Covalent vs. ionic character

Is OH^- or S^{2-} more likely to form insoluble salts with +3 transition metal ions? Which is more likely to form insoluble salts with +2 transition metal ions?

Because S^{2-} is soft and OH^- is hard, OH^- is more likely to form insoluble salts with +3 transition metal ions (hard) and S^{2-} is more likely to form insoluble salts with +2 transition metal ions (borderline or soft).

Hardness and softness

Use acid–base concepts to comment on the fact that the only important ore of mercury is cinnabar, HgS, whereas zinc occurs in nature as sulfides, silicates, carbonates, and oxides.

Mercury(II) is a soft Lewis acid, and so it is found in nature only combined with soft Lewis bases, the most common of which is S^{2-}.

Identifying Lewis acids and bases

Identify the Lewis acids and bases in the reactions:

(a) $BrF_3 + F^- \rightarrow BrF_4^-$.

(b) (b) $KH + H_2O \rightarrow KOH + H_2$.

We need to identify the electron pair acceptor (the acid) and the electron pair donor (the base). (a) The acid BrF_3 accepts a pair of electrons from the base F^-. Therefore BrF_3 is a Lewis acid and F^- is a Lewis base. (b) The ionic hydride complex KH provides H^-, which displaces H^+ from water to give H_2 and OH^-.

The net reaction is:

$H^- + H_2O \rightarrow H_2 + OH^-$

If we think of this reaction as:

$H^- + H^+{:}OH^- \rightarrow HH + {:}OH^-$

we see that H provides a lone pair and is therefore a Lewis base. It reacts with H_2O to drive out OH^-, another Lewis base.