Three Redox reactions of Potassium Permanganate and Sodium Sulphite : Saturday 17th November 2018

Balancing reaction equations / Ionic equations

The examiners could use Manganese to test your ability to manipulate ionic equations/to balance chemical equations/to use ionic half-equations to understand the essence of a chemical reaction.

Manganese can have different oxidisation states, and different reactions will produce different products with different oxidisation states for Manganese.

You don't need to know any of these reactions off by heart, but the new 'A' Level Chemistry exams could easily expect you to recognise such ionic reaction equations if you were given them in an exam paper. You **WILL** be expected to be able to balance any and all of such reactions using ionic half-equations. You might therefore want to try writing the ionic half-equations for these reactions.

- $KMnO_4$ is Potassium Permanganate and it contains the Manganate ion **MnO_4^-** .
- $NaHSO_3$ is Sodium Bisulphite, and it contains the Bisulphite ion **HSO_3^-** or the Sulphite ion **SO_3^{2-}**.
- $NaHSO_4$ is Sodium Bisulphate (the modern name for which is Sodium Hydrogen Sulphate), while Na_2SO_4 is Sodium **Sulphate**. In contrast to the Sulphite ion (**SO_3^{2-}**), the Sulphate ion is **SO_4^{2-} .**
- **H^+** is a dissociated proton from *any acid*. When you see the phrase "acidified XYZ" it just means that some acid has been added to the solution of XYZ(aq) e.g. in Organic Chemistry "Acidified Potassium Dichromate" means Potassium Dichromate with some acid added to it (very often Sulphuric Acid).
- (H_2O + H^+) can be written as **$H^+(aq)$** or as $H_3O^+(aq)$.

Please try to create all the following equations for yourself and make sure that they are all correctly balanced, both for numbers of atoms AND for electrostatic charges.

A) Mn^{7+} —> Mn^{6+}

Ionic Equation $2MnO_4^- + 3OH^- + HSO_3^- \longrightarrow 2MnO_4^{2-} + SO_4^{2-} + 2H_2O$
Chemical Equation $2KMnO_4 + 3NaOH + NaHSO_3 \longrightarrow 2Na_2MnO_4 + K_2SO_4 + 2H_2O$
Mn^{7+} base acid Mn^{6+} water

This is both a **Redox** reaction and an **Acid-Base** reaction.

B) Mn^{7+} —> Mn^{4+}

Ionic Equation $2MnO_4^- + 3HSO_3^- + OH^- \longrightarrow 2MnO_2 + 3SO_4^{2-} + 2H_2O$
Chemical Equation $2KMnO_4 + 3NaHSO_3 + H_2O \longrightarrow 2MnO_2 + 3NaHSO_4 + 2KOH$
Mn^{7+} Mn^{4+}

Did you understand why if you take out an "H^+" from the left side, then OH^- becomes H_2O on the right side?
Under the Arrhenius definition of an acid, an acid and a base will react to form Water but, according to the Brønsted–Lowry definition, an acid is a proton donor, therefore this reaction is also both a **Redox** reaction and an **Acid-Base** reaction.

C) Mn^{7+} —> Mn^{2+}

Ionic Equation $2MnO_4^- + 6H^+ + 5HSO_3^- \longrightarrow 2Mn^{2+} + 5SO_4^{2-} + 3H_2O$
Chemical Equation $2KMnO_4 + 6HCl + 5NaHSO_3 \longrightarrow 2MnCl_2 + 5NaHSO_4 + 3H_2O + 2KCl$
Mn^{7+} sodium bisulphite Mn^{2+} sodium bisulphate potassium chloride

I want you to start preparing for the end-of-your-two-years' exams right from the word "Go".
It is possible to get an A* in 'A' Level Chemistry by being only moderately intelligent but **very** hard-working.
The same is true of success in life. During my lifetime, I have preferred hard-workers to geniuses.

These reactions have all come up in different exam questions.