FINAL EXAM REVIEW PRACTICE (12 POINTS)

This practice review will be considered replacement points for the final exam.

Chapter 12. Chemical Kinetics

1. What is the rate law for the reaction 2A + 2B + 2C → products **(0.5 pts)**

Initial [A], M	*Initial [B], M*	*Initial [C], M*	*Rate (M/s)*
0.273	0.763	0.400	3.0
0.819	0.763	0.400	9.0
0.273	1.526	0.400	12.0
0.273	0.763	0.800	6.0

a) *rate* $= k[A][B][C]$
b) *rate* $= k[A][B]^2[C]$
c) *rate* $= k[A]^3[B]^4[C]^2$
d) *rate* $= k[A]^2[B]^2[C]^2$

2. *Consider the reaction:* $2\ NO + 2\ H_2 \longrightarrow N_2 + 2\ H_2O$ *and the following data in order to answer the questions a-c.* **(1.0 pts)**

Exp	*Initial [NO]*	*Initial [H_2]*	$\left(\frac{d\,[NO}{d\,t}\right)_{t=0}$ M•s^{-1}
1	*1.00*	*1.00*	3.5×10^{-5}
2	*1.20*	*1.20*	6.1×10^{-5}
3	*0.80*	*0.80*	1.8×10^{-5}
4	*1.00*	*2.00*	7.0×10^{-5}
5	*2.00*	*1.00*	1.4×10^{-4}

a) Determine the rate law for this reaction consistent with the above data.

b) Determine the rate constant for this reaction consistent with the rate law you determined at a)

3. *Initial rate data for the reaction follows.* **(0.5 pts)** $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$

Experiment	$[N_2O_5]_0$	$[O_2]_0$	*Initial Rate in* $M \cdot s^{-1}$
1	*0.15 M*	*0.30 M*	*46*
2	*0.20 M*	*0.60 M*	*61*
3	*0.20 M*	*0.30 M*	*61*

What is the rate law for this reaction?

(A) rate = $k[N_2O_5]$

(B) rate = $k[[N_2O_5]^2$

(C) rate = $k[N_2O_5]^{1.3}[O_2]^2$

D) rate = $k[N_2O_5]^2[O_2]$

4. Nitrogen and oxygen gas react to produce poisonous nitrogen monoxide. Assume the activation energy for the forward reaction is 270 kJ. (**2.0 pts**)

N_2 (g) + O_2(g) → 2 NO(g) ΔH = +90 kJ/mol

a. In the box provided, sketch and completely label a potential energy diagram for this reaction. Be sure to label the;
   1. potential energy of the reactants
   2. potential energy of the products
   3. enthalpy (heat) of reaction
   4. activated complex
   5. activation energy of the forward and reverse reactions.

b. Classify the forward reaction as endothermic or exothermic. Justify your choice.

c. Consider the activation energy of the forward reaction. Is the forward reaction fast or slow? Why?

d. What is the value of E_a for the reverse reaction? _____

e. What is the relationship between ΔH, $E_{a,fwd}$ and $E_{a,rev}$_____

Chapter 13 & 14. Equilibrium & Acids, Bases

5. What is the K_a of a weak acid (HA) if a 0.19M solution has a pH of 4.52? **(1.0 pts)**

Chapter 15: Applications of Aqueous Equilibria

6. *A* solution is prepared by mixing 2.00 g propionic acid, $HC_3H_5O_2$ (MW = 74 g/mol, $K_a = 1.3 \times 10^{-5}$) with 0.45 g of solid NaOH (MW = 40 g/mol) in water to make 500.0 mL. **(2.0 pts)**

   a) Write the complete chemical equation including phases for the neutralization reaction that occurs. Use on of the following arrows: $\rightleftharpoons$ or $\xrightleftharpoons{}$ or $\rightarrow$, to show the equilibrium of the reaction.

   b) Write any electrolytes in the above neutralization ***product*s** in their dissociated form.

   c) Calculate moles of NaOH added:

   d) Calculate moles of propionic acid added:

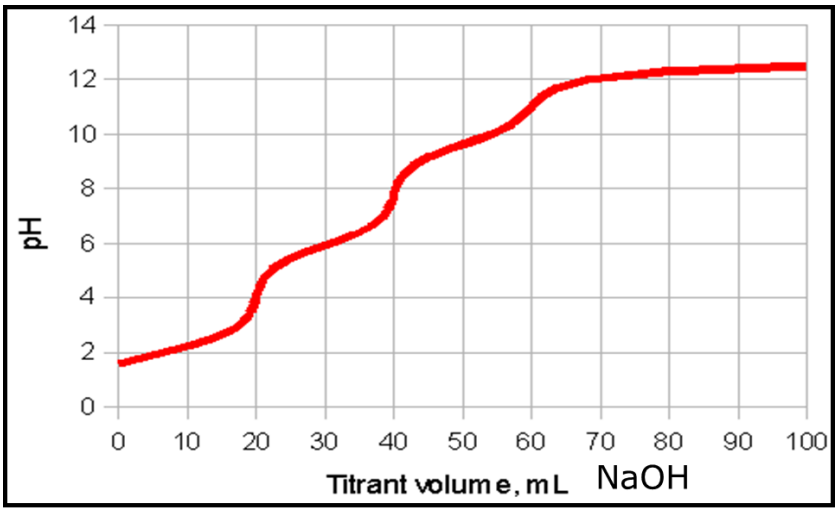
   e) Determine the pH of the resulted solution?

5. A 35.00 mL sample of 0.2500 M HCl is titrated with 0.440 M NaOH. Calculate the pH after the following amounts of base have been added. (**1.5 pts**)

   a. 10.00 mL; b. 20.00 mL; c. 30.00 mL

   Show work:

6. A volume of 10.0 mL of 0.10 M H_3PO_4 was titrated with 0.10 M NaOH. The pH response to addition of various amounts of NaOH is shown in the graph below. Answer the questions **A-F**. **(1.5 pts)**



A. The titration curve shown above describes the:

a. titration of a triprotic base.
b. titration of a diprotic acid.
c. titration of a triprotic acid.
d. titration of a diprotic base.

B. Use letters A & B to label on the graph the first two half titration points and read the value of pK_{a1} and the value of pK_{a2}? _____

C. Use letters C& D to label on the graph the first and the second equivalence points?

D. At what pH would you want your indicator color change to occur at in order to titrate to the first equivalence point?____

E. At point **A** the ratio of $[H_3PO_4]/[H_2PO_4^-]$ is:

a) 1 b) 2 c) 3 d) 4

F. When more than 15.0 mL of titrant have been added in the titration curve above, the pH can be determined by assuming there is:

a) a weak base in solution.
b) excess strong acid added to solution.
c) a buffer with $H_2PO_4^-$ and HPO_4^{2-}.
d) excess strong base added to solution.

7. The addition of solid Na_2SO_4 to an aqueous solution in equilibrium with solid $BaSO_4$ will cause: (*Circle one*) **(0.25 pts)**

a) no change in $[Ba^{2+}]$ in solution.
b) more BaSO4 to dissolve.
c) precipitation of more BaSO4.
D) an increase in the K_{sp} of BaSO4.

8. If two salts, **AX** and **BX**$_2$, have the same K_{sp} values of 4.0×10^{-12} at a given temperature, then (*Circle one*) **(0.25 pts)**

a) their molar solubilities in water are the same.
b) the salts are more soluble in 0.1 M Na**X** than in water.
c) the molar solubility of **AX** in water is less than that of **BX**2.
d) addition of Na**X** will not affect the solubilities of the salts.

Chapter 16. Thermodynamics

9. Consider the reaction of decomposition of calcium carbonate, ($CaCO_3(s)$) to form calcium oxide ($CaO(s)$ and $CO_2(g)$ under standard conditions and 25.0°C. **(1.5 pts)**

Compound	**$\Delta_f G°$ / kJ/mol**	**$\Delta H_f°$/kJ/mol**	**S°/J/(K•mol)**
$CaCO_3(s)$	-1129.1	-1207.6	91.7
$CO_2(g)$	-394.4	-393.5	213.6
$CaO(s)$	-603.3	-634.9	38.1

a) Write the balanced chemical equation for this reaction.

b) What is the enthalpy change of reaction per gram of calcium carbonate? **Give your final answer in J/g.**

c) Is this process spontaneous under standard conditions? **Answer this question with calculation using two methods (prove that free energy of the system is negative and entropy of universe positive).**