

Chem 1B Midterm 1

Version B

Credit will only be given for answers on this sheet. Units must be included in your answers and points will be taken off for incorrect or missing units. No partial credit will be awarded. Calculators are allowed. Cell phones may not be used as calculators.

Name:	Perm Number

Make sure your writing is **dark** and **large** enough to be picked up by a scanner. Failure to do this results in the loss of 5 points on the exam.

If you are sitting next to someone with the same version of the test, you both will lose 5 points on the exam.

If you are still writing after time is called, you will lose 5 points on the exam.

Fundamentals	
Question (Points)	Answer
1 (6 pts)	NH ₄ Cl
2 (7 pts)	1.5 mL
3 (7 pts)	0.72
4 (6 pts)	8x10 ¹⁸
5 (6 pts)	0.54
6 (6 pts) 3 each	13.70
	7.0

Multiple Choice	
Question (Points)	Answer
7 (6 pts) 2 each	☐ A ☒ B
	☐ A ☒ B
	☐ A ☒ B
8 (6 pts) 2 each section	H ₂ ☐ increase ☒ decrease ☐ (no change)
	Cl ₂ ☐ increase ☒ decrease ☐ (no change)
	HCl ☒ increase ☐ decrease ☐ (no change)
	H ₂ ☐ increase ☒ decrease ☐ (no change)
	Cl ₂ ☐ increase ☒ decrease ☐ (no change)
	HCl ☒ increase ☐ decrease ☐ (no change)
	H ₂ ☒ increase ☐ decrease ☐ (no change)
	Cl ₂ ☒ increase ☐ decrease ☐ (no change)
	HCl ☐ increase ☒ decrease ☐ (no change)
9 (8 pts) 2 each	☐ ionic ☒ molecular ☒ s. acid ☐ w. acid ☐ s. base ☐ w. base
	☐ ionic ☒ molecular ☐ s. acid ☐ w. acid ☐ s. base ☒ w. base
	☒ ionic ☐ molecular ☐ s. acid ☐ w. acid ☐ s. base ☐ w. base
	☐ ionic ☒ molecular ☐ s. acid ☒ w. acid ☐ s. base ☐ w. base
10 (6 pts)	☐ A ☐ B ☒ C ☐ D
11 (6 pts)	☐ A ☒ B ☐ C
12 (10 pts) 2 each	☐ A ☐ B ☒ C
	☒ A ☐ B ☐ C
	☒ A ☐ B ☐ C
	☐ A ☒ B ☐ C
	☐ A ☐ B ☒ C

Challenge Problems	
Question (Points)	Answer
13 (10 pts)	NO ₂ : 0.704 atm N ₂ O ₄ : 0.12 atm
14 (10 pts)	4.9

Fundamental Questions

- 1) 6 pts A solution is tested for pH and conductivity as pictured to the right:
Note: the bulb is very bright. The solution contains one of the following substances: HCl, NaOH, NH_4Cl , HCN, NH_3 , HF, or NaCN. If the solute concentration is about 1.0 M, what is the identity of the solute?



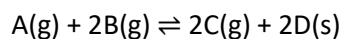
- 2) 7 pts A chemist must prepare 350.0 mL of nitric acid solution with a pH of at 1.60 at 25°C.
He will do this in three steps:
- Fill a 350.0 mL volumetric flask about halfway with distilled water.
 - Measure out a small volume of concentrated (6.0 M) stock nitric acid solution and add it to the flask.
 - Fill the flask to the mark with distilled water.
- Calculate the volume of concentrated nitric acid that the chemist must measure out in the second step. Round your answer to 2 significant digits.
- 3) 7 pts A sample of gaseous PCl_5 was introduced into an evacuated flask so that the pressure of PCl_5 would be 0.50 atm at 523K. However, PCl_5 decomposed to gaseous PCl_3 and Cl_2 , and the actual pressure in the flask was found to be 0.84 atm. Calculate K_p for the decomposition reaction.



At 523K.

- 4) 6 pts Given the following equilibrium constants at 427°C
- | | |
|---|---------------------------|
| $\text{Na}_2\text{O(s)} \rightleftharpoons 2\text{Na(l)} + \frac{1}{2}\text{O}_2\text{(g)}$ | $K_1 = 2 \times 10^{-25}$ |
| $\text{NaO(g)} \rightleftharpoons \text{Na(l)} + \frac{1}{2}\text{O}_2\text{(g)}$ | $K_2 = 2 \times 10^{-5}$ |
| $\text{Na}_2\text{O}_2\text{(s)} \rightleftharpoons 2\text{Na(l)} + \text{O}_2\text{(g)}$ | $K_3 = 5 \times 10^{-29}$ |
| $\text{NaO}_2\text{(s)} \rightleftharpoons \text{Na(l)} + \text{O}_2\text{(g)}$ | $K_4 = 3 \times 10^{-14}$ |
- Determine the value for the equilibrium constant for
- $$2\text{NaO(g)} \rightleftharpoons \text{Na}_2\text{O}_2\text{(s)}$$

- 5) 6 pts The equilibrium constant K for the following reaction at 50.°C is 14.2. What is K_p at this temperature?



- 6a) 3 pts What is the pH of the following:
0.25 M Ba(OH)_2

- 6b) 3 pts 1×10^{-12} M HCl

Multiple Choice

- 7) 6 pts You may need your constant sheet to answer the following
Which is the stronger base?

A. Cl^- B. H_2O

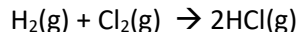
Which is the stronger base?

A. H_2O B. NO_2^-

Which is the stronger base?

A. CN^- B. OC_6H_5^-

- 8) 6 pts A chemical engineer is studying the following reaction:



At the temperature the engineer picks, the equilibrium constant K_p for this reaction is 0.74.

The engineer charges ("fills") three reaction vessels with hydrogen and chlorine, and lets the reaction begin. He then measures the composition of the mixture inside each vessel from time to time. His first set of measurements are shown in the table below.

Predict the changes in the compositions the engineer should expect *next* time he measures the compositions

reaction vessel	compound	pressure	expected change in pressure		
A	H_2	3.27 atm	↑ increase	↓ decrease	(no change)
	Cl_2	4.84 atm	↑ increase	↓ decrease	(no change)
	HCl	2.44 atm	↑ increase	↓ decrease	(no change)
B	H_2	3.31 atm	↑ increase	↓ decrease	(no change)
	Cl_2	4.88 atm	↑ increase	↓ decrease	(no change)
	HCl	2.36 atm	↑ increase	↓ decrease	(no change)
C	H_2	2.55 atm	↑ increase	↓ decrease	(no change)
	Cl_2	4.12 atm	↑ increase	↓ decrease	(no change)
	HCl	3.88 atm	↑ increase	↓ decrease	(no change)

- 9) 8 pts Some chemical compounds are listed in the first column of the table below. Each compound is soluble in water.

Imagine that a few tenths of a mole of each compound is dissolved in a liter of water. The important chemical species that would be present in this solution are written in the second column of the table. Use the checkboxes to classify each compound.

compound	important species present when dissolved in water	type of compound (select all that apply)					
		ionic	molecular	strong acid	weak acid	strong base	weak base
HNO_3	H_3O^+ , NO_3^- , H_2O						
$\text{C}_2\text{H}_5\text{NH}_2$	$\text{C}_2\text{H}_5\text{NH}_3^+$, OH^- , $\text{C}_2\text{H}_5\text{NH}_2$, H_2O						
KNO_3	K^+ , NO_3^- , H_2O						
HNO_2	H_3O^+ , NO_2^- , HNO_2 , H_2O						

- 10) 6 pts What is the $[\text{OH}^-]$ concentration of a solution of HCl with a pH of 3.40?
- 10.60
 - 4.0×10^{-4}
 - 2.5×10^{-11}
 - None of the above
- 11) 6 pts The following K_p values were collected for a system
- $$K_p = 6.8 \times 10^5 \quad 25^\circ\text{C}$$
- $$K_p = 1.9 \times 10^{-4} \quad 400^\circ\text{C}$$
- What side of the equation is the heat on?
- Reactants
 - Products
 - Not enough information
- 12) 10 pts Consider the following equilibrium
- $$\text{H}_2(\text{g}) + \text{I}_2(\text{s}) \rightleftharpoons 2\text{HI}(\text{g}) \quad \Delta H = 68.0 \frac{\text{kJ}}{\text{mol}} \text{ (endothermic reaction)}$$
- Identify which way the reaction will predominantly run in to reestablish equilibrium when the following changes are made to the system.
- | | | |
|-----------------------|-------------|-------------------|
| Adding I_2 | | |
| A. Reactants | B. Products | C. At Equilibrium |
| Removing H_2 | | |
| A. Reactants | B. Products | C. At Equilibrium |
| Reducing the volume | | |
| A. Reactants | B. Products | C. At Equilibrium |
| Heating the system | | |
| A. Reactants | B. Products | C. At Equilibrium |
| Adding Ar | | |
| A. Reactants | B. Products | C. At Equilibrium |

Challenge Problems

- 13) 10 pts The partial pressures of an equilibrium mixture of $\text{N}_2\text{O}_4(\text{g})$ and $\text{NO}_2(\text{g})$ are $P_{\text{N}_2\text{O}_4} = 0.34 \text{ atm}$ and $P_{\text{NO}_2} = 1.20 \text{ atm}$ at a certain temperature. The volume of the container is doubled. Find the partial pressures of the two gases when a new equilibrium is established.

- 14) 10 pts Calculate the pH at 25°C of a 0.33 M solution of ammonium bromide, NH_4Br . Note that ammonia NH_3 is a weak base with a pK_b of 4.75. Round your answer to 1 decimal place.