Detailed Solutions (Option-by-Option)
Chapter: Chemical Equilibrium — DPP–1

"Clarity on each option = guaranteed marks."

Q1. Which of the following statement is correct regarding chemical equilibrium

(1) We may have negligible reactant left depending on extent to equilibrium: **Correct** if K is very large.

(2) Equilibrium is not static: **Correct** it's *dynamic*.

(3) Concentrations of reactants and products become constant at equilibrium: **Correct**.

(4) All of these: **Correct**.

Final Answer: (4)

Q2. Find out the correct statement

(1) Equilibrium is a state of a reversible reaction: **Correct**.

(2) Important in biological processes (e.g., $Hb + O_2 \rightleftharpoons HbO_2$): **Correct**.

(3) Reversible reactions can be homogeneous or heterogeneous: **Correct**.

(4) All of these: **Correct**.

Final Answer: (4)

Q3. Which of the following reaction is endothermic

(1) Bond formation by unstable atoms (at ordinary conditions): **Incorrect** bond formation is typically exothermic.

(2) Combustion reactions: **Incorrect** strongly exothermic.

(3) Conversion of more stable allotrope to less stable allotrope: **Correct** needs energy input.

(4) Condensation of vapour to liquid: **Incorrect** exothermic.

Final Answer: (3)

Q4. In any chemical reaction, equilibrium is established when

(1) Mutual opposite reactions simply "occur": **Incorrect** occurrence alone is not the criterion.

(2) Concentrations of reactants and products are equal: **Incorrect** they are constant, not necessarily equal.

(3) Rates of the opposite reactions are equal ($r_f = r_b$): **Correct**.

(4) Temperatures of opposite reactions become equal: **Incorrect** not a thermodynamic criterion.

Final Answer: (3)

Q5. Volatile liquid in evacuated closed vessel reaches equilibrium when

(1) Liquid completely becomes vapour: **Incorrect** not required at a given T.

(2) Equal amounts of liquid and vapour present: **Incorrect** amounts need not be equal.

(3) Rate of evaporation equals rate of condensation: **Correct** dynamic phase equilibrium.

(4) Liquid cannot convert to vapour and vice versa: **Incorrect**.

Final Answer: (3)

Q6. $x \rightleftharpoons y$ **is at equilibrium when**

(1) Only 10% conversion of $x \rightarrow y$: **Incorrect** extent is irrelevant.

(2) Complete conversion of $x \rightarrow y$: **Incorrect** contradicts reversibility.

(3) Exactly 50% conversion: **Incorrect** not necessary.

(4) Rate$(x \rightarrow y)$ = Rate$(y \rightarrow x)$: **Correct**.

Final Answer: (4)

Q7. $N_2 + 3H_2 \rightleftharpoons 2NH_3$ **at equilibrium — true statement**

(1) Equal volumes of N_2 and H_2 reacting: **Incorrect** stoichiometry is 1:3 in moles, not equal volumes.

(2) Equal masses of N_2 and H_2 reacting: **Incorrect**.

(3) Reaction has stopped: **Incorrect** dynamic equilibrium continues.

(4) Amount of NH_3 formed equals the amount decomposed (rates equal): **Correct**.

Final Answer: (4)

Q8. In a reversible reaction, equilibrium will be established when

(1) Reactant completely converts to product: **Incorrect**.

(2) Rate of forward and backward reactions are equal: **Correct**.

(3) Minimum possible yield of product: **Incorrect**.

(4) Concentrations of reactant and product are equal: **Incorrect**.

Final Answer: (2)

Q9. Which of the following is *not* a characteristic of equilibrium

(1) Rate is equal in both directions: **Correct** a true characteristic.

(2) Measurable quantities are constant at equilibrium: **Correct** true characteristic.

(3) Occurs in reversible condition: **Correct** true characteristic.

(4) Occurs only in open vessel at constant temperature: **Incorrect** needs a closed system to maintain composition.

Final Answer: (4)

Q10. In a reversible chemical reaction equilibrium will be established when

(1) Reactant completely converted to product: **Incorrect**.

(2) $r_f = r_b$: **Correct**.

(3) Minimum yield of product: **Incorrect**.

(4) Concentrations of reactant and product are equal: **Incorrect**.

Final Answer: (2)

Q11. A reversible reaction is one which

(A) Achieves an equilibrium state: **Correct**.

(B) Proceeds in both forward and backward directions: **Correct**.

(C) Does not occur at all: **Incorrect**.

(D) Both (A) and (B): **Correct**.

Final Answer: (D)

Q12. A chemical reaction is at equilibrium when

(A) Measurable properties become constant: **Correct**.

(B) Rates of forward and backward reactions are equal: **Correct**.

(C) Net rate is zero: **Correct** consequence of $r_f = r_b$.

(D) All are correct: **Correct**.

Final Answer: (D)

Q13. A chemical reaction is at equilibrium when

(A) Reactants are completely transformed: **Incorrect**.

(B) Rates of forward and backward reactions are equal: **Correct**.

(C) Formation of products is minimised: **Incorrect**.

(D) Equal amounts of reactants and products are present: **Incorrect**.

Final Answer: (B)

Q14. Which of the following statements is *incorrect*

(A) At equilibrium, vapour pressure (or refractive index) becomes constant: **Correct** correct statement.

(B) Equilibrium can be attained in both homogeneous and heterogeneous reactions: **Correct**; correct.

(C) At equilibrium, concentrations of reactants and products become constant *and equal*: **Incorrect**; constant but not necessarily equal.

(D) Equilibrium is dynamic in nature: **Correct**; correct.

Final Answer: (C) is the incorrect one

Q15. Which one of the following statements is *incorrect* about chemical equilibrium

(A) Equilibrium can be attained whether we start with reactants or products: **Correct**.

(B) Chemical equilibrium is dynamic in nature: **Correct**.

(C) $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ is attained in an *open* vessel: **Incorrect**; CO_2 escapes, so no equilibrium pressure builds.

(D) At equilibrium, concentration of each reactant and product becomes constant: **Correct**.

Final Answer: (C)

Q16. State True/False for dynamic equilibrium

(a) Concentration of reactants and products are always equal: **Incorrect**.

(b) Rate of forward and backward reactions are equal: **Correct**.

(c) Ratio of concentrations of reactants and products is constant (K_c): **Correct** at fixed T.

(d) Ratio of partial pressures is constant (K_p): **Correct** at fixed T.

(e) Vapour density of a mixture is constant (at equilibrium): **Correct** at fixed T.

(f) Concentrations remain constant with time at equilibrium: **Correct**.

(g) Equilibrium constant depends only on stoichiometry/temperature, not on mechanism: **Correct**.

Final Answer: F, T, T, T, T, T, T

Q17. Find the correct graph regarding equilibrium state (concentration vs time) **Pick the graph where:** reactant concentrations decrease from their initial values and approach horizontal plateaus > 0; product concentrations increase from their initial values (often 0) and approach horizontal plateaus; *slopes* tend to 0 as $t \to \infty$. Reactant and product plateaus *need not be equal*.
Final Answer: Choose the option whose curves all become horizontal constants at long time; $dC/dt \to 0$.

Q18. $NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g$ **— correct concentration–time graph** **Pick the graph where:** $[NH_3]$ rises from 0 to a plateau; $[CO_2]$ rises from 0 to a lower plateau; the ratio at equilibrium respects stoichiometry $n_{NH_3} : n_{CO_2} = 2 : 1$; solid does not appear in concentration plots.
Final Answer: Choose the option with two increasing gas curves to constants, $[NH_3]_\infty$ about double $[CO_2]_\infty$.

Q19. Rate–time curves for a reaction approaching equilibrium can be **Pick the graph where:** the forward rate starts high and decreases with time; the backward rate starts low (often near 0) and increases; both approach the *same nonzero* value as $t \to \infty$ (dynamic equilibrium). The *net* rate tends to 0.
Final Answer: Choose the option with two monotonic rate curves converging to the same horizontal value.

Q20. An example of a reversible reaction is

(A) $Pb(NO_3)_2(aq) + 2NaI(aq) \to PbI_2(s) + 2NaNO_3(aq)$: **Incorrect** precipitation drives it essentially to completion.

(B) $AgNO_3(aq) + HCl(aq) \to AgCl(s) + HNO_3(aq)$: **Incorrect** precipitation of AgCl drives it forward.

(C) $2Na(s) + 2H_2O(\ell) \to 2NaOH(aq) + H_2(g)$: **Incorrect** highly irreversible under normal conditions.

(D) $KNO_3(aq) + NaCl(aq) \rightleftharpoons KCl(aq) + NaNO_3(aq)$: **Correct** all strong electrolytes, no precipitate—mixture is governed by ionic equilibrium/mixing; effectively reversible.

Final Answer: (D)

Q21. **Two containers at equilibrium are mixed:** $N_2 + 3H_2 \rightleftharpoons 2NH_3$ **and** $N_2 + 3D_2 \rightleftharpoons 2ND_3$ At new equilibrium, isotopic scrambling yields: $N_2, H_2, D_2, NH_3, ND_3, NH_2D, NHD_2, HD$ (via exchange in the NH_3/ND_3 network and $H_2 \rightleftharpoons HD \rightleftharpoons D_2$). That's 8 distinct species.
Final Answer: (D) 8