

## 2005 - Question 1

**Why was it necessary to analyse the sample of river water *immediately*?**

The sample was analysed immediately so that oxygen content doesn't change (increase/decrease) due to activity of organisms in the water.

**In making the additions to the sample, why should the solutions used be *concentrated*?**

The solutions used should be concentrated in order to minimise the amount of the water sample that is displaced / minimise the change in the oxygen dissolved in the sample.

**Describe how the additions of the concentrated solution of manganese(II) sulfate (MnSO<sub>4</sub>) and alkaline potassium iodide (KOH/KI) to the bottle of river water should be carried out. What essential precaution should be taken when replacing the stopper of the bottle after these additions are made?**

- remove a few cm<sup>3</sup> of river water from the bottle; addition made so that water overflows from the bottle.
- make additions under the level of the water using a dropper (pipette, syringe); do not bubble air (oxygen) into the water in the process.

The precaution should be taken in order to not trap air (oxygen) bubbles.

**Describe clearly the procedure for using a pipette to measure exactly 50 cm<sup>3</sup> portions of the iodine (I<sub>2</sub>) solution into the titration flask.**

- rinse with water followed by iodine.
- fill pipette using a pipette filler to above the mark (graduation line)
- adjust to have bottom of meniscus on mark and ensure reading is at eye level (vertically)
- remove droplets sticking to the outside
- drain under gravity into titration flask
- touch tip of pipette against side of flask to add droplet sticking to outside tip
- do not blow out drop inside pipette

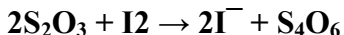
**What indicator is used in this titration? State when the indicator should be added to the titration flask and describe the colour change observed at the end point.**

Starch

WHEN: when the solution is straw-yellow (light yellow, straw-coloured).

COLOURS: blue-black (black, blue, indigo, navy) to colourless.

**The titration reaction is described by the following equation.**



**Calculate the concentration of the iodine solution in moles per litre given that 6.0 cm<sup>3</sup> of the 0.01 M sodium thiosulfate (Na<sub>2</sub>S<sub>2</sub>O<sub>3</sub>) solution were required in the titration for complete reaction with 50 cm<sup>3</sup> portions of the iodine solution.**

$$\frac{50 \times X}{1} = \frac{6.0 \times 0.01}{2}$$

$$X = 0.0006 / 6 \times 10^{-4}$$

For every 1 mole of oxygen gas (O<sub>2</sub>) in the water sample 2 moles of iodine (I<sub>2</sub>) are liberated in this experiment. Hence calculate the concentration of dissolved oxygen in the water sample in p.p.m.

$$0.0006 \div 2 = 0.0003$$

$$0.0003 \times 32 \times 1000 = 9.6$$

## Question 2

**Why was the receiving vessel cooled in ice-water?**

There is a volatile product produced; ethanal has low b.p. / ethanal boils at about 21 °C

**State two features of the preparation that are necessary to maximise the yield of ethanal and, for each feature stated, explain why it is necessary.**

- Adding excess ethanol – the product stops at ethanal/doesn't go to ethanoic acid / prevents further oxidation.
- Immediate distillation – ethanal removed before oxidation / prevents further oxidation.

**Describe and account for the colour change which is observed during the addition of the ethanol and sodium dichromate(VI) solution to the hot acid.**

DESCRIBE: Orange solution added to colourless liquid and becomes green.

ACCOUNT: Cr(VI) / Cr<sub>2</sub>O<sub>7</sub><sup>2-</sup> is reduced to Cr(III) / Cr<sup>3+</sup>

**Describe how you would carry out Fehling's test on a sample of ethanal. What observation would you expect to make in this test?**

- Mix equal amounts of Fehling's A and Fehling's B solutions.
- Add ethanal and warm / heat / put test tube in hot (boiling) water
- A brick-red precipitate produced

**Assuming that all of the features needed to maximize the yield of ethanal were present, what mass of ethanal would be produced in the preparation if the students used 8.94 g of sodium dichromate(VI) (Na<sub>2</sub>Cr<sub>2</sub>O<sub>7</sub>·2H<sub>2</sub>O), and a 75% yield was obtained?**

$$8.94 \text{ g sodium dichromate} \xrightarrow{\div 298^*} 0.03 \text{ mol}$$

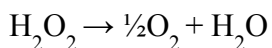
$$0.03 \text{ mol dichromate} \equiv 0.09 \text{ mol ethanal}$$

$$0.09 \text{ mol ethanal} \xrightarrow{\times 44^*} 3.96 \text{ g ethanal}$$

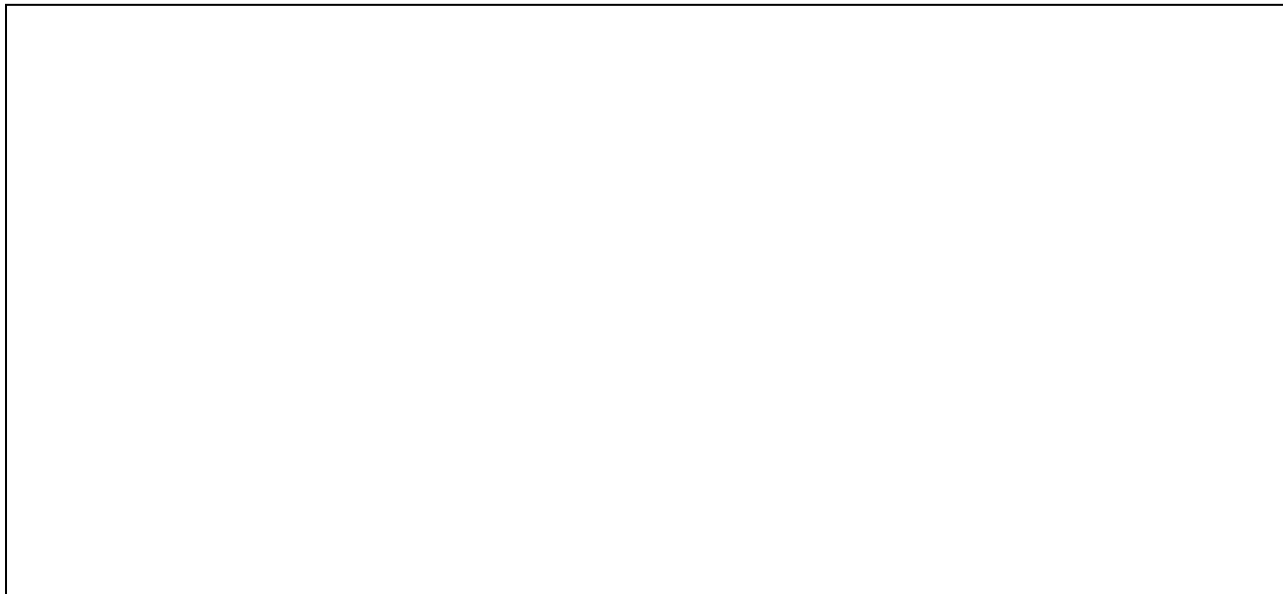
$$75 \% \text{ yield} = \frac{3.96 \times 75}{100} = 2.97 \text{ g}$$

### Question 3

Write a balanced equation for the decomposition of hydrogen peroxide.



Draw a labelled diagram of an apparatus a student could assemble to measure the rate of decomposition of hydrogen peroxide in the presence of a manganese(IV) oxide (MnO<sub>2</sub>) catalyst. Indicate clearly how the reaction could be started at a time known exactly, and how the gas produced is collected and its volume measured.



A student has a choice of using the same mass of finely powdered manganese(IV) oxide or coarsely powdered (granulated) manganese(IV) oxide. Which of these would you expect to have a greater average rate of reaction over the first minute of the reaction? Give a reason for your answer.

The finely powdered option would be the one which would give the greater initial reaction rate; this is because there is a greater surface area and the reaction would occur more quickly.

A set of results obtained in an experiment to measure the rate of decomposition of hydrogen peroxide, in a solution of known volume and concentration, is given in the table.

Time/minutes	0	1	2	3	4	5	6	7	8
Volume of O <sub>2</sub> /cm <sup>3</sup>	0.0	13.5	23.4	30.5	35.4	38.3	39.6	40.0	40.0

Plot a graph to illustrate the volume of oxygen produced *versus* time.

Use the graph to determine

- the volume of oxygen produced during the first 2.5 minutes and
- the instantaneous rate of the reaction at 2.5 minutes.

What changes would you expect in the graph if the experiment were repeated using a solution of the same volume but exactly half the concentration of the original hydrogen peroxide solution?

There would be a less steep rise to a maximum volume 20 cm<sup>3</sup>