

# CHEM 188 – Spring, 2012

## Final Exam (Red)

May 11, 2012

### Instructions:

Your scantron answer sheet must show your **NAME**, **STUDENT ID NUMBER**, and **LAB SECTION**. (Begin these entries at the **LEFT** end of the space provided.)

In answering the questions, be careful to fill in the corresponding circles on the answer sheet according to the number of the question on the exam. **USE A SOFT (No. 2) PENCIL.**

Note that a **periodic table** of the elements is attached at the end of the exam.

You are allowed to use a one page (8½"x11") study guide that you have prepared.

Useful information: Gas constant **R = 0.0821 L·atm/K·mol = 8.314 J/K·mol**

Avogadro's constant **N<sub>Avo</sub> = 6.02 × 10<sup>23</sup> mol<sup>-1</sup>**

Speed of light **c = 3.00 × 10<sup>8</sup> m·s<sup>-1</sup>**

Boltzmann's constant **k = 1.38 × 10<sup>-23</sup> J·K<sup>-1</sup>**

Planck's constant **h = 6.63 × 10<sup>-34</sup> J·s**

**1 atm = 760 mmHg = 760 torr**

**1 L·atm = 101.3 J**

**1 kg = 6.02 × 10<sup>26</sup> amu**

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1. Consider the reaction



Suppose that the rate of loss of molecular hydrogen,  $-\frac{d[\text{H}_2]}{dt}$ , is 0.060 M/s at a particular time during the reaction. What is the rate of loss of molecular nitrogen,  $-\frac{d[\text{N}_2]}{dt}$ ?

**A. 0.020 M/s**    B. 0.030 M/s    C. 0.060 M/s    D. 0.12 M/s    E. 0.18 M/s

2. Consider the hypothetical reaction  $\text{A} + 2\text{B} \rightarrow \text{products}$ . Use the following data to determine the **rate** of the reaction when  $[\text{A}] = 0.25 \text{ M}$  and  $[\text{B}] = 0.15 \text{ M}$ .

Expt. #	[A] <sub>0</sub>	[B] <sub>0</sub>	Initial rate
1	0.20	0.20	0.76 M/s
2	0.20	0.40	0.76 M/s
3	0.40	0.20	1.52 M/s

- A. 0.19 M/s    B. 0.38 M/s    C. 0.57 M/s    **D. 0.95 M/s**    E. none of these

3. The rate constant for the second-order reaction



is  $0.80 \text{ M}^{-1}\text{s}^{-1}$  at  $10^\circ\text{C}$ . If the initial concentration of NOBr was 0.50 M, what would the **concentration of NOBr** be after 2.0 sec?

- A. 0.068 M    B. 0.12 M    C. 0.19 M    **D. 0.28 M**    E. 0.36 M

4. The isomerization of cyclopropane follows first-order kinetics. The rate constant at 600 K is  $2.72 \times 10^{-7} \text{ min}^{-1}$ , and the activation energy for the reaction is 270 kJ/mol. Calculate the value of the **rate constant** (in  $\text{min}^{-1}$ ) at 800 K.

- A.  $6.20 \times 10^{24}$     **B.  $2.05 \times 10^{21}$**     C.  $1.86 \times 10^1$   
D.  $6.87 \times 10^2$     E.  $1.32 \times 10^4$

5. If a catalyst could be found that would lower the activation energy by 20.0 kJ/mol for a particular reaction, by what **factor** would the rate constant for this reaction be increased at  $25^\circ\text{C}$ ? (Assume the frequency factor remains the same.)

- A.  $5.66 \times 10^1$     B.  $4.26 \times 10^2$     **C.  $3.20 \times 10^3$**     D.  $2.41 \times 10^4$     E.  $1.81 \times 10^5$

6. The equilibrium constant ( $K_c$ ) for the reaction shown below is  $4.17 \times 10^{-34}$  at  $25^\circ\text{C}$ .



What is the equilibrium constant for the following reaction at the same temperature?



- A.  $4.17 \times 10^{-34}$     B.  $2.04 \times 10^{-17}$     C.  $4.90 \times 10^{16}$   
**D.  $2.40 \times 10^{33}$**     E. none of these

7. For the reaction



If  $[\text{H}_2] = [\text{I}_2] = [\text{HI}] = 1.75 \times 10^{-3} \text{ M}$  at  $445^\circ\text{C}$ , which one of the following statements is(are) **true**?

1. The system is at equilibrium; no change will occur.
2. The concentration of  $\text{H}_2$  will increase as the system approaches equilibrium.
3. The concentration of HI will increase as the system approaches equilibrium.
4. The concentration of  $\text{I}_2$  will decrease as the system approaches equilibrium.
5. The concentration of HI will decrease as the system approaches equilibrium.

- A. 1 only    B. 2 only    C. 3 only    D. 2 & 5    **E. 3 & 4**

8. A sample consisting of 0.50 moles of  $AB(g)$  was placed in a 10.0 L reaction chamber at  $500^{\circ}C$ . After equilibrium was reached, it was found that 20% of the AB had dissociated according to the reaction



Calculate the **equilibrium constant  $K_c$**  for this reaction at this temperature.

- A.  $4.1 \times 10^{-7}$     B.  $3.5 \times 10^{-6}$     C.  $3.1 \times 10^{-5}$     **D.  $3.1 \times 10^{-4}$**     E.  $4.4 \times 10^{-3}$

9. A 10.0 L flask was filled to a pressure of 1.00 atm with  $A_2(g)$  at  $700^{\circ}C$ . The dissociation reaction



was allowed to reach equilibrium, at which point the total pressure was found to be 1.31 atm. Calculate  **$K_c$ , the equilibrium constant in terms of concentrations**, for this reaction at this temperature.

- A.  $9.7 \times 10^{-4}$     B.  $2.8 \times 10^{-3}$     **C.  $7.0 \times 10^{-3}$**     D.  $7.8 \times 10^{-2}$     E.  $5.6 \times 10^{-1}$

10. Consider the gas-phase dissociation process shown below.



At  $727^{\circ}C$ , the total pressure of the system at equilibrium is found to be 1.00 atm. Calculate the **equilibrium partial pressure of A**.

- A. 0.39 atm**    B. 0.50 atm    C. 0.59 atm    D. 0.67 atm    E. 0.75 atm

11. Which of the following statements is **true** for a 0.10 M solution of a weak acid, HA?

- A. The  $pH > 1.00$   
B.  $[H^+] < [HA]$   
C.  $[H^+] = [A^-]$   
**D. all of the above**  
E. none of the above

12. At  $25^{\circ}C$ , what would be the **concentration of  $H^+$  ions** in a  $4.5 \times 10^{-4} M$   $Ca(OH)_2$  solution?

- A.  $4.5 \times 10^{-4} M$     B.  $9.0 \times 10^{-4} M$     C.  $2.2 \times 10^{-11} M$   
**D.  $1.1 \times 10^{-11} M$**     E.  $5.7 \times 10^{-12} M$

13. Estimate the **pH** of a 250 mL aqueous solution prepared by dissolving 10. g of acetic acid ( $CH_3COOH$ ) in water. [ $K_a = 1.8 \times 10^{-5}$  for acetic acid]

- A. 2.16    **B. 2.46**    C. 2.76    D. 3.06    E. 3.36