Chemistry CP
Chapter 9 Test

Name: Key

Please circle TRUE for true statements and FALSE for false statements. (2 points each)

1. TRUE or FALSE. The coefficients in a balanced equation tell you the relative numbers of moles of the substance in the reaction.

2. TRUE or FALSE. The coefficients in a balanced equation tell you the relative numbers of grams of the substance in the reaction.

3. TRUE or FALSE. It is always necessary to make sure you have a balanced equation before starting stoichiometry calculations.

4. TRUE or FALSE. Balanced equations are NOT necessary in performing stoichiometry calculations.

Please indicate the **mole ratios** from the following balanced equation. (6 points)

5. $C_{10}H_8 + 12\ O_2 \rightarrow 10\ CO_2 + 4\ H_2O$

12 moles of O_2 = 4 moles of H_2O

12 moles of O_2 = 10 moles of CO_2

12 moles of O_2 = 1 moles of $C_{10}H_8$

1 moles of $C_{10}H_8$ = 10 moles of CO_2

4 moles of H_2O = 10 moles of CO_2

12 moles of O_2 = 1 moles of $C_{10}H_8$

Mole to Mole Conversions

6. Please determine the number of **moles** of water (H_2O) produced if 3 **moles** of $C_{10}H_8$ is reacted with an excess of oxygen according to the following balanced equation: $C_{10}H_8 + 12\ O_2 \rightarrow 10\ CO_2 + 4\ H_2O$. (5 points)

$$3\ mol\ C_{10}H_8 \left| \frac{4\ mol\ H_2O}{1\ mol\ C_{10}H_8} \right. = 12\ mol\ H_2O$$

7. Please determine the number of **moles** of water (H_2O) produced if 1.8 **moles** of CO_2 is produced according to the following balanced equation: $C_{10}H_8 + 12\ O_2 \rightarrow 10\ CO_2 + 4\ H_2O$. (5 points)

$$1.8\ mol\ CO_2 \left| \frac{4\ mol\ H_2O}{10\ mol\ CO_2} \right. = 0.72\ mol\ H_2O$$

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Gram to Gram Conversions (3 step)

8. Please determine the number of **grams** of water (H_2O) produced if 11.23 **grams** of C_6H_6 is reacted with an excess of oxygen according to the following balanced equation: $2\ C_6H_6 + 15\ O_2 \rightarrow 12\ CO_2 + 6\ H_2O$. (8 points)

$$11.23\text{ g } C_6H_6 \left| \frac{1\text{ mol}}{78.11\text{ g}} \right. = .14377\text{ mol } C_6H_6 \left| \frac{6\text{ mol } H_2O}{2\text{ mol } C_6H_6} \right. = .4313\text{ mol } H_2O$$

$$.4313\text{ mol } H_2O \left| \frac{18.02\text{ g}}{1\text{ mol}} \right. = 7.77\text{ g } H_2O$$

9. Please determine the number of **grams** of carbon dioxide (CO_2) produced if 48.3 **grams** of oxygen is reacted according to the following balanced equation: $2\ C_6H_6 + 15\ O_2 \rightarrow 12\ CO_2 + 6\ H_2O$. (8 points)

$$48.3\text{ g } O_2 \left| \frac{1\text{ mol}}{32\text{ g}} \right. = 1.509\text{ mol } O_2 \left| \frac{12\text{ mol } CO_2}{15\text{ mol } O_2} \right. = 1.2075\text{ mol } CO_2$$

$$1.2075\text{ mol } CO_2 \left| \frac{44.01\text{ g}}{1\text{ mol}} \right. = 53.14\text{ g } CO_2$$

10. Please determine the number of **grams** of aluminum produced if 16.9 **grams** of aluminum oxide (Al_2O_3) is reacted with an excess of carbon monoxide (CO) according to the following balanced equation: $3CO + Al_2O_3 \rightarrow 3\ CO_2 + 2\ Al$. (8 points)

$$16.9\text{ g } Al_2O_3 \left| \frac{1\text{ mol}}{101.96\text{ g}} \right. = 0.16575\text{ mol } Al_2O_3 \left| \frac{2\text{ mol Al}}{1\text{ mol } Al_2O_3} \right. = 0.3315\text{ mol Al}$$

$$.3315\text{ mol Al} \left| \frac{26.98\text{ g}}{1\text{ mol}} \right. = 8.94\text{ g Al}$$

11. Please determine the number of **grams** of carbon dioxide produced if 89.1 **grams** of aluminum oxide (Al_2O_3) is reacted according to the following balanced equation: $3CO + Al_2O_3 \rightarrow 3\ CO_2 + 2\ Al$. (8 points)

$$89.1\text{ g } Al_2O_3 \left| \frac{1\text{ mol}}{101.96\text{ g}} \right. = .87387\text{ mol } Al_2O_3 \left| \frac{3\text{ mol } CO_2}{1\text{ mol } Al_2O_3} \right. = 2.6216\text{ mol } CO_2$$

$$2.6216\text{ mol } CO_2 \left| \frac{44.01\text{ g}}{1\text{ mol}} \right. = 115.4\text{ g } CO_2$$

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Limiting Reactant Problems

12. Please determine the **amount of water (in Grams)** if 191 **grams** of O_2 is reacted with 191 **grams** of C_4H_{10} according to the following balanced equation: $2\ C_4H_{10} + 13\ O_2 \rightarrow 8CO_2 + 10\ H_2O$. **Only indicate ONE answer** (15 points)

$$\frac{191\text{ g } O_2}{32\text{ g}} \left| \frac{1\text{ mol}}{} \right. = \frac{5.96875\text{ mol } O_2}{13\text{ mol } O_2} \left| \frac{10\text{ mol } H_2O}{} \right. = \frac{4.591\text{ mol } H_2O}{1\text{ mol}} \left| \frac{18.02\text{ g}}{} \right.$$

Answer → 82.74 g H_2O

$$\frac{191\text{ g } C_4H_{10}}{58.12\text{ g}} \left| \frac{1\text{ mol}}{} \right. = \frac{3.286\text{ mol } C_4H_{10}}{2\text{ mol } C_4H_{10}} \left| \frac{10\text{ mol } H_2O}{} \right. = \frac{16.4315\text{ mol } H_2O}{1\text{ mol}} \left| \frac{18.02\text{ g}}{} \right.$$

296.1 g H_2O

13. What is the limiting reactant in Question #12? (5 points)

Oxygen

14. Please determine the amount in **grams** of the non-limiting reactant that will be leftover after the reaction in Question #12 has taken place. (8 points)

$$\frac{191\text{ g } O_2}{32\text{ g}} \left| \frac{1\text{ mol}}{} \right. = \frac{5.96875\text{ mol } O_2}{13\text{ mol } O_2} \left| \frac{2\text{ mol } C_4H_{10}}{} \right. = .9182\text{ mol } C_4H_{10}$$

$$\frac{.9182\text{ mol } C_4H_{10}}{1\text{ mol}} \left| \frac{58.12\text{ g}}{} \right. = 53.37\text{ g used}$$

$191 - 53.37 =$ 137.63 g C_4H_{10} leftover

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Limiting Reactant Problems

15. Please determine the **amount of aluminum(in Grams)** if 100 **grams** of CO is reacted with 115 **grams** of Al_2O_3 according to the following balanced equation: $3CO + Al_2O_3 \rightarrow 3\ CO_2 + 2\ Al$. **Only indicate ONE answer** (15 points)

$$\frac{100\text{ g CO}}{28.01\text{ g}} \left|\frac{1\text{ mol}}{}\right. = \frac{3.57\text{ mol CO}}{3\text{ mol CO}} \left|\frac{2\text{ mol Al}}{}\right. = \frac{2.38\text{ mol Al}}{1\text{ mol}} \left|\frac{26.98\text{ g}}{}\right. = 64.22\text{ g Al}$$

$$\frac{115\text{ g } Al_2O_3}{101.96\text{ g}} \left|\frac{1\text{ mol}}{}\right. = \frac{1.1278\text{ mol } Al_2O_3}{1\text{ mol } Al_2O_3} \left|\frac{2\text{ mol Al}}{}\right. = \frac{2.2557\text{ mol Al}}{1\text{ mol}} \left|\frac{26.98\text{ g}}{}\right. =$$

answer → 60.86 g Al

16. What is the limiting reactant in Question #15? (5 points)

Al_2O_3

17. Please determine the amount in **grams** of the non-limiting reactant that will be leftover after the reaction in Question #15 has taken place. (8 points)

$$\frac{115\text{ g } Al_2O_3}{101.96\text{ g}} \left|\frac{1\text{ mol}}{}\right. = \frac{1.1278\text{ mol } Al_2O_3}{1\text{ mol } Al_2O_3} \left|\frac{3\text{ mol CO}}{}\right. = 3.3836\text{ mol CO}$$

$$\frac{3.3836\text{ mol CO}}{1\text{ mol}} \left|\frac{28.01\text{ g}}{}\right. = 94.777\text{ g CO used}$$

$$100 - 94.777 =$$

5.223 g CO leftover

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Percent Yield Calculations

18. If a reaction was predicted to produce 85 grams of NH_3, but when the reaction is carried out in the lab only 52 grams are produced, what is the percent yield of the reaction in the lab? (5 points)

$$\frac{52}{85} \times 100 = 61.18\%$$

19. If a reaction produced 115 grams of NH_3 in the lab, and the student calculated using stoichiometry that the reaction would produce 128 grams, what is the percent yield of the reaction in the lab? (5 points)

$$\frac{115}{128} \times 100 = 89.84\%$$

20. Using your answer from Question # 12, determine the percent yield of the reaction if when carried out in the lab 75.0 grams of water was produced by the reaction. (6 points)

$$\frac{75}{82.74} \times 100 = 90.6\%$$

21. Using your answer from Question # 15, determine the percent yield of the reaction if when carried out in the lab 55.0 grams of aluminum was produced by the reaction. (6 points)

$$\frac{55}{60.86} \times 100 = 90.4\%$$

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Gas Stoichiometry

22. What volume of water vapor is produced by the complete reaction of 3 liters of butane (C_4H_{10}) according to the following balanced chemical reaction at 29°C and 2.5 atm of pressure: 2 C_4H_{10} (g)+ 13 O_2 (g)→ 8CO_2 (g) + 10 H_2O (g)? (10 points)

$\frac{(2.5)(3)}{(.0821)(302)} = 0.3025 \text{ mol } C_4H_{10} \left| \frac{10 \text{ mol } H_2O}{2 \text{ mol } C_4H_{10}} \right. = 1.512 \text{ mol } H_2O$

$\frac{(1.512)(.0821)(302)}{2.5} = 15 \text{ L } H_2O$

23. What volume of carbon dioxide is produced by the complete reaction of 13 liters of naphthalene ($C_{10}H_8$) according to the following balanced chemical reaction at 24°C and 0.9 atm of pressure: $C_{10}H_8$ (g) + 12 O_2 (g)→ 10 CO_2 (g)+ 4 H_2O (g) ? (10 points)

$\frac{(0.9)(13)}{(.0821)(297)} = .4798 \text{ mol } C_{10}H_8 \left| \frac{10 \text{ mol } CO_2}{1 \text{ mol } C_{10}H_8} \right. = 4.798 \text{ mol } CO_2$

$\frac{(4.798)(.0821)(297)}{.9} = 130 \text{ L } CO_2$

The following are worth 4 points each.

24. What is Stoichiometry?

Using a balanced equation to calculate the relative masses of reactants and products for a reaction.

25. What is the molar volume of a gas?

22.4 L = 1 mol @ STP

26. What does a limiting reactant do in a reaction?

runs out and stops the reaction

27. How is a balanced equation different from an unbalanced equation?

balanced equations have coefficients that show relative moles of reactants and products

28. What are the conditions of STP?

0°C + 1 atm

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Atomic and Molar Masses

(Note: Masses are given for <u>all</u> substances on the test, regardless if they are needed or not!)

Al = 26.98 grams /1 mole

Al_2O_3 = 101.96 grams /1 mole

C_4H_{10} =58.12 grams / 1 mole

C_6H_6 = 78.11 grams / 1 mole

$C_{10}H_8$= 128.16 grams / 1 mole

CO = 28.01 grams / 1 mole

CO_2 = 44.01 grams / 1 mole

H_2O = 18.02 grams / 1 mole

NH_3 = 17.03 grams / 1 mole

O_2 = 32.00 grams / 1 mole

Kelvin = °C + 273