

**Note: There are 7 questions in this exam (check both sides of the sheet).**

**Fill in your answer in the blank space provided immediately following each question. 1/2 point will be subtracted every time you report a numerical result with an incorrect number of significant figures. The last 3 sheets of this exam contains information that may or may not be needed to answer these questions. SHOW WORK!**

1. (18) a. (6) What volume of a 0.2000 M  $K_2Cr_2O_7$  solution do we need in order to prepare 100 mL of 0.0400 M  $K_2Cr_2O_7$  solution?

$$M_c V_c = M_d V_d \Rightarrow V_c = (0.0400 \text{ M} \times 100 \text{ mL}) / 0.2000 \text{ M} = 20 \text{ mL}$$

b. (6) We have a sample of gas at 285 °C. To what Celsius temperature must the gas be heated to double its pressure if there is no change in the volume of the gas?

$$T_i = 285 + 273 = 558 \text{ K} \quad P_f = 2 P_i$$

$$P_i V = n R T_i$$

$$\Rightarrow T_i / T_f = P_i / P_f = 1/2 \Rightarrow T_f = 2 T_i = 1116 \text{ K} \quad , \text{ or } 843 \text{ } ^\circ\text{C}$$

$$P_f V = n R T_f$$

c. (6) Assign oxidation numbers to N in each of the following compounds:

$N_2$	: 0
$NO_2$	: +4
$N_2O_3$	: +3
$HNO_2$	: +3
$N_2H_4$	: -2
$NH_3$	: -3

2. (13) A student prepares a solution of HCl and wishes to determine its concentration. A 25.00 mL portion of this solution is titrated with 0.0775 M NaOH solution. It is found that 37.46 mL of the NaOH solution are needed for complete neutralization. What is the molarity of the HCl solution?

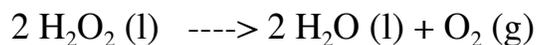


$$\text{Moles of NaOH: } 37.46 \times 10^{-3} \text{ L} \times 0.0775 \text{ mol/L} = 2.90 \times 10^{-3}$$

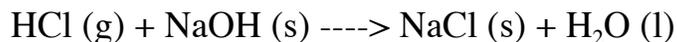
$$= \text{moles of HCl that reacted}$$

$$\text{So, molarity of HCl solution: } 2.90 \times 10^{-3} \text{ mol} / 25 \times 10^{-3} \text{ L} = 0.116 \text{ M}$$

3. (12) Using your datasheet, find the standard enthalpy of the following reactions and indicate whether they are exothermic or endothermic:



$$\Delta H^\circ = \{2\text{X}(-285.9) + 0\} - \{2\text{X}(-187.6)\} = -196.6 \quad \text{exothermic}$$



$$\Delta H^\circ = \{(-411.0) + (-285.9)\} - \{(-92.3) + (-426.8)\} = -177.8 \quad \text{exothermic}$$

4. (13) A certain ore contains lead in the form of  $\text{PbCO}_3$ . A sample of the ore weighing 1.526 g was first treated with nitric acid to dissolve all the lead and then with  $\text{Na}_2\text{SO}_4$ . This gave a precipitate of  $\text{PbSO}_4$ , which was dried and found to weigh 1.081 g. Assuming that all the lead has precipitated, what is the percentage by mass of Pb in the ore?

**Molar mass of  $\text{PbSO}_4$  :  $207.2 + 32.07 + 4 \times 16.00 = 303.27 \text{ g/mol}$**

**Pb contained in  $\text{PbSO}_4$ :**

**$1.081 \text{ g PbSO}_4 \times (207.2 \text{ g Pb}) / (303.27 \text{ g PbSO}_4) = 0.7386 \text{ g Pb}$**

**0.7386**

**----- X 100% = 48.40 %**

**1.526**

5. (13) How many mL of oxygen are required to react completely with 175.0 mL of butane if the volumes of both gases are measured at the same temperature and pressure? The reaction is (from first exam) :



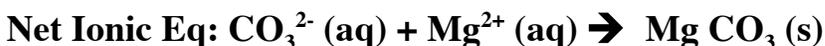
**Since T,P are the same, ratio of moles is equal to the ratio of volumes:**

**Say 1 is butane, 2 is oxygen:**

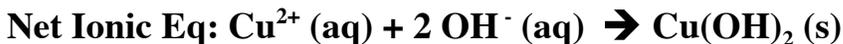
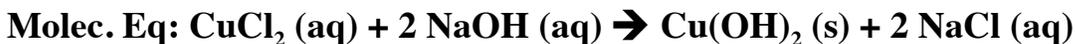
$$V_1/V_2 = n_1/n_2 = 2/13 \Rightarrow V_2 = 13/2 \times V_1 = 1138 \text{ mL}$$

6. (18) Use the solubility rules to predict whether or not a precipitation reaction will occur when the following aqueous solutions are mixed. Write the molecular and the net ionic equation for each reaction that does occur.

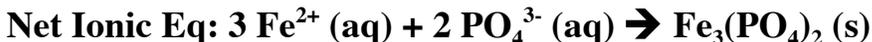
a)  $(\text{NH}_4)_2\text{CO}_3$  (aq) is mixed with  $\text{MgCl}_2$  (aq)



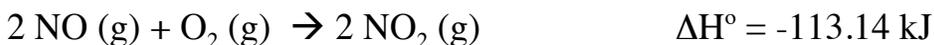
b)  $\text{CuCl}_2$  (aq) is mixed with  $\text{NaOH}$  (aq)



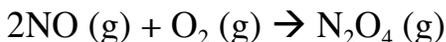
c)  $\text{FeSO}_4$  (aq) is mixed with  $\text{Na}_3\text{PO}_4$  (aq)



7. (13) Use the following thermochemical equations,



to obtain the standard enthalpy of the reaction:



**Flip the first equation and add to the second:**

