Vernacular

ULTIMATE KCET CRASH COURSE 2026

CHEMISTRY

EQUILIBRIUM

DPP: 1

Q1 Equilibrium constants for the following reactions at 1200 K are given :

$2H_2O_{(g)} \rightleftharpoons 2H_{2(g)} + O_{2(g)}; K_1 = 6.4 \times 10^{-8}$

$2CO_{2(g)} \rightleftharpoons 2CO(g) + O_{2(g)}; K_2 = 1.6 \times 10^{-6}$

The equilibrium constant for the reaction $H_{2(g)} + CO_{2(g)} \rightleftharpoons CO_{(g)} + H_2O_{(g)}$ at 1200 K will be

(A) 0.05 (B) 20

(C) 0.2 (D) 5.0

Q2 A chemical reaction A B is said to be in equilibrium when

(A) complete conversion of A to B has taken place

(B) conversion of A to B is only 50% complete

(C) only 10% conversion of A to B has taken place

(D) the rate of transformation of A to B is just equal to rate of transformation of B to A in the system.

Q3 In liquid-gas equilibrium, the pressure of vapours above the liquid is constant at:

(A) Increase temperature

(B) low temperature

(C) constant temperature

(D) high temperature

Q4 In the reaction, $2SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)} + X$ cals, most favourable condition of temperature and pressure for greater yield of SO_3 are

(A) Low temperature and low pressure

(B) High temperature and low pressure

(C) High temperature and high pressure

(D) Low temperature and high pressure

Q5 A buffer solution contains 0.1 mole of sodium acetate in 1000 cm^3 of 0.1 M acetic acid. To the above buffer solution, 0.1 mole of sodium acetate is further added and dissolved. The pH of the resulting buffer is equal to

(A) $pK_a - \log 2$

(B) pK_a

(C) $pK_a + 2$

(D) $pK_a + \log 2$

Q6 Hydroxyl ion concentration of 10^{-2} M HCl is

(A) 1×10^{1} mol dm^{-3}

(B) 1×10^{-12} mol dm^{-3}

(C) 1×10^{-1} mol dm^{-3}

(D) 1×10^{-14} mol dm^{-3}

Q7 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 last if $AgNO_3$ solution is added to the solution containing equal moles of NaCl, NaBr, NaI and Na_2CrO_4 ?

(A) Ag_2CrO_4 (B) AgI

(C) AgCl (D) AgBr

Q8 5 moles of PCl_5 are heated in a closed vessel of 5 litre capacity. At equilibrium 40% of PCl_5 is found to be dissociated. What is the value of K_c ?

(A) 0.266 M (B) 0.133 M

(C) 2.5 M (D) 0.20 M

Q9 The K_p/K_c ratio will be highest in case of

(A) $CO(g) + \frac{1}{2} O_2(g) \quad CO_2(g)$

(B) $H_2(g) + I_2(g) \quad 2HI(g)$

(C) $PCl_5(g) \quad PCl_3(g) + Cl_2(g)$

(D) $7H_2(g) + 2NO_2(g) \quad 2NH_3(g) + 4H_2O(g)$

Q10 A 20 litre container at 400 K contains $CO_{2(g)}$ at pressure 0.4 atm and an excess of SrO (neglect the volume of solid SrO). The volume of the container is now decreased by moving the movable piston fitted in the container. The maximum volume of the container, when pressure of CO_2 attains its maximum value, will be (GIven that: $SrCO_{3(s)} \rightleftharpoons SrO_{(s)} + CO_{2(g)}$, K_p = 1.6 atm)

(A) 10 litre (B) 4 litre

(C) 2 litre (D) 5 litre

Q11 In HS^-, I^-, RNH_2 and NH_3, order of proton accepting tendency will be

(A) $I^- > NH_3 > RNH_2 > HS^-$

(B) $HS^- > RNH_2 > NH_3 > I^-$

(C) $RNH_2 > NH_3 > HS^- > I^-$

(D) $NH_3 > RNH_2 > HS^- > I^-$

Q12 $H_2O + H_3PO_4 \rightleftharpoons H_3O^+ + H_2PO_4^-, pK_1 = 2.15$

$H_2O + H_2PO_4^- \rightleftharpoons H_3O^+ + HPO_4^{2-}, pK_2 = 7.20$

hence pH of $0.01\ M\ NaH_2PO_4$ is

(A) 4.675 (B) 7.350

(C) 9.35 (D) 2.675

Q13 The reaction quotient (Q) for the reaction $N_{2(s)} + 3H_{2(g)} \quad 2NH_{3(g)}$ is given by $Q = \frac{[NH_3]^2}{[N_2][H_2]^3}$

The reaction will proceed from right to left if

(A) Q = 0 (B) $Q = K_c$

(C) $Q < K_c$ (D) $Q > K_c$

Q14 Find out the solubility of $Ni(OH)_2$ in 0.1M NaOH. Given that the ionic product of $Ni(OH)_2$ is 2×10^{-15}.

(A) 2×10^{-8} M

(B) 1×10^{-13} M

(C) 1×10^{8} M

(D) 2×10^{-13} M

Q15 The pOH of a buffer solution made by mixing 25 mL of 0.02 M NH_4OH and 25 mL of 0.2 M NH_4Cl at 25°C is ______.

[pK_b of NH_4OH = 4.8]

(A) 5.8

(B) 2.8

(C) 3.8

(D) 4.8

Q16 An acid/base dissociation equilibrium is dynamic involving a transfer of proton in forward and reverse directions. Now, with passage of time in which direction equilibrium is favoured?

(A) in the direction of stronger base and stronger acid

(B) in the direction of formation of stronger base and weaker acid

(C) in the direction of formation of weaker base and weaker acid

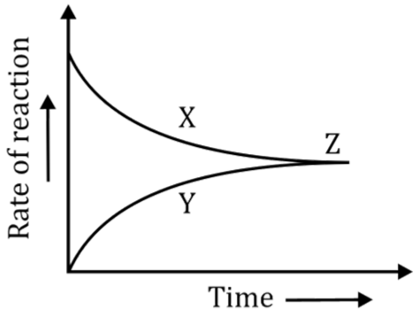
(D) in the direction of formation of weaker base and stronger acid

Q17 In the reaction, $Fe(OH)_3(s) \rightleftharpoons Fe^{3+}(aq) + 3OH^-(aq)$, if the concentration of OH^- ions is decreased by 1/4 times, then the equilibrium concentration of Fe^{3+} will increase by

(A) 8 times (B) 16 times

(C) 64 times (D) 4 times

Q18 Study the given figure and label X, Y and Z.



(A) X Y Z Backward reaction Forward reaction Products

(B) Forward reaction Backward reaction Equilibrium

(C) Reversible reaction Irreversible reaction Equilibrium

(D) Forward reaction Forward reaction Backward reaction

Q19 For the reaction C(s) + CO_2(g)   2CO(g), the partial pressures of CO_2 and CO are 2.0 and 4.0 atm respectively at equilibrium. The K_p for the reaction is.

(A) 0.5 (B) 4.0

(C) 8.0 (D) 32.0

Q20 The following reaction is at equilibrium,

$$\underset{\text{Yellow}}{Fe^{3+}_{(aq)}} + \underset{\text{Colourless}}{SCN^{-}_{(aq)}} \rightleftharpoons \underset{\text{Deepred}}{[Fe(SCN)]^{2+}_{(aq)}} ; K_c$$

$$= \frac{[Fe(SCN)]^{2+}}{[Fe^{3+}][SCN^{-}]}$$

In the above reaction, colour intensity of red colour can be increased by

(A) addition of KSCN

(B) addition of oxalic acid which reacts with Fe^{3+} ions

(C) addition of Hg^{2+} ions which react with SCN^- ions

(D) red colour intensity cannot be changed.

Q21 For the equilibrium, PCl_5(g)? PCl_3(g) + Cl_2(g), the total pressure at equilibrium is P and degree of dissociation of PCl_5 is x.

Which of the following is the partial pressure of PCl_3 ?

(A) $\frac{x}{x-1} \times P$

(B) $\frac{x}{1-x} \times P$

(C) $\frac{x}{x+1} \times P$

(D) $\frac{x}{x-1} \times P$

Q22 A buffer solution of pH = 9 can be prepared by mixing

(A) CH_3COONa and CH_3COOH

(B) NaCl and NaOH

(C) NH_4Cl and NH_4OH

(D) KH_2PO_4 and K_2HPO_4.

Q23 The equilibrium constant for the reversible reaction 2A(g)   2B(g) + C(g) is K_1 and for the reaction $\frac{3}{2}A(g) \rightleftharpoons \frac{3}{2}B(g) + \frac{3}{4}C(g)$ is K_2 K_1 and K_2 are related as:

(A) $K_2 = K_1^{\frac{3}{4}}$ (B) $K_1 = \sqrt{K_2}$

(C) $K_2 = \sqrt{K_1}$ (D) $K_1 = K_2^{\frac{3}{4}}$

Q24 The conjugate base of NH_3 is

(A) NH_4OH (B) NH_2OH

(C) NH_2^- (D) NH_4^+

Q25 The dissociation constants for acetic acid and HCN at 25°C are 1.5 × 10^{-5} and 4.5 × 10^{-10} respectively. The equilibrium constant for the equilibrium,

$$CN^- + CH_3\,COOH \rightleftharpoons HCN + CH_3\,COO^-$$

would be

(A) 3 × 10^{-5}

(B) 3 × 10^{-5}

(C) 3 × 10^{4}

(D) 3 × 10^{5}

Answer Key

Q1	D
Q2	D
Q3	C
Q4	D
Q5	D
Q6	B
Q7	A
Q8	A
Q9	C
Q10	D
Q11	C
Q12	A
Q13	D
Q14	D
Q15	A
Q16	C
Q17	C
Q18	B
Q19	C
Q20	A
Q21	C
Q22	C
Q23	A
Q24	C
Q25	C

Hints & Solutions

Note: scan the QR code to watch video solution

Q1 Text Solution:

Given:

$2H_2O_{(g)} \rightleftharpoons 2H_{2(g)} + O_{2(g)}; K_1 = 6.4 \times 10^{-8}$ ....(i)

$2CO_{2(g)} \rightleftharpoons 2CO_{(g)} + O_{2(g)}; K_2 = 1.6 \times 10^{-6}$ ....(ii)

Required equation is : $H_{2(g)} + CO_{2(g)} \rightleftharpoons CO_{(g)} + H_2O_{(g)}; K = ?$

By reversing equation (i) and by multiplying it with 1/2, we get $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightleftharpoons H_2O_{(g)}; K_1' = \sqrt{\frac{1}{6.4\times10^{-8}}}$ ....(iii)

And by multiplying equation (ii) with 1/2, we get $CO_{2(g)} \rightleftharpoons CO_{(g)} + \frac{1}{2}O_{2(g)}; K_2'$ ....(iv) $= \sqrt{1.6\times10^{-6}}$

By adding equations (iii) and (iv), we get $H_{2(g)} + CO_{2(g)} \rightleftharpoons CO_{(g)} + H_2O_{(g)}; K' = K_1' \times K_2'$

$K' = \sqrt{\frac{1.6\times10^{-6}}{6.4\times10^{-8}}} = \sqrt{25} = 5$

Video Solution:

Q2 Text Solution:

At equilibrium, the rate of forward reaction is equal to rate of backward reaction thus rate of transformation of A to B is equal to rate of transformation of B to

A.

Video Solution:

Q3 Text Solution:

For liquid⇌gas

$K_p = P_{gas}$

Vapour pressure of a liquid is constant at constant temperature.

Video Solution:

Q4 Text Solution:

For 2 $SO_2(g)$ + $O_2(g)$ 2 $SO_3(g)$ (+ X cals, exothermic)

- **Low temperature** favours the exothermic forward reaction.
- **High pressure** favours the side with fewer gas moles (3 2).

Hence the greatest SO_3 yield is obtained at **low temperature and high pressure**.

Video Solution:

Q5 Text Solution:

pH = $pK_a + \log\frac{[\text{Salt}]}{[\text{Acid}]}$

[salt] = $\frac{0.1+0.1}{1000\,\text{mL}} = \frac{0.2}{1} = 0.2$

[Acid] = $\frac{0.1}{1000\,\text{mL}} = \frac{0.1}{1} = 0.1$

$pH = pK_a + \log 2$

Video Solution:

Q6 Text Solution:

$[H^+][OH^-] = 10^{-14}$

$[10^{-2}][OH^-] = 10^{-14}$

$[OH^-] = \frac{10^{-14}}{10^{-2}} = 10^{-12}\ \text{mol dm}^{-3}$

So, the hydroxyl ion concentration of HCl is 1 × 10^{-12} mol dm^{-3}

Video Solution:

Q7 Text Solution:

Lower the higher will be precipitation of the salts:

For,

$Ag_2CrO_4 : K_{SP} = 4S^3 = 1.1 \times 10^{-12} \Rightarrow S = 0.65 \times 10^{-4}$.

$AgCl : K_{SP} = S^2 = 1.8 \times 10^{-10} \Rightarrow S = 1.34 \times 10^{-5}$.

$AgBr : K_{SP} = S^2 = 5 \times 10^{-13} \Rightarrow S = 0.71 \times 10^{-6}$.

$AgI : K_{SP} = S^2 = 8.3 \times 10^{-17} \Rightarrow S = 0.9 \times 10^{-8}$.

Since, Ag_2CrO_4 has high solubility, it precipitates last.

Video Solution:

Q8 Text Solution:

$$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$$

Initial conc. $\frac{5}{5} = 1$ 0 0

At equilibrium 1–0.4 0.4 0.4

$$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{0.4M \times 0.4M}{0.6M} = 0.266M$$

Video Solution:

Q9 Text Solution:

Using the relation $K_p = K_c.(RT)^{\Delta n}$, we get

$$\frac{K_p}{K_c} = (RT)^{\Delta n}$$

Thus $\frac{K_p}{K_c}$ will be highest for the reaction having highest value of Δn.

The Δn values for various reactions are

(a) $\Delta n = 1 - \left(1 + \frac{1}{2}\right) = -1/2$

(b) $\Delta n = 2 - (1 + 1) = 0$

(c) $\Delta n = (1 + 1) - 1 = 1$

(d) $\Delta n = (2 + 4) - (7 + 2) = -3$

Thus maximum value of $\Delta n = 1$

Video Solution:

Q10 Text Solution:

$$SrCO_{3(s)} \rightleftharpoons SrO_{(s)} + CO_{2(g)}; K_p = 1.6 \text{ atm}$$

$$K_p = \frac{p_{CO_2} \times p_{SrO}}{p_{SrCO_3}} \Rightarrow 1.6$$

$$= p_{CO_2} \left(\because p_{SrO} = p_{SrCO_3} = 1\right)$$

$\therefore$ Maximum pressure of CO_2 = 1.6 atm

Let the maximum volume of the container when pressure of CO_2 is 1.6 atm be VL

During the proces, PV = constant

$$\therefore \quad 0.4 \times 20 = 1.6 \times V$$

$$\Rightarrow V = \frac{0.4 \times 20}{1.6} = 5 \text{ L.}$$

Video Solution:

Q11 Text Solution:

Strong base has higher tendency to accept the proton. Increasing order of base and hence the order of accepting tendency of proton is I^- < HS^- < NH_3 < RNH_2

Video Solution:

Q12 Text Solution:

$H_2PO_4^-$ is amphiprotic.

$$H_2PO_4^- + H_2OH_3PO_4 + OH^-$$

$$H_2PO_4^- + H_2OHPO_4^{2-} + H_3O^+$$

$$pH = \frac{pK_1 + pK_2}{2} = \frac{2.15 + 7.20}{2} = 4.675$$

Video Solution:

Q13 Text Solution:

If Q > K_c it means concentration of product is more than that reactants at equilibrium, so reaction will proceed from products to reactants i.e., right to left.

Video Solution:

Q14 Text Solution:

If 'S' is the solubility of $Ni(OH)_2$ then for the equilibrium, $Ni(OH)_2 \rightleftharpoons Ni^{+2} + 2OH^-$, solubilities will be: S S 2S.

NaOH is a strong electrolyte and dissociates completly as: $Ni(OH)_2 \rightleftharpoons Ni^{+2} + 2OH^-$, the concentrations

will be 0.1 0.1 0.1

$\therefore$ Total $[OH^-] = 0.1 + 2s \simeq 0$ Ionic $.1 [\because 2s <<< 0.1]$

product of, $Ni(OH)_2 = 2 \times 10^{-15} = [Ni^{+2}][OH^-]^2$

$2 \times 10^{-15} = s[0.1]^2$

$\therefore \quad S = \frac{2\times10^{-15}}{(0.1)^2} = 2 \times 10^{-13} M$

Video Solution:

Q15 Text Solution:

$pOH = pKb + \log \frac{[Salt]}{[base]}$

$pOH = 4.8 + \log \frac{0.2}{0.02}$

$pOH = 4.8 + \log 10$

$= 5.8$

Video Solution:

Q16 Text Solution:

Dissociation of a weak acid in water :

$$\underset{\text{acid}}{HA(aq)} + \underset{\text{base}}{H_2O(l)} \rightleftharpoons \underset{\text{conjugate acide}}{H_3O^+(aq)} + \underset{\text{conjugate base}}{A^-(aq)}$$

If HA is a stronger acid than H_3O^+ then HA will donate protons and not H_3O^+ and the solution will mainly contain A^- and H_3O^+ ions. Hence, the equilibrium moves in the direction of formation of weaker acid and weaker base. Similarly, this is true for dissociation of a weak base also.

Video Solution:

Q17 Text Solution:

Given relation,

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

$K_{eq} = \frac{[Fe^{3+}][OH^-]^3}{[Fe(OH)_3]} = \frac{[Fe^{3+}][OH^-]^3}{1}$

When [OH-] is decreased by 1/4 times, K becomes

$K_{eq} = [Fe^{3+}]\left(\frac{1}{4} \cdot [OH^-]\right)^3$

$=[Fe^{3+}]\frac{1}{64}[OH^-]^3$

To keep the value of K_{eq} constant, the $[Fe^{3+}]$ must be increased by 64 times so that K_{eq} remains as such

$K_{eq}=64\times\frac{1}{64}[Fe^{3+}][OH^-]^3$

$K_{eq}=[Fe^{3+}][OH^-]^3$

Video Solution:

Q18 Text Solution:

The concentration of reactants decreases and that of products increases with time. Rate of reaction increases with time. At equilibrium, $R_f = R_b$

Video Solution:

Q19 Text Solution:

$K_p=\frac{(P_{CO})^2}{(P_{CO_2})}; K_p=\frac{4\times4}{2}=8; C(s)=1;$

The concentration of solids and liquids are taken as unity.

Video Solution:

Q20 Text Solution:

Addition of KSCN increases the colour intensity of the solution as it shifts the equilibrium to right. Addition of reagents like oxalic acid or Hg^{2+} ions which remove Fe^{3+} or SCN^- ions shift the equilibrium to the left and colour intensity decreases.

Video Solution:

Q21 Text Solution:

$$\begin{array}{lccc} & PCl_5 & \rightarrow PCl_3 & + Cl_2 \\ \text{initial} & 1 & 0 & 0 \\ \text{At eqm} & 1-x & x & x \end{array}$$

total number of moles at eqm=1-x+x+x = 1+x

number of moles of PCl3 =x

molefraction of $PCl_3=\chi_{PCl_3}=\frac{x}{1+x}$

Partial pressure of $PCl_3=P_{PCl_3}=\chi_{PCl_3}\times P=\frac{x}{1+x}.P$

Video Solution:

Q22 Text Solution:

$NH_4OH + NH_4Cl$ is a basic buffer solution.

Video Solution:

Q23 Text Solution:

$2A(g) \rightleftharpoons 2B(g) + C(g)$ K_1 ...(i)

$\frac{3}{2}A(g) \rightleftharpoons \frac{3}{2}B(g) + \frac{3}{4}C(g)$ is K_2 ...(ii)

eq. (ii) is $\frac{3}{2}$ times of eq. (i), hence, $K_2 = (K_1)^{\frac{3}{4}}$

Video Solution:

Q24 Text Solution:

Conjugate base is formed by removal of a proton. Hence conjugate base of NH_3 is NH_2^-.

$NH_3 \xrightarrow{-H^+} NH_2^-$

Video Solution:

Q25 Text Solution:

Given, $CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

$K_1 = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]} = 1.5 \times 10^{-5}$

$HCN \rightleftharpoons H^+ + CN^-$

$K_2 = \frac{[CN^-][H^+]}{[HCN]} = 4.5 \times 10^{-10}$

$CN^- + CH_3COOH \rightleftharpoons HCN + CH_3COO^-$

$K = \frac{[HCN][CH_3COO^-]}{[CN^-][CH_3COOH]}$

$K = \frac{K_1}{K_2} = \frac{1.5 \times 10^{-5}}{4.5 \times 10^{-10}} \approx 0.3 \times 10^5$ or $K = 3 \times 10^4$

Video Solution: