CONSERVATION OF MASS

Name _____

In chemical reactions, mass is neither gained nor lost. The total mass of all the reactants equals the total mass of all the products. Atoms are just rearranged into different compounds.

Using this idea, solve the following problems.

1. $2KClO_3 \rightarrow 2KCl + 3O_2$

   If 500 g of $KClO_3$ decomposes and produces 303 g of KCl, how many grams of O_2 are produced?

   _____

2. $N_2 + 3H_2 \rightarrow 2NH_3$

   How many grams of H_2 are needed to react with 100 g of N_2 to produce 121 g of NH_3?

   _____

3. $4Fe + 3O_2 \rightarrow 2Fe_2O_3$

   How many grams of oxygen are needed to react with 350 g of iron to produce 500 g of Fe_2O_3?

   _____

4. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

   16 g of CH_4 react with 64 g of O_2, producing 44 g of CO_2. How many grams of water are produced?

   _____

5. $CaCO_3 \rightarrow CaO + CO_2$

   How much CO_2 is produced from the decomposition of 200 g of $CaCO_3$ if 112 g of CaO are produced?

   _____

Page 1

Regents Chemistry: Stoichiometry

Name: _____ Date: _____

1) Base your answers to the following questions on the balanced equation below:

$$2\ CH_3OH + 3\ O_2 \rightarrow 2\ CO_2 + 4\ H_2O$$

a) How many moles of water will be produced when 0.5 moles of CH_3OH is reacted completely?

b) How many moles of oxygen gas are needed to react completely with 0.5 moles of CH_3OH?

c) How many moles of CO_2 are produced when 0.5 moles of CH_3OH reacts completely?

d) How many moles of water will be produced when 1.5 moles of O_2 reacts completely?

e) How many moles of CH_3OH would be needed to react completely to produce 0.5 moles of water?

2) Base your answers to the following questions on the balanced equation below:

$$N_2 + 3\ H_2 \rightarrow 2\ NH_3$$

a) How many moles of NH_3 can be produced from the complete reaction of 3 moles of N_2?

b) How many moles of H_2 will completely react with 2 moles of N_2?

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c) How many moles of NH_3 will be produced when 0.25 moles of N_2 is completely reacted?

d) How many moles of H_2 are needed to completely react with 0.25 moles of N_2?

NAME: _____ Stoiciometry Practice Problems

1. Given the following equation: **2 C_4H_{10} + 13 O_2 ---> 8 CO_2 + 10 H_2O**, show what the following molar ratios should be.

a. C_4H_{10} / O_2
b. O_2 / CO_2
c. O_2 / H_2O
d. C_4H_{10} / CO_2
e. C_4H_{10} / H_2O

2. Given the following equation: **2 $KClO_3$ ---> 2 KCl + 3 O_2**

How many moles of O_2 can be produced by letting 12.00 moles of $KClO_3$ react?

3. Given the following equation: **2 K + Cl_2 ---> 2 KCl**

a) How many grams of KCl is produced from 2.50 g of K and excess Cl_2.

b) From 1.00 g of Cl_2 and excess K?

4. Given the following equation: **Na_2O + H_2O ---> 2 NaOH**

a) How many grams of NaOH is produced from 1.20×10^2 grams of Na_2O?

b) How many grams of Na_2O are required to produce 1.60×10^2 grams of NaOH?

5. Given the following equation: **8 Fe + S_8 ---> 8 FeS**

a) What mass of iron is needed to react with 16.0 grams of sulfur?

b) How many grams of FeS are produced?

6. Given the following equation: **2 $NaClO_3$ ---> 2 NaCl + 3 O_2**

a) 12.00 moles of $NaClO_3$ will produce how many grams of O_2?

b) How many grams of NaCl are produced when 80.0 grams of O_2 are produced?

7. Given the following equation: **Cu + 2 $AgNO_3$ ---> $Cu(NO_3)_2$ + 2 Ag**

a) How many moles of Cu are needed to react with 3.50 moles of $AgNO_3$?

b) If 89.5 grams of Ag were produced, how many grams of Cu reacted?

8. Molten iron and carbon monoxide are produced in a blast furnace by the reaction of iron (III) oxide and coke (pure carbon). If 25.0 kilograms of pure Fe_2O_3 is used, how many kilograms of iron can be produced? The reaction is: **$Fe_2O_3 + 3\ C \longrightarrow 2\ Fe + 3\ CO$**

9. The average human requires 120.0 grams of glucose ($C_6H_{12}O_6$) per day. How many grams of CO_2 (in the photosynthesis reaction) are required for this amount of glucose? The photosynthetic reaction is: **$6\ CO_2 + 6\ H_2O \longrightarrow C_6H_{12}O_6 + 6\ O_2$**

This problem is slightly different from those above.

10. Given the reaction: **$4\ NH_3\ (g) + 5\ O_2\ (g) \longrightarrow 4\ NO\ (g) + 6\ H_2O\ (l)$**

When 1.20 mole of ammonia reacts, the total number of moles of products formed is:

a. 1.20 b. 1.50 c. 1.80 d. 3.00 e. 12.0

STOICHIOMETRY:
VOLUME-VOLUME PROBLEMS

Name _____

1. $N_2 + 3H_2 \rightarrow 2NH_3$

   What volume of hydrogen is necessary to react with five liters of nitrogen to produce ammonia? (Assume constant temperature and pressure.)

   _____

2. What volume of ammonia is produced in the reaction in Problem 1?

   _____

3. $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

   If 20 liters of oxygen are consumed in the above reaction, how many liters of carbon dioxide are produced?

   _____

4. $2H_2O \rightarrow 2H_2 + O_2$

   If 30 mL of hydrogen are produced in the above reaction, how many milliliters of oxygen are produced?

   _____

5. $2CO + O_2 \rightarrow 2CO_2$

   How many liters of carbon dioxide are produced if 75 liters of carbon monoxide are burned in oxygen? How many liters of oxygen are necessary?

   _____

   _____

the **molecular formula** shows the number of each kind of atom in a molecule as well as the ratios of the numbers of atoms of each kind in the compound. Molecular formulas are often multiples greater than 1 of empirical formulas; the multiplier is found by determining molecular mass. Once an empirical or molecular formula is known for a compound, it can be used to calculate the percent composition of the compound. **Structural formulas** show how the atoms are joined together in molecules. The **structures** of molecules can also be shown by **ball-and-stick** and **space-filling models.** The properties of molecules depend on their structures. Compounds that have the same molecular formula but different structures are called **isomers.**

Do circled problems

(h) $C_6H_6(l) + O_2(g) \longrightarrow CO_2(g) + H_2O(g)$

(i) $H_2S(g) + O_2(g) \longrightarrow SO_2(g) + H_2O(g)$

(j) $SO_2(g) + H_2S(g) \longrightarrow S_8(l) + H_2O(g)$ (3.2)

3.22 How many moles of C atoms are in 1 mol C_4H_{10}? (3.3)

3.23 Given the equation $2KClO_3(s) \longrightarrow 2KCl(s) + 3O_2(g)$, (a) how many moles of $O_2(g)$ are formed by the decomposition of 0.35 mol $KClO_3(s)$? (b) How many moles $KClO_3(s)$ must decompose to form 4.8 mol KCl(s)? (3.3)

3.24 In sunlight, hydrogen and chlorine react to form hydrogen chloride, which is a gas under ordinary conditions. (a) How many moles of chlorine are needed to react with 3.8 mol of hydrogen? (b) How many moles of hydrogen chloride will be formed by the reaction in part (a)? (3.3)

3.25 Given the equation $2Na(s) + Cl_2(l) \longrightarrow 2NaCl(s)$, (a) how many grams of NaCl can be formed from 4.68 g Na, assuming enough Cl_2 is present to react with all of the Na? (b) How many grams of Cl_2 are needed to react with 4.68 g Na? (c) To make 39.6 g NaCl, how many grams of Na should you start with, assuming the reaction is quantitative and enough chlorine is available? (3.4)

3.26 Given the equation $N_2O_4(l) + 2N_2H_4(l) \longrightarrow 3N_2(g) + 4H_2O(g)$, (a) how many grams of N_2H_4 are required to react with 25.49 g N_2O_4? (b) How many grams of N_2 will be formed from the reaction of 89.7 g N_2H_4, assuming that the reaction is quantitative and that enough N_2O_4 is available? ~~(c) How many pounds of N_2H_4 are required to react with 25.49 lb of N_2O_4?~~ (3.4)

3.27 Given the equation $4HCl(aq) + MnO_2(s) \longrightarrow 2H_2O(l) + MnCl_2(aq) + Cl_2(g)$, (a) how many moles of HCl are required to react with 31.8 g MnO_2? (b) How many grams of MnO_2 must react for 0.56 mol Cl_2 to be formed? (3.4)

3.28 When heated, mercury(II) oxide decomposes to oxygen gas and mercury vapor. (a) How many grams of mercury(II) oxide must be decomposed to form 0.567 mol oxygen gas? (b) How many grams of mercury will be formed by the reaction in part (a)? (3.4)

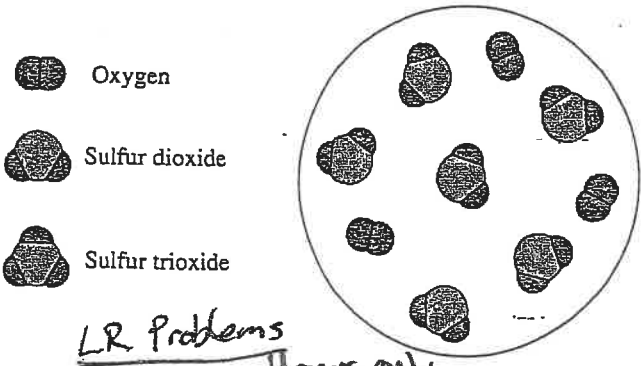
3.29 Potassium nitrate is decomposed by heat to potassium nitrite and oxygen gas. Potassium nitrate and potassium nitrite are

solids. (a) How many moles of oxygen gas are formed by t decomposition of 3.91 g of potassium nitrate? (b) How ma grams of oxygen gas are formed by the decomposition 25.63 g of potassium nitrate? (3.4)

3.30 Titanium(IV) chloride, which is a liquid, reacts with wat vapor to form solid titanium(IV) oxide and hydrogen chlori gas. (a) From 309.8 g $TiCl_4$, how many grams of TiO_2 can formed? (b) If 46.2 g TiO_2 is made, how many grams of H are also formed? (c) How many grams of H_2O are needed react with 87.3 g $TiCl_4$? (d) How many grams of $TiCl_4$ are r quired to make 266.4 g TiO_2? (3.4)

3.31 Calcium phosphate, which is a solid, reacts with sulfuric aci $H_2SO_4(aq)$, to yield solid calcium sulfate and phosphoric aci $H_3PO_4(aq)$. (a) How many grams of H_2SO_4 are required to rea with 212.4 g $Ca_3(PO_4)_2$? (b) From 212.4 g $Ca_3(PO_4)_2$, how mar grams of H_3PO_4 can be made? (c) If 135.4 g H_3PO_4 is mad how many grams of $CaSO_4$ are also formed? (d) To make 135.4 H_3PO_4, how many grams of $Ca_3(PO_4)_2$ are needed? (3.4)

3.32 The mixture of sulfur dioxide and oxygen shown in the molecular-level picture is made to react to form sulfur trioxide.



LR Problems

Honors only

Sketch a molecular-level picture of the result. (3.5)

Honors

3.33 The equation for the reaction between aqueous solutions o silver nitrate and barium chloride is $2AgNO_3(aq) + BaCl_2(aq) \longrightarrow 2AgCl(s) + Ba(NO_3)_2(aq)$. If a solution tha contains 41.6 g $AgNO_3$ is mixed with a solution that contains 35.4 g $BaCl_2$, (a) which reactant is limiting? (b) How many grams of which reactant will be left over? (c) How many grams of AgCl will be formed? (3.5)

3.34 The reaction $Cr_2O_3(s) + 2Al(l) \longrightarrow 2Cr(l) + Al_2O_3(l)$ takes place at high temperatures. If 42.7 g Cr_2O_3 and 9.8 g Al are mixed and reacted until one reactant is used up, (a) which reactant will be left over? How much of it will be left? (b) How many grams of chromium will be formed? (3.5)

3.35 If 52.9 g $Ca_3(PO_4)_2$ and a solution that contains 52.5 g H_2SO_4 are used to carry out the reaction in problem 3.31, (a) which reactant is limiting? (b) How many grams of the other reactant will be left over? (c) How many grams of H_3PO_4 will be formed? (3.5)

3.36 When heated together, silicon dioxide and carbon, which are both solids, react to form solid silicon carbide, SiC, and carbon monoxide gas. If 75.0g SiO_2 and 112.0g C are used, how many grams of SiC will be formed? (3.5)

3.37 When a mixture of methane, CH_4, ammonia, and oxygen gases is heated over a platinum catalyst, hydrogen cyanide gas,

$SiO_2 + C \rightarrow SiC + O_2$

1. Given the reaction: $2CO + O_2 \rightarrow 2CO_2$. What is the minimum number of moles of O_2 required to produce 1 mole of CO_2? (1) 1.0 (2) 2.0 (3) 0.25 (4) 0.50

2. Given the reaction:

$$3PbCl_2 + Al_2(SO_4)_3 \rightarrow 3PbSO_4 + 2AlCl_3$$

How many moles of $PbSO_4$ are formed when 0.150 mole of $Al_2(SO_4)_3$ is consumed? (1) 0.050 (2) 0.150 (3) 0.45 (4) 0.60

* 3. Given the reaction:

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

How many moles of CO_2 are produced when 30.0 grams of C_2H_6 are burned completely? (1) 1.0 (2) 2.0 (3) 8.0 (4) 4.0

* 4. What mass of oxygen is produced by the decomposition of 3.0 moles of water:

$$2H_2O \rightarrow 2H_2 + O_2$$

(1) 1.5 g (2) 32 g (3) 36 g (4) 48 g

5. Given the reaction: $N_2 + 3H_2 \rightarrow 2NH_3$. If 14 grams of N_2 are consumed in the reaction, what is the mass of H_2 consumed? (1) 6.0 g (2) 2.0 g (3) 3.0 g (4) 4.0 g

6. Given the reaction:

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$$

What volume of CO_2 is produced when 15.0 liters of O_2 are consumed? (1) 10.0 L (2) 15.0 L (3) 22.5 L (4) 45.0 L

7. Given the reaction:

$$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$$

What volume of O_2 is required to produce 80.0 L of NO(g)? (1) 5.0 L (2) 64.0 L (3) 80.0 L (4) 100.0 L

8. Given the reaction:

$$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$$

How many moles of H_2O are needed to react exactly with 2.0 moles of Ca? (1) 1.0 (2) 2.0 (3) 0.50 (4) 4.0

* 9. Given the reaction: $N_2 + 3H_2 \rightarrow 2NH_3$. How many grams of H_2 are needed to produce exactly 1 mole of ammonia? (1) 1 g (2) 2 g (3) 3 g (4) 4 g

10. Given the reaction:

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

What is the total number of moles of NaOH needed to react completely with 2 moles of H_2SO_4? (1) 1 (2) 2 (3) 0.5 (4) 4

11. Given the reaction:

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

What is the total number of moles of hydrogen produced when 4 moles of sodium react completely? (1) 1 (2) 2 (3) 3 (4) 4

12. Given the reaction:

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

What volume of H_2 is produced when 36.0 grams of H_2O are consumed? (1) 89.6 L (2) 44.8 L (3) 33.6 L (4) 22.4 L

13. Given the reaction: $2H_2 + O_2 \rightarrow 2H_2O$. What mass of oxygen will combine with 3.0 grams of hydrogen to produce water? (1) 1.5 g (2) 0.37 g (3) 6.0 g

14. Given the reaction:

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$$

What is the total volume of $H_2O(g)$ formed when 8.00 liters of $C_3H_8(g)$ is completely oxidized? (1) 32.0 L (2) 22.4 L (3) 8.00 L (4) 4.00 L

15. Given the reaction:

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

What is the total volume of H_2 gas consumed when 22.4 liters of Cl_2 gas completely reacts? (1) 11.2 L (2) 22.4 L (3) 44.8 L (4) 89.6 L

16. According to the reaction $H_2 + Cl_2 \rightarrow 2HCl$, the production of 2.0 moles of HCl would require 70. grams of Cl_2 and (1) 1.0 g of H_2 (2) 2.0 g of H_2 (3) 3.0 g of H_2 (4) 4.0 g of H_2

17. Given the reaction:

$$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$$

What is the total number of liters of $O_2(g)$ required to produce 40 liters of NO? (1) 5 L (2) 9 L (3) 32 L (4) 50 L

9. Given the reaction:

$$(NH_4)_2CO_3 \rightarrow 2NH_3 + CO_2 + H_2O$$

What is the minimum amount of ammonium carbonate that reacts to produce 1.0 mole of ammonia? (1) 0.25 mole (2) 0.50 mole (3) 17 moles (4) 34 moles

10. Given the reaction:

$$4Na + O_2 \rightarrow 2Na_2O$$

How many grams of oxygen are completely consumed in production of 1.00 mole of Na_2O? (1) 16.0 (2) 32.0 (3) 62.0 (4) 124

11. Given the balanced equation:

$$NaOH + HCl \rightarrow NaCl + H_2O$$

What is the total number of grams of H_2O produced when 116 grams of the product, NaCl, is formed? (1) 9.0 g (2) 18 g (3) 36 g (4) 54 g

12. Given the reaction:

$$4Al + 3O_2 \rightarrow 2Al_2O_3$$

How many moles of Al_2O_3 will be formed when 27 grams of Al reacts completely with O_2? (1) 1.0 (2) 2.0 (3) 0.50 (4) 4.0

25. Given the equation: $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$ When 30. grams of C_2H_6 (molecular mass = 30) are completely burned, the total number of moles of CO_2 produced is:
(1) 1.0 (2) 2.0 (3) 8.0 (4) 4.0

26. Given the reaction: $2Na + 2H_2O \rightarrow 2NaOH + H_2$ What is the total number of moles of hydrogen produced when 4 moles of sodium react completely?
(1) 1 (2) 2 (3) 3 (4) 4

27. Given the reaction: $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$ What is the total number of CO_2 molecules produced when one mole of C_2H_6 is consumed?
(1) $1 \times 6.02 \times 10^{23}$ (3) $3 \times 6.02 \times 10^{23}$
(2) $2 \times 6.02 \times 10^{23}$ (4) $4 \times 6.02 \times 10^{23}$

28. In the reaction: $Zn + 2HCl \rightarrow ZnCl_2 + H_2$ How many moles of hydrogen will be formed when 4 moles of HCl are consumed?

. Consider the following equation.

$$2C_2H_6 + O_2 \rightarrow 4CO_2 + 6H_2O$$

When 4 mol of C_2H_6 are burned the number of moles of CO_2 produced will be

(1) 2 mol (3) 7 mol

(2) 6 mol (4) 8 mol

. Given the equation $Mg + 2HCl \rightarrow MgCl_2 + H_2$, how many moles of hydrochloric acid are needed to react with 0.50 mol of magnesium?

(1) 0.5 mol

(2) 1.0 mol

(3) 2.0 mol

(4) 4.0 mol

. Given the reaction $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$, what is the total number of moles of O_2 required to produce 40 mol of NO? (1) 5 mol (2) 9 mol (3) 32 mol (4) 50 mol

. Given the reaction $2CH_3OH(\ell) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(g)$, how many moles of $O_2(g)$ are needed to produce exactly 20. mol of $CO_2(g)$? (1) 10. mol (2) 20. mol (3) 30. mol (4) 40. mol

. Given the reaction $4Na + O_2 \rightarrow 2Na_2O$, how many moles of oxygen are completely consumed in the production of 1.00 mol of Na_2O? (1) 0.50 mol (2) 1 mol (3) 2 mol (4) 4.0 mol

1. Given the reaction $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$, what is the total number of moles of Ca needed to react completely with 4.0 mol of H_2O? (1) 0.50 mol (2) 1.0 mol (3) 2.0 mol (4) 4.0 mol

2. Consider the following equation.

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$$

How many moles of oxygen are needed for the complete combustion of 3.0 mol of $CH_4(g)$?
(1) 2.0 mol (2) 3.0 mol (3) 4.0 mol (4) 6.0 mol

3. According to the reaction $2Al + 3H_2SO_4 \rightarrow 3H_2 + Al_2(SO_4)_3$, the total number of moles of H_2SO_4 needed to react completely with 5.0 mol of Al is (1) 2.5 mol (2) 5.0 mol (3) 7.5 mol (4) 9.0 mol

4. Given the equation $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$, what is the total number of moles of NH_3 produced when 10. mol of H_2 reacts completely with N_2? (1) 2.0 mol (2) 3.0 mol (3) 6.7 mol (4) 15 mol

5. According to the equation $2K(s) + Cl_2(g) \rightarrow 2KCl(s)$, potassium reacts with chlorine to form potassium chloride. If 100 atoms of potassium react with chlorine gas, how many chlorine molecules will be needed to completely react?

8. Consider the equation $H_2 + Cl_2 \rightarrow 2HCl$. A student suggests that according to the ratio shown by the coefficients, 20 g of hydrogen will react with 20 g of

$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

What is the total number of moles of Ca needed to react completely with 4.0 moles of H_2O? Rxn $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

25. Given the *unbalanced* equation:

$$N_2(g) + H_2(g) = NH_3(g)$$

When the equation is balanced using the smallest whole-number coefficients, the ratio of moles of hydrogen compared to moles of ammonia produced is _____.

30. In a laboratory experiment, a student reacted 2.8 grams of Fe(s) (steel wool) in excess $CuSO_4(aq)$, according to the following balanced equation:

$$Fe(s) + CuSO_4(aq) \longrightarrow FeSO_4(aq) + Cu(s)$$

When the Fe(s) was completely consumed, the precipitated Cu(s) had a mass of 3.2 grams. Did the student's result in this experiment verify the mole ratio of Fe(s) to Cu(s) as predicted by the equation? Calculate the mole ratio of Fe to Cu and explain.

27. Given the balanced equation:

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

What is the total number of liters of H_2 produced at STP when 36.0 grams of H_2O is consumed? (1) 22.4 (2) 33.6 (3) 44.8 (4) 89.6

44. Given the reaction $4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$, what is the minimum number of moles of oxygen gas required to produce 1.00 mol of aluminum oxide?
(1) 1.0 mol (2) 1.5 mol (3) 3.0 mol (4) 6.0 mol

45. Given the reaction $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$, what is the maximum number of moles of H_2O that can be produced when 2.0 mol of NH_3 are completely reacted? (1) 1.0 mol (2) 2.0 mol (3) 3.0 mol (4) 6.0 mol

46. Given the reaction $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$, what is the total number of moles of $KClO_3$ needed to produce 6 mol of O_2? (1) 1 mol (2) 2 mol (3) 3 mol (4) 4 mol

47. Given the reaction $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$, what amount of oxygen is needed to completely react with 1 mol of CH_4? (1) 2 mol (2) 2 atoms (3) 2 g (4) 2 molecules

Chapter 11 test/Review Sheets