# Chemical Equilibrium Review

1. Which of the following statements concerning chemical equilibrium is incorrect?
    A) Chemical equilibrium can occur at different temperatures.
    B) Chemical equilibrium may be established quickly.
    C) Chemical equilibrium may be established slowly.
    D) When chemical equilibrium is established, the reaction stops.

2. For the closed system below, the temperature is held constant. Which one of the following statements concerning this system at equilibrium is false?
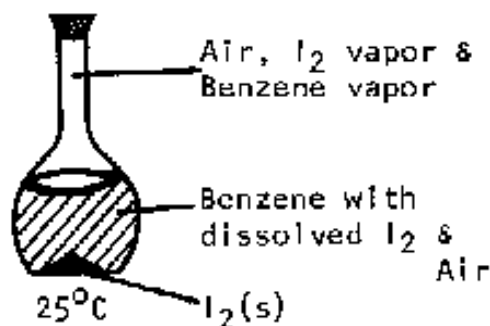

    A) There is no further evaporation of the liquid.
    B) There is no change in pressure of the vapour phase.
    C) There is no change in colour of the liquid phase.
    D) The amount of solid iodine remains constant.

3. Which equilibrium system will contain the largest concentration of products at 25°C?
    A) $AgI(s) \leftrightarrow Ag^+(aq) + I^-(aq)$ $K_c = 8.5 \times 10^{-17}$
    B) $HC_2H_3O_2 (aq) \leftrightarrow H^+(aq) + C_2H_3O_2^-(aq)$ $K_c = 1.8 \times 10^{-5}$
    C) $Pb^{+2}(aq) + 2 Cl^-(aq) \leftrightarrow PbCl_2(s)$ $K_c = 6.3 \times 10^4$
    D) $Cu(s) + 2Ag^+(aq) \leftrightarrow Cu^{+2}(aq) + 2Ag(s)$ $K_c = 2.0 \times 10^{15}$

4. What will be the effect of adding some solid $AgNO_3$ to a saturated solution of $AgCl$?
    A) The $AgNO_3$ will not dissolve.
    B) More solid $AgCl$ will dissolve.
    C) More solid $AgCl$ will be produced.
    D) The $AgNO_3$ will not affect the $AgCl$ equilibrium.

5. Which of the following has the lowest molar solubility?
    A) $NiCO_3$ $Ksp = 6.6 \times 10^{-9}$
    B) $Ni(CN)_2$ $Ksp = 3.0 \times 10^{-23}$
    C) $Ni(OH)_2$ $Ksp = 2.8 \times 10^{-16}$
    D) NiS $Ksp = 3.0 \times 10^{-21}$

6. Consider the reaction: $BaCO_3(s)$ + heat $\leftrightarrow$ $BaO(s) + CO_2(g)$. Suggest a way that one could tell if the reaction has reached equilibrium.

7. In a 1.0 L vessel, a mixture of hydrogen and nitrogen are allowed to come to equilibrium at a specific temperature according to the reaction: $3\,H_2(g) + N_2(g) \leftrightarrow 2\,NH_3(g)$. Analysis of the equilibrium mixture shows that it contains 1.5 mols NH_3, 2.0 mols N_2, and 3.0 mols H_2. How many mols of H_2 were present at the beginning of the reaction?

8. The following graph shows the concentrations of species A, B and C.
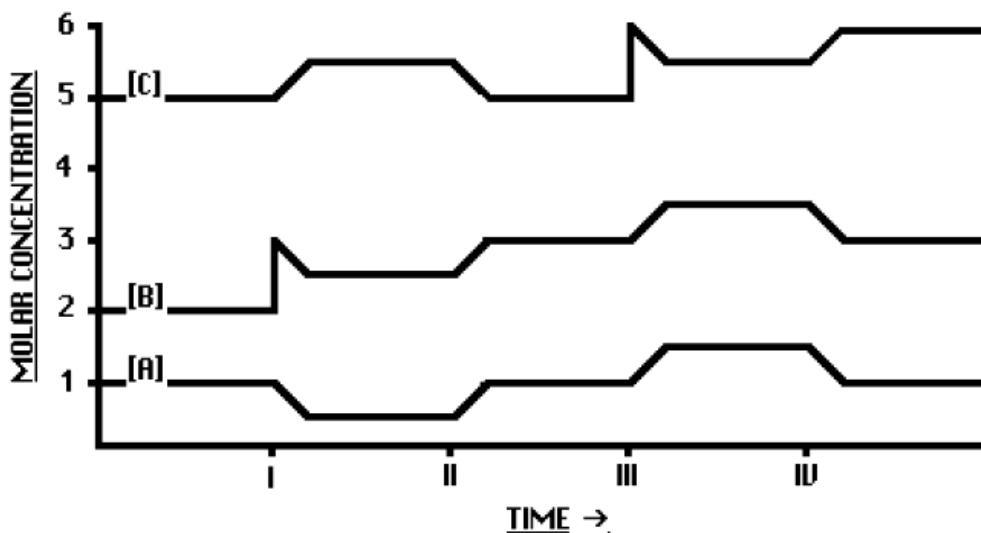
9. State what changes in **temperature** or **concentration** are responsible for each of the shifts shown on the graph. The equilibrium equation is: $A(g) + B(g) \leftrightarrow C(g)$ ΔH = -65 kJ

10. The graph below shows the variation of concentration with time for the following reaction: $3A(aq) \leftrightarrow B(aq) + 2C(aq)$ at 25°C.
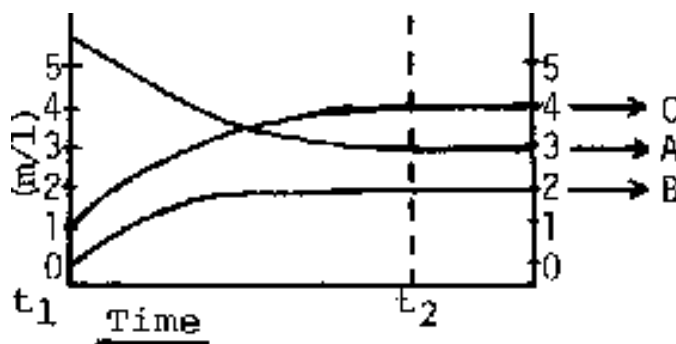
What is the value of the equilibrium constant at time t_2?

11. Write the reaction represented by the equilibrium expression: $K_c = \dfrac{[C]^2}{[A]^3[B]}$.

12. Consider the reaction: $NaI(aq) + H_2SO_4(aq) \leftrightarrow NaHSO_4(aq) + HI(aq)$. The equilibrium constant is 7.3×10^{-4}. If the equilibrium concentrations of H_2SO_4, $NaHSO_4$ and HI are 2.1×10^{-1} mol/L, 3.2×10^{-2} mol/L and 4.6×10^{-4} mol/L respectively, what is the concentration of NaI?

13. Consider the following equilibrium: $2N_2O(g) \leftrightarrow 2N_2(g) + O_2(g)$. Initially, 0.800 mol of N_2O is placed in a 1.0 L container. At equilibrium, the $[N_2]$ is found to be 0.780 mol/L. What is the value of K_c?

14. Consider the following reaction: $2SO_2(g) + O_2(g) \leftrightarrow 2SO_3(g)$ $\Delta H = -200$ kJ/mol.
    a. What change(s) will increase equilibrium concentrations of $SO_2(g)$?
    b. What will adding a catalyst to the system at equilibrium do?

15. When $Fe(OH)_2$ dissolves to create a saturated solution, the concentration of OH^- is 2.50×10^{-5} mol/L. What is the value of K_{sp} for $Fe(OH)_2$?

16. How many grams of $BaCO_3$ will dissolve in 1.2 L of water? ($K_{sp} = 5.1 \times 10^{-9}$)

17. Give the expression for the K_{sp} of bismuth (III) iodide.

18. Indicate whether the following compounds are soluble or insoluble in water.
    a. $PbCl_2$
    b. $BaCO_3$
    c. $AlPO_4$

19. How many moles of $Mg(OH)_2$ can be precipitated when 15 mL of 0.20 mol/L $MgCl_2$ solution is mixed with 25 mL of 0.18 mol/L KOH assuming the reaction goes to completion?

20. Solutions of lead (II) nitrate and potassium bromide are mixed. Give the net ionic equation for the precipitation reaction.

21. Calculate the solubility in g/L of Silver Chloride in water and in a 6.5×10^{-3} mol/L silver nitrate solution. K_{sp} of AgCl $= 1.6 \times 10^{-10}$.

22. Explain, using reactions, why the solubility of ZnS ($K_{sp} = 2.0 \times 10^{-25}$) is greater in nitric acid than in pure water.