Review

Name: **Period:** **Seat#:**

STATION 1 • MASS ACTION EXPRESSIONS

Write the mass action expression for the equilibrium: $Fe_3O_4(s) + 4\ H_2(g) \rightleftharpoons 3\ Fe(s) + 4\ H_2O(g)$

Write the mass action expression for the equilibrium: $Ca(OH)_2(s) \rightleftharpoons Ca^{2+}(aq) + 2\ OH^-(aq)$

The equilibrium constant, $K_c = 7.9 \times 10^{-6}$, is this equilibrium system reactant or product-favored. __________

Chemical Equilibrium

STATION 2 • MANIPULATING K

Given:

$H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$ $K_c = 1 \times 10^{-14}$

$HCN(aq) \rightleftharpoons H^+(aq) + CN^-(aq)$ $K_c = 4.0 \times 10^{-10}$

Calculate K_c for this reaction:

$HCN(aq) + OH^-(aq) \rightleftharpoons H_2O(l) + CN^-(aq)$ $K_c = ???$

This reaction is __________________-favored.

Chemical Equilibrium

STATION 3 • K_p & K_c

Consider the equilibrium: $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$.

At 100°C, the equilibrium concentrations for this system are:
[NO] = 0.52 M; [O_2] = 0.24 M; [NO_2] = 0.18 M

Write the expression for K_c and calculate its value at this temperature?

What is Δn for this system? _____

Write the expression for K_p and calculate its value at this temperature.

Chemical Equilibrium

STATION 4 • LE CHÂTELIER'S PRINCIPLE

Consider the gaseous equilibrium: $2CCl_4(g) + O_2(g) \rightleftharpoons 2COCl_2(g) + 2Cl_2(g)$ $\Delta H = +35$ kJ
Predict the effect each change would have on the concentrations of the each substance.

Add CCl_4	____	____	____	____
Remove Cl_2	____	____	____	____
Add $COCl_2$	____	____	____	____
Increase temperature	____	____	____	____
Reduce container volume	____	____	____	____
Add a catalyst	____	____	____	____
Remove O_2	____	____	____	____
Add He to increase pressure	____	____	____	____

A different equilibrium shifts toward the reactants when the temperature is increased. From this observation, you know that the reaction is ________________________ (exothermic / endothermic).

Chemical Equilibrium

STATION 5 • ICE BOX PROBLEM

Consider the equilibrium: $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

If 0.200 mol $SO_3(g)$ is placed a 0.500 Liter container, it is found that 0.050 mole of $O_2(g)$ is in the container at equilibrium. Fill in the ICE box and determine the K_c for this reaction.

	SO_2	O_2	SO_3
Initial			
Change			
Equilibrium			

Chemical Equilibrium

STATION 6 • ANOTHER ICE BOX PROBLEM

At 985°C, the equilibrium constant, K_c, for the reaction, $H_2(g) + CO_2(g) \rightleftarrows H_2O(g) + CO(g)$, is 1.63.

If 2.00 moles each of $H_2(g)$ and $CO_2(g)$ are placed in a 1.00-Liter container and allowed to come to equilibrium, determine the equilibrium concentrations of the four chemicals.

	H_2	CO_2	H_2O	CO
Initial				
Change				
Equilibrium				

Chemical Equilibrium

STATION 7 • TEST QUOTIENT, Q

Consider the equilibrium: $2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$. $K_c = 0.499$

The system is set up with the following concentrations:

[NO] = 0.50 M; [O_2] = 0.25 M; [NO_2] = 0.25 M

This reaction will ____________________ (shift right, shift left, remain unchanged).

Justify your prediction.

Chemical Equilibrium

STATION 8 • NChO PROBLEMS

33. Mercury(II) oxide, HgO, is decomposed upon heating according to this equation.

$$2HgO(s) \rightleftharpoons 2Hg(l) + O_2(g)$$

What is the equilibrium expression for this process?

(A) $K = \frac{[Hg]^2[O_2]}{[HgO]^2}$ **(B)** $K = \frac{[Hg][O_2]}{[HgO]}$

(C) $K = [Hg][O_2]$ **(D)** $K = [O_2]$

34. Consider this reaction.

$$2NO(g) + Cl_2(g) \rightleftharpoons 2NOCl(g) \qquad \Delta H = -78.38 \text{ kJ}$$

What conditions of temperature and pressure will produce the highest yield of NOCl at equilibrium?

	T	*P*
(A)	high	high
(B)	high	low
(C)	low	high
(D)	low	low

Questions **32** and **33** should both be answered with reference to this system.

$$H_2(g) + I_2(s) \rightleftharpoons 2HI(g) \quad \Delta H = +51.8 \text{ kJ}$$

32. Which would increase the equilibrium quantity of HI(*g*)? Assume the system has reached equilibrium with all three components present.

I. increasing pressure **II.** increasing temperature

(A) **I** only **(B)** **II** only

(C) Both **I** and **II** **(D)** Neither **I** nor **II**

33. What is the equilibrium constant expression for this system?

(A) $K = \frac{[HI]^2}{[H_2][I_2]}$ **(B)** $K = \frac{[H_2][I_2]}{[HI]^2}$

(C) $K = \frac{2[HI]}{[H_2][I_2]}$ **(D)** $K = \frac{[HI]^2}{[H_2]}$

Chemical Equilibrium – Not assessed. Challenge Problem

STATION 9 • PREDICTING REACTIONS

A solution of hydrochloric acid is added to a solution of potassium nitrite.

(i) Balanced equation:

(ii) What are the oxidation states of the N atom before and after the reaction?

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