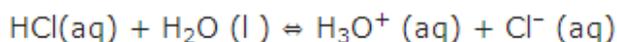


## Equilibrium

### Short Answer Type Questions

1. The ionisation of hydrochloric in water is given below:



Label two conjugate acid-base pairs in this ionisation.

2. The aqueous solution of sugar does not conduct electricity. However, when sodium chloride is added to water, it conducts electricity. How will you explain this statement on the basis of ionisation and how is it affected by concentration of sodium chloride?
3.  $\text{BF}_3$  does not have proton but still acts as an acid and reacts with  $\text{NH}_3$ . Why is it so? What type of bond is formed between the two?
4. Ionisation constant of a weak base MOH, is given by the expression

$$K_b = \frac{[\text{M}^+][\text{OH}^-]}{[\text{MOH}]}$$

Values of ionisation constant of some weak bases at a particular temperature are given below:

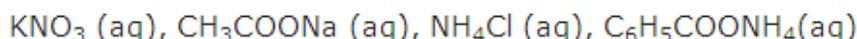
Base	Dimethylamine	Urea	Pyridine	Ammonia
$K_b$	$5.4 \times 10^{-4}$	$1.3 \times 10^{-14}$	$1.77 \times 10^{-9}$	$1.77 \times 10^{-5}$

Arrange the bases in decreasing order of the extent of their ionisation at equilibrium. Which of the above base is the strongest?

5. Conjugate acid of a weak base is always stronger. What will be the decreasing order of basic strength of the following conjugate bases?

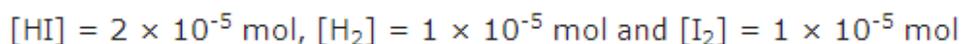


6. Arrange the following in increasing order of pH.



7. The value of  $K_c$  for the reaction  $2\text{HI} \text{ (g)} \rightleftharpoons \text{H}_2 \text{ (g)} + \text{I}_2 \text{ (g)}$  is  $1 \times 10^{-4}$

At a given time, the composition of reaction mixture is



In which direction will the reaction proceed?

8. On the basis of the equation  $\text{pH} = -\log [\text{H}^+]$ , the pH of  $10^{-8} \text{ mol dm}^{-3}$  solution of HCl should be 8. However, it is observed to be less than 7.0. Explain the reason.
9. pH of a solution of a strong acid is 5.0. What will be the pH of the solution obtained after diluting the given solution a 100 times?
10. A sparingly soluble salt gets precipitated only when the product of concentration of its ions in the solution ( $Q_{\text{sp}}$ ) becomes greater than its solubility product. If the solubility of  $\text{BaSO}_4$  in water is  $8 \times 10^{-4} \text{ mol dm}^{-3}$ . Calculate its solubility in  $0.01 \text{ mol dm}^{-3}$  of  $\text{H}_2\text{SO}_4$ .
11. pH of  $0.08 \text{ mol dm}^{-3}$  HOCl solution is 2.85. Calculate its ionisation constant.
12. Calculate the pH of a solution formed by mixing equal volumes of two solutions A and B of a strong acid having pH = 6 and pH = 4 respectively.
13. The solubility product of  $\text{Al}(\text{OH})_3$  is  $2.7 \times 10^{-11}$ . Calculate its solubility in  $\text{g L}^{-1}$  and also find out pH of this solution. (Atomic mass of Al = 27 u).
14. Calculate the volume of water required to dissolve 0.1 g lead (II) chloride to get a saturated solution. ( $K_{\text{sp}}$  of  $\text{PbCl}_2 = 3.2 \times 10^{-8}$ , atomic mass of Pb = 207 u).
15. A reaction between ammonia and boron trifluoride is given below:  
:  $\text{NH}_3 + \text{BF}_3 \rightarrow \text{H}_3\text{N} : \text{BF}_3$   
Identify the acid and base in this reaction. Which theory explains it? What is the hybridisation of B and N in the reactants?
16. Following data is given for the reaction:  $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$   
 $\Delta_f H^\ominus [\text{CaO}(\text{s})] = - 635.1 \text{ kJ mol}^{-1}$   
 $\Delta_f H^\ominus [\text{CO}_2(\text{g})] = - 393.5 \text{ kJ mol}^{-1}$   
 $\Delta_f H^\ominus [\text{CaCO}_3(\text{s})] = - 1206.9 \text{ kJ mol}^{-1}$   
Predict the effect of temperature on the equilibrium constant of the above reaction.

## Long Answer Type Questions

1. How can you predict the following stages of a reaction by comparing the value of  $K_c$  and  $Q_c$  ?
  - (i) Net reaction proceeds in the forward direction.
  - (ii) Net reaction proceeds in the backward direction.
  - (iii) No net reaction occurs.
2. On the basis of Le Chatelier principle explain how temperature and pressure can be adjusted to increase the yield of ammonia in the following reaction.  
$$\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g}) \quad \Delta H = -92.38 \text{ kJ mol}^{-1}$$

What will be the effect of addition of argon to the above reaction mixture at constant volume?
3. A sparingly soluble salt having general formula  $\text{A}^{p+}_x \text{B}^{q-}_y$  and molar solubility  $S$  is in equilibrium with its saturated solution. Derive a relationship between the solubility and solubility product for such salt.
4. Write a relation between  $\Delta G$  and  $Q$  and define the meaning of each term and answer the following :
  - (a) Why a reaction proceeds forward when  $Q < K$  and no net reaction occurs when  $Q = K$ .
  - (b) Explain the effect of increase in pressure in terms of reaction quotient  $Q$ . for the reaction :  $\text{CO}(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons \text{CH}_4(\text{g}) + \text{H}_2\text{O}(\text{g})$