INDIAN SCHOOL AL WADI AL KABIR		
Class: XI	**Department: SCIENCE 2023-24**	**Date:**
Worksheet No.: 9	**Topic: CHEMISTRY** Equilibrium	**Note: A4 FILE FORMAT**
NAME OF THE STUDENT:	**CLASS & SEC:**	**ROLL NO.**

I. MULTIPLE CHOICE QUESTIONS (1 MARK)

1.For the chemical reaction
$3X_{(g)} + Y_{(g)} \rightleftharpoons X_3Y_{(g)}$
the amount of X3Y at equilibrium is affected by
(a) Temperature and pressure
(b) Pressure only
(c) Temperature only
(d) Temperature, pressure and catalyst.

2. When the pressure is increased in a closed system at equilibrium containing only gaseous reactants and products, the equilibrium will shift in the direction of the:

(a) reaction with fewer gas molecules.
(b) reaction with more gas molecules.
(c) reaction with higher enthalpy.
(d) reaction with lower enthalpy.

3. For the chemical reaction:
$2A + B \rightleftharpoons C$, the units of Kp is
(a) atm^{-2}
(b) atm^{-3}
(c) atm^{-1}
(d) Dimensionless

4.In which manner, the increase of the pressure will affect the following equilibrium?
$C_{(s)} + H2O_{(g)} \rightleftharpoons CO_{(g)} + H2_{(g)}$
(a) Shifts in the forward direction
(b) Shifts in the reverse direction
(c) Increase the yield of hydrogen
(d) No effect.

5. Kp/Kc for the reaction $CO_{(g)} + ½\ O_{2\,(g)} \rightleftharpoons CO_{2\,(g)}$ is
(a) 1
(b) RT
(c) $1/\sqrt{RT}$
(d) $(RT)^{½}$

6. In the reaction $PCl5_{(g)} \rightleftharpoons PCl3_{(g)} + Cl2_{(g)}$ the equilibrium concentrations of PCl5 and PCl3 are 0.4 and 0.2 mole/litre respectively. If the value of Kc. is 0.5, what is the concentration of Cl2 in moles/ litre?
(a) 2.0
(b) 1.5
(c) 1.0
(d) 0.5

7. The value of the equilibrium constant (Kc) depends on:

(a) the initial concentrations of reactants and products.
(b) the temperature of the system.
(c) the nature of the reactants and products.
(d) all of the above.

II. ASSERTION REASON TYPE QUESTIONS (I MARK)

For the following questions, two statements are given- one labeled *Assertion* (A) and the other labeled *Reason* (R). Select the correct answer to these questions from the codes (i), (ii), (iii) and (iv) as given below

(a) Both A and R are true and R is the correct explanation of the assertion.
(b) Both A and R are true but R is not the correct explanation of the assertion.
(c) A is true but R is false.
(d) A is false but R is true.

8. Assertion: Addition of a catalyst to a closed system at equilibrium will change the value of Kc.
Reason: A catalyst increases the rate of both forward and backward reactions without affecting the equilibrium positions.

9 Assertion: pH of a buffer solution does not change on dilution.
Reason: On dilution, the ratio of concentration of salt and acid (or base) remains unchanged.

10. Assertion: The solubility of a salt increases with increasing common ion concentration.
Reason: The common ion effect shifts the equilibrium towards the less soluble form of the salt, decreasing its solubility.

III. 2 MARKS QUESTIONS

11Explain why adding a catalyst to a closed system at equilibrium does not change the equilibrium constant (Kc).

12. Consider the reaction $N_2 + 3H_2 \rightleftharpoons 2NH_3$. How will adding more nitrogen gas (N_2) affect the concentration of ammonia (NH_3) at equilibrium? Explain using Le Chatelier's principle.

13. Briefly explain the difference between a strong acid and a weak acid in terms of their degree

of ionization and the equilibrium constant (Ka)

14. The standard Gibbs free energy change ($\Delta G°$) for the reaction A ⇌ B is -10 kJ $mol^{-1.}$ What is the relationship between $\Delta G°$ and the equilibrium constant (Kc) for the reaction?

.

1V 3 MARKS QUESTIONS

15. Explain how the equilibrium constant (Kc) is affected by the following changes in a closed system:
    (a) Concentration of a reactant is increased.
    (b) Pressure is increased in a system containing only gaseous reactants and products.
    (c) Temperature is increased for an exothermic reaction. Use Le Chatelier's principle to justify your answers.
16. The solubility product (K_{sp}) of calcium carbonate ($CaCO_3$) is 25 x 10^{-10} M^3
    (a) What is the equilibrium concentration of Ca^{2+} ions in a saturated solution of $CaCO_3$?
    (b) How will the addition of excess Na_2CO_3 (sodium carbonate) affect the solubility of $CaCO_3$? Explain using the concept of the common ion effect.

V 5 MARKS QUESTIONS

17 (a) Explain the concept of solubility product (K_{sp}) and its significance in predicting the precipitation of salts.

18. Le Chatelier's principle is a fundamental concept in understanding equilibrium shifts. Describe the principle in detail, and apply it to predict the changes in equilibrium position and concentrations of species involved when the following occur in a closed system:
    (a) Concentration of a reactant is decreased
    (b) Pressure is increased in a system with gaseous reactants and products present in different ratios
    (c) Temperature is decreased for an endothermic reaction.

19 The Haber-Bosch process for ammonia synthesis is an industrially crucial reaction

$N_2 + 3H_2 \longleftrightarrow 2NH_3$

The $\Delta H°$ for this reaction is negative, and the $\Delta S°$ is positive.

(a) Discuss the factors affecting the equilibrium position and yield of ammonia in this process.
(b) Analyze how changes in temperature, pressure, and the presence of a catalyst influence the equilibrium and suggest strategies to optimize ammonia production.

VI PASSAGE BASED /CASE STUDY BASED QUESTIONS

20

A solution containing weak acid and its salt with strong base resists change in pH on addition of small amounts of acids or bases and is called a buffer solution. Similarly, a solution containing a weak base and its salt with strong acid behaves as a buffer solution. pH of a buffer solution can be calculated by applying Henderson-Hasselbalch equation. Maintaining a stable pH is crucial for the health of fish in an aquarium.

(a) How can the accumulation of fish waste or addition of external chemicals affect the aquarium's pH?
(b) Give an example of an acidic buffer and basic buffer.
(c) Calculate the pH of a solution which is 0.1M in CH_3COOH and 0.1 M in CH_3COONa.

(pKa (CH_3COOH = 4.74)

21**.** A closed system initially contains 1.00 mol of NO2 and 0.50 mol of N2O4 according to the following equilibrium:

$2\ NO_{2\ (g)} \rightleftharpoons N_2O_{4\ (g)}\ \Delta H° = -9.4\ kJ\ mol^{-1}$

(a) Write the expression for the equilibrium constant (Kc) for this reaction.

(b) Calculate the initial value of Kc at 25°C given the initial concentrations.

(c) If the system absorbs heat, will the concentration of NO_2 increase, decrease, or remain the same? Explain your reasoning using Le Chatelier's principle and the sign of $\Delta H°$.

Q. No.	ANSWERS
1.	(a)
2.	(a)
3.	(a)
4.	(b)
5.	(c)
6.	(c)
7.	(b)
8.	(c)
9.	(a)
10	(d)
11	This is because a catalyst speeds up the forward and back reaction to the same extent. Therefore equilibrium constant Kc not affected
12.	If more Nitrogen is added to the system, the equilibrium will shift to the right. When an extra concentration of reactants is added the system will readjust by forming more products according to Le Chatelier's principle
13	A strong acid is an acid which is completely ionized in an aqueous solution whereas the weak acid do not completely ionizes. The Ka of the strong acids will be higher than that of the weak acids
14	ΔG^0=-2.303RTlog K

15	(a) Unchanged because when the concentration of the reactants is increased more products will be formed as per the Le Chatelier's principle and hence the Kc doesn't change (b) No change. When the pressure is increased the system will readjust to nullify the change by shifting to the side with lesser number of moles of products and hence the Kc doesn't change (c) The Kc will decrease because increasing the temperature favors the endothermic reaction so the reverse reaction happens more and therefore the Kc will decrease
16	(a) [Ca2+] = 5x10-5 (b) The common ion effect is used to precipitate out the calcium carbonate (which is sparingly soluble) from the water via the addition of sodium carbonate, which is highly soluble. When sodium carbonate is added to the equilibrium carbonate being a common ion the equilibrium shifts in the reverse reaction precipitating the calcium carbonate
17	(a) If Solubility product is larger than the ionic product then no precipitate will form (b) If Solubility product is smaller than the ionic product then excess solute will precipitate out because of the formation of supersaturated solution.
18	Le Chatelier's principle is used to predict the effect of some changes on a system in chemical equilibrium (such as the change in temperature or pressure). (a) The equilibrium shifts in the reverse direction (b) The reaction shifts in the direction with the lesser number of moles (c) When temperature is decreased in an endothermic reaction the reaction shifts in the reverse direction
19	(a)The factors affecting the yield are concentration, temperature and pressure. (b) As the reaction is exothermic, lowering the temperature favours the forward reaction. When the pressure is increased the equilibrium shifts in the forward reaction making more ammonia because increasing the pressure shifts the equilibrium in the direction with the fewer number of moles of gaseous products. The catalyst speeds up the reaction even though it doesn't affect the equilibrium
20	(a) The fish waste decreases the pH increasing the acidity (b) Acidic buffer -Acetic acid and Sodium acetate Basic buffer - Ammonia and Ammonium chloride (c) pH = $= PKa + \log \frac{[salt]}{[acid]}$ = 4.74 + log 0.1/0.1 = 4.74
21	(a) Kc = $[N_2O_4]/ [NO_2]^2$ (b) Kc = 0.5/1 = 0.5 $mol^{-1}L^{-1}$ (c) As the forward reaction is exothermic increasing the temperature will favour the reverse reaction and hence increase the concentration of NO_2

PREPARED BY Ms JENESHA JOSEPH	CHECKED BY HoD SCIENCE