Notes, Dec 2 - 6, 2013

Balancing Equations, Moles,
Stoichiometry,

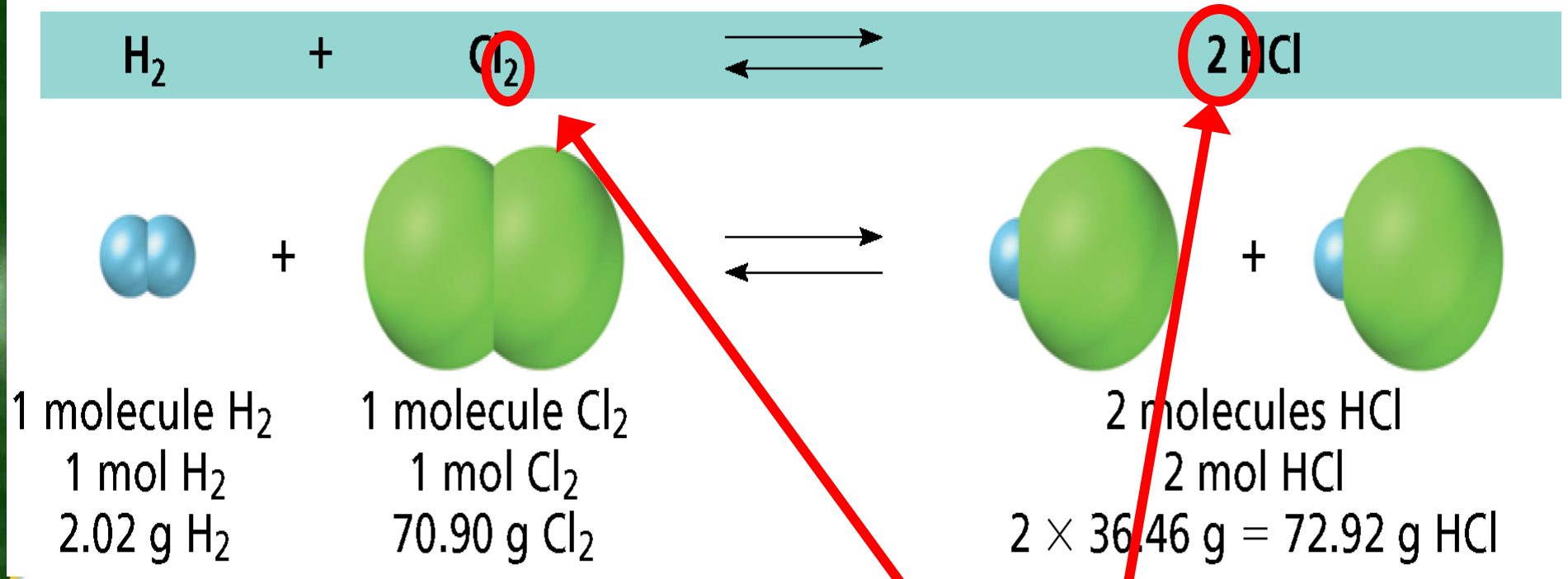
**Textbook pages for Unit 8,
Stoichiometry: pages 382 - 403**

**Textbook pages for Unit 7, Balancing
Equations: pages 344 - 353**

Additional Symbols Used in Chemical Equations

Symbol	Explanation
$\longrightarrow$	"Yields"; indicates result of reaction
$\rightleftharpoons$	Used in place of a single arrow to indicate a reversible reaction
(s)	A reactant or product in the solid state; also used to indicate a precipitate
$\downarrow$	Alternative to (s), but used only to indicate a precipitate
(l)	A reactant or product in the liquid state
(aq)	A reactant or product in an aqueous solution (dissolved in water)
(g)	A reactant or product in the gaseous state

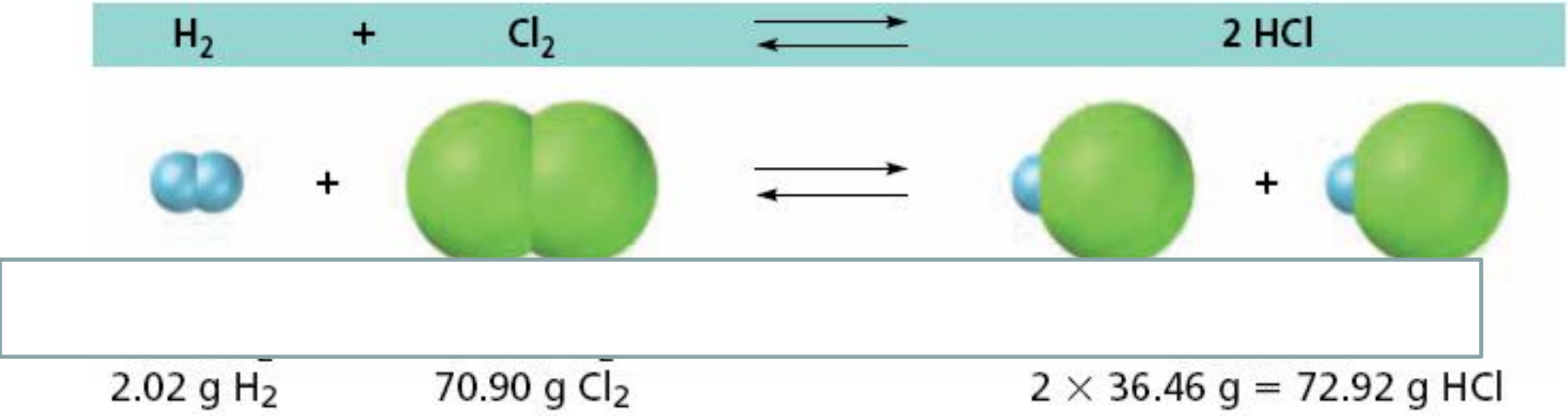
Interpreting a Chemical Reaction



This 2 is called a coefficient

This 2 is called a subscript

A balanced equation shows that mass is conserved



This illustrates the Law of Conservation of Mass

Write the formula equation.

$Zn(s) + HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$ (not balanced)

Count the atoms (not the molecules)

Adjust the **coefficients.**

$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

Balance chlorine first because it is combined on both sides of the equation.

You can never change the subscripts!!!!!

Count atoms to check balance.

$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

$(1Zn) + (2H + 2Cl) = (1Zn + 2Cl) + (2H)$

Balanacing combustion reactions

- $C_xH_y + O_2 \rightarrow \mathbf{x}CO_2 + \frac{y}{2}H_2O$
- $C_7H_{14} + O_2 \rightarrow$ _____
- $C_7H_{14} + O_2 \rightarrow \mathbf{7}CO_2 + \frac{14}{2}H_2O$
- $C_7H_{14} + O_2 \rightarrow \mathbf{7}CO_2 + \mathbf{7}H_2O$
- $C_7H_{14} + \frac{21}{2}O_2 \rightarrow \mathbf{7}CO_2 + \mathbf{7}H_2O$

- ***Multiply both sides by 2***
- $\mathbf{2C_7H_{14} + 21O_2 \rightarrow 14CO_2 + 14H_2O}$

Stoichiometry

Mass (g) of the given → Moles of the given→ Moles of the answer → mass of the answer.

To convert moles of given to moles of answer you must use the *mole ratio.* This ratio is determined by the balanced equation

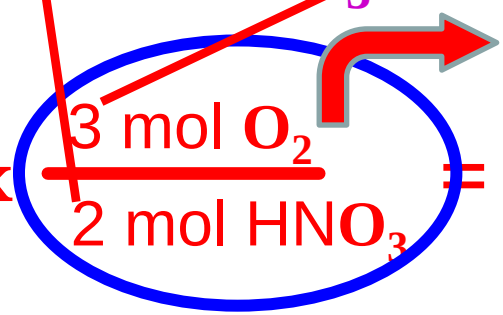
Example:

2.What is the mass of oxygen molecules (O_2) produced from 250 g of nitric acid according to the following balanced equation:

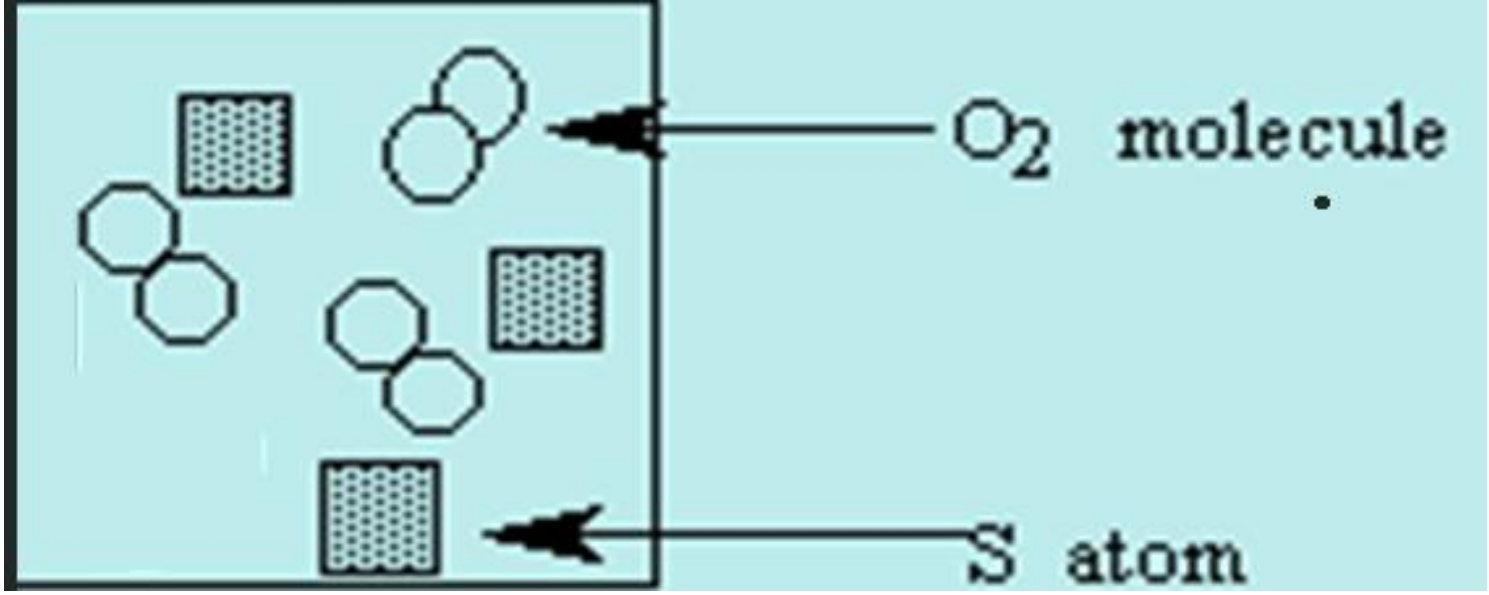
$$2\ HNO_3 \rightarrow H_2 + N_2 + 3O_2$$

Solve the problem as follows:

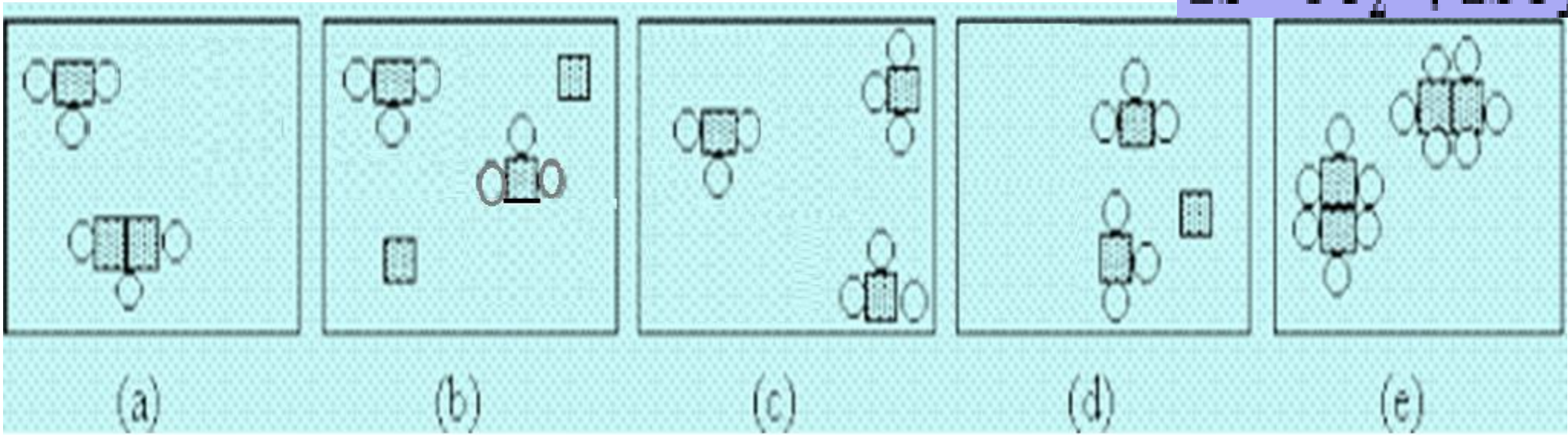
Mass (g) HNO_3 → Moles HNO_3 → Moles O_2 → mass (g) O_2

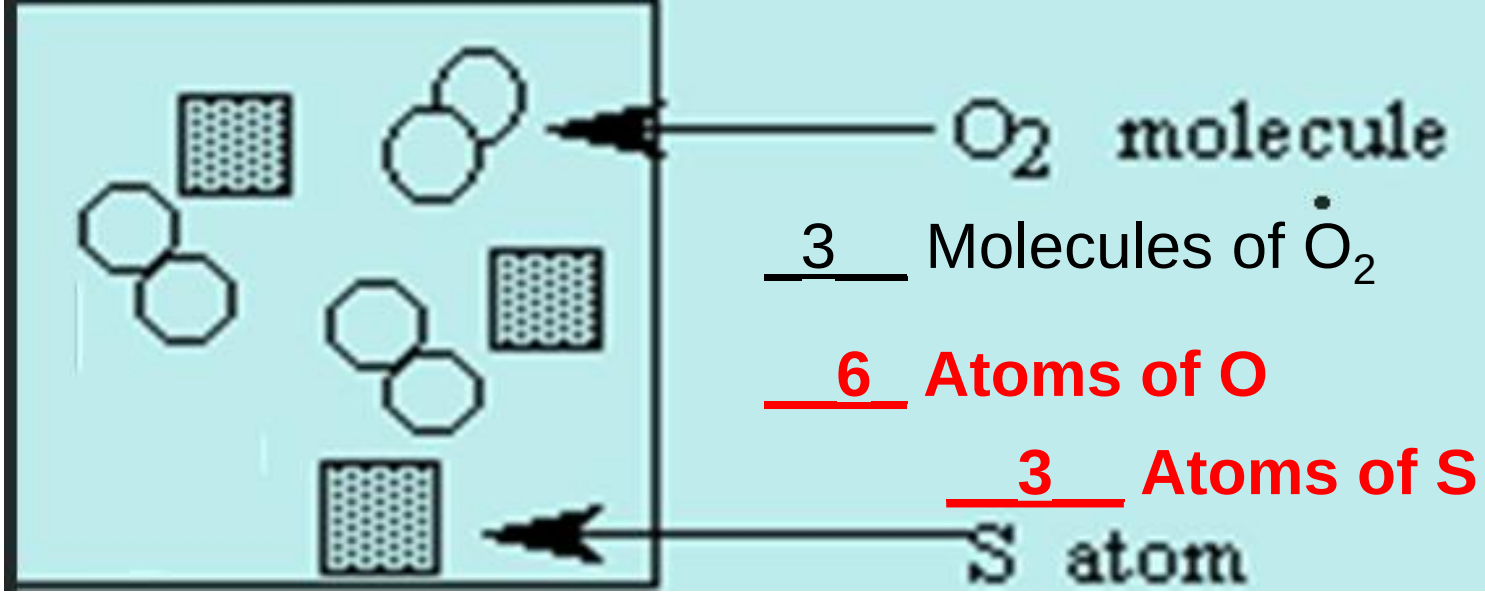


3.967 mol HNO_3 x $\frac{3\ mol\ O_2}{2\ mol\ HNO_3}$ = 5.9505 mol O_2



Which diagram shows the results after the mixture reacts as completely as possible according to the equation: $2S + 3O_2 \rightarrow 2SO_3$



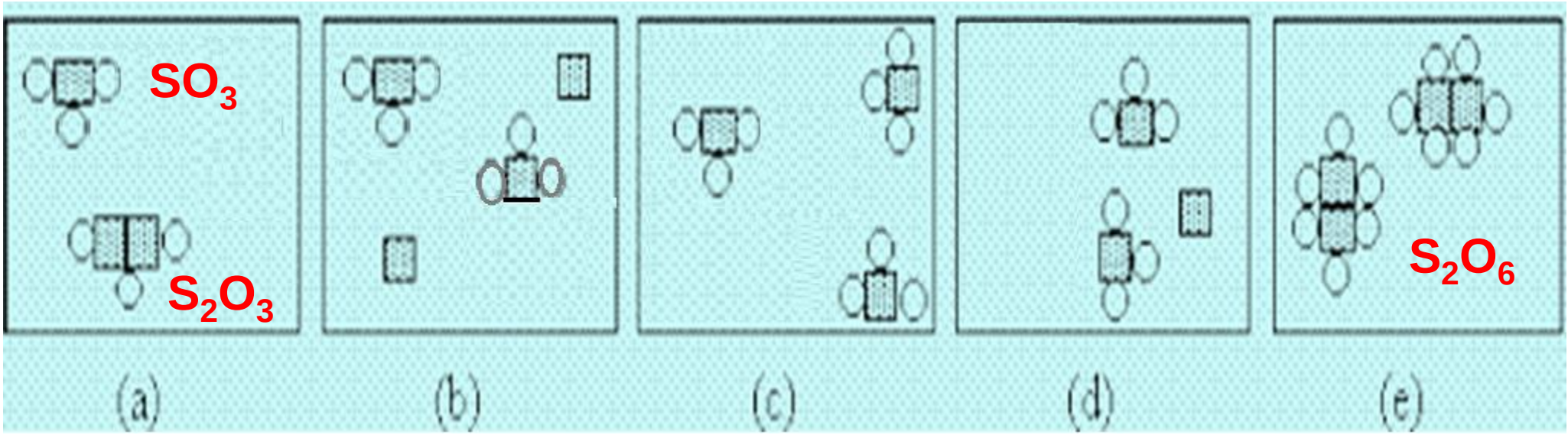


3 Molecules of O_2

6 Atoms of O

3 Atoms of S

$$2S + 3O_2 \rightarrow 2SO_3$$



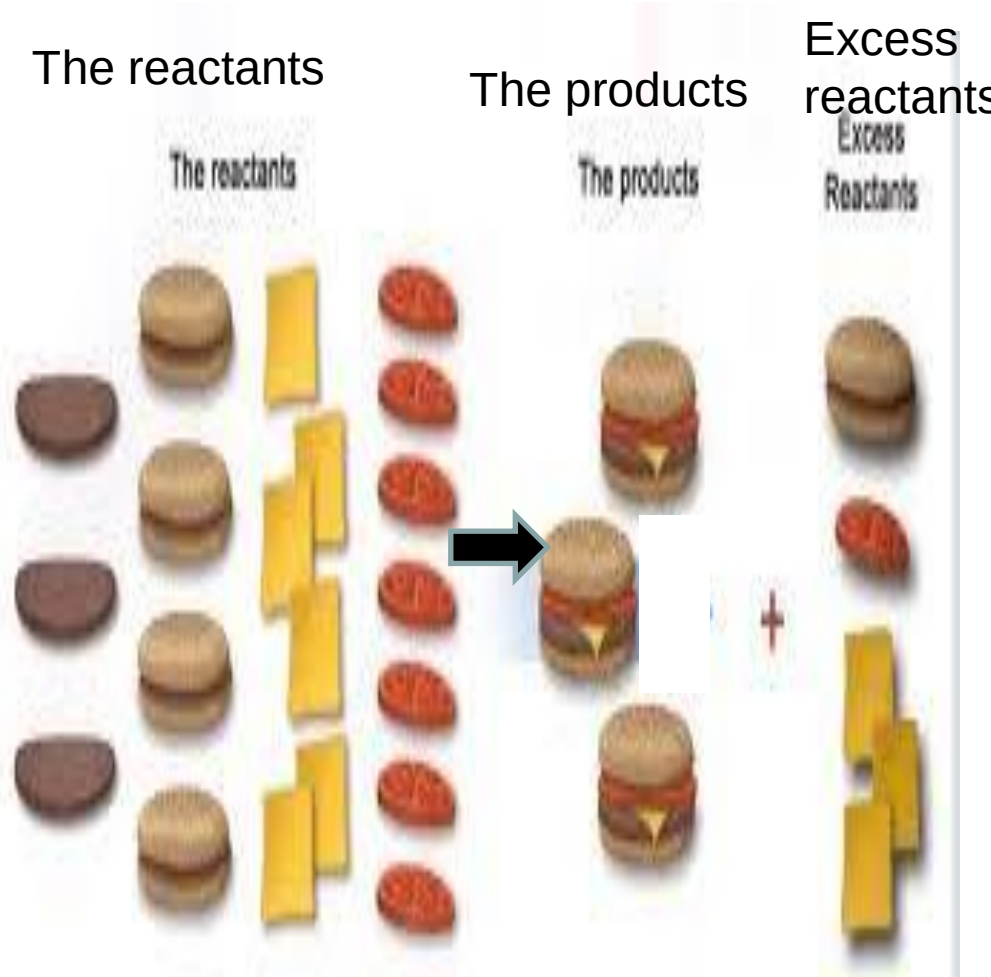
The Limiting Reactant

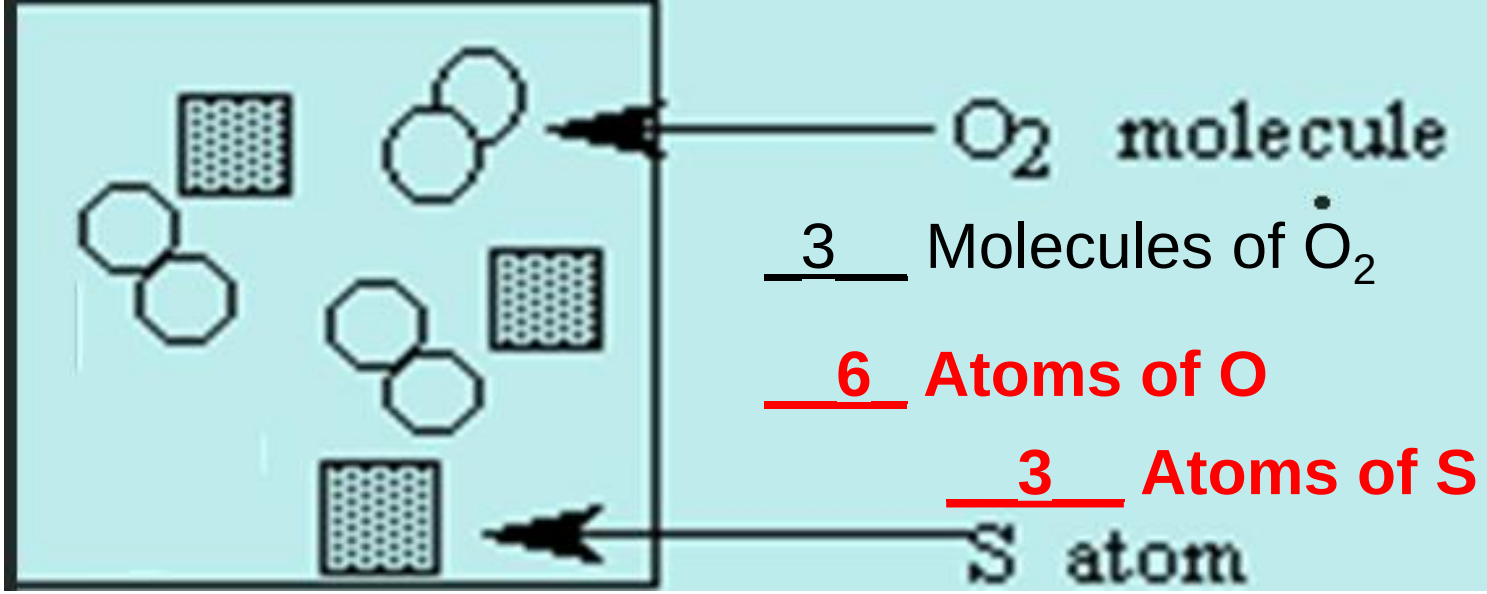
What ever you have the least of limits how much you can make.

How much product (bikes) can you make?

The reactants are six wheels and two frames.

How much product (hamburgers) can you make?





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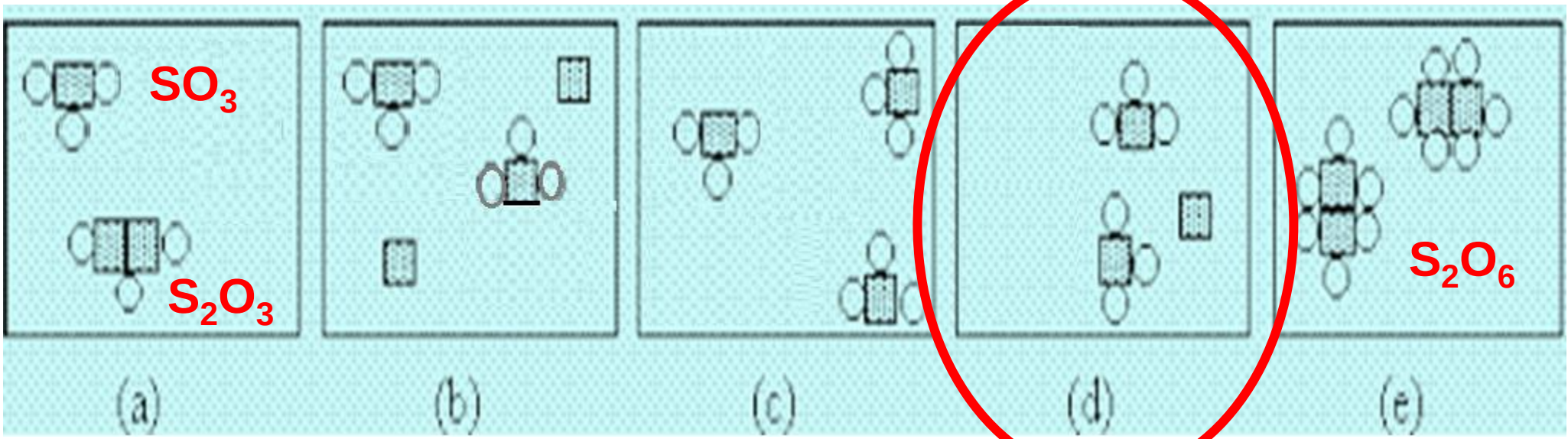

Limiting Reactant

1. **Sulfur will react with oxygen gas to produce sulfur trioxide. *How many moles of oxygen gas* are needed to react with 3.0 mole of sulfur so there is no sulfur remaining (completely react)? How many moles of sulfur trioxide will form?**

Equation: $2\,S + 3\,O_2 \rightarrow 2\,SO_3$

	$2\,S$	$+$	$3\,O_2$	$\rightarrow$	$2\,SO_3$
Before	3		3		0
Change	-3		?		?
After	0		?		?

Change: Amount of O_2 needed to react with 3 mol of S =

$$3 \text{ mol S} \times \frac{3 \text{ mol } O_2}{2 \text{ mol S}} = ? \text{ mol } O_2$$

Limiting Reactant

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Equation: $2\ S + 3\ O_2 \rightarrow 2\ SO_3$

	$2\ S$	$+\ 3\ O_2$	$\rightarrow\ 2\ SO_3$
Before	3	3	0
Change	-3	-4.5	*
After	0	-1.5	*

* The ratio of S to SO_3 is 2:2 or 1:1. So, 3 moles of S should produce 3 moles of SO_3. However, there isn't enough O_2.

Amount of O_2 needed to react with 3 mol of S =

$$3\ \text{mol S} \times \frac{3\ \text{mol } O_2}{2\ \text{mol S}} = 4.5\ \text{mol } O_2$$

We only have 3 moles of O_2 and we need 4.5 to react with all three moles of S (we lack 1.5 mol O_2). The amount SO_3 produced is limited by the O_2 because there is not enough O_2.

Limiting Reactant

2. **Sulfur will react with oxygen gas to produce sulfur trioxide. *How many moles of sulfur* are needed to react with 3.0 mole of oxygen gas so there is no oxygen remaining (completely react)? How many moles of sulfur trioxide will form?**

Equation:	$2\ S$	+	$3\ O_2$	→	$2\ SO_3$
Before	3		3		0
Change	-?		-3		+?
After	?		0		?

Change =

$$3\ \text{mol}\ O_2 \times \frac{2\ \text{mol}\ S}{3\ \text{mol}\ O_2} = 2\ \text{mol}\ S$$

$$3\ \text{mol}\ O_2 \times \frac{2\ \text{mol}\ SO_3}{3\ \text{mol}\ O_2} = 2\ \text{mol}\ SO_3$$

Limiting Reactant

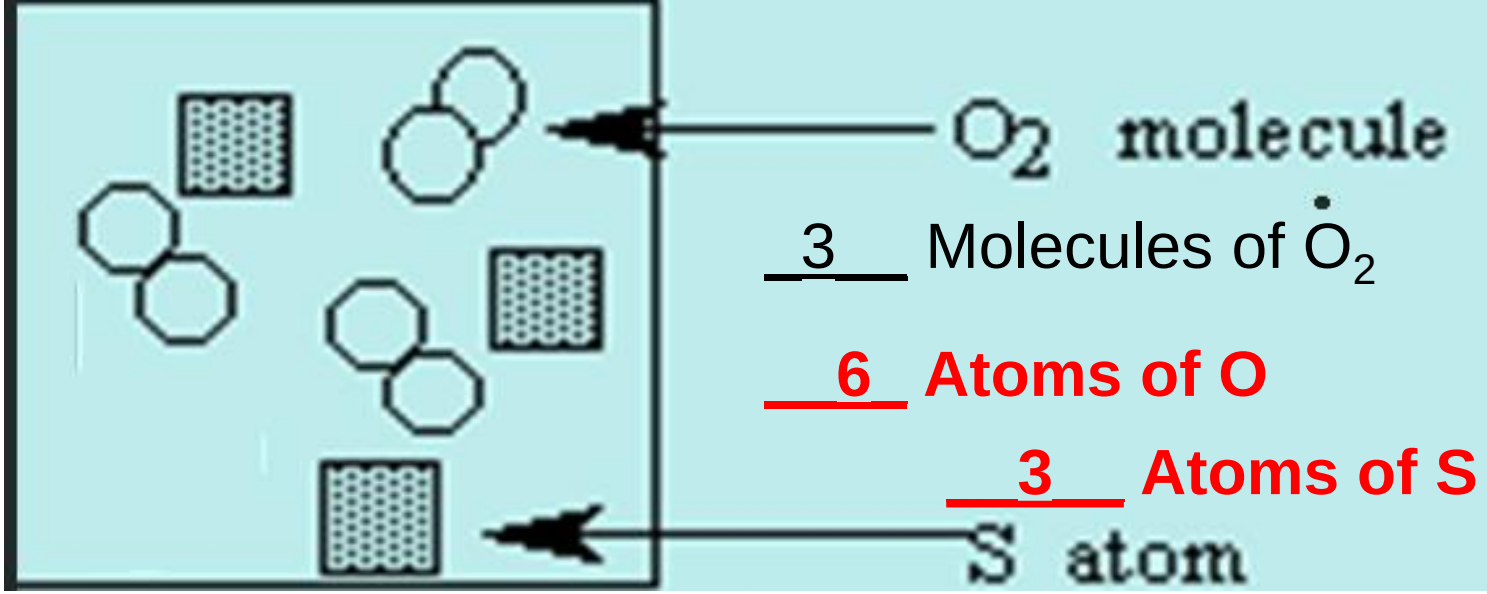
2. **Sulfur will react with oxygen gas to produce sulfur trioxide. *How many moles of sulfur* are needed to react with 3.0 mole of oxygen gas so there is no oxygen remaining (completely react)? How many moles of sulfur trioxide will form?**

Equation:	$2\ S$	+	$3\ O_2$	→	$2\ SO_3$
Before	3		3		0
Change	-2		-3		+2
After	1		0		2

Change =

$$\frac{3\ \text{mol}\ O_2}{} \times \frac{2\ \text{mol}\ S}{3\ \text{mol}\ O_2} = \frac{2\ \text{mol}\ S}{}$$

$$\frac{3\ \text{mol}\ O_2}{} \times \frac{2\ \text{mol}\ SO_3}{3\ \text{mol}\ O_2} = \frac{2\ \text{mol}\ SO_3}{}$$



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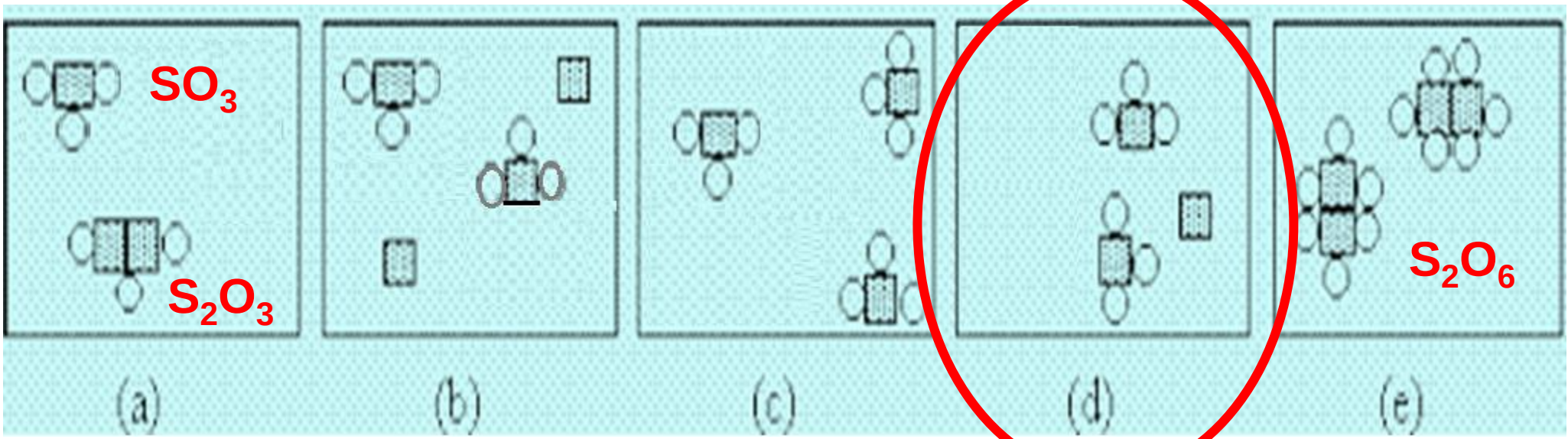

Mole Ratios

1. Lead will react with hydrochloric acid to produce lead (II) chloride and hydrogen gas. How many moles of hydrochloric acid are needed to completely react with 4.0 mole of lead?

Equation: $1\ Pb + 2\ HCl \rightarrow 1\ PbCl_2 + 1H_2$

Assume more than enough HCl to react

	Pb	HCl	$PbCl_2$	H_2
Before	4.0	?	0.0	0.0
Change	-4.0	-8.0	+ 4.0	+ 4.0
After	0	? -8.0	+ 4.0	+ 4.0

$$\frac{4.0 \text{ mol Pb}}{} \times \frac{2 \text{ mol HCl}}{1 \text{ mol Pb}} = \frac{8 \text{ mol HCl}}{}$$

Reactants are consumed (-), products accumulate (+)

BCA table

*

Equation: →

Before

Change

After

Mole change:

_____ x ——————— = _____

Unit 8 Worksheet 1: Mole relationships

1. $\underline{2}\ H_2S + \underline{3}\ O_2 \rightarrow \underline{2}\ SO_2 + \underline{2}\ H_2O$

2) $\underline{1}\ C_3H_8 + \underline{5}\ O_2 \rightarrow \underline{3}\ CO_2 + \underline{4}\ H_2O$

3) $\underline{1}\ N_2 + \underline{3}\ H_2 \rightarrow \underline{2}\ NH_3$

Sticky Tape Lab

	Top	Bottom	Foil	Paper
Top				
Bottom				
Foil				
Paper				
Plastic				

A = attract, R= repel, n= nothing, c= conducting, nc= not conducting

Bell Work, Thursday, Nov 14, 2013

4. Describe the four main concepts of Dalton's Atomic Theory

1. **All matter is composed of indivisible, indestructible particles called atoms.**

2. **All atoms of a given element are identical; atoms of different elements have different properties.**

3. **Chemical reactions involve the combination of atoms, not the destruction of atoms.**

This was an extremely advanced concept for its time; while Dalton's theory implied that atoms bonded together, it would be more than 100 years before scientists began to explain the concept of chemical bonding.

4. **When elements react to form compounds, they react in defined, whole-number ratios.**

Whiteboards- Unit 7 W/S

	Rearranging atoms	Work Sheet 1
Red	1, 3	1
Blue	2, 4	2
Pink	5, 6	4
Orange	x	3, 5, 6
Green	7, 8	14
White	7, 8	14
Yellow	x	3, 5, 6
Brown	5, 6	4
Grey	1, 3	1
Purple	2, 4	2

Whiteboards- Unit 7 W/S

	Worksheet 1	Work Sheet 2
Red	7,8,9	
Blue	10, 11,12	
Pink	13	1, 2
Orange		3, 4, 5
Green		6, 7, 8
White		6, 7, 8
Yellow		3, 4, 5
Brown	13	1, 2
Grey	7,8,9	
Purple	10, 11,12	

Whiteboards- Unit 8 W/S

	Mole relationships	Mole Ratios
Red		2
Blue		3
Pink	1	
Orange	2	
Green	3	
White	3	
Yellow	2	
Brown	1	
Grey		2
Purple		3

Thursday, Dec 5, 2013

- ***How many moles of S*** **are needed to react with 6.0 moles of oxygen gas so there is no sulfur remaining (completely react)?**
- **Is six moles of S enough to react with all 6 moles of O_2?**

Equation: $2\,S + 3\,O_2 \rightarrow 2\,SO_3$

	$2\,S$	$+$	$3\,O_2$	$\rightarrow$	$2\,SO_3$
Before	6		6		0
Change					
After					

_____ x _____ = _____