

Chapter 13 Practice Exam

Multiple Choice

Identify the choice that best completes the statement or answers the question.

- A 1. Equilibrium is reached in chemical reactions when:
 A) The rates of the forward and reverse reactions become equal. 13.1
 B) The concentrations of reactants and products become equal.
 C) The temperature shows a sharp rise.
 D) All chemical reactions stop.
 E) The forward reaction stops.
- A 2. The value of the equilibrium constant, K , is dependent on:
 I. the temperature of the system ✓
 II. the nature of the reactants and products ✓ 13.2
 III. the concentration of the reactants
 IV. the concentration of the products
- A) I, II
 B) II, III
 C) III, IV
 D) It is dependent on three of the above choices.
 E) It is not dependent on any of the above choices.
- D 3. Apply the law of mass action to determine the equilibrium expression for $2\text{NO}_2\text{Cl}(aq) \rightleftharpoons 2\text{NO}_2(aq) + \text{Cl}_2(aq)$.
 A) $K = 2[\text{NO}_2][\text{Cl}_2]/2[\text{NO}_2\text{Cl}]$
 B) $K = 2[\text{NO}_2\text{Cl}]/2[\text{NO}_2][\text{Cl}_2]$
 C) $K = [\text{NO}_2\text{Cl}]^2/[\text{NO}_2]^2[\text{Cl}_2]$
 D) $K = [\text{NO}_2]^2[\text{Cl}_2]/[\text{NO}_2\text{Cl}]^2$ 13.2
 E) $K = [\text{NO}_2\text{Cl}]^2/[\text{NO}_2]^2[\text{Cl}_2]$
- B 4. At a given temperature, $K = 0.017$ for the equilibrium:
 $\text{PCl}_5(g) \rightleftharpoons \text{PCl}_3(g) + \text{Cl}_2(g)$
 What is K for:
 $\text{Cl}_2(g) + \text{PCl}_3(g) \rightleftharpoons \text{PCl}_5(g)$
 A) 0.017
 B) 59 13.2
 C) 0.00029
 D) 17
 E) 3500

- E 5. Determine the equilibrium constant for the system $\text{N}_2\text{O}_4 \rightleftharpoons 2\text{NO}_2$ at 25°C . The concentrations are shown here: $[\text{N}_2\text{O}_4] = 2.32 \times 10^{-2} \text{ M}$, $[\text{NO}_2] = 1.41 \times 10^{-2} \text{ M}$.

- A) 0.608
B) 1.65
C) 1.17×10^2
D) 0.369
E) 8.57×10^{-3}

$$\frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]} = \frac{[1.41 \times 10^{-2}]^2}{[2.32 \times 10^{-2}]} = 8.57 \times 10^{-3} \quad 13.2$$

- B 6. Given the equation $2\text{NOCl}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) + \text{Cl}_2(\text{g})$, the equilibrium constant is about 0.0196 at 115°C . Calculate K_p .

- A) 0.0196
B) 0.624
C) 0.185
D) 19.9
E) none of these

$$K_p = K(RT)^{\Delta n}$$

$$K_p = (0.0196)(.08206 \cdot 388\text{K})^1 = 0.624 \quad 13.3$$

- E 7. Consider the following equilibrated system: $2\text{NO}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) + \text{O}_2(\text{g})$. If the K_p value is 0.604, find the equilibrium pressure of the O_2 gas if the NO_2 gas pressure is 0.520 atm and the P_{NO} is 0.300 atm at equilibrium.

- A) 1.05 atm
B) 24.8 atm
C) 0.348 atm
D) 0.201 atm
E) 1.81 atm

$$\frac{[\text{NO}]^2 [\text{O}_2]}{[\text{NO}_2]^2} = K_p \quad .604 = \frac{[.300]^2 [\text{O}_2]}{[.520]^2}$$

$$P_{\text{O}_2} = 1.81 \quad 13.5$$

- C 8. The following reaction is investigated (assume an ideal gas mixture):



Initially there are 0.10 moles of N_2O and 0.25 moles of N_2H_4 , in a 10.0-L container. If there are 0.048 moles of N_2O at equilibrium, how many moles of N_2 are present at equilibrium?

- A) 2.6×10^{-2}
B) 5.2×10^{-2}
C) 7.8×10^{-2}
D) 1.6×10^{-1}
E) none of these

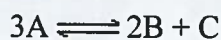
$$2\text{N}_2\text{O} + \text{N}_2\text{H}_4 \rightleftharpoons 3\text{N}_2 + 2\text{H}_2\text{O}$$

0.10	0.25	0	0
-2x	-x	+3x	+2x
0.01-2x = 0.048			

$$.01 - 2x = .048 \quad 2x = -.038 \quad x = -.019$$

$$3x = .057 \text{ moles} \quad 13.5$$

- B 9. A 3.00-liter flask initially contains 3.00 mol of gas A and 1.50 mol of gas B. Gas A decomposes according to the following reaction:



The equilibrium concentration of gas C is 0.115 mol/L. Determine the equilibrium concentration of gas A.

- A) 0.115 M
B) 0.655 M
C) 0.730 M
D) 0.885 M
E) 0.345 M

$$3\text{A} \rightleftharpoons 2\text{B} + \text{C}$$

3.00	1.50	0
-3x	+2x	+x
1-3x	.5+2x	.115

$$x = .115$$

$$3x = 3(.115) = .345$$

$$1 - 3x = .655 \quad 13.5$$

- B 10. Exactly 1.0 mol N_2O_4 is placed in an empty 1.0-L container and is allowed to reach equilibrium described by the equation $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$. If at equilibrium the N_2O_4 is 37% dissociated, what is the value of the equilibrium constant, K_c , for the reaction under these conditions?
- A) 1.2
 B) 0.87
 C) 1.2
 D) 0.55
 E) 0.22
- Handwritten work:
 $\text{N}_2\text{O}_4 \rightleftharpoons 2\text{NO}_2$
 1M 0
 $-\text{x}$ $+2\text{x}$
 $.37$ $(.37)_2$
 $1-.37 = .63$
 $37\% \cdot .37(1) = \Delta = \text{x}$
 $\frac{[\text{NO}_2]^2}{[\text{N}_2\text{O}_4]} = \frac{(.74)^2}{(.63)} = .87$
 13.6

Consider the following equilibrium: $2\text{H}_2(\text{g}) + \text{X}_2(\text{g}) \rightleftharpoons 2\text{H}_2\text{X}(\text{g}) + \text{energy}$

- A 11. Addition of X_2 to a system described by the above equilibrium
- A) will cause $[\text{H}_2]$ to decrease ✓
 B) will cause $[\text{X}_2]$ to decrease
 C) will cause $[\text{H}_2\text{X}]$ to decrease ✗
 D) will have no effect ✗
 E) cannot possibly be carried out
- Handwritten notes: 3 ↑, 2

- D 12. Addition of argon to the above equilibrium
- A) will cause $[\text{H}_2]$ to decrease
 B) will cause $[\text{X}_2]$ to increase
 C) will cause $[\text{H}_2\text{X}]$ to increase
 D) will have no effect
 E) cannot possibly be carried out

- A 13. Increasing the pressure by decreasing the volume will cause
- A) the reaction to occur to produce H_2X ✓ →
 B) the reaction to occur to produce H_2 and X_2 ✗
 C) the reaction to occur to produce H_2 but no more X_2 ✗
 D) no reaction to occur
 E) X_2 to dissociate

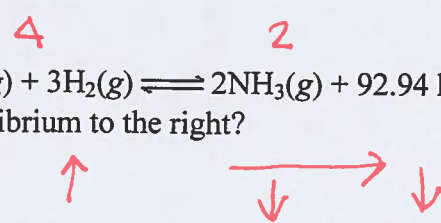
- B 14. Increasing the temperature will cause
- A) the reaction to occur to produce H_2X ✗ ←
 B) the reaction to occur to produce H_2 and X_2 ✓
 C) the reaction to occur to produce H_2 but no more X_2
 D) no reaction to occur
 E) an explosion

Name: _____

ID: A

15. Consider the following system at equilibrium: $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g}) + 92.94 \text{ kJ}$
Which of the following changes will shift the equilibrium to the right?

- I. increasing the temperature ✓
- II. decreasing the temperature ✓
- III. increasing the volume
- IV. decreasing the volume ✓
- V. removing some NH_3 ✓
- VI. adding some NH_3
- VII. removing some N_2
- VIII. adding some N_2 ✓



13.7

- A) I, IV, VI, VII
- B) II, III, V, VIII
- C) I, VI, VIII
- D) I, III, V, VII
- E) II, IV, V, VIII**