Practice problems
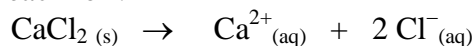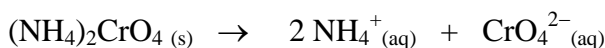
1. If the concentration of a calcium chloride solution is 0.10 mol/L, what is the concentration of each ion?

$$CaCl_{2\ (s)} \rightarrow Ca^{2+}_{(aq)} + 2\,Cl^-_{(aq)}$$

$$c_{Ca^{2+}} = 0.10\,^{mol}\!/_L \times \frac{1}{1} = \mathbf{0.10\,^{mol}\!/_L}$$

$$c_{Cl^-} = 0.10\,^{mol}\!/_L \times \frac{2}{1} = \mathbf{0.20\,^{mol}\!/_L}$$

2. In an ammonium chromate solution where the ammonium ion concentration is 0.0466 mol/L, what is the concentration of the solute?

$$(NH_4)_2CrO_{4\ (s)} \rightarrow 2\,NH_4^+{}_{(aq)} + CrO_4^{2-}{}_{(aq)}$$

$$c_{(NH_4)_2CrO_4} = 0.0466\,^{mol}\!/_L \times \frac{1}{2} = \mathbf{0.0233\,^{mol}\!/_L}$$

3. 35.1 g of aluminum dichromate is dissolved to form 200 mL of solution. What is the concentration of each ion in solution?
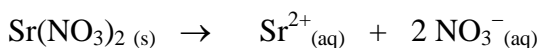
$$Al_2(Cr_2O_7)_{3\ (s)} \rightarrow 2\,Al^{3+}_{(aq)} + 3\,Cr_2O_7^{2-}{}_{(aq)}$$

$$c_{Al^{3+}} = 0.250\,^{mol}\!/_L \times \frac{2}{1} = \mathbf{0.500\,^{mol}\!/_L}$$

$$c_{Cr_2O_7^{2-}} = 0.250\,^{mol}\!/_L \times \frac{3}{1} = \mathbf{0.750\,^{mol}\!/_L}$$

$$n = \frac{m}{M} = \frac{35.1g}{701.96\,^g\!/_{mol}} = 0.05000 mol$$

$$c = \frac{n}{v} = \frac{0.05000\,mol}{0.200\,L} = 0.250\,^{mol}\!/_L$$

4. 15 mL of a 0.65 mol/L solution of strontium nitrate is diluted with 85 mL of water. What is the concentration of each ion in the new solution?

$$Sr(NO_3)_{2\ (s)} \rightarrow Sr^{2+}_{(aq)} + 2\,NO_3^-{}_{(aq)}$$

$$c_{Sr^{2+}} = 0.0975\,^{mol}\!/_L \times \frac{1}{1} = \mathbf{0.098\,^{mol}\!/_L}$$

$$c_{NO_3^-} = 0.0975\,^{mol}\!/_L \times \frac{2}{1} = \mathbf{0.20\,^{mol}\!/_L}$$

$$c_i v_i = c_f v_f$$

$$c_f = \frac{c_i v_i}{v_f}$$

$$c_f = \frac{0.65\,^{mol}\!/_L\,(15mL)}{(15mL + 85mL)}$$

$$c_f = 0.0975\,^{mol}\!/_L$$

Assignment

Part A

a) sodium hydrogen sulfite

/2 $NaHSO_{3\ (s)} \rightarrow Na^+_{(aq)} + HSO_3^-_{(aq)}$
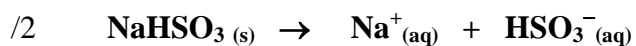
b) aluminum chloride hexahydrate

/2 $AlCl_3 \cdot 6H_2O_{(s)} \rightarrow Al^{3+}_{(aq)} + 3\ Cl^-_{(aq)} + 6\ H_2O_{(l)}$

c) rubidium phosphate

/2 $Rb_3PO_{4\ (s)} \rightarrow 3\ Rb^+_{(aq)} + PO_4^{3-}_{(aq)}$
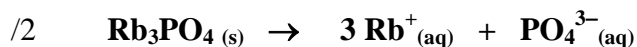
d) calcium dihydrogen phosphate monohydrate

/2 $Ca(H_2PO_4)_2 \cdot H_2O_{(s)} \rightarrow Ca^{2+}_{(aq)} + 2\ H_2PO_4^-_{(aq)} + H_2O_{(l)}$

e) ammonium dichromate

/2 $(NH_4)_2Cr_2O_{7\ (s)} \rightarrow 2\ NH_4^+_{(aq)} + Cr_2O_7^{2-}_{(aq)}$

f) silver chloride

/2 $AgCl_{(s)} \rightarrow AgCl_{(s)}$

g) sodium oxide

/2 $Na_2O_{(s)} \rightarrow 2\ Na^+_{(aq)} + O^{2-}_{(aq)}$

h) ethanol

/2 $C_2H_5OH_{(l)} \rightarrow C_2H_5OH_{(aq)}$
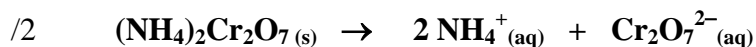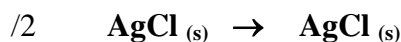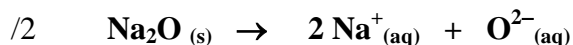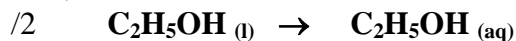
i) ammonium perchlorate

/2 $NH_4ClO_{4\ (s)} \rightarrow NH_4^+_{(aq)} + ClO_4^-_{(aq)}$

j) barium hydroxide octahydrate

/2 $Ba(OH)_2 \cdot 8H_2O_{(s)} \rightarrow Ba^{2+}_{(aq)} + 2\ OH^-_{(aq)} + 8\ H_2O_{(l)}$
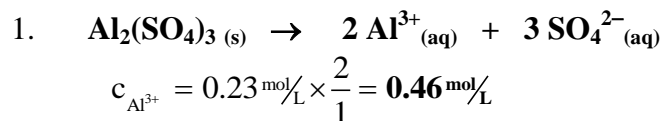
Which of the compounds above will form electrolytic solutions?
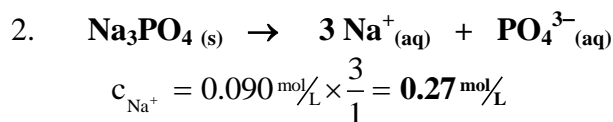
/2 **All of the compounds will form electrolytic solutions except for silver chloride and ethanol.**
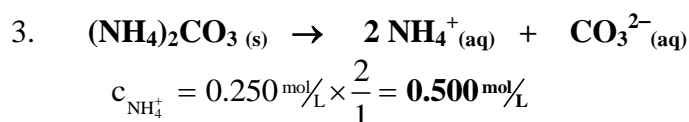
Part B

1. $Al_2(SO_4)_{3\ (s)} \rightarrow 2\ Al^{3+}_{(aq)} + 3\ SO_4^{2-}_{(aq)}$

$$c_{Al^{3+}} = 0.23\,{}^{mol}\!/\!_L \times \frac{2}{1} = \mathbf{0.46\,{}^{mol}\!/\!_L}$$

/4

$$c_{SO_4^{2-}} = 0.23\,{}^{mol}\!/\!_L \times \frac{3}{1} = \mathbf{0.69\,{}^{mol}\!/\!_L}$$

2. $Na_3PO_{4\ (s)} \rightarrow 3\ Na^+_{(aq)} + PO_4^{3-}_{(aq)}$

$$c_{Na^+} = 0.090\,{}^{mol}\!/\!_L \times \frac{3}{1} = \mathbf{0.27\,{}^{mol}\!/\!_L}$$

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$$c_{PO_4^{3-}} = 0.090\,{}^{mol}\!/\!_L \times \frac{1}{1} = \mathbf{0.090\,{}^{mol}\!/\!_L}$$

3. $(NH_4)_2CO_{3\ (s)} \rightarrow 2\ NH_4^+_{(aq)} + CO_3^{2-}_{(aq)}$

$$c_{NH_4^+} = 0.250\,{}^{mol}\!/\!_L \times \frac{2}{1} = \mathbf{0.500\,{}^{mol}\!/\!_L}$$

/7

$$c_{CO_3^{2-}} = 0.250\,{}^{mol}\!/\!_L \times \frac{1}{1} = \mathbf{0.250\,{}^{mol}\!/\!_L}$$

$$n = \frac{m}{M} = \frac{9.61\,g}{96.11\,{}^{g}\!/\!_{mol}} = 0.100\,mol$$

$$c = \frac{n}{v} = \frac{0.100\,mol}{0.400\,L} = 0.250\,{}^{mol}\!/\!_L$$

4. $ZnCl_{2\ (s)} \rightarrow Zn^{2+}_{(aq)} + 2\ Cl^-_{(aq)}$

$$c_{Zn^{2+}} = 1.30\,{}^{mol}\!/\!_L \times \frac{1}{1} = \mathbf{1.30\,{}^{mol}\!/\!_L}$$
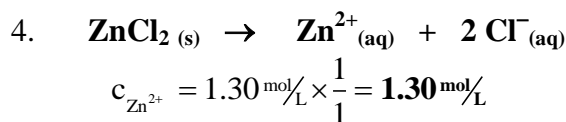
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$$c_{Cl^-} = 1.30\,{}^{mol}\!/\!_L \times \frac{2}{1} = \mathbf{2.61\,{}^{mol}\!/\!_L}$$

$$n = \frac{m}{M} = \frac{800\,g}{136.31\,{}^{g}\!/\!_{mol}} = 5.869\,mol$$

$$c = \frac{n}{v} = \frac{5.869\,mol}{4.50\,L} = 1.30\,{}^{mol}\!/\!_L$$

5. $(NH_4)_2Cr_2O_{7\ (s)} \rightarrow 2\ NH_4^+_{(aq)} + Cr_2O_7^{2-}_{(aq)}$
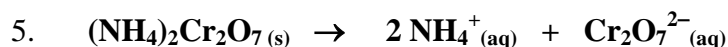
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$$c_{(NH_4)_2Cr_2O_7} = 0.0466\,{}^{mol}\!/\!_L \times \frac{1}{2} = \mathbf{0.0233\,{}^{mol}\!/\!_L}$$

6. $CaCl_{2\ (s)} \rightarrow Ca^{2+}_{(aq)} + 2\ Cl^-_{(aq)}$

$$c_{CaCl_2} = 0.120\ ^{mol}\!/_L \times \frac{1}{2} = 0.0600\ ^{mol}\!/_L$$

/7 $n = c\,v$ $m = n\,M$

$\quad\quad\quad n_{CaCl_2} = 0.0600\ ^{mol}\!/_L\,(2.00L)$ $m_{CaCl_2} = 0.120\,mol\,(110.98\ ^g\!/_{mol})$

$\quad\quad\quad n_{CaCl_2} = 0.120\,mol$ $\boxed{m_{CaCl_2} = 13.3\,g}$

7. $NaBr_{(s)} \rightarrow Na^+_{(aq)} + Br^-_{(aq)}$
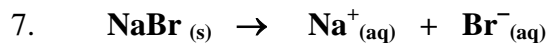
$$c_{Na^+} = 0.6074\ ^{mol}\!/_L \times \frac{1}{1} = \mathbf{0.607\ ^{mol}\!/_L} \quad\quad\quad n = \frac{m}{M} = \frac{50.0\,g}{102.89\ ^g\!/_{mol}} = 0.48596\,mol$$

/7

$$c_{Br^-} = 0.6074\ ^{mol}\!/_L \times \frac{1}{1} = \mathbf{0.607\ ^{mol}\!/_L} \quad\quad\quad c = \frac{n}{v} = \frac{0.48596\,mol}{0.800\,L} = 0.6074\ ^{mol}\!/_L$$

8. $Al(NO_3)_{3\ (s)} \rightarrow Al^{3+}_{(aq)} + 3\ NO_3^-_{(aq)}$
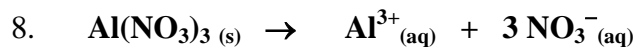
$$c_{Al^{3+}} = 1.25\ ^{mol}\!/_L \times \frac{1}{1} = \mathbf{1.25\ ^{mol}\!/_L}$$

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$$c_{NO_3^-} = 1.25\ ^{mol}\!/_L \times \frac{3}{1} = \mathbf{3.75\ ^{mol}\!/_L}$$

9. $K_2Cr_2O_{7\ (s)} \rightarrow 2\ K^+_{(aq)} + Cr_2O_7^{2-}_{(aq)}$

$$c_{K^+} = 0.194\ ^{mol}\!/_L \times \frac{2}{1} = \mathbf{0.388\ ^{mol}\!/_L} \quad\quad n = \frac{m}{M} = \frac{40.0\,g}{294.20\ ^g\!/_{mol}} = 0.13596\,mol$$

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$$c_{Cr_2O_7^{2-}} = 0.194\ ^{mol}\!/_L \times \frac{1}{1} = \mathbf{0.194\ ^{mol}\!/_L} \quad\quad c = \frac{n}{v} = \frac{0.13596\,mol}{0.700\,L} = 0.194\ ^{mol}\!/_L$$