

**City College, Chemistry Department
Chemistry 10301, sections L and L2, Prof. T. Lazaridis
Second Midterm exam, Oct. 26, 2000**

Name (last name first): _____

I.D. Number: _____

Workshop leader: _____

**Note: There are 9 questions in this exam (check both sides of the sheet).
Fill in your answer in the blank space provided immediately following each
question. One point will be subtracted every time you report a numerical result
with an incorrect number of significant figures. The last sheet of this exam
contains information that may or may not be needed to answer these questions.**

1. a. (3) Will a nail made of iron dissolve in a calcium chloride solution?
(Hint: use information provide on your data sheet)

Iron is below calcium in the activity series. It will not dissolve

- b. (4) How many grams of glucose do you need to dissolve in 100 mL
of water to make a solution of molarity 3.00 M? The molar mass
of glucose is 180.2 g/mol.

$$3.00 \text{ mol/L} \times 0.100 \text{ L} \times 180.2 \text{ g/mol} = 54.1 \text{ g}$$

- c. (4) Write a balanced chemical equation for the neutralization of
Ba(OH)₂ by hydrochloric acid. (You don't need to indicate the
states of the reactants and products)



- d. (4) What volume of a 14.8 M ammonia solution do we need in order
to prepare 2.0 L of a 2.0 M ammonia solution?

Say V is the needed volume.

$$2.0 \text{ L} \times 2.0 \text{ mol/L} = V \times 14.8 \text{ mol/L} \Rightarrow V = 0.27 \text{ L}$$

2. (10) How many liters of oxygen at 25 °C and 750 torr and needed for the
combustion of 2.0 g of propane (C₃H₈)? (R=0.0821 atm L/mol K)

Molar mass of propane : 3*12.01 + 8*1.008 = 44.09 g/mol

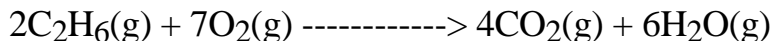


$$\frac{2.0 \text{ g}}{44.09 \text{ g/mol}} \times \frac{5 \text{ mol O}_2}{1 \text{ mol C}_3\text{H}_8} = 0.227 \text{ mol O}_2 \text{ are required}$$

Ideal gas law: V= nRT/P =

$$\frac{0.227 \text{ mol} \times 0.0821 \text{ atm L/mol K} \times (273.15+25) \text{ K}}{750 \text{ torr} \times 1\text{atm}/760 \text{ torr}} = 5.6 \text{ L} \text{ (2 signif fig)}$$

3. (10) What is the standard enthalpy of the following reaction at 25 °C:



(Hint: use information on your data sheet)

Using the table of enthalpies of formation:

$$\Delta\text{H}^\circ = 6 \text{ mol X } (-241.8 \text{ kJ/mol}) + 4 \text{ mol X } (-393.5 \text{ kJ/mol}) - 2 \text{ mol X } (-84.7 \text{ kJ/mol}) = -2855.4 \text{ kJ}$$

4. (10) A 20.0 g bar of an unknown metal at 90.0 °C is dropped into 100 mL of water at 25.0 °C. The final temperature of the system is 26.1 °C. Estimate the specific heat of the unknown metal. The density of water is 1.00 g/cm³. (Hint: use information on your data sheet)

From Table 6.6 the specific heat of water at 25 C is 4.179 J/g °C

Say S is the specific heat of the unknown metal.

$$\text{Heat} = 100 \text{ mL X } 1.00 \text{ g/mL X } 4.179 \text{ J/g}^\circ\text{C X } (26.1-25.0) \text{ }^\circ\text{C}$$

$$= 20.0 \text{ g X } S \text{ X } (90.0-26.1) \text{ }^\circ\text{C}$$

$$\Rightarrow S = 0.360 \text{ J/g }^\circ\text{C}$$

5. (15) 5.0 g of a sample containing CaCl₂ along with other substances is dissolved in water together with potassium sulfite (K₂SO₃) and gives insoluble calcium sulfite, which, after drying, is found to weigh 2.1 g. The molar mass of calcium sulfite is 120.14 g/mol and of CaCl₂ is 110.99 g/mol.

(a) (4) Write a balanced chemical equation for the reaction



(b) (4) Write the net ionic equation for the reaction



(c) (7) Find the percentage by mass of CaCl_2 in the original sample.

$$\begin{aligned} 2.1 \text{ g} / 120.14 \text{ (g/mol)} &: \text{ moles of } \text{CaSO}_3 = \text{ moles of } \text{CaCl}_2 \\ &\times 110.99 \text{ g/mol} = 1.94 \text{ g } \text{CaCl}_2 \end{aligned}$$

$$\frac{1.94}{5.0} \times 100\% = 39\% \quad (\text{the final number has 2 significant figures})$$

6. A gas held at constant pressure of 1 atm is heated with an electrical wire of power 10 Watts for 10 minutes and its volume increases by 0.50 L. (1 Watt= 1J/s) ($R = 8.3145 \text{ J/mol K} = 0.0821 \text{ atm L/ mol K}$)

(a) (5) In the first law of thermodynamics, what is q , w , and ΔE in Joule?

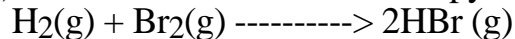
$$\begin{aligned} q &= 10 \text{ J/s} \times 10 \text{ min} \times 60 \text{ s/min} = + 6000 \text{ J} \\ w &= -P\Delta V = -1 \text{ atm} \times 0.5 \text{ L} = -0.50 \frac{8.3145}{0.0821} \text{ J} = -51 \text{ J} \end{aligned}$$

$$\Delta E = q + w = +6000 - 51 = + 5949 \text{ J}$$

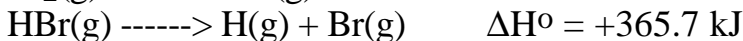
(b) (5) What is the change in enthalpy of the gas

It is a constant pressure process, therefore $\Delta H = q = +6000 \text{ J}$

7. (10) Calculate the standard enthalpy of the reaction



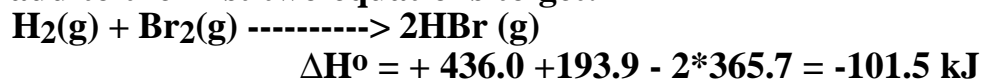
using the following data:



Invert the last equation and multiply by 2:



Then add to the first two equations to get:

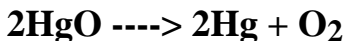


8. (10) Mercury(II) oxide is heated and decomposed into oxygen and mercury. The oxygen is collected over water to give a total pressure of 730.0 torr at 50 °C in 500 mL volume. How many moles of mercury oxide have decomposed in this reaction? ($R=0.0821$ atm L/mol K) (Hint: use information on your data sheet)

From Table 5.4, $P_{H_2O} = 92.51$ torr $\Rightarrow P_{O_2} = 730.0 - 92.51 = 637.5$ torr

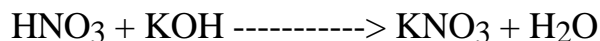
Ideal gas law: $P_{O_2} V = n_{O_2} RT \Rightarrow$

$$n_{O_2} = \frac{637.5 \text{ torr} \times 1 \text{ atm}/760 \text{ torr} \times 0.500 \text{ L}}{0.0821 \text{ atm L/mol K} (273.15 + 50)} = 0.0158 \text{ mol}$$



This corresponds to 0.0316 mol HgO.

9. (10) A 100 mL solution of 1.50 M KOH was added to a 100 mL solution of 1.50 M HNO₃ in a polystyrene cup:



The enthalpy of reaction is -57.10 kJ/mol. If the resulting temperature change was +9.50 °C, what is the heat capacity of the calorimeter (cup plus water) in J/°C?

150 mol/ L X 0.100 L = 0.150 mol of HNO₃ and 0.150 mol of KOH (stoichiometric ratio)

$$0.150 \times (-57.10) = -8.565 \text{ kJ} = \text{heat capacity} \times 9.50 \text{ K}$$
$$\Rightarrow \text{heat capacity} = 902 \text{ J/K}$$