Answers to Exercise 6.3
Reactions of Metal Oxides with Acids (Including Water)

1.

(a) $O^{2-} + 2H^+ \rightarrow H_2O$

(b) In this reaction, three ions with high charge densities combine to make a single neutral product.

2.

(a) *before simplification:* $O^{2-} + H_2O \rightarrow OH^- + OH^-$
after simplification: $O^{2-} + H_2O \rightarrow 2OH^-$

(b) In this reaction, the negative charge is dispersed from one atom to two atoms. In the reactants, there is one oxygen atom with a -2 charge and one neutral oxygen atom. In the products, both oxygen atoms have a -1 charge.

(c) If a metal hydroxide is heated to a high enough temperature that water evaporates, it can be dehydrated to give the corresponding metal oxide. This is an example of Le Châtelier's Principle; removal of a reactant from a system at equilibrium favours the reverse reaction.

3.

(a) $Li_2O(s) + 2H^+(aq) \rightarrow 2Li^+(aq) + H_2O(l)$

(b) $CaO(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2O(l)$

(c) $MgO(s) + 2HBr(aq) \rightarrow MgBr_2(aq) + H_2O(l)$

(d) $Na_2O(s) + 2HBr(aq) \rightarrow 2NaBr(aq) + H_2O(l)$

(e) *before simplification:* $BaO(s) + 2H_2O(l) \rightarrow Ba(OH)_2(aq) + H_2O(l)$
after simplification: $BaO(s) + H_2O(l) \rightarrow Ba(OH)_2(aq)$

(f) *before simplification:* $Li_2O(s) + 2H_2O(l) \rightarrow 2LiOH(aq) + H_2O(l)$
after simplification: $Li_2O(s) + H_2O(l) \rightarrow 2LiOH(aq)$

H^+ from the acid combines with O^{2-} from the metal oxide to give H_2O.
The cation from the metal oxide remains.
The conjugate base of the acid remains (except in (a) and (b) since H^+ has no conjugate base).

*Please note that the preliminary (unsimplified) answers in parts (e) and (f) would **not** get full credit. They are only shown to help you follow the thought process. It is not acceptable to list the same thing as both a reactant and product in a balanced chemical equation.*

The metal oxide reactants are all in the solid state. Given that they react with water, they cannot be (aq). If they were (aq), they would already have reacted with the water they were dissolved in!

Net ionic equations are also acceptable:

(c) $MgO(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2O(l)$

(d) $Na_2O(s) + 2H^+(aq) \rightarrow 2Na^+(aq) + H_2O(l)$

4.

(a) $Ba(OH)_2(s) \xrightarrow{\Delta} BaO(s) + H_2O(g)$

(b) $2LiOH(s) \xrightarrow{\Delta} Li_2O(s) + H_2O(g)$

*Start with solid hydroxides or you will have a *lot* of water to evaporate off!*