1.

At equilibrium, _____.

	Student Response
1.	all chemical reactions have ceased
2.	the rates of the forward and reverse reactions are equal
3.	the rate constants of the forward and reverse reactions are equal
4.	the value of the equilibrium constant is 1
5.	the limiting reagent has been consumed

2.

A flask is initially charged with 0.2 atm of pure NO_2, which then reacts to form N_2O_4 according to the equilibrium:

$$2NO_2 \leftrightarrow N_2O_4$$

At what point does the conversion of NO_2 to N_2O_4 stop?

3.

For the following reaction, the rate coefficients are:

$k_1 = 5.82 \times 10^{-21}\ s^{-1}$

$k_{-1} = 8.19 \times 10^{15}\ M^{-2}s^{-1}$

The equilibrium constant for this reaction is K = _____ M^{-2}

4-7 EQUILBRIUM CONSTANT

4.

If the equilibrium constant for the reaction

$$6A + 6B \leftrightarrow 6AB$$

is 444, what is the equilibrium constant for the reaction

$$2AB \leftrightarrow 2A + 2B$$

5.

At some temperature, the following reactions have the equilibrium constants shown:

$NO_2(g) \leftrightarrow NO(g) + O(g)$ $\quad K = 1.44\times10^{23}$

$O_3(g) + NO(g) \leftrightarrow NO_2(g) + O_2(g)$ $\quad K = 2.61\times10^{-5}$

What is the equilibrium constant for the reaction

$$O_2 + O \leftrightarrow O_3$$

6.

Consider the generic reaction:

$$4A + 2B \leftrightarrow 2C + 3D.$$

If the equilibrium constant in terms of pressures is $K_p = 157$ at 19°C, what is the value of equilibrium constant in terms of concentrations, K_C. *[Assume pressures are in atmosphere and concentrations are in moles/liter, R = 0.08206 atm/M-K.]*

7.

Consider the following equilibrium:

$$4A + 5B \leftrightarrow 3C + 2D$$

If the equilibrium pressures are $P_A = 4.69$ atm, $P_B = 2.53$ atm, $P_C = 1.24$ atm, and $P_D = 2.34$ atm, what is Kp

8-12 REACTION QUOTIENT

8.

For each of the following systems at equilibrium and at constant temperature indicate whether increasing the volume would cause the reaction to shift towards reactants, towards products, or have no effect.

Statement
$H_2O(g) \rightleftharpoons 2H_2(g)+O_2(g)$
$COCl_2(g) \rightleftharpoons CO(g) + Cl_2(g)$
$H_2(g)+Cl_2(g) \rightleftharpoons 2HCl(g)$
$NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)$

9.

The following equilibrium:

$$SO_2Cl_2(g) \rightleftharpoons SO_2(g)+Cl_2(g)$$

is endothermic (ΔH = 67 kJ). What change (if any) in each of the following parmeters would result in an increase yield of products.

Statement
Pressure
Temperature

10.

The reaction below is exothermic:

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

Le Châtelier's Principle predicts that _____ will result in an increase in the number of moles of SO_3 (g) in the reaction container.

Student Response
1. increasing the pressure
2. decreasing the pressure
3. increasing the temperature
4. removing some oxygen

5. increasing the volume of the container

11.

For the reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, K_c = 0.0454 at 261°C. If a vessel is filled with these gases such that the initial concentrations are $[PCl_5]$ = 0.25M, $[PCl_3]$ = 0.20 M, and $[Cl_2]$ = 2.25 M, in which direction will a reaction occur and why?

Student Response
a. toward products because Q = 0.56
b. toward reactants because Q = 1.8
c. toward products because Q = 2.8
d. toward reactants because Q = 0.0454
e. it is at equilibrium

12.

A reaction flask is charged with 2.9 atm of A_2 and 4.1 atm of A_2B. When equilibrium occurs via:

$$2A_2(g) + B_2(g) \leftrightarrow 2A_2B(g),$$

the equilibrium partial pressure of B_2 is 0.2 atm. Determine K_p.

13-14 HETERO EQUILIBRIUM

13.

A solution of NaF is added dropwise to a solution that is 0.0144 M in Ba^{2+}. When the concentration of F^- exceeds _____ M, BaF_2 will precipitate. Neglect volume

changes. For BaF_2,

Student Response
1. 5.9×10^{-5}
2. 1.1×10^{-2}

3. 2.4×10^{-8}
4. 2.7×10^{-3}
5. 1.2×10^{-4}

14.

The hypothetical solid A_4B_2 decomposes according to:

$$2A_4B_2(s) \leftrightarrow 4A_2(g) + 2B_2(g)$$

If the equilibrium constant is 523.1 atm(4+2) at 159K, what is the total pressure at equilibrium, if 30.5-g of A_4B_2 is placed in a 12-L vessel and decomposed at this temperature?

15-17 THERMODYNAMICS

15.

Is it possible for a reaction to be endothermic but at the same time be spontaneous. Conversly is it possible for a reaction to be exothermic yet nonspontaneous? Explain.

16.

Calculate the standard free energy change, and determine whether or not hematite spontaneously converts to magnetite under standard conditions. $3Fe_2O_3(s)$(hematite)

$2Fe_3O_4(s)$(magnetite) + $1/2O_2(g)$; G_f (hematite) = -742.2 kJ/mol;

G_f (magnetite) = -1015 kJ/mol.

Student Response
a. G = -272.8 kJ; spontaneous
b. G = 272.8 kJ; not spontaneous
c. G = 469.4 kJ; spontaneous
d. G = 196.6 kJ; not spontaneous
e. G = -196.6 kJ; spontaneous

17.

For the hypothetical reaction $A_2 + B_2 \rightarrow 2AB$

ΔH° = 68.3 kJ/mol, and ΔS° = 123.9 J/(mol-K). What is ΔG° for this reaction at 215 K?

18-20 THERMODYNAMIC EQUILIBRIUM

18.

At 1,720 K, the equilibrium contant for a given reaction is K = 0.0918. What is the free energy for this reaction in kJ/mol?

19.

For a certain equilibrium process, the equilibrium constant is 9.45×10^{-5} at 105 K, and 4.03×10^{11} at 536 K. What is ΔH° (in kJ/mol) for this reaction?

20.

A certain equilibrium reaction has an equilibrium constant of K = 5.51 at a temperature of 360K. If the reaction quotient is 7.20 what is ΔG (in kJ/mol)?