

Oxygen and methylene blue

Topic

Organic chemistry, redox reactions, dyes and colour chemistry.

Timing

15 min.

Description

In this experiment students generate oxygen gas by the reaction between hydrogen peroxide and potassium manganate(VII), and then test for the gas by bubbling it into a solution of the reduced form of methylene blue dye, turning the solution blue.

Apparatus (per group)

- One student worksheet
- One 10 cm³ beaker
- One plastic pipette (standard form)
- One piece of rubber tubing, ca 10 cm long
- Scissors.

Chemicals (per group)

Solutions contained in plastic pipettes, see 'Apparatus and techniques for microscale chemistry' handout.

- Hydrogen peroxide 5% solution
- Potassium manganate(VII) 0.1 mol dm⁻³
- Methylene blue solution (colourless, leuco form of dye)
- Glucose.

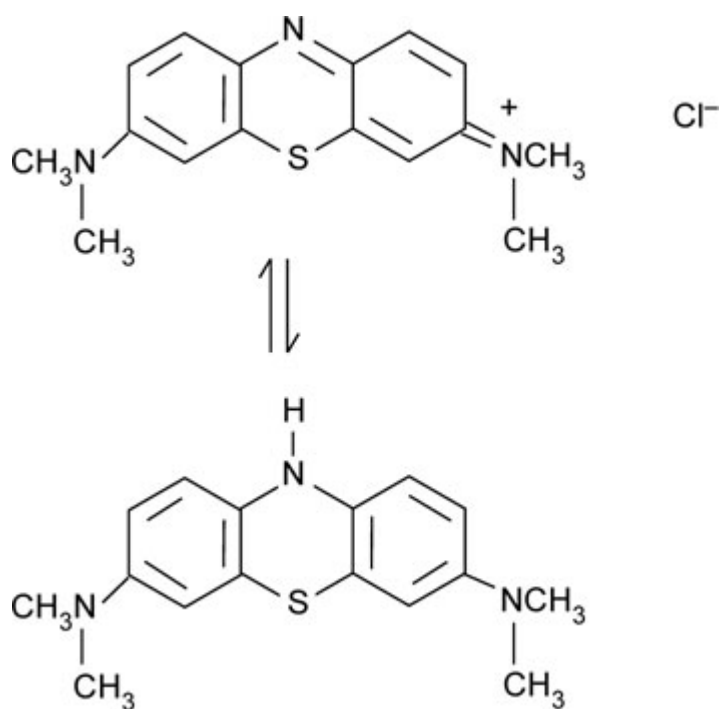
Dissolve 4 g of potassium hydroxide pellets in 150 cm³ of deionised water in a plastic bottle or stoppered 250 cm³ conical flask. Allow to cool and add 5 g of glucose powder. Add 3–4 drops of methylene blue solution (0.25 g in 1000 cm³ of deionised water or Aldrich cat. no. 31,911-2). The blue solution should become colourless on standing a few minutes but will turn blue when shaken.

Observations

This experiment is a little tricky to perform and students will need to practice it first! The hydrogen peroxide and potassium manganate(VII) react together vigorously to produce oxygen gas. The colourless solution of methylene blue should turn blue quickly when the oxygen gas is directed into it.

Students are given the structures of the oxidised and reduced forms of methylene blue and are asked to say which is which. The oxidised (blue) form contains conjugated double and single bonds throughout the whole molecule whereas in the colourless form the delocalised electron systems are isolated from each other. The structures are given overleaf.





Reference

D. Barton and W. D. Ollis, *Comprehensive organic chemistry*, vol 4, pp1102–1107. Oxford: Pergamon, 1979.

This book gives an interesting account of the dibenzo-1,4-thiazines, of which methylene blue is a member.

Health & Safety

Eye protection is not required but may be useful in case H₂O₂ splashes out of the pipette. (It will sting but not cause any damage).

Glucose / methylene blue / sodium hydroxide solution is corrosive (goggles (to BS EN166 3) should be worn. (Reducing the concentration to below 0.5 mol dm⁻³ will mean it is merely an irritant and will still work)

Sodium hydroxide itself is highly corrosive – if students are making up their own solutions.

Hydrogen peroxide, 5% solution H₂O₂ (aq) and Potassium manganate(VII), 0.1 mol dm⁻³ KMnO₄ (aq) Are of low hazard

Using less (2.4g) of potassium hydroxide will mean the solution is irritant rather than corrosive and pupils can just use safety glasses.

Credits

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Health & safety checked May 2018

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