CHEMISTRY (CODE - 043)

CHAPTER TEST - QUESTION PAPER

Class XI (2026-27) | Chapter 6: Equilibrium

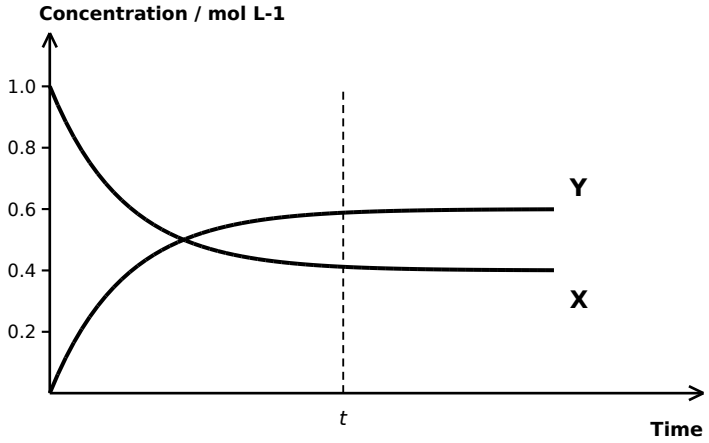
Time: 1 hour 30 minutes | Max. Marks: 35

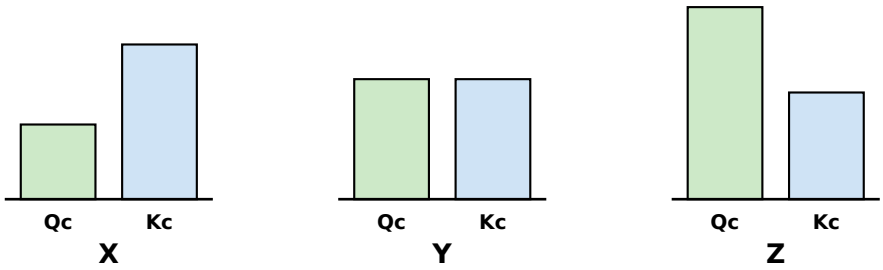
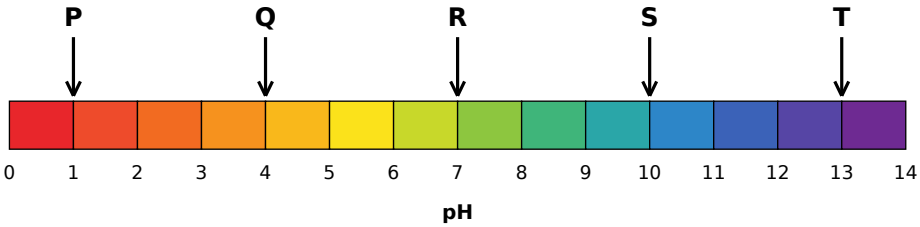
GENERAL INSTRUCTIONS:

1. Read the following instructions carefully.
2. There are 20 questions in this question paper with internal choice.
3. SECTION A consists of 12 questions carrying 1 mark each (Q. 1 to 9 are multiple-choice questions and Q. 10 to 12 are Assertion–Reason questions).
4. SECTION B consists of 4 very short answer questions carrying 2 marks each.
5. SECTION C consists of 2 short answer questions carrying 3 marks each.
6. SECTION D consists of 1 case-based question carrying 4 marks.
7. SECTION E consists of 1 long answer question carrying 5 marks.
8. All questions are compulsory. Internal choice is provided in Q. 16 (Section B) and Q. 20 (Section E).
9. Use of log tables and calculators is not allowed.
10. Constants: $K_w = 1 \times 10^{-14}$ at 298 K; log 2 = 0.30.

SECTION A

Questions 1 to 9 are multiple-choice questions. Only one of the choices is correct. Questions 10 to 12 are Assertion–Reason questions.

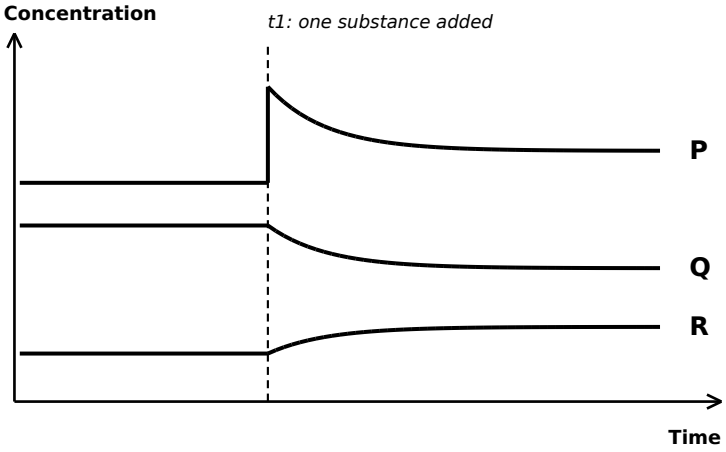
1	For which of the following equilibria is K_p equal to K_c? A. $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ B. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ C. $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ D. $N_2O_4(g) \rightleftharpoons 2NO_2(g)$	1
2	Initially only X is present in a closed vessel and the reaction X ⇌ Y takes place. The graph shows how the concentrations of X and Y change with time.  The equilibrium constant K_c of the reaction is: A. 0.67 B. 1.5 C. 0.60 D. 2.5	1
3	Ammonia is formed by the exothermic reaction $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$. According to Le Chatelier's principle, the equilibrium yield of NH_3 is the highest at: A. high pressure and low temperature B. high pressure and high temperature C. low pressure and low temperature D. low pressure and high temperature	1

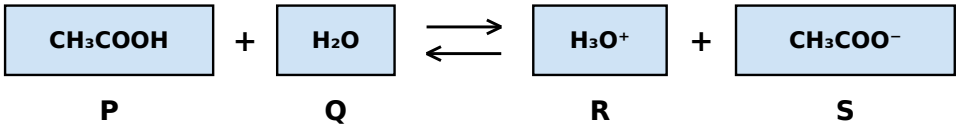
4	The figure compares the reaction quotient Q_c with K_c for the same reaction in three different reaction mixtures X, Y and Z.  The net reaction in X, Y and Z proceeds respectively in the direction: A. reverse, forward, at equilibrium B. at equilibrium, reverse, forward C. reverse, at equilibrium, forward D. forward, at equilibrium, reverse	1
5	Which of the following species acts as a Lewis acid? A. NH_3 B. BF_3 C. OH^- D. H_2O	1
6	The pH of a 0.005 M solution of $Ba(OH)_2$ at 298 K (assume complete ionisation) is: A. 2 B. 10 C. 11.7 D. 12	1
7	The figure shows five solutions P, Q, R, S and T on the pH scale at 298 K.  Which solution has a hydroxide ion concentration of 1×10^{-4} M? A. Q B. R C. S D. T	1
8	A sparingly soluble salt MX_2 has a molar solubility S in water. Its solubility product is: A. S^2 B. $4S^3$ C. $27S^4$ D. $108S^5$	1
9	Which of the following mixtures forms an acidic buffer solution? A. HCl + NaCl B. NaOH + NaCl C. $CH_3COOH + CH_3COONa$ D. $NaCl + H_2O$	1
10	Questions 10 to 12 are Assertion (A) and Reason (R) type questions. Select the correct option. **Assertion (A):** A catalyst does not change the value of the equilibrium constant. **Reason (R):** A catalyst lowers the activation energy of the forward and the reverse reactions by the same amount. A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true.	1

11	**Assertion (A):** The pH of a 1×10^{-8} M HCl solution is 8. **Reason (R):** Water also supplies hydrogen ions to the solution when the acid is very dilute. A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true.	1
12	**Assertion (A):** The equilibrium constant of an exothermic reaction decreases when the temperature is raised. **Reason (R):** The rate of a reaction increases with temperature. A. Both A and R are true, and R is the correct explanation of A. B. Both A and R are true, and R is not the correct explanation of A. C. A is true but R is false. D. A is false but R is true.	1

SECTION B

Questions 13 to 16 are very short answer questions carrying 2 marks each.

13	The reaction $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ is at equilibrium. At time t_1 one of the reactants is added at constant temperature and volume. The graph shows the concentrations of H_2, I_2 and HI (not necessarily in this order) as curves P, Q and R.  (i) Identify the substances represented by P, Q and R, and state which reactant was added. [1] (ii) State Le Chatelier's principle. Does the value of K_c change after t_1? [1]	2
14	The ionisation constants of some weak acids at 298 K are given below. **Acid** | **HF** | **HCOOH** | **CH_3COOH** | **HCN** K_a | 3.5×10^{-4} | 1.8×10^{-4} | 1.8×10^{-5} | 5×10^{-10} (i) Arrange the acids in the increasing order of their strength and name the acid whose conjugate base is the strongest. [1] (ii) Calculate K_b of the conjugate base of HCN. ($K_w = 1 \times 10^{-14}$) [1]	2
15	For the reaction $N_2O_4(g) \rightleftharpoons 2NO_2(g)$, $K_c = 0.05$ mol L^{-1} at 500 K. (i) Write the expressions for K_c and K_p for this reaction. [1] (ii) Calculate K_p at 500 K. ($R = 0.08$ L bar mol^{-1} K^{-1}) [1]	2

16	The figure shows the proton transfer reaction when acetic acid is dissolved in water.  **P** **Q** **R** **S** (i) Identify the Brønsted acid, the Brønsted base, the conjugate acid and the conjugate base among P, Q, R and S. [1] (ii) Is S a strong or a weak base? Give a reason. [1] **OR** Classify each of $AlCl_3$, F^-, Mg^{2+} and H_2O as a Lewis acid or a Lewis base and show how it behaves as such. [½ each]	2

SECTION C

Questions 17 and 18 are short answer questions carrying 3 marks each.

17	At 800 K, $K_c = 4$ for the reaction $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$. 0.10 mol L^{-1} each of CO and H_2O are taken initially in a closed vessel. Let x mol L^{-1} of CO react at equilibrium. **Concentration / M** | **CO** | **H_2O** | **CO_2** | **H_2** Initial | 0.10 | 0.10 | 0 | 0 Change | −x | −x | +x | +x At equilibrium | ? | ? | ? | ? (i) Write the expression for K_c. [1] (ii) Fill in the equilibrium row and calculate x. (Hint: take the square root of both sides.) [1½] (iii) State the equilibrium concentration of each species. [½]	3
18	A weak monobasic acid HA has $K_a = 1 \times 10^{-5}$ at 298 K. Its concentration is 0.1 M. (Assume that $1 - \alpha \approx 1$.) (i) Calculate the degree of ionisation (α) and the pH of the solution. [1] (ii) Calculate the $[H^+]$ and the pH when the solution is made 0.1 M in NaA (a salt of the acid). [1] (iii) Name the effect responsible for the change in (ii) and explain it with Le Chatelier's principle. [1]	3

SECTION D

Question 19 is a case-based question carrying 4 marks.

19	**Buffer solutions** Many body fluids have a definite pH, and a change in it indicates a malfunction. Buffer solutions help to keep the pH nearly constant. A student prepares 1 L of a buffer solution by dissolving 0.20 mol of sodium acetate and 0.10 mol of acetic acid in water. The pK_a of acetic acid is 4.75. The Henderson–Hasselbalch equation is $pH = pK_a + \log([salt] / [acid])$. (log 2 = 0.30) (i) What are buffer solutions? [1] (ii) Calculate the pH of the buffer prepared by the student. [1] (iii) How does this buffer resist the change in pH when a small amount of HCl is added? [1] (iv) Name a pair of substances that gives a buffer of pH about 9.25. Why does the pH of a buffer not change on dilution? [1]	4

SECTION E

Question 20 is a long answer question carrying 5 marks.

20	The solubility product constants (K_{sp}) at 298 K of two sparingly soluble salts AB and AB_2 are given below. **Salt** | **AB** | **AB_2** K_{sp} | 4×10^{-10} | 4×10^{-12} (i) Write the expression for K_{sp} of AB_2 in terms of its molar solubility S. [1] (ii) Calculate the molar solubilities of AB and AB_2. [2] (iii) Which salt is more soluble? Is the salt with the larger K_{sp} always the more soluble one? [1] (iv) Calculate the solubility of AB in a 0.1 M solution of a soluble salt that contains A^+ ions. Name the effect involved. [1] **OR** (i) Predict whether the aqueous solutions of NaCl, NH_4Cl, CH_3COONa and KF are acidic, basic or neutral. [2] (ii) Write the hydrolysis reaction of CH_3COONa and explain why the solution is basic. [1] (iii) The pK_a of acetic acid is 4.8 and the pK_b of NH_4OH is 4.6. Calculate the pH of an aqueous solution of ammonium acetate using $pH = 7 + ½(pK_a - pK_b)$. [1] (iv) K_b of NH_3 is 2×10^{-5}. Calculate K_a of NH_4^+. [1]	5

***** END OF QUESTION PAPER *****