# HW03 - Chemical Equilibria

⚠ This is a preview of the published version of the quiz

Started: Feb 14 at 9:21am

## Quiz Instructions

Homework 03

Chemical Equilibria

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**Question 1** 1.2 pts

When the chemical reaction

$A + B \rightleftharpoons C + D$

is at equilibrium, which of the following is true?

- both the forward and reverse reactions have stopped
- the sum of the concentrations of A and B equals the sum of the concentrations of C and D
- all four concentrations are equal
- neither the forward nor the reverse reactions have stopped

**Question 2** 1.2 pts

Explain why equilibrium constants are dimensionless.

- They are dimensionless because the pressures or concentrations we put in are all for the substances in their standard states.
- This is a trick question. Equilibrium constants have units that involve some multiple of atmospheres or moles per liter.
-

They are not really dimensionless, but we must treat them as such in order to be able to take ln(K) in the expression:

$$\Delta G^\circ = -RT \ln K$$

- Every concentration or pressure that enters into $K_c$ or $K_p$ is really divided by the corresponding concentration or pressure of the substance in its standard state.

## Question 3

1.2 pts

The expression for $K_c$ for the reaction

$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$

at equilibrium is:

- $\frac{[NH_3]^4 [O_2]^5}{[NO]^4 [H_2O]^6}$
- $\frac{[NO] [H_2O]}{[NH_3] [O_2]}$
- $[NH_3]^4 [O_2]^5$
- $\frac{[NO]^4 [H_2O]^6}{[NH_3]^4 [O_2]^5}$

## Question 4

1.2 pts

Consider the following reactions at 25°C:

$2NO(g) \rightleftharpoons N_2(g) + O_2(g)$ $K_c = 1 \times 10^{30}$

$2H_2O(g) \rightleftharpoons 2H_2(g) + O_2(g)$ $K_c = 5 \times 10^{-82}$

$2CO(g) + O_2(g) \rightleftharpoons 2CO_2(g)$ $K_c = 3 \times 10^{91}$

Which compound is most likely to dissociate and give $O_2(g)$ at 25°C?

- $H_2O$

- CO
- $CO_2$
- NO

## Question 5

1.2 pts

At 600°C, the equilibrium constant for the reaction

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

is 2.8. Calculate the equilibrium constant for the reaction

$0.5O_2(g) + Hg(l) \longrightarrow HgO(s)$.

- 1.7
- 0.36
- 1.1
- 0.60

## Question 6

1.2 pts

Consider the reaction

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

What is the form of the equilibrium constant $K_c$ for this reaction?

- $\frac{[O_2]}{[HgO]^2}$
- $[Hg]^2[O_2]$
- $\frac{[Hg]^2[O_2]}{[HgO]^2}$

- ○ $[O_2]$

## Question 7

1.2 pts

$K_c = 2.6 \times 10^8$ at 825 K for the reaction

$2H_2(g) + S_2(g) \rightleftharpoons 2H_2S(g)$

The equilibrium concentration of $H_2$ is 0.0020 M and $S_2$ is 0.0010 M. What is the equilibrium concentration of $H_2S$?

- ○ 10 M
- ○ 0.10 M
- ○ 0.0010 M
- ○ 1.0 M

## Question 8

1.2 pts

Consider the reaction below

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

At 1000 K the equilibrium pressures of the three gases in one mixture were found to be 0.562 atm $SO_2$, 0.101 atm $O_2$, and 0.332 atm $SO_3$. Calculate the value of $K_p$ for the reaction.

- ○ 0.171
- ○ 2.64
- ○ 3.46
- ○ 0.289

## Question 9

1.2 pts

Consider the following reaction:

$2NO(g) + Br_2(g) \rightleftharpoons 2NOBr(g)$ $K_p = 2.40$ @ 373 K

Calculate $K_c$ for this reaction at 100°C.

- 19.7
- 7440
- 0.0784
- 73.5

## Question 10

**1.2 pts**

Calculate the equilibrium constant at 25°C for a reaction for which $\Delta G°$ = -4.22 kcal/mol.

- 1240.51
- -1240.51
- 620.254
- 2481.02

## Question 11

**1.2 pts**

The reaction

$A + B \rightleftharpoons C + 2D$

has an equilibrium constant of $3.7 \times 10^{-3}$. Consider a reaction mixture with:

$[A] = 2.0 \times 10^{-2}$ M

$[B] = 1.7 \times 10^{-4}$ M

$[C] = 2.4 \times 10^{-6}$ M

$[D] = 3.5 \times 10^{-3}$ M

Which of the following statements is definitely true?

- No conclusions about the system can be made without additional information.
- The system is at equilibrium.
- The reverse reaction will occur to a greater extent than the forward reaction until equilibrium is established.
- The forward reaction will occur to a greater extent than the reverse reaction until equilibrium is established.

## Question 12

**1.2 pts**

The reaction

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

has an equilibrium constant of $4.0 \times 10^8$ at 25°C. What will eventually happen if 44.0 moles of $NH_3$, 0.452 moles of $N_2$, and 0.108 moles of $H_2$ are put in a 10.0 L container at 25°

- More $NH_3$ will be formed.
- Nothing. The system is at equilibrium.
- More $N_2$ and $H_2$ will be formed.
- It is impossible to know what will happen unless we know what the equilibrium constant is at 298 K.

## Question 13

**1.2 pts**

Consider the reaction:

$Ni(CO)_4(g) \longrightarrow Ni(s) + 4CO(g)$

If the initial concentration of $Ni(CO)_4(g)$ is 1.0 M and x is the equilibrium concentration of CO(g), what is the correct equilibrium relation?

- $K_c = \dfrac{4x}{(1.0 - 4x)}$
-

$$K_c = \frac{x^4}{\left(1.0 - \frac{x}{4}\right)}$$

$$K_c = \frac{x^5}{\left(1.0 - \frac{x}{4}\right)}$$

$$K_c = \frac{256x^4}{(1.0 - 4x)}$$

**Question 14** **1.2 pts**

Suppose the reaction

$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

has an equilibrium constant $K_c = 49$ and the initial concentrations of $H_2$ and $I_2$ is 0.5 M and of HI is 0.0M. Which of the following is the correct value for the final concentration of HI(g)?

- 0.599 M
- 0.778 M
- 0.219 M
- 0.250 M

**Question 15** **1.2 pts**

The system

$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

is at equilibrium at a fixed temperature with a partial pressure of $H_2$ of 0.200 atm, a partial pressure of $I_2$ of 0.200 atm, and a partial pressure of HI of 0.100 atm. An additional 0.26 atm pressure of HI is admitted to the container, and it is allowed to come to equilibrium again. What is the new partial pressure of HI?

- 0.360 atm
- 0.152 atm

- 0.104 atm
- 0.464 atm

## Question 16

**1.2 pts**

At 990°C, $K_c$ = 1.6 for the reaction

$H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$

How many moles of $H_2O(g)$ are present in an equilibrium mixture resulting from the addition of 1.00 mole of $H_2$, 2.00 moles of $CO_2$, 0.75 moles of $H_2O$, and 1.00 mole of CO to a 5.00 liter container at 990°C?

- 1.1 mol
- 1.0 mol
- 0.60 mol
- 1.7 mol

## Question 17

**1.2 pts**

What happens to the concentration of NO(g) when the total pressure on the reaction below is increased (by compression) when it is at equilibrium?

$3NO_2(g) + H_2O(l) \rightleftharpoons 2HNO_3(aq) + NO(g)$

- it increases
- it decreases
- it remains the same
- it is impossible to tell

**Question 18** 1.2 pts

Consider the following reaction:

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

where $\Delta H_{rxn}$ = -198 kJ. The amount of $SO_2(g)$ at equilibrium increases when...

- $SO_3$ is removed.
- the volume is increased.
- the temperature is decreased.
- more oxygen is added.

**Question 19** 1.2 pts

Suppose the reaction mixture

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

is at equilibrium at a given temperature and pressure. The pressure is then increased at constant temperature by compressing the reaction mixture, and the mixture is then allowed to reestablish equilibrium. At the new equilibrium...

- there is less ammonia present than there was originally.
- there is the same amount of ammonia present as there was originally.
- the nitrogen is used up completely.
- there is more ammonia present than there was originally.

**Question 20** 1.2 pts

Consider the system:

$2N_2O_5(g) \rightleftharpoons 2N_2O_4(g) + O_2(g)$

at equilibrium at 25°C. If this is an exothermic reaction and the temperature was raised, would the equilibrium be shifted

to produce more $N_2O_5$ or more $N_2O_4$?

- it is impossible to tell
- there would be no change
- more $N_2O_5$
- more $N_2O_4$

## Question 21

**1.2 pts**

The system

$CO_2(g) + H_2(g) \rightleftharpoons H_2O(g) + CO(g)$

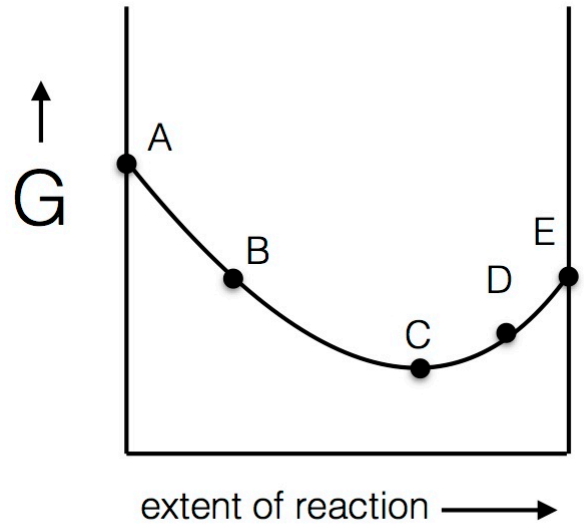
is at equilibrium at some temperature. At equilibrium, a 4.00L vessel contains 1.00 mole $CO_2$, 1.00 mole $H_2$, 2.40 moles $H_2O$, and 2.40 moles CO. How many moles of $CO_2$ must be added to this system to bring the equilibrium CO concentration to 0.669 mol/L?

- 0.993 moles
- 0.429 moles
- 0.498 moles
- 0.069 moles

## Question 22

**1.2 pts**

The figure below represents a reaction at 298 K.




Based on the figure, which of the following statements (if any) are FALSE?

- For this reaction, $\Delta G^{\circ}$ is negative.
- At point B, Q < K.
- At point C, the system is at equilibrium.
- None of the other statements are false.
- At point D, the reaction will move toward the reactants to get to equilibrium.

**Question 23** **1.2 pts**

Given the hypothetical reaction:

X(g) $\rightleftharpoons$ Y(g)

Predict what will happen when 1.0 mol Y is placed into an evacuated container.

- Nothing. The products are already formed, so no reaction occurs.
- $\Delta G^{\circ}$ will decrease until $\Delta G^{\circ}$ = 0.
- Q will increase until Q = K.

- Q will decrease until Q = K.

## Question 24 — 1.2 pts

Consider the reaction:

$C_{graphite}(s) + O_2(g) \rightleftharpoons CO_2(g)$ $\Delta G^\circ = -400\ kJ \times mol^{-1} \times K^{-1}$

Which of the following is a possible value of K for this reaction?

- $10^{-70}$
- $10^{70}$
- -0.56
- 0.56

## Question 25 — 1.2 pts

The equilibrium constant K for the synthesis of ammonia is $6.8 \times 10^5$ at 298 K. What will K be for the reaction at 375 K?

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ $\Delta H^\circ = -92.22\ kJ \cdot mol^{-1}$

- $1.42 \times 10^9$
- $6.75 \times 10^5$
- 326
- $6.85 \times 10^5$

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