# TUNNELWORKS
# A2 CHEMISTRY
# STUDENT SHEET 2

## Oxygen detectives – Winkler equations

Take a sample of water from the river then:

### Stage 1: Add manganese sulphate and then potassium iodide in potassium hydroxide.
First, the manganese sulphate reacts with the potassium hydroxide to form manganese hydroxide:

$Mn^{2+}SO4 + 2KOH > Mn^{2+}(OH)_2 + K_2SO_4$

The manganese hydroxide reacts with the dissolved oxygen to form manganese oxyhydroxide.

$2Mn^{2+}(OH)_2 + O_2 > 2Mn^{4+}O(OH)_2$

(1 mol oxygen causes 2 mol manganic oxide to form)
The manganese was oxidised. Nothing's happened to the potassium iodide yet.

................................................................................................................................................

### Stage 2: Add sulphuric acid.
This dissolves the manganic oxide to form manganic sulphate, which reacts with the potassium iodide:

$2Mn^{4+}O(OH)_2 + 4H_2SO_4 > 2Mn^{4+}(SO_4)_2 + 6H_2O$

$2Mn^{4+}(SO_4)_2 + 4KI > 2Mn^{2+}SO_4 + 2K_2SO_4 + 2I_2$

(2 mol manganic oxide releases 2 mol I2 hence 2 mol I2 is equivalent to 1 mol oxygen)
The manganese has been reduced again.

................................................................................................................................................

### Stage 3: Titrate with sodium thiosulphate using starch indicator.

$4Na_2S_2O_3 + 2I_2 > 2Na_2S_4O_6 + 4NaI$

(2 mol I2 requires 4 mol thiosulphate. Hence 4 mol thiosulphate equates to 1 mol oxygen.)

................................................................................................................................................

### Stage 4: Quantify the results.
As an example, using 0.025 M thiosulphate solution, how much dissolved O2 does each ml (cm3) of thiosulphate represent in the sample?

**1/1000 x 0.025 M x 1/4 = 0.000625 mol $O_2$ per ml 0.025M thiosulphate.**

**$O_2$ = 32g per mol so 0.000625 mol = 0.0002g, or 0.2mg $O_2$ per ml thiosulphate.**

Scale the sample volume up to 1 litre to obtain a standard measurement of mg per litre.