Chem25, Winter 2012, Foothill College, LecTest3 Name KEY

Please read all the questions VERY carefully before answering. Ask your instructor if you don not understand. No outside paper is allowed. The last page is a periodeic table with constants. Total points = ~~57~~ 47 + (21 * 3 =) 63 = 110

SHORT ANSWER. Please write the set-up equation first, then put the raw data with units before calculating. Write the word or phrase that best completes each statement or answers the question.

1) Iron, Fe(s) reacts with oxygen gas, $O_2(g)$ to produce Fe_2O_3 (s). Calculate moles of Fe_2O_3 produced from 2.3 moles of Fe (4 pts.)

1) 1.2 mol Fe_2O_3

$$4\,Fe(s) + 3\,O_2(g) \rightarrow 2\,Fe_2O_3(g)$$

$$2.3\,\text{mol Fe} \times \frac{2\,\text{mol } Fe_2O_3}{4\,\text{mol Fe}} = 1.2\,\text{mol } Fe_2O_3$$

2) In the reaction between Fe_2O_3 (s) and Al (s) to produce Fe (s) and Al_2O_3 (s), 23.5 g of Fe_2O_3 was reacted with 13.2 g of Al. (a) Show all your calculations to find out the limiting reagent (8 pts.)

2) Fe_2O_3

$$Fe_2O_3(s) + 2\,Al(s) \rightarrow 2\,Fe(s) + Al_2O_3(s)$$

$$23.5\,g\,Fe_2O_3 \times \frac{1\,\text{mol } Fe_2O_3}{(2\times 55.845 + 3\times 16)\,g\,Fe_2O_3} \times \frac{2\,\text{mol Fe}}{1\,\text{mol } Fe_2O_3} = 0.294\,\text{mol Fe}$$

$$13.2\,g\,Al \times \frac{1\,\text{mol Al}}{26.982\,g\,Al} \times \frac{2\,\text{mol Fe}}{2\,\text{mol Al}} = 0.489\,\text{mol Fe}$$

23.5 g of Fe_2O_3 can only produce 0.294 mol of Fe while 13.2 g of Al is able to produce 0.489 mol of Fe. Fe_2O_3 is limiting reagent

(b) Calculate the amount (in grams) of the reagent that remained unreacted (6 pts.)

$$23.5\,g\,Fe_2O_3 \times \frac{1\,\text{mol } Fe_2O_3}{159.69\,g\,Fe_2O_3} \times \frac{2\,\text{mol Al}}{1\,\text{mol } Fe_2O_3} \times \frac{26.982\,g\,Al}{1\,\text{mol Al}} = 7.94\,g\,Al \text{ used}$$

Unreacted = 13.2 g Al initial − 7.94 g Al reacted = **5.26 g Al unreacted**

3) Calculate the volume of NH_3 (g) in liters at 729°C and 4.5 atm pressure that is required to react with 2.52 moles of O_2(g) according to reaction, 4 NH_3(g) + 5 O_2(g) -----> 4 NO(g) + 6 H_2O(g) (8 pts.)

3) 36.9 L NH_3 (g)

$$2.52 \text{ mol } O_2 \times \frac{4 \text{ mol } NH_3}{5 \text{ mol } O_2} = 2.02 \text{ mol } NH_3$$

$n = 2.02$ mol
$P = 4.5$ atm
$T = 729°C + 273 = 1002$ K
$R = 0.0821 \frac{L \cdot atm}{mol \cdot K}$
$V = ?$ L

$$PV = nRT$$
$$V = \frac{nRT}{P} = \frac{(2.02 \text{ mol})(0.0821 \frac{L \cdot atm}{mol \cdot K})(1002 K)}{4.5 \text{ atm}} = 36.9 L$$

4) A ball has a volume of 120.3 cm^3 and it contains 0.25 g of N_2 gas. Calculate the pressure inside the ball at 31°C (6 pts.)

4) 1.8 atm

$$n = 0.25 \text{ g } N_2 \times \frac{1 \text{ mol } N_2}{28 \text{ g } N_2} = 0.0089 \text{ mol } N_2$$

$$V = 120.3 \text{ mL} \times \frac{1 L}{1000 \text{ mL}} = 0.1203 L$$

$T = 31°C + 275 = 304$ K
$R = 0.0821 \frac{L \cdot atm}{mol \cdot K}$
$P = ?$ atm

$$PV = nRT$$
$$P = \frac{nRT}{V}$$
$$= \frac{(0.0089 \text{ mol } N_2)(0.082 \frac{L \cdot atm}{mol \cdot K})(304 K)}{0.1203 L}$$
$$= 1.8 \text{ atm}$$

5) An inflated baloon has a volume of 6.0 L at 1 atm pressure and at 22°C. Calculate its volume when it ascends to an altitude where the pressure is 0.45 atm and the temperature is -21°C. (5 pts.)

5) 11 L

$P_1 = 1$ atm
$T_1 = 22°C + 273 = 295$ K
$V_1 = 6.0$ L
$P_2 = 0.45$ atm
$T_2 = -21°C + 273 = 252$ K
$V_2 = ?$ L

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$
$$V_2 = \frac{P_1 V_1 T_2}{T_1 P_2} = \frac{(1 \text{ atm})(6.0 L)(252 K)}{(295 K)(0.45 \text{ atm})} = 11 L$$

6) When nitrogen (N_2) gas is collected by decomposing NH_4NO_2 (s) ------> N_2(g) + 2 H_2O(g), its volume is 3.27 mL at 19.5°C and 753.0 mm of mercury pressure. Calculate how many grams of NH_4NO_2 was decomposed. Vapor pressure of water at 19.5°C is 17.0 torr. (10 pts.)

6) 8.45×10^{-3} g NH_4NO_2

$P_{N_2} = 753.0 \text{ mm Hg} - 17.0 \text{ mm Hg} = 736 \text{ mm Hg} \times \frac{1 \text{ atm}}{760 \text{ mm Hg}} = 0.968 \text{ atm}$

$V = 3.27 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 0.00327 \text{ L}$

$T = 19.5°C + 273 = 292.5 \text{ K}$

$R = 0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}$

$PV = nRT$

$n = \frac{PV}{RT} = \frac{(0.968 \text{ atm})(0.00327 \text{ L})}{(0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}})(292.5 \text{ K})} = 0.000132 \text{ mol } N_2$

$0.000132 \text{ mol } N_2 \times \frac{1 \text{ mol } NH_4NO_2}{1 \text{ mol } N_2} \times \frac{(1 \times 4 + 14 \times 2 + 16 \times 2) \text{ g } NH_4NO_2}{1 \text{ mol } NH_4NO_2} = 8.45 \times 10^{-3} \text{ g } NH_4NO_2$

7) An evacuated flask weighs 134.567 g. When filled with an unknown gas at 735 torr and 31°C , it weighs 137.456 g. If the flask is filled with water at 31°C, it weighs 1067.9 g. If the ideal gas law applies and the density of water at 31°C is 0.997 g/mL, then calculate the molar mass (in grams per mole) of the unknown gas. (10 pts.) {Extra pt. question}

7) 79.6 g/mol

$D = \frac{m}{V} \quad V = \frac{m}{D} \quad V_{flask} = \frac{1067.9 \text{ g} - 134.567 \text{ g}}{0.997 \text{ g/mL}} = 936 \text{ mL} \times \frac{1 \text{ L}}{1000 \text{ mL}} = 0.936 \text{ L}$

$P = 735 \text{ torr} \times \frac{1 \text{ atm}}{760 \text{ torr}} = 0.967 \text{ atm}$

$T = 31°C + 273 = 304 \text{ K}$

$PV = nRT$

$n = \frac{PV}{RT} = \frac{(0.967 \text{ atm})(0.936 \text{ L})}{(0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}})(304 \text{ K})} = 0.0363 \text{ mol unknown gas}$

Weight gas = 137.456 g − 134.567 g = 2.889 g

Unknown gas = $\frac{2.889 \text{ g}}{0.0363 \text{ mol}} = 79.6 \text{ g/mol}$

MULTIPLE CHOICE. On the scantron, fill up the circle with the same number as the question number. Choose the one alternative that best completes the statement or answers the question (3 pts each).

8) When the equation $\_4NO_2 + \_2H_2O + \_1O_2 \rightarrow \_4HNO_3$ is balanced, the coefficient of HNO_3 is 8) D

A) 5.
B) 3.
C) 2.
D) 4.
E) none of the above

9) What are the coefficients for the following reaction when it is properly balanced? 9) B
$\_2O_2 + \_1CH_4 \rightarrow \_1CO_2 + \_2H_2O$

A) 2, 1, 3, 1
B) 2, 1, 1, 2
C) 2, 3, 2, 2
D) 1, 3, 2, 1
E) none of the above

10) Which of the following equations is NOT balanced properly? 10) A
A) $4NH_3 + 14O_2 \rightarrow 4NO_2 + 6H_2O$
B) $2Cr + 6HCl \rightarrow 2CrCl_3 + 3H_2$
C) $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$
D) $Cr_2(SO_4)3 + 6KOH \rightarrow 2Cr(OH)3 + 3\ K_2SO_4$
E) none of the above

11) Which of the following compounds is INSOLUBLE? 11) D
A) magnesium bromide
B) potassium acetate
C) lithium carbonate
D) aluminum sulfide
E) none of the above

12) All of the following compounds are soluble in water EXCEPT 12) C
A) NH_4Cl. B) NaCl. C) $PbCl_2$. D) $CaCl_2$. E) $FeCl_3$.

13) A precipitate is expected to be formed when an aqueous solution of sodium sulfate is added to an aqueous solution of 13) A
$(Na_2SO_4^{2-})$
A) barium chloride.
B) potassium chloride.
C) iron(III) chloride.
D) magnesium chloride.
E) none of the above

14) What type of a reaction occurs when a silver nitrate solution is mixed with sodium chloride solution? 14) C

$Ag^+NO_3^- + Na^+Cl^- \rightarrow NaNO_3 + AgCl$

A) oxidation-reduction
B) acid-base neutralization
C) precipitation
D) gas evolution
E) no reaction

15) What type of reaction is the generic equation AB → A + B? 15) A

A) decomposition
B) synthesis/combination
C) single displacement
D) double-displacement
E) none of the above

16) If the theoretical yield of the reaction below corresponds to 99.2 g and the actual yield was 60.9 g, calculate the percent yield. 16) A

Given: $Li_2O + H_2O \rightarrow 2\ LiOH$

$\frac{60.9}{99.2} \times 100 =$

A) 61.4 %
B) 71.8 %
C) 16.0 %
D) 38.0 %
E) none of the above

17) Starting with 156 g Li_2O and 33.3 g H_2O, decide which reactant is present in limiting quantities. 17) C

Given: $Li_2O + H_2O \rightarrow 2\ LiOH$

$156\,g\ Li_2O \times \frac{1\ mol\ Li_2O}{(2\times 6.941 + 16)\,g\ Li_2O} \times \frac{2\ mol\ LiOH}{1\ mol\ Li_2O} = 10.4\ mol$

$33.3\,g\ H_2O \times \frac{1\ mol\ H_2O}{(2\times 1.01 + 16)\,g\ H_2O} \times \frac{2\ mol\ LiOH}{1\ mol\ H_2O} = 3.69$

A) lithium oxide
B) lithium hydroxide
C) water
D) insufficient data
E) none of the above

18) Which of the following types of compounds will NOT undergo a gas evolution reaction when acid is added? 18) D

A) carbonates
B) bisulfites
C) sulfides
D) hydroxides
E) none of the above

19) Which of the following statements about pressure is FALSE? 19) E

A) After creating a pressure difference, the atmospheric pressure can push liquid up a straw.
B) A deep well dug in the ground must have the pump located at the bottom of well in order to have the water come to the surface.
C) Pressure is caused by gas molecules colliding with surfaces.
D) The atmosphere has a pressure as the components of air collide with surfaces.
E) All of the above statements are true.

20) What is the equivalent pressure of 0.905 atm in units of mm Hg? 20) A

A) 688
B) 0.905
C) 13.3
D) 840
E) none of the above

$0.905\ atm \times \frac{760\ mm\ Hg}{1\ atm}$

21) If the initial pressure of a system was 1.00 atm and the volume was halved and the temperature was tripled, what is the final pressure? 21) D

A) 0.667 atm
B) 2.00 atm
C) 1.50 atm
D) 6.00 atm
E) not enough information

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $P_2 = \frac{P_1V_1T_2}{T_1V_2}$

$P_2 = \frac{(1\ atm)(1L)(3K)}{(1K)(0.5L)} =$

22) A 3.76 g sample of a noble gas is stored in a 2.00 L vessel at 874 torr and 25°C. What is the noble gas? 22) C
(R= 0.0821 L atm/ mol K)

A) He
B) Ne
C) Ar
D) Kr
E) not enough information

$874\ torr \times \frac{1\ atm}{760\ torr} = 1.15\ atm$ $PV = nRT$

$25°C + 273 = 298\ K$

$n = \frac{PV}{RT} = \frac{(1.15\ atm)(2.00L)}{(0.0821 \approx)(298K)} = 0.094\ mol$ $\frac{3.76g}{0.094mol}$ $40\ g/mol$

23) The vapor pressure of water at 20.0°C is 17.5 mm Hg. If the pressure of a gas collected over water was measured to be 453.0 mm Hg. What is the pressure of the pure gas? 23) D

A) 0.596 atm
B) 0.0230 atm
C) 0.619 atm
D) 0.573 atm
E) none of the above

$453.0 - 17.5 = 435.5\ mm\ Hg \times \frac{1}{760} =$

24) What is the theoretical yield of waffles if you have 5 cups of flour, 9 eggs and 3 tbs of oil? 24) A
Given: 2 cups flour + 3 eggs + 1 tbs oil → 4 waffles

A) 10
B) 12
C) 4
D) 6
E) not enough information

$5\ cups \times \frac{4\ waf}{2\ cups} = 10$ $9\ egg \times \frac{4}{3\ egg} = 12$ $3\ tbs \times \frac{4}{1\ tbs} = 12$

TRUE/FALSE. On the scantron, fill up circle "A" for a true answer and "B" for wrong answer (3 pts each).

25) Combustion reactions are a subcategory of oxidation-reduction reactions. 25) A

26) A precipitate will form when you mix solutions of potassium chloride and lead nitrate. 26) A

27) A spectator ion is one that does not actively participate in a chemical reaction. 27) A

28) There is a large distance between gas particles as compared to their relative size. 28) A