IB · HL · Chemistry

15 mins 15 questions

Multiple Choice Questions

How Far? The Extent of Chemical Change

The Characteristics of Dynamic Equilibrium / The Equilibrium Law / The Equilibrium Constant / Le Chatelier's Principle / The Reaction Quotient (HL) / Equilibrium Law Problem Solving (HL) / The Equilibrium Constant & Gibbs Energy (HL)

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Total Marks /15

1 Study the following equilibrium reaction and determine which of the statements must be true.

$$2X \rightleftharpoons Y \qquad K_c = 1.1$$

A. [X] ≫ [Y]

B. [X] > [Y]

C. [X] = [Y]

D. [X] < [Y]

(1 mark)

2 Hydrogen reacts with iodine according to the following equation

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

The value of K_c for this reaction has been measured at different temperatures

$$K_c = 60 \text{ at } 355\,^{\circ}C$$

$$K_c = 47 \text{ at } 450\,^{\circ}C$$

From the information given which of the following must be true?

A. The reaction is exothermic

B. The reaction is endothermic

C. The reaction barely proceeds at 355 °C

D. The reaction almost goes to completion at 450 °C

(1 mark)

3 The following K_c values were obtained for a reaction carried out at different temperatures, T_1 to T_4.

Temperature	K_c value
T_1	1×10^{-2}
T_2	1×10^{1}
T_3	1
T_4	1×10^{2}

Which of the following gives the correct amount of products in the mixtures from least to most?

A. $T_1 < T_2 < T_3 < T_4$

B. $T_4 < T_3 < T_2 < T_1$

C. $T_4 < T_2 < T_3 < T_1$

D. $T_1 < T_3 < T_2 < T_4$

(1 mark)

4 Which of the following conditions and reasons will increase the amount of hydrogen iodide produced?

$$H_2(g) + I_2(g) \rightleftharpoons 2HI(g) \qquad \Delta H = -126 \text{ kJ}$$

	Condition	Reason	Condition	Reason
A	increase T	exothermic reaction	increase P	two gaseous reactants but only one gaseous product
B	increase T	endothermic reaction	no change in P	equal numbers of moles of gases
C	decrease T	exothermic reaction	decrease P	two moles of gaseous product but only one mole of each gaseous reactant
D	decrease T	exothermic reaction	no change in P	equal numbers of moles of gases

(1 mark)

5 The blood-red complex iron (III) thiocynanate, $[FeSCN]^{2+}$ is formed when iron (III) ions react with thiocyanate ions in the following equilibrium reaction:

$$\underset{\text{yellow}}{Fe^{3+}(aq)} + \underset{\text{colourless}}{SCN^{-}(aq)} \rightleftharpoons \underset{\text{red}}{[FeSCN]^{2+}} \qquad \Delta H = +12\ kJ$$

Which of the following changes would make the solution go darker?

I raising the temperature of the solution

II adding iron(III) chloride solution

III adding a catalyst

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

(1 mark)

6 Which of the following features is not a characteristic of a state of equilibrium?

A. Equilibrium is dynamic

B. Equilibrium is achieved in a closed system

C. Concentrations of reactants and products are equal

D. Equilibrium can be reached from either direction

(1 mark)

7 What is the relationship between K_{c1} and K_{c2} in the following reactions?

$$2NOBr\ (g) \rightleftharpoons 2NO\ (g) + Br_2\ (g) \quad K_{c1}$$

$$NO\ (g) + \frac{1}{2}Br_2\ (g) \rightleftharpoons NOBr\ (g) \quad K_{c2}$$

A. $2K_{c2} = K_{c1}$

B. $(K_{c2})^2 = K_{c1}$

C. $K_{c2} = \frac{1}{\sqrt{K_{c1}}}$

D. $K_{c2} = \frac{1}{2K_{c1}}$

(1 mark)

8 Nitrogen dioxide can react with itself to produce a dimer molecule called dinitrogen tetroxide in the following equilibrium reaction.

$$2NO_2\,(g) \rightleftharpoons N_2O_4\,(g) \qquad K_c = 0.01 \text{ at } 25\,^{\circ}C$$

In an experiment, 100 cm^3 of nitrogen dioxide is placed in a gas syringe and the barrel is pushed in, meaning the volume is reduced to 50 cm^3 at constant temperature.

Which of the following statements are true?

I. The value of *K*c increases
II. More N_2O_4 is formed
III. The ratio of $\frac{[NO_2]}{[N_2O_4]}$ decreases

A. I and II only

B. I and III only

C. II and III only

D. I, II and III

(1 mark)

9 One of the characteristics of a state of equilibrium, is that equilibria are said to be *dynamic.* What is the meaning of *dynamic* in this context?

A. The position of equilibrium is constantly changing

B. The rates of forward and backward reactions change

C. The reactants and products are continually reacting

D. The concentrations of the reactants and products continue to change

(1 mark)

10 The reaction shown below has a value of $K_c = 1.0 \times 10^{-4}$ at 25 °C.

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

Which of the following relationships is correct about this equilibrium at 25 °C?

A. [NO] ≫ [NOBr]

B. [NOBr] ≫ [Br_2]

C. 2 x [NOBr] = [Br_2]

D. [NO] = [NOBr]

(1 mark)

11 The Haber process is a key step in the manufacture of fertilisers:

$$N_2\ (g) + 3H_2\ (g) \rightleftharpoons 2NH_3\ (g) \qquad \Delta H = \text{-ve}$$

Which is correct about the effect of increasing temperature for this reaction?

	Effect on equilibrium position	Effect on K_c
A.	Shifts left	No change
B.	Shifts right	No change
C.	Shifts right	Increase
D.	Shifts left	Decrease

(1 mark)

12 Which equation represents a reaction where the number of moles alone can not be used to calculate the value of K_c?

A. $CH_3CH_2OH\ (aq) + CH_3COOH\ (aq) \rightleftharpoons CH_3CH_2OCOCH_3\ (aq) + H_2O\ (l)$

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

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

D. $N_2\ (g) + O_2\ (g) \rightleftharpoons 2NO\ (g)$

(1 mark)

13 When 0.20 mol NO, 0.08 mol H_2 and 0.10 mol of H_2O are placed in a 1.0 dm^3 flask, the following equilibrium is established:

$$2NO\ (g) + 2H_2\ (g) \rightleftharpoons N_2\ (g) + 2H_2O\ (g)$$

At equilibrium, the concentration of H_2 (g) was found to be 0.02 mol dm^{-3}.

What is the correct value of K_c?

A. 1.02×10^{-2}

B. 98.0

C. 8.3

D. 489.8

(1 mark)

14 Nitrogen dioxide can form a dimer that can also break back down again as part of a reversible reaction:

$$N_2O_4\,(g) \rightleftharpoons NO_2\,(g) \qquad \Delta H = +ve$$

The reaction reaches an equilibrium at temperature T, where $K_c = 1$

What is true for a higher temperature, T_2?

	K_c value	ΔG^θ value
A.	Increases	Increases
B.	Decreases	Increases
C.	Decreases	Decreases
D.	Increases	Decreases

(1 mark)

15 Which would be the correct way to plot a graph and then calculate ΔG^θ from experimental data of K_c and temperature values?

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

	y-axis	x-axis	ΔG^θ =
A.	1 / T	ln K	-R x gradient
B.	ln K	1 / T	-R x gradient
C.	ln K	1 / T	R / gradient
D.	1 / T	ln K	R / gradient

(1 mark)