Oxford Cambridge and RSA

AS Level Chemistry B

H033/02 Chemistry in Depth

Question Set 1

1 Hydrogen peroxide decomposes very slowly in aqueous solution.

The equation for this decomposition is shown below.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

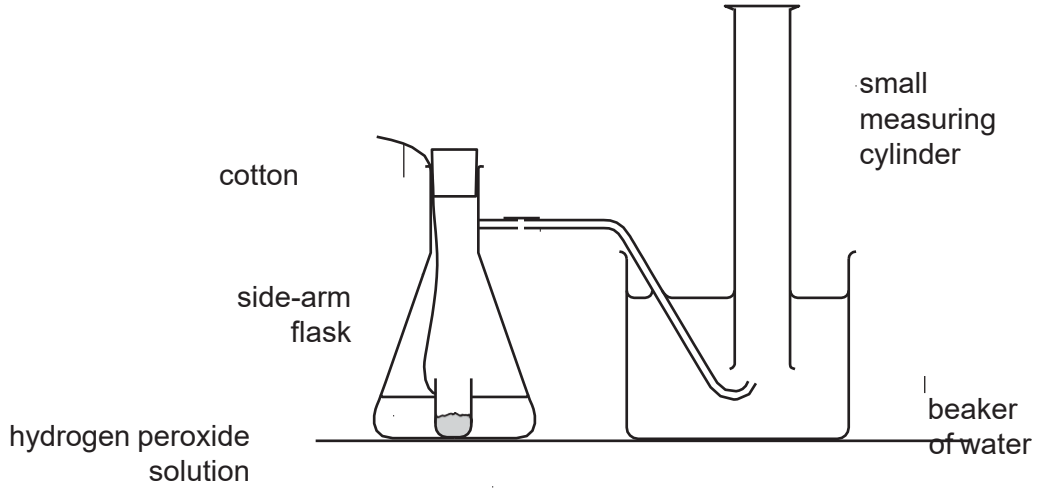
It is known that some solid transition metal oxides can act as heterogeneous catalysts for this reaction.

(a) Explain what is meant by the terms *heterogeneous* and *catalyst*.

..... **[2]**

(b) A student decides to investigate the catalytic effect of three different transition metal oxides: copper(II) oxide, zinc oxide and manganese(IV) oxide.

The student measures the volume of oxygen produced at regular intervals of time using the apparatus shown below.



(i) The student says that the same mass of each powdered transition metal oxide must be used in order to make valid comparisons.

State and explain whether or not the student is correct.

..... **[1]**

(ii) Identify **two** variables, apart from details of the transition metal oxide, that the student must control in this experiment.

1 .....

2 ..... **[1]**

(c) The student displays the results of the investigation on a graph.

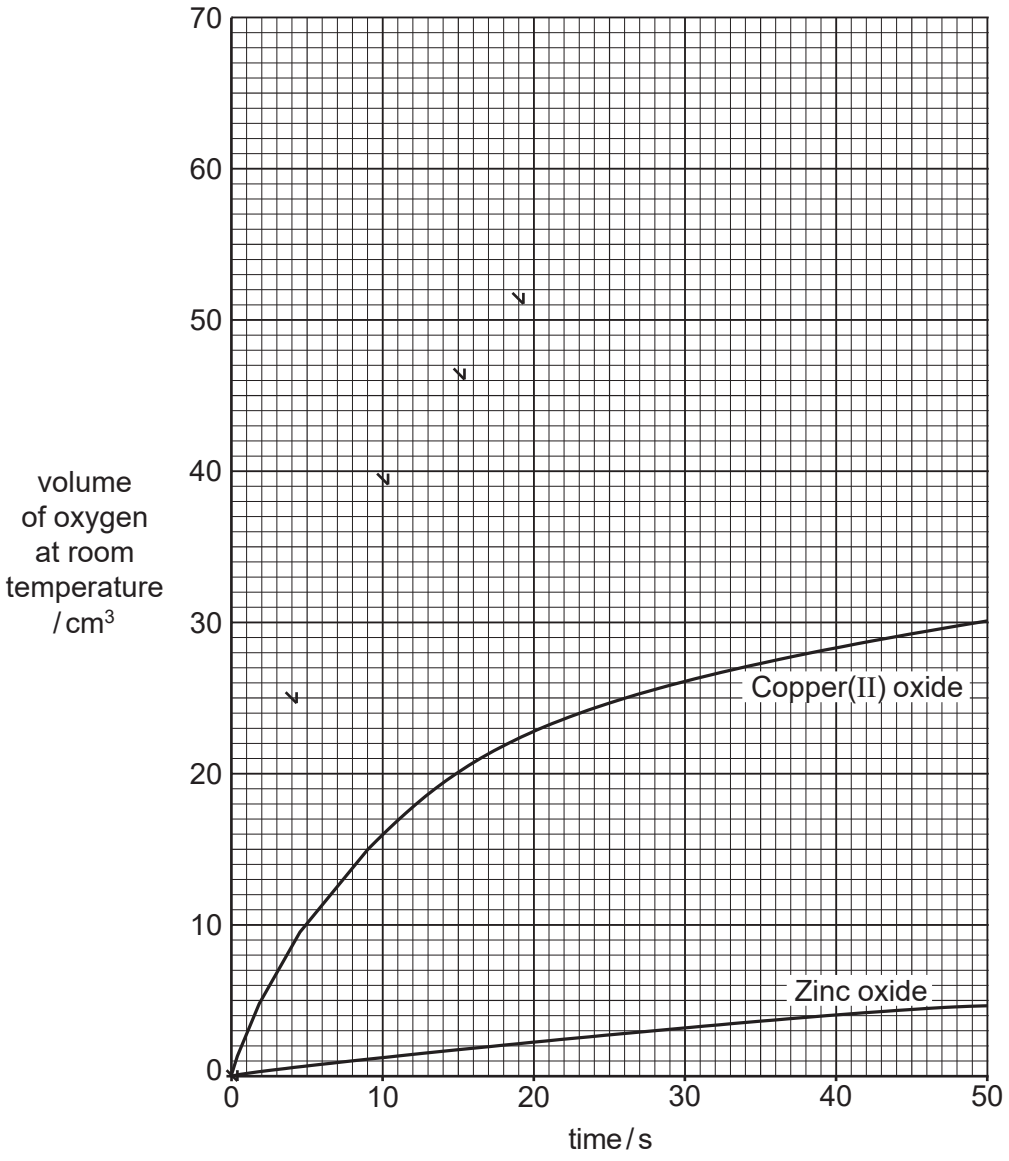
The results for copper(II) oxide and zinc oxide are plotted on the graph on page 5.

The student obtained the following results using manganese(IV) oxide.

Time / s	**Volume of oxygen measured at room temperature / cm^3**
0	0.0
4	25.0
10	39.5
15	46.5
19	51.5
25	55.0
30	60.5
36	62.5
40	63.0
45	63.0
49	63.0

(i) The first five results for manganese(IV) oxide have been plotted on page 5.

Plot the remaining results and draw the line of best fit. **[1]**



(ii) Use the graph to explain which of the three catalysts is the most effective. **[1]**

(iii) The experiment is carried out at room temperature and pressure.

Use the graph to calculate the average rate of formation of oxygen over the first 15 s using copper(II) oxide. Give your answer in mol s^{-1}.

average rate = ...mol s^{-1} **[2]**

(d) All three transition metal oxides used in the experiment are heterogeneous catalysts. Heterogeneous catalysts are used in a variety of reactions including cracking.

Write an equation for the cracking of decane, $C_{10}H_{22}$. Show the products as a branched alkene with four carbon atoms and one other branched product.

Use **skeletal** formulae.

[2]

(e) There are four main stages in a simple generalised model of heterogeneous catalysis.

(i) List these four stages in order.

Stage 1 .....

Stage 2 .....

Stage 3 .....

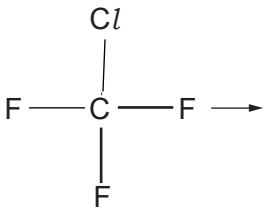
Stage 4 ..... **[2]**

(ii) Use this model to explain the effect of a catalyst poison on the action of a heterogeneous catalyst. **[1]**

(f) Chlorine radicals in the stratosphere are homogeneous catalysts for the breakdown of ozone. These radicals are produced by the breakdown of CFCs when they absorb ultraviolet radiation in the stratosphere.

(i) $CCl F_3$ is one such CFC.

Show the electron movements and give the products for the photodissociation of $CCl F_3$.



[1]

(ii) The bond enthalpy of the C–C*l* bond is +346 kJ mol^{-1}.

Calculate the maximum wavelength of radiation (in nm) needed to break a **single** C—C*l* bond.

Give your answer to **three** significant figures.

(1 nm = 10^{-9}m)

maximum wavelength = ... nm **[3]**

(g) Both oxygen and chlorine atoms react with ozone in the stratosphere.

Describe and compare the roles of oxygen and chlorine atoms in the breakdown of ozone and their relative effects. Include equations where appropriate. **[6]**

Total Marks for Question Set 1: 23