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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.
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.

13.1

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
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.

13.2

D 3. Apply the law of mass action to determine the equilibrium expression for $2NO_2Cl(aq) \rightleftharpoons 2NO_2(aq) + Cl_2(aq)$.
A) $K = 2[NO_2][Cl_2]/2[NO_2Cl]$
B) $K = 2[NO_2Cl]/2[NO_2][Cl_2]$
C) $K = [NO_2Cl]^2/[NO_2]^2[Cl_2]$
D) $K = [NO_2]^2[Cl_2]/[NO_2Cl]^2$
E) $K = [NO_2Cl]^2[NO_2]^2[Cl_2]$

$\frac{[NO_2]^2[Cl_2]}{[NO_2Cl]^2}$

13.2

B 4. At a given temperature, $K = 0.017$ for the equilibrium:

$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$

What is K for:

$Cl_2(g) + PCl_3(g) \rightleftharpoons PCl_5(g)$?
A) 0.017
B) 59
C) 0.00029
D) 17
E) 3500

$\frac{[PCl_5]}{[Cl_2][PCl_3]} = .017$

$\cdot 1/.017$

$\frac{[Cl_2][PCl_3]}{[PCl_5]}$

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E

5. Determine the equilibrium constant for the system $N_2O_4 \rightleftharpoons 2NO_2$ at 25°C. The concentrations are shown here: $[N_2O_4] = 2.32 \times 10^{-2}$ *M*, $[NO_2] = 1.41 \times 10^{-2}$ *M*.
   A) 0.608
   B) 1.65
   C) 1.17×10^{2}
   D) 0.369
   E) 8.57×10^{-3}

$\frac{[NO_2]^2}{[N_2O_4]} = \frac{[1.41\times10^{-2}]^2}{[2.32\times10^{-2}]} = 8.57\times10^{-3}$ 13.2

B

6. Given the equation $2NOCl_2(g) \rightleftharpoons 2NO(g) + Cl_2(g)$, 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

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

$K_p = (.0196)(.08206 \cdot 388K)^1$ 13.3

$= .624$

E

7. Consider the following equilibrated system: $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$. 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

$\frac{[NO]^2[O_2]}{[NO_2]^2} = K_p \quad .604 = \frac{[.300]^2[O_2]}{[.520]^2}$

$P_{O_2} = 1.81$ 13.5

C

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

$2N_2O(g) + N_2H_4(g) \rightleftharpoons 3N_2(g) + 2H_2O(g)$

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? 13.5

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

	$2N_2O$	+ N_2H_4	⇌ $3N_2$	+ $2H_2O$
	.01	.025	0	0
	−2x	−x	+3x	+2x
	.01−2x = .0048			

$.01 - 2x = .0048$

$2x = .0052$

$x = .0026$

$3x = .0078\ M, \frac{x}{10L}$

$x = .078$ moles

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:

$3A \rightleftharpoons 2B + C$

3L 3L

1M .5 13.5

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*

	3A	⇌ 2B	+ C
	1M	.5	0
	−3x	+2x	+x
	1−3x	.572x	x = .115

$x = .115$

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

$1 - 3x = .655$

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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 $N_2O_4(g) \rightleftharpoons 2NO_2(g)$
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

$N_2O_4 \rightleftharpoons 2NO_2$
1M 0
$-x$ $+2x$
.37 (.37)2
1-.37= .63

37% .37(1) = Δ = x

$\frac{[NO_2]^2}{[N_2O_4]} = \frac{(.74)^2}{(.63)} = .87$

13.6

Consider the following equilibrium: $2H_2(g) + X_2(g) \rightleftharpoons 2H_2X(g)$ + energy

3 ↑ 2

A 11. Addition of X_2 to a system described by the above equilibrium
A) will cause $[H_2]$ to decrease ✓
B) will cause $[X_2]$ to decrease
C) will cause $[H_2X]$ to decrease ✗
D) will have no effect ✗
E) cannot possibly be carried out

13.7

D 12. Addition of argon to the above equilibrium
A) will cause $[H_2]$ to decrease
B) will cause $[X_2]$ to increase
C) will cause $[H_2X]$ to increase
D) will have no effect
E) cannot possibly be carried out

∴ 13.7

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

13.7

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

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4 2

____ 15. Consider the following system at equilibrium: $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + 92.94$ 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