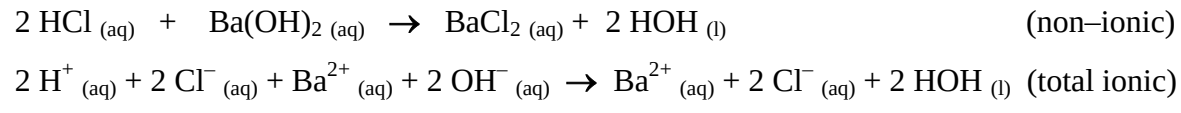
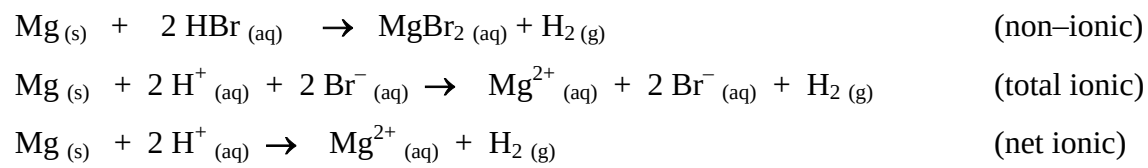
Chemistry 20 – Lesson 23
Reactions in Solution

Practice problems

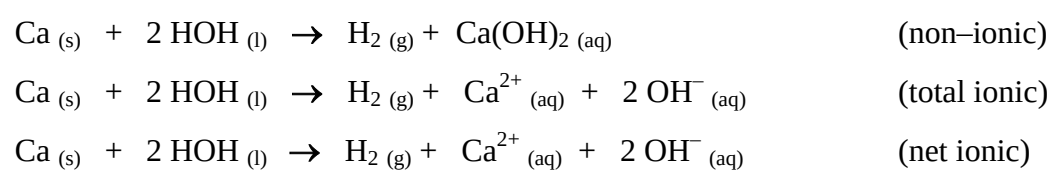
1. Hydrochloric acid is added to a solution of barium hydroxide.



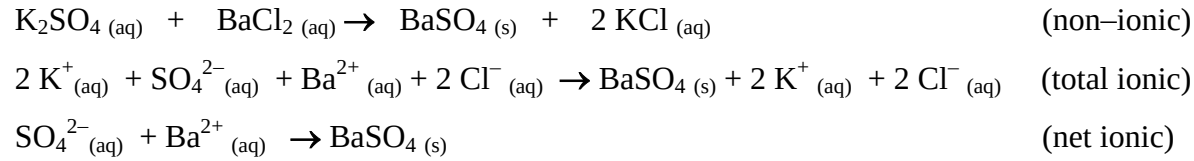
2. Magnesium metal is added to an aqueous solution of hydrogen bromide.



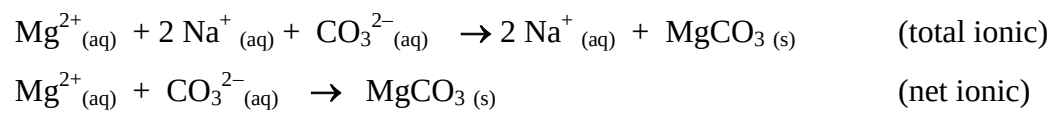
3. Calcium metal reacts with water.



4. Aqueous solutions of potassium sulfate and barium chloride are mixed.



5. An aqueous solution of washing soda, Na_2CO_3, is added to remove $Mg^{2+}_{(aq)}$ from water.



Assignment

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1. Potassium metal reacts with water.

/3 $\mathbf{K_{(s)} + 2\,HOH_{(l)} \rightarrow H_{2\,(g)} + 2\,KOH_{(aq)}}$ **(non–ionic)**

$\mathbf{K_{(s)} + 2\,HOH_{(l)} \rightarrow H_{2\,(g)} + 2\,K^{+}_{(aq)} + 2\,OH^{-}_{(aq)}}$ **(total ionic)**

$\mathbf{K_{(s)} + 2\,HOH_{(l)} \rightarrow H_{2\,(g)} + 2\,K^{+}_{(aq)} + 2\,OH^{-}_{(aq)}}$ **(net ionic)**

2. A lead (II) acetate solution reacts with a sodium sulfide solution to yield a precipitate.

/3 $\mathbf{Pb(CH_3COO)_{2\,(aq)} + Na_2S_{(aq)} \rightarrow 2\,NaCH_3COO_{(aq)} + PbS_{(s)}}$ **(non–ionic)**

$\mathbf{Pb^{2+}_{(aq)} + 2\,CH_3COO^{-}_{(aq)} + 2\,Na^{+}_{(aq)} + S^{2-}_{(aq)} \rightarrow 2\,CH_3COO^{-}_{(aq)} + 2\,Na^{+}_{(aq)} + PbS_{(s)}}$ **(total)**

$\mathbf{Pb^{2+}_{(aq)} + S^{2-}_{(aq)} \rightarrow PbS_{(s)}}$ **(net ionic)**

3. Solutions of sodium sulfate and barium bromide are added together.

/3 $\mathbf{Na_2SO_{4\,(aq)} + BaBr_{2\,(aq)} \rightarrow BaSO_{4\,(s)} + 2\,NaBr_{(aq)}}$ **(non–ionic)**

$\mathbf{2\,Na^{+}_{(aq)} + SO_4^{2-}{}_{(aq)} + Ba^{2+}_{(aq)} + 2\,Br^{-}_{(aq)} \rightarrow BaSO_{4\,(s)} + 2\,Na^{+}_{(aq)} + 2\,Br^{-}_{(aq)}}$ **(total ionic)**

$\mathbf{SO_4^{2-}{}_{(aq)} + Ba^{2+}_{(aq)} \rightarrow BaSO_{4\,(s)}}$ **(net ionic)**

4. An aqueous solution of sodium carbonate is used to remove calcium ions from water.

/3 $\mathbf{Ca^{2+}_{(aq)} + 2\,Na^{+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow 2\,Na^{+}_{(aq)} + CaCO_{3\,(s)}}$ **(total ionic)**

$\mathbf{Ca^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow CaCO_{3\,(s)}}$ **(net ionic)**

5. A precipitate forms when potassium iodide is mixed with lead (II) nitrate.

/3 $\mathbf{Pb(NO_3)_{2\,(aq)} + 2\,KI_{(aq)} \rightarrow 2\,KNO_{3\,(aq)} + PbI_{2\,(s)}}$ **(non–ionic)**

$\mathbf{Pb^{2+}_{(aq)} + 2\,NO_3^{-}{}_{(aq)} + 2\,K^{+}_{(aq)} + 2\,I^{-}_{(aq)} \rightarrow 2\,K^{+}_{(aq)} + 2\,NO_3^{-}{}_{(aq)} + PbI_{2\,(s)}}$ **(total ionic)**

$\mathbf{Pb^{2+}_{(aq)} + 2\,I^{-}_{(aq)} \rightarrow PbI_{2\,(s)}}$ **(net ionic)**

6. A calcium nitrate solution is added to a solution of sodium carbonate.

/3 $\mathbf{Ca(NO_3)_{2\,(aq)} + Na_2CO_{3\,(aq)} \rightarrow 2\,NaNO_{3\,(aq)} + CaCO_{3\,(s)}}$ **(non–ionic)**

$\mathbf{Ca^{2+}_{(aq)} + 2\,NO_3^{-}{}_{(aq)} + 2\,Na^{+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow 2\,Na^{+}_{(aq)} + 2\,NO_3^{-}{}_{(aq)} + CaCO_{3\,(s)}}$ **(total)**

$\mathbf{Ca^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow CaCO_{3\,(s)}}$ **(net ionic)**

7. A precipitate forms when iron (III) nitrate reacts with sodium phosphate.

/3 $\mathbf{Fe(NO_3)_{3\,(aq)} + Na_3PO_{4\,(aq)} \rightarrow FePO_{4\,(s)} + 3\,NaNO_{3\,(aq)}}$ **(non–ionic)**

$\mathbf{Fe^{3+}_{(aq)} + 3\,NO_3^-{}_{(aq)} + 3\,Na^+_{(aq)} + PO_4^{3-}{}_{(aq)} \rightarrow FePO_{4\,(s)} + 3\,Na^+_{(aq)} + 3\,NO_3^-{}_{(aq)}}$ **(total ionic)**

$\mathbf{Fe^{3+}_{(aq)} + PO_4^{3-}{}_{(aq)} \rightarrow FePO_{4\,(s)}}$ **(net ionic)**

8. $\mathbf{Pb^{2+}_{(aq)}}$ + $\mathbf{S^{2-}_{(aq)}}$ → $\mathbf{PbS_{(s)}}$

$c_{Pb^{2+}} = 0.100\,{}^{mol}/_{L}$ $\quad c_{S^{2-}} = ?$

/6 $v_{Pb^{2+}} = 0.0580L$ $\quad v_{S^{2-}} = 0.100L$

A. calculate moles

$n_{Pb^{2+}} = 0.100\,{}^{mol}/_{L}\,(0.0580L)$

$n_{Pb^{2+}} = 0.00580mol$

B. mole ratio

$$\frac{n_{S^{2-}}}{1} = \frac{n_{Pb^{2+}}}{1}$$

$$\frac{n_{S^{2-}}}{1} = \frac{0.00580mol}{1}$$

$n_{S^{2-}} = 0.00580mol$

C. calculate concentration

$$c_{S^{2-}} = \frac{0.00580\,mol}{0.100\,L}$$

$\boxed{c_{S^{2-}} = 0.0580\,{}^{mol}/_{L}}$

9. $\mathbf{Cl_{2\,(aq)}}$ + $\mathbf{2\,I^-_{(aq)}}$ → $\mathbf{2\,Cl^-_{(aq)}}$ + $\mathbf{I_{2\,(s)}}$

$c_{I^-} = 0.120\,{}^{mol}/_{L}$ $\quad m_{I_2} = ?$

/6 $v_{I^-} = 2.50L$

A. calculate moles

$n_{I^-} = 0.120\,{}^{mol}/_{L}\,(2.50L)$

$n_{I^-} = 0.300mol$

B. mole ratio

$$\frac{n_{I_2}}{1} = \frac{n_{I^-}}{2}$$

$$\frac{n_{I_2}}{1} = \frac{0.300mol}{2}$$

$n_{I_2} = 0.150mol$

C. calculate mass

$m_{I_2} = 0.150mol(253.80\,{}^{g}/_{mol})$

$\boxed{m_{I_2} = 38.1g}$

10. $\mathbf{Fe^{3+}_{(aq)}}$ + $\mathbf{3\,OH^-_{(aq)}}$ → $\mathbf{Fe(OH)_{3\,(s)}}$

$c_{Fe^{3+}} = ?$ $\quad c_{OH^-} = 0.0200\,{}^{mol}/_{L}$

/6 $v_{Fe^{3+}} = 0.800L$ $\quad v_{OH^-} = 0.00480L$

A. calculate moles

$n_{OH^-} = 0.0200\,{}^{mol}/_{L}\,(0.00480L)$

$n_{OH^-} = 0.0000960mol$

B. mole ratio

$$\frac{n_{Fe^{3+}}}{1} = \frac{n_{OH^-}}{3}$$

$$\frac{n_{Fe^{3+}}}{1} = \frac{0.0000960mol}{3}$$

$n_{Fe^{3+}} = 0.0000320mol$

C. calculate concentration

$$c_{Fe^{3+}} = \frac{0.0000320\,mol}{0.800\,L}$$

$\boxed{c_{Fe^{3+}} = 4.00\times10^{-5}\,{}^{mol}/_{L}}$