Practice Exam 2

These questions were taken from actual exams given to my 110 class in 2001; the test is of comparable difficulty and APPROXIMATE length to what you will see

Take this exam as if it were a REAL Exam!

Part 1. Calculation/Short Answer Problems (Values as shown). All work for the following must be done in THIS TEST BOOKLET. Answers with no work will receive zero points. Your work must be clear and logical AND SHOWN to receive maximum (OR ANY) credit.

A. The solid rocket boosters for the space shuttle employ a mixture of aluminum (molar mass = 26.98 g/mole) and ammonium perchlorate (molar mass = 117 g/mole) as fuel. The balanced reaction is

\[3\text{Al}(s) + 3\text{NH}_4\text{ClO}_4(s) \rightarrow \text{Al}_2\text{O}_3(s) + \text{AlCl}_3(s) + 3\text{NO}(g) + 6\text{H}_2\text{O}(g)\]

How many liters of gas measured at STP are produced from 235 grams of NH4ClO4 with excess aluminum?

B. A mixture is prepared from 15.0 L of ammonia and 15.0 L chlorine measured at the same conditions; these compounds react according to the following equation:

\[2\text{NH}_3(g) + 3\text{Cl}_2(g) \rightarrow \text{N}_2(g) + 6\text{HCl}(g)\]

When the reaction is completed, what is the volume of each gas (NH3, Cl2, N2, and HCl, respectively)? Assume the final volumes are measured under identical conditions.

C. A 1.00 g sample of a gaseous compound containing only boron and hydrogen occupies 0.820 L at 1.00 atm and 3°C. What is the molecular formula for the compound?

Part 2. Multiple Choice Problems (Points each as indicated). Select the best answer from the choices given and mark it on your ANSWER SHEET!

1. How many grams of oxygen are required to burn 8.8 g of C3H8? The equation for this reaction is:

\[\text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}\]

a. 8 b. 12 c. 16 d. 32 e. 64

2. A molecular compound contains 92.3% carbon and 7.7% hydrogen by weight. If 0.050 mol of the compound weighs 3.90 g, what is its molecular formula?

a. CH b. C2H2 c. C3H6
d. C6H6 e. C6H7

3. Which one of the following contains 9.03 \times 10^{23} \text{ atoms}

a. 16.0 g O2 b. 4.00 g He c. 28.0 g N2
d. 22.0 g CO2 e. 8.0 g CH4
4. The total pressure of a mixture of gases is
   a) obtained by multiplying the individual pressures by the number of moles and averaging.
   b) the sum of the partial pressures of the components.
   c) dependent only upon the pressure of the gas which is present to the greatest extent.
   d) the product of the individual pressures.
   e) none of these.

5. Consider a cylinder fitted with a movable piston. The initial pressure inside the cylinder is \( P_i \) and the initial volume is \( V_i \). What is the new pressure in the system when the piston decreases the volume of the cylinder by half?
   a) \( \frac{1}{4}P_i \)   b) \( \frac{1}{2}P_i \)   c) \( 2P_i \)   d) \( 2V_iP_i \)   e) \( P_i \)

6. A 4.40-g piece of solid CO\(_2\) (dry ice) is allowed to sublime (the process by which a solid goes directly into the gas phase) in a balloon. The final volume of the balloon is 1.00 L at 300 K. What is the pressure of the gas?
   a) 2.46 atm   b) 246 atm   c) 0.122 atm   d) 122 atm   e) none of these

7. At 1000°C and 10 torr, the density of a certain element in the gaseous state is \( 2.9 \times 10^{-3} \) g/L. The element is:
   a) Ne   b) He   c) Na   d) Ar   e) Hg

8. An element, X, has the following isotopic composition: \( X-200, 90\% \); \( X-199, 8.0\% \); and \( X-202, 2.0\% \). Its atomic mass is closest to
   a. 199 amu.   b. 200 amu.   c. 201 amu.
   d. 202 amu.   e. It cannot be determined.

9. Fluorotoluene contains 76.34% carbon, 6.41% hydrogen, and 17.25% fluorine. Each molecule of fluorotoluene contains one fluorine atom. The total number of carbon, hydrogen, and fluorine atoms in one molecule of fluorotoluene is

10. Chlorine was passed over 1.10 g of heated titanium and 3.54 g of a chloride of Ti was obtained. What is the empirical formula of the chloride?
    a. TiCl   b. Ti\(_3\)Cl\(_3\)   c. TiCl\(_2\)
    d. TiCl\(_3\)   e. TiCl\(_4\)

11. A molecular compound contains 92.3% carbon and 7.7% hydrogen by weight. If 0.050 mol of the compound weighs 3.90 g, what is its molecular formula?
    a. CH   b. C\(_2\)H\(_2\)   c. C\(_3\)H\(_6\)
    d. C\(_4\)H\(_6\)   e. C\(_3\)H\(_7\)

12. Calculate the volume occupied by 10.0 moles of chlorine gas at STP.
    A. 22.4 L   B. 112 L   C. 448 L
    D. 245 L   E. 224 L

13. Which of the following gases has the highest density at STP?
    A. sulfur trioxide, SO\(_3\)   B. carbon dioxide   C. NO\(_2\)
    D. argon   E. nitrogen
14. The volume of 2.81 g of an unknown gas is 2.25 L at STP. What is the molar mass of the gas?

A. 17.9 g/mol  B. 100 g/mol  C. 50.4 g/mol
D. 28.0 g/mol  E. 142 g/mol

Attached to this is an equation sheet you will receive with your exam...BE SURE TO NOTICE WHAT EQUATIONS ARE ON IT AS WELL AS WHICH EQUATIONS ARE NOT!!!

Constants and most conversions will be given. NO metric to metric conversions will be given!

D) (25 Pts) Manganese in an ore can be determined by treating the ore with a measured, excess quantity of sodium oxalate (Na$_2$C$_2$O$_4$) to reduce MnO$_2$(s) to MnCl$_2$(aq) followed by determination of the unreacted sodium oxalate by titration with potassium permanganate. The equations for this two step process are:

\[ \text{MnO}_2(\text{s}) + \text{Na}_2\text{C}_2\text{O}_4(\text{aq}) + 4\text{HCl}(\text{aq}) \rightarrow \text{MnCl}_2(\text{aq}) + 2\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) + 2\text{NaCl}(\text{aq}) \]

\[ 2\text{KMnO}_4(\text{aq}) + 5\text{Na}_2\text{C}_2\text{O}_4(\text{aq}) + 16\text{HCl}(\text{aq}) \rightarrow 2\text{MnCl}_2(\text{aq}) + 10\text{CO}_2(\text{g}) + 8\text{H}_2\text{O}(\text{l}) + 10\text{NaCl}(\text{aq}) + 2\text{KCl}(\text{aq}) \]

If a sample is treated with 50.0 mL of 0.275 M Na$_2$C$_2$O$_4$(aq) and the unreacted Na$_2$C$_2$O$_4$(aq) requires 18.28 mL of 0.1232 M KMnO$_4$(aq), calculate the number of grams of manganese in the sample. (HINT: it may help you to write the NET ionic equation for each FIRST)

2. Which of the following pairs of solutions will give a precipitate when mixed?

A. Hg(CH$_3$COO)$_2$(aq) and NH$_4$Cl(aq)  B. Hg$_2$(CH$_3$COO)$_2$(aq) and NaI(aq)
C. K$_2$SO$_4$(aq) and Cu(NO$_3$)$_2$(aq)  D. NaCH$_3$COO(aq) and Hg(ClO$_4$)$_2$(aq)
E. AgNO$_3$(aq) and LiClO$_4$(aq)
\[ \Delta X = X_{\text{final}} - X_{\text{initial}} \]
\[ \Delta X = \left( \sum n_i X_i \right)_{\text{products}} - \left( \sum n_j X_j \right)_{\text{reactants}} \]

1 J = 1 N\cdot m = 1 \text{ kg}\cdot \text{m}^2/\text{sec}^2

\[ \Delta H_{\text{reverse}} = -\Delta H_{\text{forward}} \]
\[ \Delta H_{\text{sub}} = \Delta H_{\text{fus}} + \Delta H_{\text{vap}} \]
\[ \Delta H_{\text{freeze}} = -\Delta H_{\text{fus}} \]
\[ \Delta E = -\frac{h \mathcal{R} Z^2}{n^2} \]
\[ \Delta E = h \mathcal{R} Z^2 \left( \frac{1}{n_i^2} - \frac{1}{n_u^2} \right) \]
\[ \Delta E = h \nu \]
\[ \lambda \nu = c \]
\[ \lambda = \frac{h}{mv} \]
\[ q_{\text{abs}} + q_{\text{rel}} = 0 \]
\[ q = C_p \cdot \Delta T \]
\[ C_p = m \cdot C_{SP} \]
\[ \Delta T = T_{\text{final}} - T_{\text{initial}} \]
\[ \Pi = iRTM \]
\[ M_{\text{init}} V_{\text{init}} = M_{\text{final}} V_{\text{final}} \]

\[ KE = \frac{1}{2} mv^2 \]
\[ t_{\text{effuse}} (A) = \frac{MM_A}{MM_B} \]
\[ PV = nRT \]
\[ P_T = P_A + P_B + P_C + \ldots + P_n \]
\[ v \propto \sqrt{\frac{T}{MM}} \]

1 Hz = 1 cycle/sec = 1 sec\(^{-1}\)

\[ MM = g/mol \]

Pressure = force/area

Molar Volume of a gas: \[ V_m = V/n_{\text{gas}} \]
\[ V = \text{mass/density} = m/d \]
\[ d = \text{mass/volume} \]

Coulomb Potential \( \propto \frac{q_1 \times q_2}{r} \)
\[ \frac{n_A}{n_{\text{tot}}} = \frac{P_A}{P_{\text{tot}}} \]
\[ \frac{\text{rate}_A}{\text{rate}_B} = \sqrt{\frac{MM_B}{MM_A}} \]