

## 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.

<b>Name:</b>	<b>Perm Number</b>

**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.**

<b>Fundamentals</b>			
<b>Question (Points)</b>	<b>Answer</b>		
<b>1</b> (7 pts)	4.05		
<b>2</b> (8 pts) 4 each	13.70		
	7.0		
<b>3</b> (6 pts) 2 each	$[\text{H}_2\text{CO}_3] = 0.14 \text{ M}$	$[\text{H}^+] = 1.9 \times 10^{-6} \text{ M}$	$[\text{CO}_3^{2-}] = 9.4 \times 10^{-7} \text{ M}$
<b>4</b> (6 pts)	$2.5 \times 10^{81}$		
<b>5</b> (7 pts)	93.3%		
<b>6</b> (6 pts) 1.5 each	Solution 1: <input type="radio"/> 1 <input type="radio"/> 2 <input checked="" type="radio"/> 3 <input type="radio"/> 4		
	Solution 2: <input type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input checked="" type="radio"/> 4		
	Solution 3: <input checked="" type="radio"/> 1 <input type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4		
	Solution 4: <input type="radio"/> 1 <input checked="" type="radio"/> 2 <input type="radio"/> 3 <input type="radio"/> 4		

Multiple Choice	
Question (Points)	Answer
<b>7</b> (7 pts)	<input type="radio"/> A <input type="radio"/> B <input checked="" type="radio"/> C <input type="radio"/> D <input type="radio"/> E <input type="radio"/> F <input type="radio"/> G
<b>8</b> (6 pts) 1.5 each	<input checked="" type="radio"/> A <input type="radio"/> B <input type="radio"/> C
	<input type="radio"/> A <input type="radio"/> B <input checked="" type="radio"/> C
	<input type="radio"/> A <input checked="" type="radio"/> B <input type="radio"/> C
	<input type="radio"/> A <input type="radio"/> B <input checked="" type="radio"/> C
<b>9</b> (7 pts)	<input checked="" type="radio"/> A <input type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/> E
<b>10</b> (7 pts)	<input type="radio"/> A <input checked="" type="radio"/> B <input type="radio"/> C <input type="radio"/> D <input type="radio"/> E
<b>11</b> (6 pts)	<input type="radio"/> A <input type="radio"/> B <input checked="" type="radio"/> C <input type="radio"/> D <input type="radio"/> E
<b>12</b> (6 pts)	H <sub>2</sub> <input type="radio"/> increase <input checked="" type="radio"/> decrease <input type="radio"/> (no change)
	I <sub>2</sub> <input type="radio"/> increase <input checked="" type="radio"/> decrease <input type="radio"/> (no change)
	HI <input checked="" type="radio"/> increase <input type="radio"/> decrease <input type="radio"/> (no change)
	H <sub>2</sub> <input checked="" type="radio"/> increase <input type="radio"/> decrease <input type="radio"/> (no change)
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	HI <input type="radio"/> increase <input checked="" type="radio"/> decrease <input type="radio"/> (no change)
	H <sub>2</sub> <input checked="" type="radio"/> increase <input type="radio"/> decrease <input type="radio"/> (no change)
	I <sub>2</sub> <input checked="" type="radio"/> increase <input type="radio"/> decrease <input type="radio"/> (no change)
HI <input type="radio"/> increase <input checked="" type="radio"/> decrease <input type="radio"/> (no change)	

Challenge Problems	
Question (Points)	Answer
<b>13</b> (9 pts)	0.00411
<b>14</b> (12 pts) 2 each	[H <sup>+</sup> ] = 1.0x10 <sup>-7</sup> M
	[OH <sup>-</sup> ] = 1.0x10 <sup>-7</sup> M
	pH = 7.0
	[H <sup>+</sup> ] = 2.7x10 <sup>-9</sup> M
	[OH <sup>-</sup> ] = 3.7x10 <sup>-6</sup> M
	pH = 8.57

### Fundamental Questions

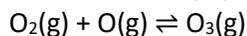
1) 7 pts When a 0.039 M aqueous solution of a certain acid is prepared, the acid is 0.23% dissociated. Calculate the pH of the solution. Round your answer to 2 decimal places.

2a) 4 pts What is the pH of the following:  
0.25 M Ba(OH)<sub>2</sub>

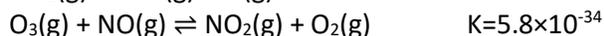
2b) 4 pts 1×10<sup>-12</sup> M HCl

3) 6 pts The following equilibrium is known to occur:  
$$\text{H}_2\text{CO}_3(\text{aq}) \rightleftharpoons 2\text{H}^+(\text{aq}) + \text{CO}_3^{2-}(\text{aq}) \quad K=2.4 \times 10^{-17}$$
  
What are the concentrations at equilibrium if initially there is only 0.14 M H<sub>2</sub>CO<sub>3</sub> present?

- 4) 6 pts Calculate the value of the equilibrium constant, K, for the reaction:



Given



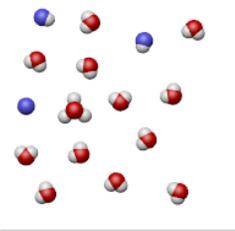
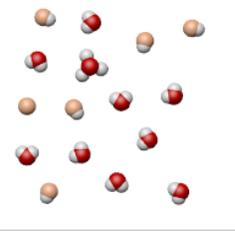
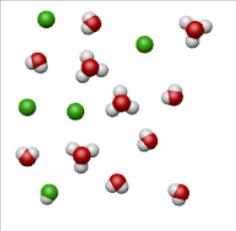
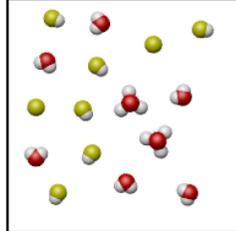
- 5) 7 pts For the reaction below  $K_p = 1.16$  at  $700^\circ\text{C}$ .



If a 10.1 g sample of  $\text{CaCO}_3$  is put into a 6.5 L container and heated to  $700^\circ\text{C}$ , what percent of the  $\text{CaCO}_3$  will react to reach equilibrium?

- 6) 6 pts Four solutions of an acid dissolved in water are sketched below, as if under a microscope so powerful individual atoms could be seen. The same volume of solution is shown in each sketch. Rank the solutions by the strength of the dissolved acid. That is, write 1 under the solution of the strongest acid, 2 under the solution of the next strongest acid, and so on.

Note:  =  $\text{H}_2\text{O}$

Solution 1	Solution 2	Solution 3	Solution 4
			
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

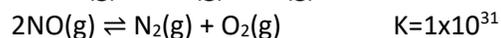
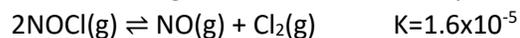
### Multiple Choice

- 7) 7 pts A solution is tested for pH and conductivity as pictured below:

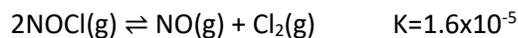


Note: the bulb is very bright. The solution contains one of the following substances: HCl, NaOH,  $\text{NH}_4\text{Cl}$ , HCN,  $\text{NH}_3$ , HF, or NaCN. If the solute concentration is about 1.0 M, what is the identity of the solute?

- A. HCl
  - B. NaOH
  - C.  $\text{NH}_4\text{Cl}$
  - D. HCN
  - E.  $\text{NH}_3$
  - F. HF
  - G. NaCN
- 8) 6 pts Consider the following reactions at some temperature:



For each reaction some quantities of the reactants were placed in separate containers and allowed to come to equilibrium. Describe the relative amounts of reactants and products that are present at equilibrium. At equilibrium, which is faster, the forward or reverse reaction in each case?

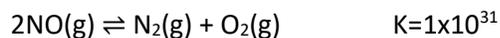


What is present?

- A. More reactants      B. More products      C. Neither

At equilibrium, which is faster?

- A. Forward reaction rate      B. Reverse reaction rate      C. Neither



What is present?

- A. More reactants      B. More products      C. Neither

At equilibrium, which is faster?

- A. Forward reaction rate      B. Reverse reaction rate      C. Neither

- 9) 6 pts The acids  $\text{HC}_2\text{H}_3\text{O}_2$  and  $\text{HF}$  are both weak, but  $\text{HF}$  is a stronger acid than  $\text{HC}_2\text{H}_3\text{O}_2$ .  $\text{HCl}$  is a strong acid. Order the following according to base strength.
- A.  $\text{C}_2\text{H}_3\text{O}_2^- > \text{F}^- > \text{H}_2\text{O} > \text{Cl}^-$   
 B.  $\text{F}^- > \text{C}_2\text{H}_3\text{O}_2^- > \text{H}_2\text{O} > \text{Cl}^-$   
 C.  $\text{C}_2\text{H}_3\text{O}_2^- > \text{F}^- > \text{Cl}^- > \text{H}_2\text{O}$   
 D.  $\text{Cl}^- > \text{F}^- > \text{C}_2\text{H}_3\text{O}_2^- > \text{H}_2\text{O}$   
 E. None of the above

- 10) 7 pts The pH of a 0.10 M solution of a weak base is 9.82. What is the  $K_b$  for the base?
- A.  $2.1 \times 10^{-4}$   
 B.  $4.3 \times 10^{-8}$   
 C.  $6.6 \times 10^{-4}$   
 D.  $2.0 \times 10^{-5}$   
 E. None of the above

- 11) 7 pts What is the pH of a 0.18 M base solution whose conjugate acid has a  $K_a = 2.8 \times 10^{-8}$ ?
- A. 3.29  
 B. 9.85  
 C. 10.40  
 D. 13.25  
 E. None of the above

- 12) 6 pts A chemical engineer is studying the following reaction:  $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightarrow 2\text{HI}(\text{g})$   
 At the temperature the engineer picks, the equilibrium constant  $K_p$  for this reaction is 1.1.  
 The engineer charges ("fills") three reaction vessels with hydrogen and iodine, and lets the reaction begin. She then measures the composition of the mixture inside each vessel from time to time. Her first set of measurements are shown in the table below. Predict the changes in the compositions the engineer should expect *next* time she measures the compositions.

reaction vessel	compound	pressure	expected change in pressure		
A	$\text{H}_2$	5.93 atm	<input type="radio"/> ↑ increase	<input type="radio"/> ↓ decrease	<input type="radio"/> (no change)
	$\text{I}_2$	6.04 atm	<input type="radio"/> ↑ increase	<input type="radio"/> ↓ decrease	<input type="radio"/> (no change)
	$\text{HI}$	5.38 atm	<input type="radio"/> ↑ increase	<input type="radio"/> ↓ decrease	<input type="radio"/> (no change)
B	$\text{H}_2$	3.83 atm	<input type="radio"/> ↑ increase	<input type="radio"/> ↓ decrease	<input type="radio"/> (no change)
	$\text{I}_2$	3.91 atm	<input type="radio"/> ↑ increase	<input type="radio"/> ↓ decrease	<input type="radio"/> (no change)
	$\text{HI}$	5.29 atm	<input type="radio"/> ↑ increase	<input type="radio"/> ↓ decrease	<input type="radio"/> (no change)
C	$\text{H}_2$	3.73 atm	<input type="radio"/> ↑ increase	<input type="radio"/> ↓ decrease	<input type="radio"/> (no change)
	$\text{I}_2$	3.81 atm	<input type="radio"/> ↑ increase	<input type="radio"/> ↓ decrease	<input type="radio"/> (no change)
	$\text{HI}$	5.50 atm	<input type="radio"/> ↑ increase	<input type="radio"/> ↓ decrease	<input type="radio"/> (no change)

### Challenge Problems

- 13) 9 pts Sulfur trioxide decomposed at 1000K via the following reaction:



A sealed container is initially charged with  $\text{SO}_3(\text{g})$  at a partial pressure of 0.500 atm. At equilibrium the  $\text{SO}_3$  partial pressure is 0.200 atm. Calculate the value of K at this temperature.

14a) 6 pts Determine  $[\text{OH}^-]$ ,  $[\text{H}^+]$ , and the pH of each of the following solutions  
1.0 M KCl

14b) 6 pts 1.0 M KF