Name:
Score: 0 / 20 points (0%)

Chapter 3 Review Quiz

Multiple Choice

Identify the choice that best completes the statement or answers the question.

____ 1. Which of the following is not included in an equilibrium expression?

a. gas in a heterogeneous system
b. gas in a homogeneous system
c. liquid in a heterogeneous system
d. liquid in a homogeneous system

ANSWER: C
In heterogeneous systems, only gases and solutions are included in the equilibrium expression. In homogeneous systems, all substances are in the same phase. Therefore, all species are included.
POINTS: 0 / 1
FEEDBACK:
REF: 54

____ 2. The equation for a chemical reaction is given below.

2A (g) + 4B (l) *ƒ* D (s) + 3E (aq)

The equilibrium expression for this reaction is:

a. $\frac{[D][E]}{[A][B]}$

b. $\frac{[D][E]^3}{[A]^2[B]^4}$

c. $\frac{[E]}{[A]}$

d. $\frac{[E]^3}{[A]^2}$

ANSWER: D
In heterogeneous systems, only gases and solutions are included in the equilibrium expression. In equilibrium expressions, the concentration of the chemical species is raised to the power of its co-efficient in the balanced chemical equation.
POINTS: 0 / 1
FEEDBACK:
REF: 54

____ 3. The equilibrium expression for a gaseous chemical reaction is given below.

$$\frac{[HCl]^x \times [O_2]}{[Cl_2]^2 \times [H_2O]^2}$$

Determine the value of *x*.

a. 1
b. 2

c. 3
d. 4

ANSWER: D

Write an equation for the reaction where the chemical species in the numerator of the equilibrium expression are the products and the chemical species in the denominator are the reactants.

Cl_2 (g) + H_2O (g) ƒ HCl (g) + O_2 (g)

Balance the equation

$2Cl_2$ (g) + $2H_2O$ (g) ƒ 4HCl (g) + O_2 (g)

x = co-efficient of HCl in the balanced chemical equation = 4

POINTS: 0 / 1
FEEDBACK:
REF: 56

___ 4. In a chemical system, the reaction quotient is greater than the equilibrium constant. This indicates that:

a. the forward reaction is favoured to reach equilibrium.
b. the reverse reaction is favoured to reach equilibrium.
c. the concentration of reactants is greater than the concentration of products.
d. the concentration of products is greater than the concentration of reactants.

ANSWER: B

The reaction quotient is large, so there is a greater concentration of products than reactants. At equilibrium, the concentration of products is smaller since K_{eq} is smaller. Hence, reverse reaction is favoured to decrease the concentration of products.

POINTS: 0 / 1
FEEDBACK:
REF: 57

___ 5. The equilibrium constant for a chemical reaction at a specific temperature is 0.0013 This indicates that:

a. the forward reaction is favoured to reach equilibrium.
b. the reverse reaction is favoured to reach equilibrium.
c. the concentration of reactants is greater than the concentration of products.
d. the concentration of products is greater than the concentration of reactants.

ANSWER: C

The equilibrium constant is a measure of the ratio of products to reactants at equilibrium; hence, a value less than 1 indicates that the numerator (products) is less than the denominator (reactants).

POINTS: 0 / 1
FEEDBACK:
REF: 57

___ 6. The units for concentrations of all species in the equilibrium expression must be in:

a. ppm.
b. g/L.
c. kg/L.
d. mol/L.

ANSWER: D

All concentrations must be in mol/L. If chemical species have other units of concentration, they must be converted to mol/L before being substituted into the equilibrium expression.

POINTS: 0 / 1
FEEDBACK:
REF: 59

___ 7. Given the reaction:

$2NO\ (g) + Br_2\ (g) \rightleftharpoons 2NOBr\ (g)$

The equilibrium constant for this reaction at 1000 K is 1.32×10^{-2}.
Calculate the equilibrium constant for the following reaction:

$NOBr\ (g) \rightleftharpoons NO\ (g) + \frac{1}{2}Br_2\ (g)$

a. 75.8
b. 8.70
c. 0.115
d. 1.32×10^{-2}

ANSWER: B

$$K_{eq}\text{ (1st equation)} = \frac{[NOBr]^2}{[NO]^2[Br_2]}$$

$$K_{eq}\text{ (2nd equation)} = \frac{[NO][Br_2]^{\frac{1}{2}}}{[NOBr]}$$

$$K_{eq}\text{ (2nd equation)} = \frac{1}{\sqrt{(K_{eq}\text{ 1st equation})}} = \frac{1}{1.32 \times 10^{-2}} = 8.70$$

POINTS: 0 / 1
FEEDBACK:
REF: 59

___ 8. Calculate the equilibrium constant for the reaction:

$I_2\ (g) \rightleftharpoons 2I\ (g)$

Given that, at equilibrium at 1200°C, the $[I_2] = 3.00 \times 10^{-3}$ mol/L and $[I] = 2.87 \times 10^{-3}$ mol/L

a. 2.75×10^{-3}
b. 0.957
c. 1.04
d. 362

ANSWER: A

$$K_{eq} = \frac{[I]^2}{[I_2]} = \frac{[2.87 \times 10^{-3}]^2}{[3.00 \times 10^{-3}]} = 2.75 \times 10^{-3}$$

POINTS: 0 / 1
FEEDBACK:
REF: 59

___ 9. $2NO\ (g) + Cl_2\ (g) \rightleftharpoons 2NOCl\ (g)$

Initially, 2 moles of NO and 2 moles of Cl_2 were added to a 2L reaction vessel.
At equilibrium, there was 0.96 mol/L NOCl present in the reaction vessel.
The temperature remained constant throughout the investigation.

What is the equilibrium constant for this reaction?

a. 46
b. 2.8×10^2
c. 1.1×10^3
d. 1.4×10^4

ANSWER: C

$2NO$ (g) + Cl_2 (g) ƒ $2NOCl$ (g)

Initial concentrations	1 mol/L	1 mol/L	0
Change in concentration	-2_x	$-x$	$+2x$

$2x$ = 0.96 mol/L, hence, x = 0.48 mol/L

Equilibrium concentrations	0.04 mol/L	0.52 mol/L	0.96 mol/L

$$K_{eq} = \frac{[NOCl]^2}{[NO]^2[Cl_2]} = \frac{0.96^2}{0.04^2 \times 0.52} = 1.1 \times 10^3 \text{mol}^{-1}$$

POINTS: 0 / 1
FEEDBACK:
REF: 59

____ 10. Which of the following can be used to measure equilibrium concentrations?

a. Colorimeter and universal indicator
b. Light meter and thermometer
c. pH meter and colorimeter
d. pH meter and thermometer

ANSWER: C

Thermometers measure temperature, not concentration.
Universal indicator measures pH, i.e. concentration of H3O+, but it is a destructive technique, i.e. it changes the concentration of the solution when it is added.
Colorimeter, light meter and pH meter are all non-destructive techniques that can be used to measure concentration, either directly or indirectly.

POINTS: 0 / 1
FEEDBACK:
REF: 63

____ 11. In colourimetry, the Beer–Lambert Law is used because there is:

a. a linear relationship between absorbance and concentration.
b. a parabolic relationship between absorbance and concentration.
c. an inverse relationship between absorbance and concentration.
d. an inverse square relationship between absorbance and concentration.

ANSWER: A

$A = \varepsilon l c$ hence A is proportional to c.

POINTS: 0 / 1
FEEDBACK:
REF: 63

____ 12. Fe^{3+} (aq) + SCN^- (aq) ƒ $FeSCN^{2+}$ (aq)

Blue light (470 nm) was used for the colourimetry experiment for the reaction above because:

a. the iron(III) ion preferentially reflects this light.
b. the iron(III) ion preferentially absorbs this light.
c. the iron(III) thiocyanate ion preferentially reflects this light.
d. the iron(III) thiocyanate ion preferentially absorbs this light.

ANSWER: D

The equilibrium concentration of the iron(III) thiocyanate ion is being determined in this investigation; hence, a wavelength that is absorbed by this ion is used, namely blue light with a wavelength of 470 nm.

POINTS: 0 / 1

FEEDBACK:

REF: 63

____ 13. $Cu (s) + 2Ag^{+} (aq)$ ƒ $2Ag (s) + Cu^{2+} (aq)$

The equilibrium constant for this reaction is 3.1×10^{9}.

Measurements were taken and it was found that the concentration of Cu^{2+} was 0.88 mol/L and the concentration of Ag^{+} was 0.050 mol/L. Which reaction will be favoured for the system to reach equilibrium?

a. The forward reaction will be favoured since $Q > K_{eq}$.

b. The forward reaction will be favoured since $Q < K_{eq}$.

c. The reverse reaction will be favoured since $Q > K_{eq}$.

d. The reverse reaction will be favoured since $Q < K_{eq}$.

ANSWER: B

$$Q = \frac{\left[Cu^{2+}\right]}{\left[Ag^{+}\right]^{2}} = \frac{0.88}{0.050^{2}} = 352$$

Since $Q < K_{eq}$, the forward reaction is favoured for the system to reach equilibrium.

POINTS: 0 / 1

FEEDBACK:

REF: 68

____ 14. $2O_3 (g)$ ƒ $3O_2 (g)$ K_{eq} 36

The equilibrium concentration of O_2 is 8.0×10^{-2} mol/L.

What is the concentration of ozone, O_3?

a. 3.8×10^{-3} mol/L

b. 4.7×10^{-2} mol/L

c. 8.0×10^{-2} mol/L

d. 1.2×10^{-1} mol/L

ANSWER: A

$$K_{eq} = \frac{\left[O_2\right]^{3}}{\left[O_3\right]^{2}}$$

$$\left[O_3\right] = \sqrt{\frac{\left[O_2\right]^{3}}{Keq}} = \sqrt{\frac{\left[8.0 \times 10^{-2}\right]^{3}}{36}} = 3.8 \times 10^{-3} molL^{-1}$$

POINTS: 0 / 1

FEEDBACK:

REF: 69

____ 15. $2NH_3 (g) \rightleftharpoons N_2 (g) + 3H_2 (g)$ $K_{eq} = 6.58 \times 10^{-3}$ at 500K

Initially, only ammonia was present in the reaction vessel. At equilibrium, the concentration of nitrogen was 0.00400 mol/L.

Calculate the concentration of ammonia present when the system reached equilibrium.

a. 1.02×10^{-3} mol/L
b. 1.05×10^{-3} mol/L
c. 2.43×10^{-3} mol/L
d. 4.93×10^{-2} mol/L

ANSWER: A

At equilibrium, $[N_2]$ = 0.00400 mol/L and $[H_2] = 3 \times 0.00400 = 0.0120$ mol/L

$$K_{eq} = \frac{[N_2][H_2]^3}{[NH_3]^2}$$

$$[NH_3]^2 = \frac{[N_2][H_2]^3}{K_{eq}} = \frac{0.00400 \times 0.0120^3}{6.58 \times 10^{-3}} = 1.05 \times 10^{-3}$$

$$[NH_3] = \sqrt{1.05 \times 10^{-3}} = 1.02 \times 10^{-3} \text{molL}^{-1}$$

POINTS: 0 / 1
FEEDBACK:
REF: 69

____ 16. A chemical reaction has reached equilibrium. The investigation for this reaction is repeated at a higher temperature. What is the effect on the reaction of raising the temperature?

a. The time for the reaction to reach equilibrium is less and the equilibrium constant remains the same.
b. The time for the reaction to reach equilibrium is less and the equilibrium constant is smaller for an exothermic reaction.
c. The time for the reaction to reach equilibrium is less and the equilibrium constant is smaller for an endothermic reaction.
d. The time for the reaction to reach equilibrium is the same and the equilibrium constant remains the same.

ANSWER: B

Increasing the temperature increases the rate of a chemical reaction. In this case, it increases the rate of both the forward and reverse reactions; hence, it takes less time to reach equilibrium.

For an exothermic reaction, an increase in temperature would favour the reverse reaction, i.e. increasing the [reactants] and decreasing the [products]. Since

$$K = \frac{[\text{products}]}{[\text{reactants}]} = \frac{\text{smaller number (decreased concentration)}}{\text{bigger number (increased concentrations)}} = \text{smaller value for } K$$

POINTS: 0 / 1
FEEDBACK:
REF: 71

____ 17. In solubility equilibria:

a. the precipitate is written on the right-hand side, the reaction quotient is called the ionic product and the equilibrium constant is called the solubility product.
b. the precipitate is written on the right-hand side, the reaction quotient is called the

solubility product and the equilibrium constant is called the ionic product.
c. the precipitate is written on the left-hand side, the reaction quotient is called the ionic product and the equilibrium constant is called the solubility product.
d. the precipitate is written on the left-hand side, the reaction quotient is called the solubility product and the equilibrium constant is called the ionic product.

ANSWER: C
In solubility equilibria:
- the precipitate is written on the left-hand side.
- the reaction quotient is called the ionic product.
- the equilibrium constant is called the solubility product.

POINTS: 0 / 1
FEEDBACK:
REF: 72

___ 18.

Name of acid	Formula of acid	K_a
Hydrocyanic acid	HCN	6.2×10^{-10}
Hydrofluoric acid	HF	6.6×10^{-4}
Hypochlorous acid	HClO	2.9×10^{-8}
Nitrous acid	HNO_2	7.2×10^{-4}

Rank these acids in terms of increasing degree of ionisation.
a. HCN < HClO < HF < HNO_2
b. HClO < HCN < HF < HNO_2
c. HNO_2 < HF < HClO < HCN
d. HCN < HClO < HNO_2 < HF

ANSWER: A
The chemical equation is written with the acid on the left (reactant side of equation) and the ions formed on the right (products). The larger the K_a, the larger the value of the numerator in equation 3.17. Hence, the greater the concentration of ions compared to the concentration of molecules of the acid, and the greater the degree of ionisation.
The question asks for increasing degree of ionisation, from the least to greatest; therefore, K_a values should be increasing.
POINTS: 0 / 1
FEEDBACK:
REF: 73

___ 19. Which statement about K_p is correct?
a. K_p for gases is the same as K_c for solutions.
b. K_p can be determined for both homogeneous systems and heterogeneous systems, which contain gases and solutions.
c. K_p can be calculated if the mole fractions of all gaseous species in a gaseous reaction are known.
d. K_p can be calculated if the partial pressures of all gaseous species in a gaseous reaction are known.

ANSWER: D
POINTS: 0 / 1
FEEDBACK:

REF: Only gaseous species are included in the expression for Kp.

____ 20. Ammonia gas is produced by the reaction of nitrogen gas and hydrogen gas.
At a particular temperature *T*, the system reaches equilibrium. The partial pressure of ammonia is found to be 0.0060 atm while nitrogen's is 0.094 atm. K_p for this reaction is 1.61.
What is the partial pressure for hydrogen?

a. 0.34 atm
b. 0.062 atm
c. 0.040 atm
d. 2.4×10^{-4} atm

ANSWER: B

N_2 (g) + $3H_2$ (g) ƒ $2NH_3$ (g)

$$Kp = \frac{\left(P_{NH_3}\right)^2}{\left(P_{N_2}\right) \times \left(P_{H_2}\right)^3}$$

$$\left(P_{H_2}\right)^3 = \frac{\left(P_{NH_3}\right)^2}{\left(P_{N_2}\right) \times K_p} = \frac{0.00600^2}{0.094 \times 1.61} = 2.379 \times 10^{-4}$$

$$P_{H_2} = \sqrt[3]{2.379 \times 10^{-4}}$$

$$= 0.062 \text{ atm}$$

POINTS: 0 / 1
FEEDBACK:
REF: 75

Retake