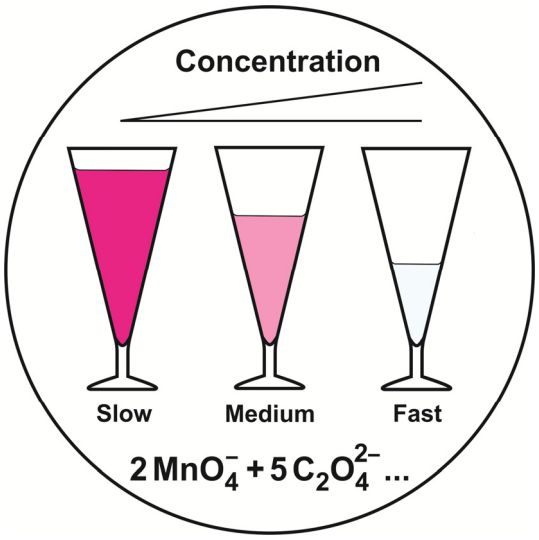
Concentration Dependency of Rate of Conversion



Equipment:

3 goblets (conical glass cups)
2 glass beakers (250 mL)
3 glass beakers (100 mL)
3 glass rods
graduated cylinders

Chemicals:

potassium permanganate solution (0.1 kmol m^{-3})
oxalic acid solution (0.5 kmol m^{-3})
sulfuric acid (4 kmol m^{-3})
deionized water

Safety:

potassium permanganate ($KMnO_4$):

H272, H302, H410
P210, P273

oxalic acid ($H_2C_2O_4$):

H302 + H312
P262, P302 + P352

sulfuric acid (H_2SO_4):

H290, H314
P301 + P 330 + P331, P305 + P351 + P338

It is necessary to wear safety goggles and protective gloves, because every contact with eyes or skin should be avoided.

Procedure:

Preparation: 15 mL of oxalic acid solution and 30 mL of sulfuric acid are poured into each of the three goblets. 15 mL of potassium permanganate solution are filled into each of the 100-mL beakers. Finally, 60 mL and 180 mL of deionized water, respectively, are poured into the remaining beakers.
Procedure: Potassium permanganate solution along with a larger amount of water is added to the first goblet. The same amount of potassium permanganate solution is added to the second goblet but with less water. The third goblet receives only potassium permanganate solution. All solutions are stirred.

Observation:

The three solutions decolorize from violet to wine red and then yellow-brown until they are colorless. At the same time, some bubble formation due to the generation of carbon diox-

ide can be observed. The decolorizing appears just after a short time (approx. 1 min) in the third goblet, after approx. 2 min in the second goblet while the reaction in the first goblet takes the most time (approx. 5 min).

Explanation:

Purple permanganate ions are reduced in acidic solution by oxalate ions to the nearly colorless manganese(II) ions, whereas the oxalate ions are oxidized to gaseous carbon dioxide:

$$2\ MnO_4^-|w + 5\ C_2O_4^{2-}|w\ + 16\ H^+|w \rightarrow 2\ Mn^{2+}|w + 10\ CO_2|g + 8\ H_2O|l.$$

Obviously, the rate density depends on the concentration. The higher the dilution, meaning the lower the concentration of the reactants, the more slowly the reaction proceeds.

Disposal:

The solutions are poured into the container for heavy metal waste.