KD EDUCATION ACADEMY (9582701166

Time : 3 Hour 20 Minute | STD 11 Science Chemistry | Total Marks : 230

kd 90+ ch-6 equilibrium

* **Choose The Right Answer From The Given Options.[1 Marks Each]** **[69]**

1. 0.10M CH_3COOH is 1.34% ionised, calculate its K_a:

(A) 1.8×10^{-5} (B) 1.8×10^{-4} (C) 5×10^{-4} (D) 4×10^{-5}

2. "An acid is a substance that is capable of donating a hydrogen ion H^+ and bases are substances capable of accepting a hydrogen ion, H^+".
The above statement is justified by

(A) Arrhenius concept. (B) Bronsted-Lowry theory.
(C) Lewis concept. (D) All of the above.

3. What will be the conjugate bases for the following Bronsted acids?
$\mathrm{HF}, \mathrm{H_2SO_4}$ and $\mathrm{HCO_3^-}$

(A) $\mathrm{F^-}, \mathrm{SO_4^{2-}}$ and $\mathrm{CO_3^{2-}}$ (B) $\mathrm{F^-}, \mathrm{SO_4^{2-}}$ and $\mathrm{H_2CO_3}$
(C) $\mathrm{F^-}, \mathrm{HSO_4^-}$ and $\mathrm{H_2CO_3}$
(D) $\mathrm{F^-}, \mathrm{HSO_4^-}$ and $\mathrm{CO_3^{2-}}$

4. What will be the molar solubility S of a solid salt with general formula $\mathrm{M_x^{p+}X_y^{q-}}$?

(A) $\left(\frac{K_{sp}}{x^y.y^x}\right)^{\frac{1}{x+y}}$ (B) $\left(\frac{K_{sp}}{x^x.y^y}\right)^{x+y}$ (C) $\left(\frac{K_{sp}}{x^x.y^y}\right)^{\frac{1}{x+y}}$ (D) $\left(\frac{K_{sp}}{x^y.y^x}\right)^{x+y}$

5. The pH of boiling water is 6.4. This implies that boiling water is:

(A) Slightly basic. (B) Slightly acidic.
(C) Neutral. (D) Amphoteric.

6. The equilibrium constant of a reaction at 298K and 1000K is 5×10^{-3} and 2×10^{-3} respectively. The $\triangle \mathrm{H}$ for the reaction is:

(A) Positive. (B) Negative.
(C) Either positive or negative. (D) Zero.

7. The mass of acetic acid present in 500ml of solution in which it is 1% ionised (Ka of $CH_3COOH = 1.8 \times 10^{-5}$)

(A) 5.4g (B) 12.6g (C) 6.4g (D) 10.8g

8. Which among the following factors changes the value of ionic product of water?

(A) Change in temperature. (B) Addition of acid.
(C) Addition of base. (D) Addition of either acid and base.

9. In which condition, the reaction proceeds in the forward direction?

(A) $Q_C = K_C$ (B) $Q_C > K_C$ (C) $Q_C < K_C$ (D) $Q_C \neq K_C$

10. The strength of acid is highest in:

(A) $pK_a = 6$ (B) $pK_a = 5$ (C) $pK_a = 10$ (D) $pK_a = 1$

11. 0.1M CH_3COOH and 1.01CH_3COONa are mixed togethere, what will be pH of buffer solution if $\mathrm{pK_a} = 4.75[\log 10 - 1 = -1]$

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(A) 3.75 (B) 4.75 (C) 5.75 (D) 6.75

12. Cottrell precipitator acts on which of the following principle?
(A) Hardy-Schulze rule.
(B) Distribution law.
(C) Le Chatelier's principle.
(D) Neutralization of charge on the colloidal particles.

13. A solution which maintains constant pH when small amounts of acid or alkali are added is known as ____.
(A) Indicator
(B) Buffer
(C) Amphoteric
(D) Neutral

14. The pH value of blood does not appreciably change by a small addition of an acid or a base, because the blood:
(A) Is a body fluid.
(B) Can be easily coagulated.
(C) Contains iron as a part of the molecule.
(D) Contains serum protein which acts as buffer.

15. Addition of HCl will not suppress the ionization of:
(A) Acetic acid
(B) Benzoic acid
(C) H_2S
(D) Sulphuric acid

16. The solubility product K_{sp} of the sparingly soluble salt Ag_2CrO_4 is 4×10^{-12}. The molar solubility of the salt is:
(A) 1.0×10^{-4} mol L^{-1}
(B) 2×10^{-6} mol L^{-1}
(C) 1.0×10^{-5} mol L^{-1}
(D) 2×10^{-12} mol L^{-1}

17. Which of the following species is amphoteric in nature.
(A) $\mathrm{H_3O^+}$ (B) $\mathrm{Cl^-}$ (C) $\mathrm{HSO_4^-}$ (D) $\mathrm{CO_3^{2-}}$

18. The ionic product of water ______ if a few drops of acid or base are added to it.
(A) Increases.
(B) Decreases.
(C) Remains the same.
(D) Can not predict.

19. A buffer solution is a solution whose pH value on keeping in the air:
(A) Increases rapidly.
(B) Decreases rapidly.
(C) May increase or decrease.
(D) Does not change.

20. In the reaction,
$N_2(g) + O_2(g) \rightleftharpoons 2NO(g) - 180.7$ kJ,
on increasing the temperature, the production of NO:
(A) Increases.
(B) Decreases.
(C) Remains same.
(D) Cannot be predicted.

21. Calculate the molar solubility (S) of a salt like zirconium phosphate of molecular formula $(\mathrm{Zr^{4+}})_3(\mathrm{PO_4^{3-}})_4$.
(A) $\left(\frac{\mathrm{K_{sp}}}{9612}\right)^{\frac{1}{8}}$ (B) $\left(\frac{\mathrm{K_{sp}}}{6912}\right)^{\frac{1}{7}}$ (C) $\left(\frac{\mathrm{K_{sp}}}{5348}\right)^{\frac{1}{6}}$ (D) $\left(\frac{\mathrm{K_{sp}}}{8435}\right)^{\frac{1}{7}}$

22. Strong electrolyte of the following is?
(A) 01M HAc
(B) 0.1M HCl

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(C) 0.1M KCl (D) 0.1M NaCl

23. In the presence of a common ion (incapable of forming complex ion), the solubility of salt _______ in solution.

(A) Increases. (B) Decreases.

(C) Remains the same. (D) Cannot predict.

24. In a reversible reaction $H_2 + I_2 \leftrightharpoons 2HI$, if the concentration of H_2 and I_2 are increased, the value of Kc:

(A) Decreases. (B) Increases.

(C) Remains the same. (D) Changes exponentially.

25. Given the chemical equilibrium, $A \rightleftharpoons B + C$, where ΔH_{rxn} is negative, what effect increasing the temperature (at constant pressure) would have on the system at equilibrium?

(A) No change.

(B) Shift to the left.

(C) Shift to the right.

(D) Shift to the left for K<1 and to the right for K>1.

26. K_a for CH_3COOH is 1.8×10^{-5} and K_b for NH_4OH is 1.8×10^{-5} . The pH of ammonium acetate will be

(A) 7.005 (B) 4.75

(C) 7.0 (D) Between 6 and 7

27. Which of the following will produce a buffer solution when mixed in equal volumes?

(A) 0.1mol dm^{-3} NH_4OH and 0.1mol dm^{-3} HCl.

(B) 0.05mol dm^{-3} NH_4OH and 0.1mol dm^{-3} HCl.

(C) 0.1mol dm^{-3} NH_4OH and 0.05mol dm^{-3} HCl.

(D) 0.1mol dm^{-3} CH_4COONa and 0.1mol dm^{-3} NaOH.

28. Which one does not give a buffer solution?

(A) Ammonia and sodium hydroxide in water.

(B) Sodium acetate and acetic acid in water.

(C) Ammonia and ammonium chloride in water.

(D) Sodium acetate and hydrochloric acid in water.

29. Acidity of BF_3 can be explained on the basis of which of the following concepts?

(A) Arrhenius concept.

(B) Bronsted Lowry concept.

(C) Lewis concept.

(D) Bronsted Lowry as well as Lewis concept.

30. Strong acid dissociates completely in water, the resulting base formed would be very weak. The reason is that:

(A) Strong acids have strong conjugate bases.

(B) Strong acids have strong conjugate acids.

(C) Strong acids have very weak conjugate bases.

(D) Strong acids have very weak conjugate acids.

31.

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$A + B \rightleftharpoons C + D.$ If the concentration of A and B are equal at equilibrium and concentration of D will be twice that of A, then what will be the equilibrium constant of the reaction?

(A) 4 (B) 6 (C) $\frac{4}{5}$ (D) $\frac{6}{7}$

32. When hydrochloric acid is added to cobalt nitrate solution at room temperature, the following reaction takes place and the reaction mixture becomes blue. On cooling the mixture it becomes pink. On the basis of this information mark the correct answer.

$$\underset{\text{(pink)}}{[Co(H_2O)_6]^{3+}(aq)} + 4Cl^-(aq) \rightleftharpoons \underset{\text{(blue)}}{[CoCl_4]^{2-}(aq)} + 6H_2O\ (l)$$

(A) $\Delta H > 0$ for the reaction.
(B) $\Delta H < 0$ for the reaction.
(C) $\Delta H = 0$ for the reaction.
(D) The sign of ΔH cannot be predicted on the basis of this information.

33. The equilibrium $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ shifts forward if:
(A) Catalyst is used.
(B) An adsorbent is used to remove SO_3 as soon as it is formed.
(C) Large amount of products are used.
(D) Small amount of reactants are used.

34. The addition of NaCl to AgCl decreases the solubility of AgCl because:
(A) Solubility product decreases.
(B) Solubility product remains constant.
(C) Solution becomes unsaturated.
(D) Solution becomes supersaturated.

35. In the equilibrium, $AB \rightleftharpoons A + B$ if the equilibrium concentration of A is double, then equilibrium concentration of B will be:

(A) Half (B) twice (C) $\frac{1}{4}$th (D) $\frac{1}{8}$th

36. Equal volume of following Ca^{2+} and F solution are mixed. In which of the Solutions will precipitation occur? [K_{SP} of $CaF_2 = 1.7 \times 10^{-10}$
(A) $10^{-2}M\ Ca^{2+} + 10^{-5}MF^-$
(B) $10^{-3}M\ Ca^{2+}$ and $10^{-3}MF^-$
(C) $10^{-2}M\ Ca^{2+} + 10^{-3}MF^-$
(D) $10^{-3}M\ Ca^{2+}$ and $10^{-5}MF^-$

37. $SO_2 + O_2 \rightleftharpoons 2SO_3$ + Heat
The equilibrium reaction proceeds in forward direction by:
(A) Addition of O_2 (B) Removal of O_2
(C) Addition of inert gas (D) Cannot proceed

38. An equimolar solution of $NaNO_2$ and HNO_2 can act as a:
(A) Strong reductant. (B) Strong oxidant.
(C) Buffer solution. (D) None of these.

39. In the gaseous equilibrium A + 2B ⇌ C + Heat, the forward reaction is favoured:
(A) Low P, High T (B) Low P, Low T

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(C) High P, Low T

(D) High P, High T

40. The solubility product of $CaSO_4$ is 6.4×10^{-5}. The solubility of salt in mol L^{-1} is:

(A) 8.10^{-16}

(B) 8.10^{-2}

(C) 8.10^{-3}

(D) 1.6^{-3}

41. Buffer Solution is prepared by mixing ________________.

(A) Weak acid and its salt of strong base.

(B) Strong acid + its salt of strong base.

(C) Weak acid + its salt of weak base.

(D) Strong base + its salts of strong acid.

42. In which of the following reactions, the equilibrium remains unaffected on addition of small amount of argon at constant volume?

(A) $\mathrm{H_2(g) + I_2(g) \rightleftharpoons 2HI(g)}$

(B) $\mathrm{PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)}$

(C) $\mathrm{N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)}$

(D) The equilibrium will remain unaffected in all the three cases.

43. PCl_5, PCl_3 and Cl_2 are at equilibrium at 500K in a closed container and their concentrations are 0.8×10^{-3}mol L^{-1}, 1.2×10^{-3} mol L^{-1} and 1.2×10^{-3} mol L^{-1} respectively. The value of K_c for the reaction $\mathrm{PCl_5 g \rightleftharpoons PCl_3(g) + Cl_2 g}$ will be.

(A) 1.8×10^{3}mol L^{-1}

(B) 1.8×10^{-3}

(C) 1.8×10^{-3}L mol^{-1}

(D) 0.55×10^{4}

44. For the reaction, $\mathrm{H_2(g) + I_2(g) \rightleftharpoons 2HI(g)}$, the standard free energy is $\Delta G^{\ominus} > 0$ The equilibrium constant (K) would be:

(A) K = 0

(B) K > 1

(C) K = 1

(D) K < 1

45. We know that the relationship between K_c and K_p is $\mathrm{K_p = K_c(RT)^{\Delta n}}$ What would be the value of Δn for the reaction $\mathrm{NH_4Cl(s) \rightleftharpoons NH_3(g) + HCl(g)}$

(A) 1

(B) 0.5

(C) 1.5

(D) 2

46. 1mL of $\frac{\mathrm{N}}{100}\mathrm{HCl}$ is added to 1L of buffer having pH = 5. The pH of the solution will be:

(A) Become 7

(B) Become 3

(C) Become 6

(D) Remain unaffected.

47. At a particular temperature and atmospheric pressure, the solid and liquid phases of a pure substance can exist in equilibrium. Which of the following term defines this temperature?

(A) Normal melting point.

(B) Equilibrium temperature.

(C) Boiling point.

(D) Freezing point.

48. The chemical equilibrium of reversible reaction is not influenced by:

(A) Pressure.

(B) Catalyst.

(C) Concentration of the reactants.

(D) Temperature.

49. The dissociation constant of water is represented by $\mathrm{K = \frac{[H_3O^+][OH^-]}{[H_2O]}}$

$\mathrm{or\ = [H^+][OH^-]K_w}$ is called:

(A) Ionic product of salts.

(B) Ionic product of water.

(C) Ionisation constant of water.

(D) Ionisation constant of acid and base.

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50. The equibrium constant K_c for the reaction:

$H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ at 700K is 49

The 'K' for reaction $HI(g) \rightleftharpoons \frac{1}{2}H_2(g) + \frac{1}{2}I_2(g)$.

(A) 49 (B) 0.02 (C) $\frac{1}{7}$ (D) 1.43

51. Production of ammonia according to the reaction,

$N_2(g) + 3H_2(g) 2NH_3(g);$

$\Delta H = -92.38 \text{kJ mol}^{-1}$

is an exothermic process. At low temperature, the reaction shifts in:

(A) Forward direction.

(B) Backward direction.

(C) Either forward or backward direction.

(D) None of the above.

52. Which buffer solution comprising of the following has its pH value greater than 7?

(A) $CH_3COOH + CH_3COONa$ (B) $HCOOH + HCOOK$

(C) CH_3COONH_4 (D) $NH_4OH + NH_4Cl$

53. 1M NaCl and 1M HCl are present in an aqueous solution . The solution is:

(A) Not a buffer solution with pH < 7 (B) Not a buffer solution with pH > 7

(C) A buffer solution with pH < 7 (D) A buffer solution with pH > 7

54. It accepts a proton. It is called as:

(A) A Bronsted acid. (B) A Bronsted base.

(C) A strong acid. (D) A weak base.

55. The addition of HCl will not suppress the ionisation of:

(A) Acetic acid (B) Sulphuric acid

(C) H_2S (D) Benzoic acid

56. 100mL of a solution contains $0.1MNH_4OH$ and $0.1MNH_4Cl$. The pH of the solution will not change on adding:

(A) 20mL of 0.1M NH_4OH solution. (B) 20mL of 0.1M NH_4Cl solution.

(C) 10mL of 0.1M NaOH solution. (D) 10mL of distilled water.

57. A 0.2 molar solution of formic acid is 3.2% ionised. Its ionisation constant is:

(A) 9.6×10^{-3} (B) 2.1×10^{-4}

(C) 1.25×10^{-6} (D) 4.8×10^{-5}

58. What will be pH of 0.01M CH_3COOH?

($K_a = 1.80 \times 10^{-5}$)

(A) 3.4 (B) 3.6 (C) 3.9 (D) 3.0

59. Buffer solution can be obtained by mixing aqueous solution of _______.

(A) Sodium acetate and excess of HCl.

(B) Sodium acetate and acetic acid.

(C) Sodium chloride and HCl.

(D) Acetic acid and excess of NaOH.

60. The concentration of hydrogen ion in a sample of soft drink is 3.8×10^{-3}M. What is its pH?

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(A) 4.32 (B) 5.12 (C) 3.31 (D) 2.42

61. Addition of water to this solution will not change $[H_3O^+]$.

(A) Chemical pH indicator. (B) Acid/ base buffer.

(C) Anhydrous solution. (D) Hypotonic solution.

62. The solubility of AgI in NaI solutions is less than that in pure water because:

(A) AgI forms complex with NaI.

(B) Of common ion effect.

(C) Solubility product of AgI is less than that of NaI.

(D) The temperature of the solution decreases.

63. The solubility product of a sparingly soluble salt AB at room temperature is 1.21×10^{-6}, its molar solubility is:

(A) 1.21 × 100M. (B) 1.1×10^{-4}M.

(C) 1.1×10^{-3}M. (D) None of these.

64. On increasing the pressure, in which direction will the gas phase reaction proceed to re-establish equilibrium, is predicted by applying the Le Chatelier's principle. Consider the reaction.

$$\mathrm{N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)}$$

Which of the following is correct, if the total pressure at which the equilibrium is established, is increased without changing the temperature?

(A) K will remain same.

(B) K will decrease.

(C) K will increase.

(D) K will increase initially and decrease when pressure is very high.

65. The solubility of CO_2 in water increases with:

(A) Increase in temperature. (B) Reduction of gas pressure.

(C) Increase in gas pressure. (D) Increase in volume.

66. Which is not a buffer solution:

(A) $NH_4Cl + NH_4OH$ (B) $CH_3COOH + CH_3COONa$

(C) CH_3COONH_4 (D) NH_4NO_3

67. The pH of neutral water at 25°C is 7.0. As the temperature increases, ionisation of water increases, however, the concentration of H^+ ions and OH^- ions are equal. What will be the pH of pure water at 60°C?

(A) Equal to 7.0 (B) Greater than 7.0

(C) Less than 7.0 (D) Equal to zero.

68. What is pH of resulting solution when equal volume when equal of 0.1M NaOH and 0.01M HCl are mixed? $[\log 4.5 = 0.65]$

(A) 7 (B) 1.04 (C) 12.65 (D) 2.0

69. Which of the following is the example of a reversible reaction?

(A) $\mathrm{Pb(NO_3)_2(aq) + 2NaI(aq) \longrightarrow PbI_2(s) + 2NaNO_3(aq)}$

(B) $\mathrm{2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)}$

(C) $\mathrm{AgNO_3(aq) + HCl(aq) \longrightarrow AgCl(s) + HNo_3(aq)}$

(D) $\mathrm{KNO_3(aq) + NaCl(aq) \longrightarrow KCl(aq) + NaNO_3(aq)}$

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*** a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option.** **[2]**

70. **Note:** In the following questions a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the choices given\ below each question.

Assertion (A): A solution containing a mixture of acetic acid and sodium acetate maintains a constant value of pH on addition of small amounts of acid or alkali.

Reason (R): A solution containing a mixture of acetic acid and sodium acetate acts as a buffer solution around pH 4.75.

i. Both A and R are true and R is correct explanation of A.
ii. Both A and R are true but R is not the correct explanation of A.
iii. A is true but R is false.
iv. Both A and R are false.

71. **Note:** In the following questions a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the choices given\ below each question.

Assertion (A): The ionisation of hydrogen sulphide in water is low in the presence of hydrochloric acid.

Reason (R): Hydrogen sulphide is a weak acid.

i. Both A and R are true and R is correct explanation of A.
ii. Both A and R are true but R is not correct explanation of A.
iii. A is true but R is false.
iv. Both A and R are false.

*** Answer The Following Questions In One Sentence.[1 Marks Each]** **[25]**

72. What is Kc for the following equilibrium when the equilibrium concentration of each substance is:

$[SO_2]$= 0.60M, $[O_2]$ = 0.82M and $[SO_3]$ = 1.90M?

$2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$

73. Calculate the hydrogen ion concentration in the following biological fluids whose pH are given below:

Human blood, 7.38

74. The equilibrium constant expression for a gas reaction is,

$$K_c = \frac{[NH_3]^4[O_2]^5}{[NO]^4[H_2O]^6}$$

Write the balanced chemical equation corresponding to this expression.

75. Write the conjugate acids for the following Brönsted bases: NH_2^-, NH_3 and $HCOO^-$.

76. Which of the following reactions will get affected by increasing the pressure? Also, mention whether change will cause the reaction to go into forward or backward direction.

$$CH_4\ (g) + 2S_2\ (g) \rightleftharpoons CS_2\ (g) + 2H_2S\ (g)$$

77. Write the expression for the equilibrium constant, K_c for each of the following reactions:

$$Fe^{3+}(aq) + 3OH^-(aq) \rightleftharpoons Fe(OH)_3(S)$$

78. At 473K, equilibrium constant K_c for decomposition of phosphorus pentachloride, PCl_5 is 8.3×10^{-3}. If decomposition is depicted as,

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$$PCl_5\ (g) \rightleftharpoons PCl_3\ (g) + Cl_2\ (g)\ \Delta_r H^\ominus = 124.0\ \text{kJ mol}^{-1}$$

what is the value of K_c for the reverse reaction at the same temperature?

79. At 473K, equilibrium constant K_c for decomposition of phosphorus pentachloride, PCl_5 is 8.3×10^{-3}. If decomposition is depicted as,

$$PCl_5\ (g) \rightleftharpoons PCl_3\ (g) + Cl_2\ (g)\ \Delta_r H^\ominus = 124.0\ \text{kJ mol}^{-1}$$

what would be the effect on Kc if

i. more PCl5 is added
ii. pressure is increased
iii. the temperature is increased?

80. Describe the effect of:
addition of H2
on the equilibrium of the reaction:

$$2H_2\ (g) + CO\ (g) \rightleftharpoons CH_3OH\ (g)$$

81. Which of the following reactions will get affected by increasing the pressure? Also, mention whether change will cause the reaction to go into forward or backward direction.

$$CO_2\ (g) + C\ (S) \rightleftharpoons 2CO\ (g)$$

82. Does the number of moles of reaction products increase, decrease or remain same when each of the following equilibria is subjected to a decrease in pressure by increasing the volume?

$$CaO\ (S) + CO_2\ (g) \rightleftharpoons CaCO_3\ (S)$$

83. Predict if the solutions of the following salts are neutral, acidic or basic:
KB_r

84. Calculate the hydrogen ion concentration in the following biological fluids whose pH are given below:
Human stomach fluid, 1.2

85. Describe the effect of:
removal of CH_3OH
on the equilibrium of the reaction:

$$2H_2\ (g) + CO\ (g) \rightleftharpoons CH_3OH\ (g)$$

86. What will be the conjugate bases for the Brönsted acids: HF, H_2SO_4 and HCO_3^-?

87. For the following equilibrium, $K_c = 6.3 \times 10^{14}$ at 1000K

$$NO(g) + O_3(g) \rightleftharpoons NO_2(g) + O_2(g)$$

Both the forward and reverse reactions in the equilibrium are elementary bimolecular reactions. What is K_c, for the reverse reaction?

88. If $Q_c < K_c$, in which direction reaction will proceed?

89. What happens to ionic product of water if some acid is added to it?

90. Classify the following as Lewis acid or Lewis base:

$$NH_4^+ \text{ and } NH_3$$

91. SO_3^{2-} is Bronsted base or acid and why?

92. Why pH of our blood remains constant at 7.4 through we quite often eat spicy food?

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93. What is the effect of temperature on solubility product (K_{sp})?

94. Write K_p in terms of K_c for the following chemical reaction:
$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

95. Which of the following is weakest acid?
$HClO_4, HClO_3, HCl_2, HClO$

96. For Tribasic acid $K_{a1} > K_{a2} > K_{a3}$ what will happen to the acid strength of polyprotic acids if protons are lost?

*** Given Section consists of questions of 2 marks each. [66]**

97. A liquid is in equilibrium with its vapour in a sealed container at a fixed temperature. The volume of the container is suddenly increased.
How do rates of evaporation and condensation change initially?

98. Assuming complete dissociation, calculate the pH of the following solutions:
0.002 M KOH

99. Assuming complete dissociation, calculate the pH of the following solutions:
0.003M HCl

100. Assuming complete dissociation, calculate the pH of the following solutions:
0.002 M HBr

101. Calculate the pH of the resultant mixtures:
10mL of 0.01M H_2SO_4 + 10mL of 0.01M $Ca(OH)_2$

102. A liquid is in equilibrium with its vapour in a sealed container at a fixed temperature. The volume of the container is suddenly increased.
What happens when equilibrium is restored finally and what will be the final vapour pressure?

103. Assuming complete dissociation, calculate the pH of the following solutions:
0.005 M NaOH

104. Calculate the pH of the resultant mixtures:
10mL of 0.1M H_2SO_4 + 10mL of 0.1M KOH

105. $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g);$
$K = 0.50 \text{ at } 673K.$
Write the equilibrium expression and equilibrium constant for reverse reaction.

106. On the basis of the equation pH = –log [H^+], the pH of 10^{-8}mol dm^{-3} solution of HCl should be 8. However, it is observed to be less than 7.0. Explain the reason.

107. Which of the following is strongest acid?
$HCl, HClO_3, HNO_3, H_2SO_4, HClO_4$

108. The K_{sp} of Ag_2CrO_4 AgCl, AgBr and AgI are respectively, 1.1×10^{-12}, 1.8×10^{-10}, 5.0×10^{-13}, 8.3×10^{-17}, which one of the following salts will precipitate first $AgNO_3$ solution is adding to a solution containing equal mole of NaCl, NaBs, NaI and Na_2CrO_4.

109. At what temperature the solid and liquid are in equilibrium under 1 atm pressure?

110. What will be effect on boiling point of liquid if pressure is increased?

111. How does a catalyst affect the equilibrium constant? Explain.

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112. Mention the conditions of temperature and pressure when gas will dissolve in liquid to maximum extent with decrease in volume and absorption of heat.

113. The value of Kc for the reaction $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$ is 1×10^{-4}
At a given time, the composition of reaction mixture is [HI] = 2×10^{-5}mol, [H_2] = 1×10^{-5}mol and [I_2] = 1×10^{-5}mol In which direction will the reaction proceed?

114. $CaCl_2(s) + aq \rightleftharpoons CaCl_2(aq) + Heat$
Discuss the solubility if temperature is increased.

115. One millilitre solution of 0.01M HCl is added to 1L of sodium chloride solution. What will be the pH of the resulting solutions?

116. Consider the following equilibrium:
$CO_2(g) + C\ (graphite) \rightleftharpoons 2CO(g)$
Write the equilibrium expression for K_c and calculate its units.

117. Will AgCl be more soluble in aqueous solution or NaCl solution and why?

118. What is the effect of reducing volume on the following system?
$2C(s) + O_2 \rightleftharpoons 2CO(g)$

119. $C(diamond) \rightleftharpoons C(graphite)$
$d = 3.5g\ cm^{-3} \quad d = 2.3g\ cm^{-3}$
What will be effect of increasing pressure in this equilibrium?

120. Conjugate acid of a weak base is always stronger. What will be the decreasing order of basic strength of the following conjugate bases?
$OH^-,\ RO^-,\ CH_3COO^-,\ Cl^-$

121. pK_a value of acids A, B, C, D are 1.5, 3.5, 2.0 and 5.0. Which of them is strongest acid?

122. What could be temperature 15°C or 100°C for $K_w = 7.5 \times 10^{-14}$. What happens to ionic product if some acid is added to it?

123. What will be the pH of 1M Na_2SO_4 solution?

124. What is the relation between K_p and K_c?

125. What is the effect of increasing pressure on the equilibrium?
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

126. Ionisation constant of a weak base MOH, is given by the expression.
$K_b = \frac{[M^+][OH^-]}{[MOH]}$
Values of ionisation constant of some weak bases at a particular temperature are given below:

Base	**Dimethylamine**	**Urea**	**Pyridine**	**Ammonia**
K_b	5.4×10^{-4}	1.3×10^{-14}	1.77×10^{-9}	1.77×10^{-5}

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

127. At 0°C, ice and water are present in equilibrium.
What will happen on increasing the pressure?

128. Why do we sweat more on humid day?

129. Write conjugate acid and conjugate base of H_2O.

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* Given Section consists of questions of 3 marks each. [60]

130. What is meant by the conjugate acid-base pair? Find the conjugate acid/base for the following species:

$\mathrm{HNO_2, CN^-, HClO_4, F^-, OH^-, CO_3^{2-} and\ S^{2-}}$

131. The value of K_c for the reaction $3O_2\ (g) \rightleftharpoons 2O_3\ (g)$ is 2.0×10^{-50} at 25°C. If the equilibrium concentration of O_2 in air at 25°C is 1.6×10^{-2}, what is the concentration of O_3?

132. Find out the value of K_c for each of the following equilibria from the value of K_p:

$\mathrm{2CaCO_3\ (S) \rightleftharpoons CaO(S) + CO_2\ (g);\ k_p = 167\ at\ 1073K}$

133. The reaction, $\mathrm{CO\ (g) + 3H_2\ (g) \rightleftharpoons CH_4\ (g) + H_2O\ (g)}$

is at equilibrium at 1300K in a 1L flask. It also contain 0.30mol of CO, 0.10molof H_2 and 0.02mol of H_2O and an unknown amount of CH_4 in the flask. Determine the concentration of CH_4 in the mixture. The equilibrium constant, K_c for the reaction at the given temperature is 3.90.

134. The degree of ionization of a 0.1M bromoacetic acid solution is 0.132. Calculate the pH of the solution and the pK_a of bromoacetic acid.

135. The pH of a sample of vinegar is 3.76. Calculate the concentration of hydrogen ion in it.

136. If $K_w = 49 \times 10^{-14}$, what will be neutral pH of H_2O?

137. Why do we pass H_2S gas in acidic medium in group 2?

138. The K_{sp} values of two slightly soluble salts AB and PQ_2 are each equal to 4.0×10^{-18}. Which salt is more soluble?

139. For the reaction : $\mathrm{N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)}$

Equilibrium constant $K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$

Some reactions are written below in Column I and their equilibrium constants in terms of K_c are written in Column II. Match the following reactions with the corresponding equilibrium constant.

	Column I (Reaction)		**Column II (Equilibrium constant)**
i.	$\mathrm{2N_2(g) + 6H_2(g) \rightleftharpoons 4NH_3(g)}$	a.	$2K_c$
ii.	$\mathrm{2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)}$	b.	$K_c^{\frac{1}{2}}$
iii.	$\mathrm{\frac{1}{2}N_2(g) + \frac{3}{2}H_2(g) \rightleftharpoons NH_3(g)}$	c.	$\frac{1}{K_c}$
		d.	K_c^2

140. Write a relation between ΔG 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: $\mathrm{CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)}$

141. Urine has a pH of 6.0. If a patient eliminates 1300mL of urine per day, how many gram equivalents of the acid he eliminates per day?

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142. Calculate the molar solubility of $Ni(OH)_2$ in 0.10M NaOH. The ionic product of $Ni(OH)_2$ is 2.0×10^{-15}.

143. For the reaction, $\mathrm{N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)}$, the partial pressures of N_2 and H_2 are 0.80 and 0.40 atmosphere respectively at equilibrium. The total pressure of the system is 2.80 atmosphere. What is K_p for the above reaction?

144.
i. Why is NH_4Cl added before addition of NH_4OH in qualitative analysis of 3rd group?
ii. Which will be added to precipitate soap (RCOONa)? NaCl or KCl and why?'

145. Solid $Ba(NO_3)$, is gradually dissolved in a 1.0×10^{-4} M Na_2CO_3 solution. At what concentration of Ba^{2+} will a precipitate begin to form.(K_{sp} for $BaCO_3 = 5.1 \times 10^{-9}$)

146. A certain buffer is made by mixing sodium formate and formic acid in water. With the help of equations explain how this buffer neutralizes addition of a small amount of an acid or a base?

147. MY and NY_3 two nearly insoluble salts, have same K_{sp} values 6.2×10^{-3} of non temperature. Calculate solubility of each salt. Which has more solubility.

148. What is the effect of temperature on the reactions? Give reason.
i. $\mathrm{N_2(g){+}3H_2(g) \rightleftharpoons 2NH_3(g) + Heat}$
ii. $\mathrm{N_2(g){+}O_2(g) \rightleftharpoons 2NO(g) + Heat}$

149.
i. Give the relationship between K_a, c and $('\alpha')$ where 'K_a' is acid dissociation constant, 'c' is molar concentration, $'\alpha'$ is degree of dissociation.
ii. If the solubility of $Ca(IO_3)_2$ in water at 18°C is 2.1g/ litre. Calculate the value of solubility product.
[Molecular mass of $Ca(IO_3)_2$ = 390]

* Case study based questions [8]

150. Read the passage given below and answer the following questions from (i) to (v).

Predicting the Direction of the Reaction- The equilibrium constant helps in predicting the direction in which a given reaction will proceed at any stage. For this purpose, we calculate the reaction quotient Q. The reaction quotient, Q (Qc with molar concentrations and QP with partial pressures) is defined in the same way as the equilibrium constant Kc except that the concentrations in Qc are not necessarily equilibrium values. For a general reaction:

$$\mathrm{aA + bB \rightleftharpoons cC + dD}$$

$$\mathrm{Qc} = \frac{\mathrm{[C]^c[D]^d}}{\mathrm{[A]^a[B]^b}}$$

Then,

If Qc > Kc, the reaction will proceed in the direction of reactants (reverse reaction).

If Qc < Kc, the reaction will proceed in the direction of the products (forward reaction).

If Qc = Kc, the reaction mixture is already at equilibrium. Consider the gaseous reaction of H_2 with I_2 ,

$$\mathrm{H_{2(g)} + l_{2(g)} \rightleftharpoons 2Hl_{(g)}; kc = 57.0 at 700k.}$$

Suppose we have molar concentrations $[H_2]$t =0.10M, $[I_2]$t = 0.20 M and [HI]t = 0.40 M. (the subscript t on the concentration symbols means that the concentrations were

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measured at some arbitrary time t, not necessarily at equilibrium). Thus, the reaction quotient, Qc at this stage of the reaction is given by,

$$\mathrm{Qc} = \frac{[\mathrm{Hl}]\mathrm{t}^2}{[\mathrm{H}]^2{}_\mathrm{t}[\mathrm{l}_2]_\mathrm{t}} = \frac{(0.40)_2}{(0.10)\times(0.20)} = 8.0$$

Now, in this case, Qc (8.0) does not equal Kc (57.0), so the mixture of $H_{2\ (g)}$, $I_{2\ (g)}$ and $HI_{(g)}$ is not at equilibrium; that is, more $H_{2\ (g)}$ and $I\ 2_{\ (g)}$ will react to form more $HI_{(g)}$ and their concentrations will decrease till Qc = Kc. The reaction quotient, Qc is useful in predicting the direction of reaction by comparing the values of Qc and Kc.Thus, we can make the following generalisations concerning the direction of the reaction

If Qc < Kc, net reaction goes from left to right

If Qc > Kc, net reaction goes from right to left.

If Qc = Kc, no net reaction occurs.

Calculating Equilibrium Concentrations In case of a problem in which we know the initial concentrations but do not know any of the equilibrium concentrations, the following three steps shall be followed:

Step 1) Write the balanced equation for the reaction.

Step 2) Under the balanced equation, make a table that lists for each substance involved in the reaction: (a) the initial concentration, (b) the change in concentration on going to equilibrium, and (c) the equilibrium concentration. In constructing the table, define x as the concentration (mol/L) of one of the substances that reacts on going to equilibrium, then use the stoichiometry of the reaction to determine the concentrations of the other substances in terms of x.

Step 3) Substitute the equilibrium concentrations into the equilibrium equation for the reaction and solve for x. If you are to solve a quadratic equation choose the mathematical solution that makes chemical sense.

Step 4) Calculate the equilibrium concentrations from the calculated value of x.

Step 5) Check your results by substituting them into the equilibrium equation.

Relationship between equilibrium constant K, reaction quotient Q and gibbs energy G The value of Kc for a reaction does not depend on the rate of the reaction. However, it is directly related to the thermodynamics of the reaction and in particular, to the change in Gibbs energy, $\triangle\mathrm{G}$. If,

$\triangle\mathrm{G}$ is negative, then the reaction is spontaneous and proceeds in the forward direction.

$\triangle\mathrm{G}$ is positive, then reaction is considered non-spontaneous. Instead, as reverse reaction would have a negative $\triangle\mathrm{G}$, the products of the forward reaction shall be converted to the reactants.

$\triangle\mathrm{G}$ is 0, reaction has achieved equilibrium; at this point, there is no longer any free energy left to drive the reaction. A mathematical expression of this thermodynamic view of equilibrium can be described by the following equation:

$$\triangle\mathrm{G} = \triangle\mathrm{G}^\phi + \mathrm{RTlnQ}$$

where, $\triangle\mathrm{G}^\phi$ is standard Gibbs energy. At equilibrium, when $\triangle\mathrm{G} = 0$ and Q = Kc, the equation becomes,

$$\triangle\mathrm{G} = \mathrm{G}^\phi + \mathrm{RTlnk} = 0$$

$$\triangle\mathrm{G}^\phi = -\mathrm{RTlnk}$$

$$\mathrm{Ink} = \frac{-\triangle\mathrm{G}^\phi}{\mathrm{RT}}$$

Taking antilog of both sides, we get,

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$\mathrm{K} = \mathrm{e} - \frac{\triangle \mathrm{G0}}{\mathrm{RT}}$

Hence, using the equation, the reaction spontaneity can be interpreted in terms of the value of $\triangle \mathrm{G}^{\phi}$.

If $\triangle \mathrm{G}^{\phi} > 0$ then $\frac{-\triangle \mathrm{G}^{\phi}}{\mathrm{RT}}$ is positive, and >1, making K > 1, which implies a spontaneous reaction or the reaction which proceeds in the forward direction to such an extent that the products are present predominantly.

If $\triangle \mathrm{G}^{\phi} > 0,$ then $\frac{-\triangle \mathrm{G}^{\phi}}{\mathrm{RT}}$ is negative, and < 1, that is, K < 1, which implies a non-spontaneous reaction or a reaction which proceeds in the forward direction to such a small degree that only a very minute quantity of product is formed.

Factors affecting equilibria One of the principal goals of chemical synthesis is to maximise the conversion of the reactants to products while minimizing the expenditure of energy. This implies maximum yield of products at mild temperature and pressure conditions. If it does not happen, then the experimental conditions need to be adjusted. For example, in the Haber process for the synthesis of ammonia from N_2 and H_2, the choice of experimental conditions is of real economic importance. Annual world production of ammonia is about hundred million tones, primarily for use as fertilizers. Equilibrium constant, Kc is independent of initial concentrations. But if a system at equilibrium is subjected to a change in the concentration of one or more of the reacting substances, then the system is no longer at equilibrium; and net reaction takes place in some direction until the system returns to equilibrium once again. Similarly, a change in temperature or pressure of the system may also alter the equilibrium. In order to decide what course the reaction adopts and make a qualitative prediction about the effect of a change in conditions on equilibrium we use Le Chatelier’s principle. It states that a change in any of the factors that determine the equilibrium conditions of a system will cause the system to change in such a manner so as to reduce or to counteract the effect of the change. This is applicable to all physical and chemical equilibria.

Effect of Concentration Change In general, when equilibrium is disturbed by the addition/removal of any reactant/ products, Le Chatelier’s principle predicts that:

The concentration stress of an added reactant/product is relieved by net reaction in the direction that consumes the added substance.

The concentration stress of a removed reactant/product is relieved by net reaction in the direction that replenishes the removed substance. or in other words, “When the concentration of any of the reactants or products in a reaction at equilibrium is changed, the composition of the equilibrium mixture changes so as to minimize the effect of concentration changes”. Let us take the reaction,

$\mathrm{H}_{2(\mathrm{g})} + \mathrm{l}_{2(\mathrm{g})} \rightleftharpoons 2\mathrm{Hl}_{(\mathrm{g})}$

If H_2 is added to the reaction mixture at equilibrium, then the equilibrium of the reaction is disturbed. In order to restore it, the reaction proceeds in a direction wherein H_2 is consumed, i.e., more of H_2 and I_2 react to form HI and finally the equilibrium shifts in right (forward) direction. This is in accordance with the Le Chatelier’s principle which implies that in case of addition of a reactant/product, a new equilibrium will be set up in which the concentration of the reactant/product should be less than what it was after the addition but more than what it was in the original mixture. The same point can be explained in terms of the reaction quotient, Qc,

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$\mathrm{Qc} = \frac{[\mathrm{HI}]^2}{[\mathrm{H}]_2[\mathrm{I}]_2}$

Addition of hydrogen at equilibrium results in value of Qc being less than Kc. Thus, in order to attain equilibrium again reaction moves in the forward direction. Similarly, we can say that removal of a product also boosts the forward reaction and increases the concentration of the products and this has great commercial application in cases of reactions, where the product is a gas or a volatile substance. In case of manufacture of ammonia, ammonia is liquified and removed from the reaction mixture so that reaction keeps moving in forward direction. Similarly, in the large scale production of CaO (used as important building material) from $CaCO_3$, constant removal of CO_2 from the kiln drives the reaction to completion. It should be remembered that continuous removal of a product maintains Qc at a value less than Kc and reaction continues to move in the forward direction.

i. If ... the reaction will proceed in the direction of reactants (reverse reaction).
   a. Qc > Kc
   b. Qc < Kc
   c. Qc = Kc
   d. None of above
ii. If ... the reaction will proceed in the direction of the products (forward reaction).
   a. Qc > Kc
   b. Qc < Kc
   c. Qc = Kc
   d. None of above
iii. If ... the reaction mixture is already at equilibrium. Consider the gaseous reaction.
   a. Qc > Kc
   b. Qc < Kc
   c. Qc = Kc
   d. All of above
iv. If $\triangle \mathrm{G}$ is .... then the reaction is spontaneous and proceeds in the forward direction.
   a. Zero
   b. Positive
   c. Negative
   d. None of above
v. $\triangle \mathrm{G}$ is ... reaction has achieved equilibrium; at this point, there is no longer any free energy left to drive the reaction.
   a. Zero
   b. Positive
   c. Negative
   d. None of above

151. Read the passage given below and answer the following questions from (i) to (v).

When a liquid evaporates in a closed container, molecules with relatively higher kinetic energy escape the liquid surface into the vapour phase and number of liquid molecules from the vapour phase strike the liquid surface and are retained in the liquid phase. It gives rise to a constant vapour pressure because of an equilibrium in which the number of molecules leaving the liquid equals the number returning to liquid from the vapour. We say that the system has reached equilibrium state at this stage. However, this is not static equilibrium and there is a lot of activity at the boundary between the liquid and the vapour. Thus, at equilibrium, the rate of evaporation is equal to the rate of condensation. It may be represented by

$$\mathrm{H_2O_{(l)}} \rightleftharpoons \mathrm{H_2O_{(vap)}}$$

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The double half arrows indicate that the processes in both the directions are going on simultaneously. The mixture of reactants and products in the equilibrium state is called an equilibrium mixture.

Equilibrium can be established for both physical processes and chemical reactions. The reaction may be fast or slow depending on the experimental conditions and the nature of the reactants. When the reactants in a closed vessel at a particular temperature react to give products, the concentrations of the reactants keep on decreasing, while those of products keep on increasing for some time after which there is no change in the concentrations of either of the reactants or products. This stage of the system is the dynamic equilibrium

The chemical equilibrium may be classified in three groups.

1. The reactions that proceed nearly to completion and only negligible concentrations of the reactants are left. In some cases, it may not be even possible to detect these experimentally.
2. The reactions in which only small amounts of products are formed and most of the reactants remain unchanged at equilibrium stage.
3. The reactions in which the concentrations of the reactants and products are comparable, when the system is in equilibrium.

The equilibrium involving ions in aqueous solutions which is called as ionic equilibrium.

Solid-Liquid Equilibrium Ice and water kept in a perfectly insulated thermos flask (no exchange of heat between its contents and the surroundings) at 273K and the atmospheric pressure are in equilibrium state and the system shows interesting characteristic features. We observe that the mass of ice and water do not change with time and the temperature remains constant. However, the equilibrium is not static. The intense activity can be noticed at the boundary between ice and water. Molecules from the liquid water collide against ice and adhere to it and some molecules of ice escape into liquid phase. There is no change of mass of ice and water, as the rates of transfer of molecules from ice into water and of reverse transfer from water into ice are equal at atmospheric pressure and 273 K. It is obvious that ice and water are in equilibrium only at particular temperature and pressure. For any pure substance at atmospheric pressure, the temperature at which the solid and liquid phases are at equilibrium is called the normal melting point or normal freezing point of the substance. The system here is in dynamic equilibrium and we can infer the following:

1. Both the opposing processes occur simultaneously.
2. Both the processes occur at the same rate so that the amount of ice and water remains constant.

Solid – Vapour Equilibriu*m* Let us now consider the systems where solids sublime to vapour phase. If we place solid iodine in a closed vessel, after sometime the vessel gets filled up with violet vapour and the intensity of colour increases with time. After certain time the intensity of colour becomes constant and at this stage equilibrium is attained. Hence solid iodine sublimes to give iodine vapour and the iodine vapour condenses to give solid iodine. The equilibrium can be represented as,

$$\mathrm{I_2(solid)} \rightleftharpoons \mathrm{I_2(vapour)}$$

Other examples showing this kind of equilibrium are,

$$\mathrm{Camphor}_{\mathrm{(solid)}} \rightleftharpoons \mathrm{Camphor}_{\mathrm{(vapour)}}$$

$$\mathrm{NH_4CI_{(solid)}} \rightleftharpoons \mathrm{NH_4CI_{(vapour)}}$$

The equilibrium Involving Dissolution of Solid in Liquids Only a limited amount of salt or sugar can dissolves in a given amount of water at room temperature. If we make a thick sugar syrup solution by dissolving sugar at a higher temperature, sugar crystals separate out if we cool the syrup to the room temperature. We call it a saturated

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solution when no more of solute can be dissolved in it at a given temperature. The concentration of the solute in a saturated solution depends upon the temperature. In a saturated solution, a dynamic equilibrium exits between the solute molecules in the solid state and in the solution: Sugar (solution) Sugar (solid), and the rate of dissolution of sugar = rate of crystallisation of sugar. Equality of the two rates and dynamic nature of equilibrium has been confirmed with the help of radioactive sugar. If we drop some radioactive sugar into saturated solution of non-radioactive sugar, then after some time radioactivity is observed both in the solution and in the solid sugar. Initially there were no radioactive sugar molecules in the solution but due to dynamic nature of equilibrium, there is exchange between the radioactive and non-radioactive sugar molecules between the two phases. The ratio of the radioactive to non- radioactive molecules in the solution increases till it attains a constant value.

i. Which of the following symbol represents equilibrium.
   a. $\rightleftharpoons$
   b. $\leftrightarrows$
   c. $\nLeftrightarrow$
   d. $\uparrow\downarrow$
ii. When there is no change in the concentrations of either of the reactants or products, this stage of the system is the ...
   a. Static equilibrium
   b. Dynamic equilibrium
   c. Physical equilibrium
   d. Chemical equilibrium
iii. A ... solution means no more of solute can be dissolved in it at a given temperature.
   a. Unsaturated
   b. Supersaturated
   c. Saturated
   d. None of these.
iv. The equilibrium involving ions in aqueous solutions which is called as ...
   a. Static equilibrium
   b. Dynamic equilibrium
   c. Physical equilibrium
   d. Ionic equilibrium
v. The concentration of the solute in a saturated solution depends upon the ...
   a. Solvent
   b. Pressure
   c. Temperature
   d. System

----- Stay away from those people who try to disparage your ambitions. ... -----

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