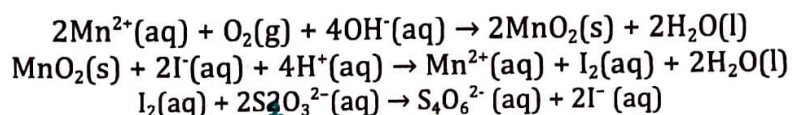


Redox Titrations: Winkler Method

Name Answer Key

1. Calculate BOD from titrations using the Winkler Method



(a) The Winkler method was used to measure the concentration of dissolved oxygen in a sample of water. Manganese(II) sulfate, sulfuric acid and potassium iodide were added to 50.0 cm³ of the water. The iodine that was formed was titrated against a sodium thiosulfate solution with a concentration of $2.00 \times 10^{-3} \text{ mol dm}^{-3}$. It was found that 17.40 cm³ of sodium thiosulfate was required for the titration. Another sample of water from the same source was incubated for 5 days at 20 °C. At the end of the incubation the Winkler method was used to determine concentration of dissolved oxygen. It was found that the concentration of dissolved oxygen in the sample was 3.50 ppm. Calculate the concentration of dissolved oxygen (in ppm) in the original sample and the biochemical oxygen demand.

(b) The Winkler method was used to measure the concentration of dissolved oxygen in a sample of water. Manganese(II) sulfate, sulfuric acid and potassium iodide were added to 25.0 cm³ of the water. The iodine that was formed was titrated against a sodium thiosulfate solution with a concentration of $1.00 \times 10^{-3} \text{ mol dm}^{-3}$. It was found that 22.30 cm³ of sodium thiosulfate was required for the titration. Another sample of water from the same source was incubated for 5 days at 20 °C. At the end of the incubation the Winkler method was used to determine concentration of dissolved oxygen. It was found that the concentration of dissolved oxygen in the sample was 2.80 ppm. Calculate the concentration of dissolved oxygen in the original sample and the biochemical oxygen demand.

2. Explain the connection between biochemical oxygen demand and the degree of pollution of a water sample.

ppm = mg/dm³

1 a. $\text{Na}_2\text{S}_2\text{O}_3: 2.00 \times 10^{-3} \text{ mol dm}^{-3} \rightarrow 0.01740 \text{ dm}^3$
 $\text{O}_2 \text{ conc?}$

$$\begin{aligned} &0.01740 \text{ dm}^3 \times \frac{2.00 \times 10^{-3} \text{ mol S}_2\text{O}_3^{2-}}{\text{dm}^3} \times \frac{1 \text{ mol I}_2}{2 \text{ mol S}_2\text{O}_3^{2-}} \times \frac{1 \text{ mol MnO}_2}{1 \text{ mol I}_2} \times \frac{1 \text{ mol O}_2}{2 \text{ mol MnO}_2} \\ &= 8.7 \times 10^{-6} \text{ mol O}_2 \times \frac{32 \text{ g O}_2}{1 \text{ mol O}_2} \times \frac{1000 \text{ mg}}{1 \text{ g}} \times \frac{1}{0.050 \text{ dm}^3} = 5.57 \text{ ppm} \end{aligned}$$

$$\frac{5.57}{3.50} = \boxed{1.59} = \text{BOD}$$

$$0.02230 \text{ dm}^3 \times \frac{1.00 \times 10^{-3} \text{ mol kg}^{-1} \text{ S}_2\text{O}_3^{2-}}{\text{dm}^3} \times \frac{1 \text{ mol I}_2}{2 \text{ mol S}_2\text{O}_3^{2-}} \times \frac{1 \text{ mol MnO}_2}{1 \text{ mol I}_2} \times \frac{1 \text{ mol O}_2}{2 \text{ mol MnO}_2}$$

$$= 5.58 \times 10^{-4} \text{ mol O}_2 \times \frac{32 \text{ g O}_2}{1 \text{ mol O}_2} \times \frac{1000 \text{ mg}}{1 \text{ g}} \times \frac{1}{0.050 \text{ dm}^3} = 3.57 \text{ ppm}$$

$$\frac{3.57}{2.80} = \boxed{1.28} = \text{BOD}$$

2. higher BOD = more pollution
 because more O_2 needed to decompose organic matter
 over a specified period of time (indicates higher level
 of organic matter)