s) + S_{8}(s)$ $2H_{2}O(l) \rightarrow 2H_{2}(g) + O_{2}(g)$ $2KClO_{3}(s) \rightarrow 2KCl(s) + 3O_{2}(g)$

 $2\mathrm{Na}_{2}\mathrm{O}_{2}(s) \rightarrow 2\mathrm{Na}_{2}\mathrm{O}(s) + \mathrm{O}_{2}(g)$ $(\mathrm{NH}_{4})_{2}\mathrm{CO}_{3}(s) \rightarrow 2\mathrm{NH}_{3}(g) + \mathrm{H}_{2}\mathrm{O}(l) + \mathrm{CO}_{2}(g)$

Set D _____

$$\begin{split} & \operatorname{AgNO}_{3}(\operatorname{aq}) + \operatorname{NaCl}(\operatorname{aq}) \rightarrow \operatorname{AgCl}(s) + \operatorname{NaNO}_{3}(\operatorname{aq}) \\ & 2\operatorname{HNO}_{3}(\operatorname{aq}) + \operatorname{Mg}(\operatorname{OH})_{2}(\operatorname{aq}) \rightarrow \\ & \operatorname{Mg}(\operatorname{NO}_{3})_{2}(\operatorname{aq}) + 2\operatorname{H}_{2}\operatorname{O}(\operatorname{I}) \\ & \operatorname{Na}_{2}\operatorname{CO}_{3}(\operatorname{aq}) + \operatorname{CaCl}_{2}(\operatorname{aq}) \rightarrow \\ & \operatorname{CaCO}_{3}(\operatorname{s}) + 2\operatorname{NaCl}(\operatorname{aq}) \\ & \operatorname{FeS}(s) + 2\operatorname{HCl}(\operatorname{aq}) \rightarrow \operatorname{H}_{2}\operatorname{S}(\operatorname{g}) + \operatorname{FeCl}_{2}(\operatorname{aq}) \\ & \operatorname{HCl}(\operatorname{aq}) + \operatorname{NaOH}(\operatorname{aq}) \rightarrow \operatorname{H}_{2}\operatorname{O}(\operatorname{I}) + \operatorname{NaCl}(\operatorname{aq}) \\ & \operatorname{FeBr}_{3}(\operatorname{aq}) + \operatorname{K}_{3}\operatorname{PO}_{4}(\operatorname{aq}) \rightarrow \operatorname{FePO}_{4}(\operatorname{s}) + 3\operatorname{KBr}(\operatorname{aq}) \end{split}$$

1. The chemical equations in Model 1 contain the phase notations (s), (l), (g), and (aq). Match each symbol with its meaning.

dissolved in water	liquid	solid	gas
	1		0

- 2. Based on the examples provided, which set(s) of reactions in Model 1 typically involve ions in solution (A, B, C or D)?
- 3. Based on the examples provided, which set(s) of reactions in Model 1 typically involve gases and/or solids?

4. Match each description below to one of the reactions sets (A, B, C or D) from Model 1.

Ionic compounds dissolved in water switch partners.

One compound breaks into elements or smaller compounds.

Two or more elements or compounds combine to form one product.

Part of an ionic compound is removed and replaced by a new element.

5. Define the following terms as they are commonly used in the English language.

Synthesis—

Decomposition—

Replacement—

6. The four sets of chemical reactions shown in Model 1 have the following general names. Discuss within your group which name belongs to which set of chemical reactions. Write the name in the appropriate place in Model 1.

Single Replacement Reaction

Double Replacement Reaction

Synthesis Reaction Decomposition Reaction



- 7. Can two elements be used as reactants for a synthesis reactions? If yes, give at least one example from Model 1 to support your answer.
- 8. Can two compounds be used as reactants for a synthesis reaction? If yes, give at least one example from Model 1 to support your answer.
- 9. What types of substances (elements or compounds) are seen in the products of decomposition reactions? Use examples from Model 1 to support your answer.
- 10. In single replacement reactions, do any of the atoms change their charge? If yes, use an example from Model 1 to describe the changes that take place.
- 11. In double replacement reactions, do any of the atoms change their charge? If yes, use an example from Model 1 to describe the changes that take place.

- 12. Choose one example from the set of synthesis reactions in Model 1.
 - *a*. Write the chemical reaction in reverse.
 - *b.* Label the reaction written in part *a* with one of the reaction types in Model 1.
- 13. Identify each of the reactions below as synthesis (S), decomposition (D), single replacement (SR) or double replacement (DR).

14. A student writes the following incorrect chemical equation for the synthesis of magnesium oxide.

Mg + $O_2 \rightarrow MgO_2$

Another student writes the following incorrect synthesis reaction.

Mg + O \rightarrow MgO

- *a.* What is the correct formula for magnesium oxide? *Hint:* Magnesium oxide is an ionic compound.
- b. What is the correct formula for elemental oxygen?
- c. Describe the error made by the first student.
- *d*. Describe the error made by the second student.
- e. Write the correct balanced chemical equation for the synthesis of magnesium oxide.

15. A student writes the following *incorrect* chemical equation for a single replacement reaction between lithium bromide and fluorine.

 $2\text{LiBr}(aq) + F_2(g) \rightarrow 2\text{Li}(s) + 2\text{FBr}(g)$

- *a.* In a single replacement reaction, part of an ionic compound is removed and replaced by a new element. What element will fluorine replace in lithium bromide? *Hint:* What is the most common ionic form of fluorine?
- b. What is wrong with the student's prediction of the products in the above reaction?
- *c.* Predict the products and write the correct balanced equation for the single replacement reaction between lithium bromide and fluorine.
- 16. A student writes the following incorrect chemical equation for a double replacement reaction between iron(III) bromide and sodium hydroxide solutions.

 $\text{FeBr}_3(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{FeOH}(s) + \text{NaBr}_3(\text{aq})$

- a. What is wrong with the chemical formula(s) of the product(s) predicted by this student?
- *b.* Write the correct equation for the double replacement reaction between iron(III) bromide and sodium hydroxide.
- 17. Consider the following chemical reaction written as a word equation.
 diphosphorus pentoxide + water → phosphoric acid
 - *a*. Identify the type of chemical reaction from Model 1 that would describe this reaction.
 - b. Write chemical formulas under the names of the substances in the word equation.
 - *c.* Balance the chemical equation.

Read This!

Chemists use their knowledge of synthesis, decomposition, single replacement, and double replacement to predict what will happen in chemical reactions. When predicting the products for a reaction it is important to remember that atoms or ions will only combine in ways that make them stable, otherwise the reaction will not happen under normal conditions. This means that it is important to pay attention to ion charges, the natural state of elements, and the formulas of common molecular substances like carbon dioxide and water. It is only *after* predicting the products and writing the correct formulas that a chemist would then apply the law of conservation of mass and balance the chemical equation using coefficients as needed.

- 18. Use your understanding of common chemical reactions to predict the products for the following reactions. Writing a word equation may be helpful. Balance the chemical equations *after* you have written the correct chemical formulas for all of the reactants and products.
 - a. Al(s) + N₂(g) \rightarrow
 - *b.* dinitrogen oxide(g) \rightarrow
 - c. SrCl₂(aq) + 2AgNO₃(aq) →
 - *d.* chromium(III) nitrate(aq) + zinc chloride(aq) \rightarrow
 - e. 2Na(s) + $Cl_2(g) \rightarrow$
 - f. Zn(s) + 2HCl(aq) \rightarrow



TYPES OF CHEMICAL REACTIONS

(A) <u>SYNTHESIS</u> (or Combination): two or more substances combine to form a single substance. The general formula for this reaction is given below.

$$A + B \rightarrow AB$$
Examples:

$$2 H_2 + O_2 \rightarrow 2 H_2O$$
CaO + H₂O \rightarrow Ca(OH)₂

(B) <u>DECOMPOSITION</u>: a single compound is broken down into two or more less complex products (elements or compounds). The general formula for this reaction is given below.

> $AB \rightarrow A + B$ <u>Examples</u>: $CaCO_3 \rightarrow CaO + CO_2$ $2 \text{ KClO}_3 \rightarrow 2 \text{ KCl} + 3 \text{ O}_2$

(C) <u>SINGLE REPLACEMENT</u>: atoms of one element replace the atoms of a second element in a compound. The general formula for this reaction is given below.

 $\begin{array}{c} \mathbf{A} + \mathbf{BC} \twoheadrightarrow \mathbf{AC} + \mathbf{B} \\ \underline{\text{Examples}} \\ \text{Mg} + 2 \text{ AgNO}_3 \twoheadrightarrow \text{Mg(NO}_3)_2 + 2 \text{ Ag} \\ \text{Cl}_2 + 2 \text{ KBr} \twoheadrightarrow \text{Br}_2 + 2 \text{ KCl} \end{array}$

(D) <u>DOUBLE REPLACEMENT</u>: Two compounds reacting to form two new compounds. The general formula for this reaction is given below.

> $AB + CD \rightarrow AD + CB$ <u>Examples</u>: FeS + 2 HCl → H₂S + FeCl₂ HCl + NaOH → NaCl + H₂O

(E) <u>COMBUSTION</u>: A carbon compound is burned in oxygen to form carbon dioxide and water. This reaction is very specific. The only variable is the carbon compound that is being burned.

Carbon compound + $O_2 \rightarrow CO_2 + H_2O$

Examples: $CH_4 + 2 O_2 \rightarrow CO_2 + 2 H_2O$ $2 C_8H_{18} + 25 O_2 \rightarrow 16 CO_2 + 18 H_2O$