

Answers to Exercise 6.1

Reactions of Metals with Nonmetals

1.

- (a) Ba^{2+} (b) Ca^{2+} (c) Cs^+ (d) K^+
(e) Li^+ (f) Mg^{2+} (g) Na^+ (h) Sr^{2+}

Metals in Groups 1 and 2 form the monoatomic cation in which they have the same electron configuration as the nearest noble gas:

- *Metals in Group 1 always form cations with a +1 charge.*
- *Metals in Group 2 always form cations with a +2 charge.*

2.

- (a) Br^- (b) Cl^- (c) F^- (d) I^-
(e) N^{3-} (f) O^{2-} (g) S^{2-} (h) Se^{2-}

Nonmetals most commonly form the monoatomic ion in which they have the same electron configuration at the nearest noble gas:

- *Nonmetals in Group 17 form monoatomic anions with a -1 charge.*
- *Nonmetals in Group 16 form monoatomic anions with a -2 charge.*
- *Nonmetals in Group 15 form monoatomic anions with a -3 charge.*

Some nonmetals can also form anions containing more than one atom, but you do not need to know those ions in CHEM 1000.

3.

- (a) Li_2O (b) MgO
(c) Li_3N (d) Ca_3N_2
(e) KI (f) $BaCl_2$
(g) $SrBr_2$ (h) Na_2S

Combine the metal's most commonly formed cation with the nonmetal's most commonly formed monoatomic anion to give the ionic compound produced. Make sure that the cation : anion ratio is such that you get a neutral product (no net charge).

e.g. Ca^{2+} and N^{3-} must be combined in a 3 : 2 ratio so that the total positive charge is +6 ($+2 \times 3 = +6$) and the total negative charge is -6 ($-3 \times 2 = -6$), giving an overall charge of 0.

4.

- (a) $4Li(s) + O_2(g) \rightarrow 2Li_2O(s)$ (b) $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$
(c) $6Li(s) + N_2(g) \rightarrow 2Li_3N(s)$ (d) $3Ca(s) + N_2(g) \rightarrow Ca_3N_2(s)$
(e) $2K(s) + I_2(s) \rightarrow 2KI(s)$ (f) $Ba(s) + Cl_2(g) \rightarrow BaCl_2(s)$
(g) $Sr(s) + Br_2(l) \rightarrow SrBr_2(s)$ (h) $16Na(s) + S_8(s) \rightarrow 8Na_2S(s)$

The product of each reaction was predicted in question 3. For question 4, you had to reformat this information into a balanced chemical equation and add states of matter.

Unless indicated otherwise, always assume that ionic compounds are either solid or aqueous. Since there is no water present in any of these reactions (either as product, reactant or aqueous reactant), the products cannot be aqueous. Thus, all the ionic compounds are expected to be solids.