Questions 1-3 refer to the reaction below.

$$HCN\ (aq) \leftrightarrow H^+\ (aq) + CN^-\ (aq) \qquad Ka = 4.9 \times 10^{-10}$$

1. Given the reaction above for HCN:
   Determine the equilibrium constant expression, Ka, for HCN.
   (A) $Ka = \frac{[HCN]}{[H^+][CN^-]}$
   (B) $Ka = \frac{[HCN]}{[H^+]+[CN^-]}$
   (C) $Ka = \frac{[H^+][CN^-]}{[HCN]}$
   (D) $Ka = \frac{[H^+]+[CN^-]}{[HCN]}$

2. Calculate the $[H^+]$ for a 0.20 M solution of HCN at equilibrium.
   (A) $[H^+] = 4.9\ x\ 10^{-10} M$
   (B) $[H^+] = 9.9\ x\ 10^{-6} M$
   (C) $[H^+] = 9.8\ x\ 10^{-11} M$
   (D) $[H^+] = 7.2\ x\ 10^{-14} M$

3. Calculate the pH of a 0.20 M solution of HCN at equilibrium.
   (A) $pH = 3.40$
   (B) $pH = 4.50$
   (C) $pH = 5.00$
   (D) $pH = 10.01$

Questions 4-5 refer to the solubility product of silver chloride.

4. The Ksp for AgCl (s) at 25˚C is 1.8×10^{-10}.
   Identify the balanced chemical equilibrium reaction for the solubility of AgCl (s).
   (A) $Ag^+ + Cl^- \leftrightarrow AgCl\ (s)$
   (B) $AgCl\ (s) \leftrightarrow Ag^+ + Cl^-$
   (C) $2\ Ag^+ + 2\ Cl^- \leftrightarrow AgCl\ (s)$
   (D) $AgCl\ (s) \leftrightarrow 2\ Ag^+ + 2\ Cl^-$

5. Calculate the concentration of $[Ag^+]$ in a saturated solution of AgCl.
   (A) $[Ag^+] = 1.8\ x\ 10^{-10} M$
   (B) $[Ag^+] = 3.6\ x\ 10^{-8} M$
   (C) $[Ag^+] = 2.6\ x\ 10^{-5} M$
   (D) $[Ag^+] = 1.3\ x\ 10^{-5} M$

Questions 6-7 refer to the reaction below.

$Cu(IO_4)_2$ (s) ↔ Cu^{2+} (aq) + 2 IO_4^- (aq) Ksp = 1.4 x 10^{-7}

6. Given the balanced chemical equilibrium reaction for the solubility of copper periodate:
   Determine the equilibrium constant expression, Ksp, for $Cu(IO_4)_2$.
   (A) $Ksp = \frac{[Cu^+][IO_4^-]}{[Cu(IO_4)_2]}$
   (B) $Ksp = \frac{[Cu^+][IO_4^-]^2}{[Cu(IO_4)_2]}$
   (C) $Ksp = [Cu^+][IO_4^-]$
   (D) $Ksp = [Cu^+][IO_4^-]^2$

7. Calculate the concentration of $[IO_4^-]$ in a saturated solution of copper periodate.
   (A) $[IO_4{}^-] = 1.2\ x\ 10^{-3} M$
   (B) $[IO_4{}^-] = 3.3\ x\ 10^{-3} M$
   (C) $[IO_4{}^-] = 6.6\ x\ 10^{-3} M$
   (D) $[IO_4{}^-] = 3.7\ x\ 10^{-4} M$

Questions 8-10 refer to the reaction below.

H_2 (g) + Br_2 (g) ↔ 2 HBr (g)

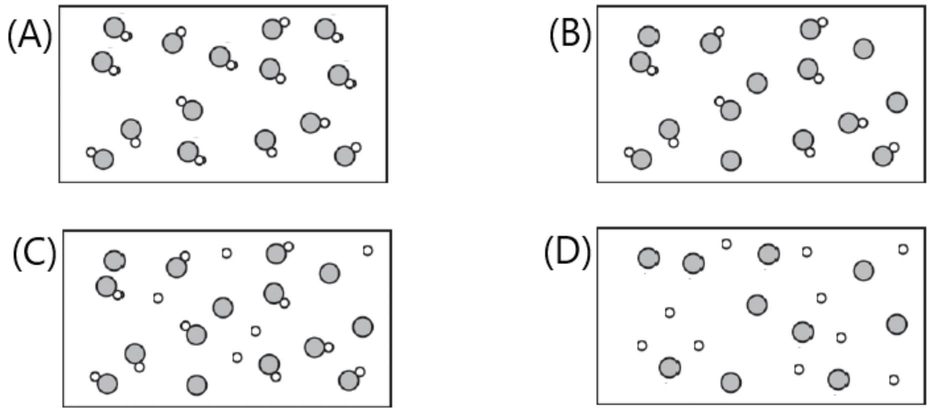
8. Given the balanced chemical equilibrium reaction for the equilibrium of hydrogen bromide:
   Determine the equilibrium constant expression, K_c, for HBr.
   (A) $Kc = \frac{[HBr]^2}{[H_2][Br_2]}$
   (B) $Kc = \frac{[H_2][Br_2]}{[HBr]^2}$
   (C) $Kc = \frac{[HBr]^2}{[H_2]+[Br_2]}$
   (D) $Kc = \frac{[H_2]+[Br_2]}{[HBr]^2}$

9. According to the reaction above, 0.35 M of H_2 (g) and 0.22 M of Br_2 (g) are initially placed in a container. At equilibrium, the concentration of H_2 is found to be 0.14 M.
   Calculate the equilibrium concentrations of Br_2 (g) and HBr (g).
   (A) $[Br_2] = 0.14\ M, [HBr] = 0.14\ M$
   (B) $[Br_2] = 0.14\ M, [HBr] = 0.28\ M$
   (C) $[Br_2] = 0.01\ M, [HBr] = 0.28\ M$
   (D) $[Br_2] = 0.01\ M, [HBr] = 0.42\ M$

10. Calculate the Kc for the above reaction.
   (A) $Kc = 4$
   (B) $Kc = 14.3$
   (C) $Kc = 126$
   (D) $Kc = 300$

Questions 11-13 refer to the equilibrium of a weak acid.

11. Which of the following particle diagrams best represents the equilibrium of a weak acid.



12. A certain weak acid has an initial concentration of 0.10 M. This weak acid at equilibrium is found to have a pH of 2.00.

    Calculate the $[H^+]$ concentration of this weak acid at equilibrium.

    (A) $[H^+] = 0.01\ M$
    (B) $[H^+] = 0.02\ M$
    (C) $[H^+] = 0.001\ M$
    (D) $[H^+] = 0.002\ M$

13. Calculate the Ka value for this weak acid.

    (A) $Ka = 0.50$
    (B) $Ka = 0.11$
    (C) $Ka = 0.0050$
    (D) $Ka = 0.0011$

Questions 14-15 refer to the solubility product of lead (II) bromide.

14. Identify the balanced chemical equilibrium reaction for the solubility of $PbBr_2$ (s).

    (A) $Pb^{2+}(aq) + Br^-(aq) \leftrightarrow PbBr_2(s)$
    (B) $Pb^{2+}(aq) + 2\ Br^-(aq) \leftrightarrow PbBr_2(s)$
    (C) $PbBr_2(s) \leftrightarrow Pb^{2+}(aq) + Br^-\ (aq)$
    (D) $PbBr_2(s) \leftrightarrow Pb^{2+}(aq) + 2\ Br^-\ (aq)$

15. The molar solubility of $PbBr_2$ (s) is 0.01 mol L^{-1}.

    Calculate the Ksp for $PbBr_2$.

    (A) $Ksp = 1\ x\ 10^{-2}$
    (B) $Ksp = 1\ x\ 10^{-4}$
    (C) $Ksp = 4\ x\ 10^{-4}$
    (D) $Ksp = 4\ x\ 10^{-6}$