Dougherty Valley HS Chemistry

Equilibrium

Name

Period _____ Date _____

UNIT QUIZ • PRACTICE

- You may use a pencil, eraser, and scientific calculator to complete the test.
- You will be given a periodic table. No other resources are allowed.
- Please transfer your answers for Sections 1, 2, and 3 onto the Answer Document. Work for these questions will not be graded. However, sufficient and appropriate work must be shown for the Free Response questions in order to receive full credit.

SECTION 1: A, B, OR C. For each of the following descriptions, determine whether the reaction shifts to the right, shifts to the left, or has no shift from its equilibrium position. (1 point each)

 NH_4NO_3 (s) \leftrightarrows 2 H_2O (g) + N_2O (g) + heat

		(A)	(B)	(C)
1.	A catalyst is added.	Left	Right	No Shift
2.	N ₂ O (g) is removed.	Left	Right	No Shift
3.	NH_4NO_3 (s) is added.	Left	Right	No Shift
4.	The pressure is increased by decreasing the volume.	Left	Right	No Shift
5.	The temperature is increased.	Left	Right	No Shift

SECTION 2: TRUE/FALSE. (1 point each)

Evaluate the statement in column 1. If it's TRUE, fill in bubble A. If it's FALSE, fill in bubble B. Evaluate the statement in column 2. If it's TRUE, fill in bubble C. If it's FALSE, fill in bubble D. If column 2 is the correct explanation for column 1, then bubble E.

- If both columns are TRUE, and column 2 is the correct explanation, bubble ACE.
- If both columns are TRUE, but column 2 is not the correct explanation, bubble AC.
- If column 1 is TRUE and column 2 is FALSE, bubble AD.
- If column 1 is FALSE and column 2 is TRUE, bubble BC.
- If column 1 is FALSE and column 2 is FALSE, bubble BD.

6.	$\frac{Column 1}{A \text{ reaction A} \leftrightarrows B \text{ with } K_{eq} = 500 \text{ has more}}$ products than reactants at equilibrium	BECAUSE	$\label{eq:column2} \frac{Column \ 2}{When \ Q < K_{eq}}, \ the \ reaction \ will \ shift \ to \ the \ right \ to \ form \ more \ products.$
7.	When a system is at equilibrium, the reaction stops	BECAUSE	at equilibrium, observable, measureable properties of the reaction mixture remain constant.
8.	In a reaction X (s) \leftrightarrows Y (g), adding more substance X to an equilibrium mixture will not shift the reaction	BECAUSE	solids and liquids are not included in the equilibrium constant expression (K_{eq}).

9. For the reaction system,

 $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + heat$ the conditions that would shift this equilibrium to the right are

- (A) high temperature and high pressure
- (B) high temperature, pressure unimportant
- (C) high temperature and low pressure
- (D) low temperature and high pressure
- (E) low temperature and low pressure
- 10. Consider the following equilibrium:

 $H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \Delta H = -40 \text{ kJ/mol}$ Which change will shift the equilibrium to the left?

- (A) adding $H_2(g)$
- (B) increasing the temperature
- (C) reducing the volume
- (D) adding a catalyst
- (E) removing some HI.
- 11. Consider the reaction system,

 $CoO(s) + H_2(g) \rightleftharpoons Co(s) + H_2O(g)$. The equilibrium constant expression is

(A) $\frac{[\text{CoO}][\text{H}_2]}{[\text{Co}][\text{H}_2\text{O}]}$

(B)
$$\frac{[Co][H_2O]}{[CoO][H_2]}$$

(C)
$$\frac{[Co][H_2O]}{[H_2]}$$

(D)
$$\frac{[H_2]}{[H_2O]}$$

(E)
$$[H_2O]$$

 $[H_2]$

- 12. Which of the following is/are true at equilibrium?
 - I. The concentrations of the reactants and products are equal.
 - II. The rates of the forward and reverse reactions are equal.
 - III. The reaction has stopped.
 - (A) I only.
 - (B) II only.
 - (C) II and III only.
 - (D) I and II only.
 - (E) I, II, and III.

<u>Questions 13-15</u>: Use the following reaction: CH₄ (g) + 2 Cl₂ (g) \leftrightarrows CCl₄ (ℓ) + 2 H₂ (g) + heat At 25°C, the value of K_{eq} is 285.

In a particular experiment, some CH_4 and Cl_2 were placed in a container and were allowed to mix until equilibrium was established.

13. The equilibrium expression for this reaction is: 12000 JUL

(Δ)	$[\text{CCI}_4][\text{H}_2]^2$
(A)	$[CH_4][Cl_2]^2$
(D)	$[H_2]^2$
(B)	$[CH_4][Cl_2]^2$
(\mathbf{O})	[H ₂]
(C)	$[CH_4][Cl_2]$
	[CH ₄][Cl ₂]
(D)	$[H_2]^2$
(\mathbf{E})	[2 H ₂]
(E)	$[CH_4][2 Cl_2]$

- 14. Which of the following changes to the equilibrium mixture would shift the reaction so that more H₂ (g) would be produced?
 - I. Add a catalyst
 - II. Add $Cl_2(g)$
 - III. Remove $CCl_4(\ell)$
 - (A) I only.
 - (B) II only.
 - (C) I and III only.
 - (D) II and III only.
 - (E) I, II, and III.
- 15. Under which of the following conditions would we have the most $CCl_4(\ell)$ when equilibrium is established? (T = temperature, V = volume)
 - $\begin{array}{ll} (A) \ T = 50^{\circ} C & V = 2.0 \ L \\ (B) \ T = 50^{\circ} C & V = 8.0 \ L \\ (C) \ T = 75^{\circ} C & V = 5.0 \ L \\ (D) \ T = 100^{\circ} C & V = 2.0 \ L \\ (E) \ T = 100^{\circ} C & V = 8.0 \ L \end{array}$

<u>Questions 16-17:</u> For the following reaction: $H_2O(\ell) \leftrightarrows H_2O(g)$ At 25°C, $K_{eq} = 1.3 \times 10^{-3} M$.

- 16. If a 50.0 mL sample of H₂O (ℓ) is placed in a 2.0 L closed container at 25°C. At equilibrium, much of the H₂O (ℓ) remains, and the concentration of H₂O (g) is
 (A) 0 M
 (B) 0.65 × 10⁻³ M
 - (C) 1.3×10^{-3} <u>M</u>
 - (D) 2.6×10^{-3} M
 - (E) Cannot be determined
- 17. If an additional 100 mL of $H_2O(\ell)$ is added to the container at the same temperature:
 - (A) The pressure of $H_2O(g)$ would increase until no $H_2O(\ell)$ is left.
 - (B) The pressure of H₂O (g) would increase until the system reaches equilibrium.
 - (C) The pressure of $H_2O(g)$ would not change.
 - (D) The pressure of H_2O (g) would decrease.
 - (E) It cannot be determined how the pressure of H₂O (g) would change.

<u>Questions 18-20:</u> The graph below shows the concentrations of the reaction A (g) \leftrightarrows 2 B (g) over time.



- 18. At approximately what time is equilibrium established?
 - (A) 0 s
 - (B) 1 s
 - (C) 2 s
 - (D) 3 s
 - (E) 4 s

- 19. What is the value of the equilibrium constant, K_{eq} , for this reaction $A(g) \leftrightarrows 2 B(g)$?
 - (A) 0.25
 - (B) 0.40
 - (C) 0.80
 - (D) 3.2
 - (E) 4.0
- 20. In a different experiment for the same reaction, if we started with equal concentrations of A and B, when the system reaches equilibrium,
 - (A) [A] > [B]
 - (B) $[A] \approx [B]$
 - (C) [A] < [B]
 - (D) [A] = 0
 - (E) It cannot be determined from the information given.
- 21. In the reaction: N₂ (g) +3 H₂ (g) ≒ 2 NH₃ (g)
 1.8 mol of N₂, 1.8 mol H₂, and 1.8 mol NH₃ were placed in a 2.0 L vessel. After the reaction mixture was allowed to come to equilibrium, it was found that 0.90 mol H₂ remained in the reaction mixture. How much NH₃ was present at equilibrium?
 - (A) 0.90 mol
 - (B) 1.2 mol
 - (C) 1.8 mol
 - (D) 2.4 mol
 - (E) 2.7 mol
- 22. In the reaction

 $2 \operatorname{NO}_2(g) \leftrightarrows \operatorname{N}_2\operatorname{O}_4(g) \qquad \qquad \operatorname{K}_{eq} = 2.0$

- A 1.0 L reaction mixture contains 0.20 mol NO₂
- and 0.40 mol N_2O_4 . The reaction:
- (A) Is at equilibrium.
- (B) Will proceed in the forward direction until it reaches equilibrium.
- (C) Will proceed in the forward direction until the NO₂ runs out.
- (D) Will proceed in the reverse direction until it reaches equilibrium.
- (E) Cannot be determined.

SECTION 4: FREE RESPONSE. Show all your work to receive full credit.

- 23. Given the following reaction: $H_2(g) + I_2(g) \leftrightarrows 2 HI(g)$ At a particular temperature, $K_{eq} = 92.6$.
 - (a) Write the equilibrium constant expression for the reaction. (2 points)
 - (b) Experiment #1: In a reaction mixture at equilibrium, $[H_2]_{eq} = 0.15 \text{ M}$ and $[HI]_{eq} = 2.2 \text{ M}$. Find $[I_2]_{eq}$. (4 points)
 - (c) Experiment #2: 0.80 mol H₂, and 0.80 mol I₂ were placed in a 1.0 L container at equilibrium. Find the concentrations of all substances at equilibrium. Use an ICE Box to show your work. (6 points)

- (d) Experiment #3: 0.50 mol of H₂, 0.50 mol I₂, and 0.500 mol HI were placed in a 2.0 L container. H₂ and HI are colorless gases, while I₂ is a purple gas.
 - (i) This reaction: (3 points)
 [proceed in the forward direction | is at equilibrium | will proceed in the reverse direction]
 because (using math):
 - (ii) What can we observe when the reaction is at equilibrium? (1 point)

24. Given the following reaction:

(a) The concentrations of the substances in the reaction mixture were found:

 $[N_2O_4]_{eq} = 0.0247 \ \underline{M} \qquad [H_2]_{eq} = 0.0495 \ \underline{M} \qquad [O_2]_{eq} = 0.000545 \ \underline{M}$

Write the equilibrium constant expression for this reaction and find its value. (4 points)

- (b) At equilibrium, this reaction is: (select one) (1 point) [reactant-favored | product-favored | about equal reactants and products].
- (c) In an experiment, 0.500 mol N₂O₄, 0.500 mol H₂, and 0.500 mol O₂ were placed in a 2.0 L container. Determine the direction in which the reaction will proceed, or if the reaction is at equilibrium. Explain briefly. (3 points)
- (d) Determine the how the concentration of each substance will change (↑, -, or ↓) and the direction the reaction will shift (∪, -, or ∪), when each of the changes are applied to a system originally at equilibrium. (4 points)

	[N ₂ O ₄]	[H ₂]	Shift	[N ₂ H ₄]	[O ₂]
Increase temperature					
Increase pressure by decreasing volume					
Add $N_2H_4(\ell)$					
Remove $H_2(g)$					