

Mechanisms, catalysts and activation energy

AP Chemistry · Lab

Name: _____ Date: _____ Class: _____

What does a catalyst do to the rate of a reaction, and how can its effect be measured? Manganese dioxide speeds up the decomposition of hydrogen peroxide, giving oxygen gas that you collect in a syringe. By reading the volume against time you find the rate, check the order and show that the catalyst is not used up.

Level: AP Chemistry · **Curriculum:** AP Chem Unit 5

Aim

Measure the volume of oxygen released from 3 % hydrogen peroxide with manganese dioxide as catalyst, determine the rate constant, and test whether the catalyst is restored.

Equipment

- 3.0 % (w/v) hydrogen peroxide solution, manganese dioxide powder (0.20 g per run)
- 100 cm³ conical flask with side-arm bung, 100 cm³ gas syringe, stopwatch
- 10 cm³ measuring cylinder, filter paper and funnel, balance (± 0.01 g)

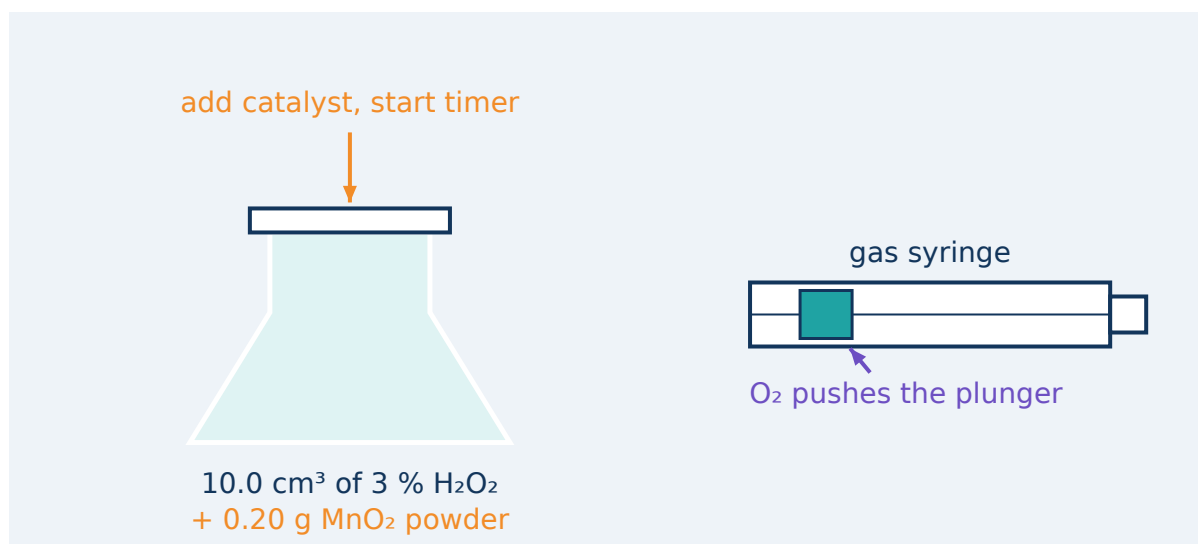
Safety

Safety

Wear eye protection. 3 % hydrogen peroxide may irritate eyes and skin; rinse splashes with water. Do not seal the flask without the syringe, because the gas must escape. Keep flames away: oxygen supports burning. Do not inhale manganese dioxide dust.

Method

1. Weigh 0.20 g of manganese dioxide on a small paper.
2. Measure 10.0 cm³ of hydrogen peroxide into the flask and connect the gas syringe.
3. Tip in the catalyst, close the bung at once and start the stopwatch.
4. Read the syringe every 20 s until the plunger stops moving.
5. Filter the mixture, dry the residue and weigh it.
6. Repeat the run with no catalyst for 5 minutes as a control.



Set-up: oxygen from the flask moves the syringe plunger; the volume is read every 20 s.

Results

Time (s)	0	20	40	60	80	100	120
Volume of O ₂ (cm ³)	0	42	67	82	92	97	101

Final volume when reaction stops: 106 cm³. Control without catalyst: no visible gas in 5 minutes. Mass of dried residue: 0.20 g.

Analysis questions

Question 1 Theory yield

Write the equation and calculate the expected volume of O₂ at room temperature (1 mol of gas = 24 dm³) from 10.0 cm³ of 3.0 g per 100 cm³ H₂O₂ ($M = 34.0$ g/mol).

Question 2 Shape of the curve

Describe how the volume curve changes and explain why the slope decreases.

Question 3 Average rates

Calculate the average rate between 0 and 20 s and between 100 and 120 s.

Question 4 Order and rate constant

Calculate $(106 - V)$ at each time from 20 s to 120 s, plot its natural logarithm against time and find k .

Question 5 Is the catalyst used up?

State two pieces of evidence from the results that the catalyst is restored.

Question 6 Control variables

List three variables to keep constant in a comparison of two catalysts.

Question 7 Improving the lab

Suggest two improvements and predict the effect of doubling the mass of powder.