

Chemguide – answers

COMPLEX IONS: REACTIONS OF HEXAAQUA IONS WITH CARBONATE IONS

1. a) hexaaquairon(II) ions: FeCO_3

hexaaquairon(III) ions: $[\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3]$

b) Hexaaquairon(III) ions are more acidic than hexaaquairon(II) ions, because the more positive iron at the centre of the complex drags electrons in the various bonds towards itself, leaving the hydrogens on the water molecules more positive than they would otherwise be, and more likely to form positive ions.

The hexaaquairon(II) ions aren't sufficiently acidic to release carbon dioxide from carbonate ions, but the hexaaquairon(III) ions are.

c) Hydrogencarbonate ions, HCO_3^- .

2. The general principle to remember is that 3+ ions are acidic enough to produce carbon dioxide from sodium carbonate, but the 2+ ions aren't. The 2+ ions will give precipitates which can be thought of as MCO_3 . The 3+ ions produce a neutral complex of the form $[\text{M}(\text{H}_2\text{O})_3(\text{OH})_3]$ by the removal of 3 hydrogen ions from 3 of the water molecules in the original complex.

a) aluminium chloride solution (containing $[\text{Al}(\text{H}_2\text{O})_6]^{3+}$) gives CO_2 . $[\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3]$

b) chromium(III) sulphate solution (containing $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$) gives CO_2 . $[\text{Cr}(\text{H}_2\text{O})_3(\text{OH})_3]$

b) cobalt(II) chloride solution (containing $[\text{Co}(\text{H}_2\text{O})_6]^{2+}$) doesn't give CO_2 . CoCO_3

c) copper(II) sulphate solution (containing $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$) doesn't give CO_2 . CuCO_3

d) vanadium(III) chloride solution (containing $[\text{V}(\text{H}_2\text{O})_6]^{3+}$) gives CO_2 . $[\text{V}(\text{H}_2\text{O})_3(\text{OH})_3]$

(In the last case, it doesn't matter if you haven't come across any vanadium chemistry. It follows the same patterns.)