

Chemistry 114
Fourth Hour Exam

Name: _____

1. (12 points) The pH of the fluid in your stomach drops to about 2 when you start digesting a meal.

A. What is the concentration H^+ in stomach fluid?

$$\begin{aligned}2 &= -\log [H^+] \\-2 &= \log [H^+] \\10^{-2} &= 1 \times 10^{-2} [H^+]\end{aligned}$$

B. What is the pOH of your stomach fluid?

$$\begin{aligned}14 &= \text{pH} + \text{pOH} \\14 &= 2 + \text{pOH} \\14 - 2 &= \text{pOH} \\ \text{pOH} &= 12\end{aligned}$$

C. What is the concentration of OH^- in stomach fluid

$$\begin{aligned}12 &= -\log[OH^-] \\-12 &= \log[OH^-] \\1 \times 10^{-12} &= [OH^-]\end{aligned}$$

2. (13 points) What is the pH of a solution that is .055M Triethylamine? (The K_b of triethylamine is 4.0×10^{-4})

$$4.0 \times 10^{-4} = \frac{[BH^+][OH^-]}{[B]}$$

$$x = [BH^+] = [OH^-]$$

$$4.0 \times 10^{-4} = \frac{x^2}{.055 - x}$$

assume $.055 - x \approx .055$

$$4.0 \times 10^{-4} = \frac{x^2}{.055}; \quad x^2 = 4.0 \times 10^{-4} \times .055$$

$$x = \sqrt{2.2 \times 10^{-5}}; \quad x = 4.69 \times 10^{-3}, \quad \text{pOH} = 2.33, \quad \text{pH} = 11.67$$

The assumption $.055 - x \approx .055$ is not great

$$\text{solving} \quad 4.0 \times 10^{-4} = \frac{x^2}{.055 - x}; \quad X = .0045, \quad \text{pOH} = 2.35, \quad \text{pH} = 11.65$$

3. (13 points) Arrange the following 0.1M solutions in order from most acidic to most basic.



Most Acidic



Most Basic

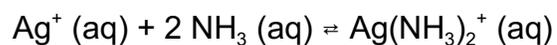


Most Acidic



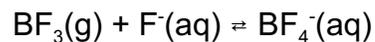
Most Basic

4. (12 points) Identify the Lewis acid and Lewis base in each of the following reactions:



Acid Ag⁺

Base NH₃



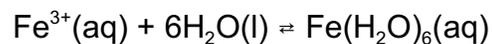
Acid BF₃

Base F⁻



Acid HgI₂

Base I⁻



Acid Fe³⁺

Base H₂O

5. (12 points) I have a 100. mls of a 0.10M Acetic Acid solution. I am going to add to this solution 75 mls of .090M KOH. What is the pH of the mixture? (The K_a of acetic acid is 1.8×10^{-5})

$$\text{Moles acetic acid} = \text{HA} = .1\text{l} \times .1\text{M} = .01 \text{ moles}$$

$$\text{Moles OH}^- = .075\text{l} \times .09\text{M} = .00675 \text{ mole}$$

Reaction table

	HA +	OH ⁻ →	A ⁻ +	H ₂ O
Initial	.01	.00675	0	skip
Reaction	-.00675	-.00675	+.00675	skip
Net	.00325	0	.00675	skip

Now have a mix of HA and A⁻, this is a buffer so use the Henderson Hasselbach Equation: $\text{pH} = \text{p}K_a + \log (\text{A}^-/\text{HA})$

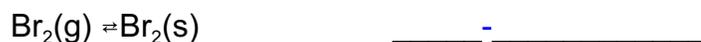
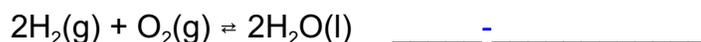
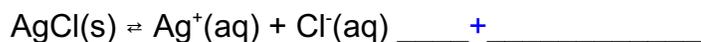
$$\text{p}K_a = -\log(1.8 \times 10^{-5}) = 4.74$$

$$\text{pH} = 4.74 + \log [(.00675/.175)/(.00325/.175)] = 5.06$$

6. (6 points) What are the three laws of thermodynamics?

1. Energy cannot be created or destroyed
2. For any spontaneous process the entropy of the universe increases
3. The entropy of a perfect crystal at 0K is zero.

7. (6 points) Predict the sign of ΔS° for each of the following changes



8. (13 points) Given the data in the table below, calculate ΔS° for the reaction
 $2\text{H}_2\text{S}(\text{g}) + \text{SO}_2(\text{g}) \rightleftharpoons 3\text{S}_{\text{Rhombic}}(\text{s}) + 2\text{H}_2\text{O}(\text{g})$

Substance (state)	$S^\circ(\text{J/K}\cdot\text{mol})$
$\text{S}_{\text{rhombic}}(\text{s})$	32
$\text{S}_{\text{monoclinic}}(\text{s})$	33
$\text{S}^{2-}(\text{aq})$	-15
$\text{H}_2\text{S}(\text{g})$	170
$\text{H}_2\text{S}(\text{l})$	65
$\text{SO}_2(\text{g})$	248
$\text{H}_2\text{O}(\text{g})$	189

$$\begin{aligned}\Delta S_{\text{RXN}} &= \sum n_p \Delta S_p^\circ - \sum n_r \Delta S_r^\circ \\ &= [3(32) + 2(189)] - [2(170) + 1(248)] \\ &= 474 - 588 \\ &= -114 \text{ J/K}\end{aligned}$$

9. (13 points) Given the values of ΔH and ΔS and T below, answer the following questions:

	ΔH	ΔS	T	$\Delta G = \Delta H - T\Delta S$
A.	+25 kJ	+5.0 J/K·mol	300.K	$25000 - 300(5) = 23500$
B.	+25 kJ	+100 J/K·mol	300.K	$25000 - 300(100) = -5000$
C.	-10 kJ	+5.0 J/K·mol	298.K	$-10000 - 298(5) = -11490$
D.	-10 kJ	-40 J/K·mol	200.K	$-10000 + 200(40) = -2000$

Which of the above processes are spontaneous at constant P and T ?

(A, B, C, or D, there may be more than one answer) B,C,D (-ΔG)

In which of the above processes does the entropy of the system increase?

(A, B, C, or D, there may be more than one answer) A,B,C (+ΔS)

In which of the above process does the entropy of the surroundings increase?

(A, B, C, or D, there may be more than one answer) C,D (-ΔH)

In which of the above process does the entropy of the universe increase?

(A, B, C, or D, there may be more than one answer) B,C,D (-ΔG)