Transition Elements Overview

Here is a summary of the chemistry of potassium permanganate ($KMnO_4$) based on the provided textbook:

Preparation:

1. **Industrial Method**: Potassium permanganate is commercially prepared through the alkaline oxidative fusion of manganese dioxide (MnO_2) with potassium hydroxide (KOH) and an oxidizing agent such as potassium nitrate (KNO_3). The reaction yields potassium manganate (K_2MnO_4), which is then electrolytically oxidized to potassium permanganate.
   - Reaction:

     $$2MnO_2 + 4KOH + O_2 \rightarrow 2K_2MnO_4 + 2H_2O$$

     The manganate (K_2MnO_4) disproportionates in neutral or acidic conditions to form permanganate ($KMnO_4$).
   - Disproportionation reaction:

     $$3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$$

2. **Laboratory Preparation**: It is produced by oxidizing manganese (II) salts with peroxodisulphate in an acidic medium:

   $$2Mn^{2+} + 5S_2O_8^{2-} + 8H_2O \rightarrow 2MnO_4^- + 10SO_4^{2-} + 16H^+$$

Properties:

- **Physical Properties**: Potassium permanganate forms dark purple, nearly black crystals, which are isostructural with potassium perchlorate ($KClO_4$). It is moderately soluble in water.
  - Solubility: 6.4 g/100 g of water at 293 K.
  - When heated, $KMnO_4$ decomposes:

    $$2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$$

- **Magnetic Properties**: $KMnO_4$ exhibits diamagnetism but also shows weak paramagnetism that is temperature-dependent.

Chemical Behavior:

1. **Oxidizing Agent**: Potassium permanganate is a strong oxidizing agent, especially in acidic solutions. It can oxidize substances such as iodide to iodine, iron (II) to iron (III), and oxalates to carbon dioxide.
   - Example reactions in acidic solution:
     - $5Fe^{2+} + MnO_4^- + 8H^+ \rightarrow Mn^{2+} + 4H_2O + 5Fe^{3+}$
     - $10I^- + 2MnO_4^- + 16H^+ \rightarrow 2Mn^{2+} + 8H_2O + 5I_2$

2. **Redox Potential**: Potassium permanganate's reduction to various manganese species depends on the medium's pH. In acidic media, it can reduce to Mn^{2+}, while in neutral or alkaline media, it reduces to MnO_2 or manganate (MnO_4^{2-}).

Uses:

- **In Chemistry**: Widely used as an oxidizing agent in organic synthesis, volumetric analysis, and titrations.
- **In Industry**: Employed in bleaching textiles and decolorizing oils due to its strong oxidative properties.

This summary provides a concise understanding of potassium permanganate's preparation, properties, and chemical behavior, as extracted from the textbook.