# 2. Making oxygen and measuring its density

### Purpose

By finding out the mass of  $1 L (0^{\circ}C, 1 \text{ atm})$  oxygen produced from the decomposition of KClO<sub>3</sub> (potassium chlorate), the density of oxygen and its molecular weight can be determined.

#### **Experimental procedure**

 Weigh ~0.5g KClO<sub>3</sub> and mixes it with a small spoon of MnO<sub>2</sub> (manganese dioxide). Then, put the mixture into a dry test tube and weigh the total mass by a balance (**a** g).



Figure 1 Diagram for O2 generation experiment

- 2. Assemble experimental set as Figure 1. First of all, pure enough water into the big empty bottle. After letting water be filled in rubber tube from bottle to beaker, put the test tube on as Figure 1 and make sure there is no water leaking from the rubber tube.
- 3. After making sure there is no water leaking, heat the test tube with Bunsen burner. First heat and warm up the whole test tube and then heat strongly one side of KClO<sub>3</sub> and MnO<sub>2</sub> mixture. Gradually, heating other part of the mixture and let all be reacted.
- 4. Stop heating when there is no more generation of gas (O<sub>2</sub>). After leaving the experiment set for a while, cool down the test tube to room temperature by touching it with wet cleaning-cloth.
- 5. Let the water surface in both bottle and beaker at the same level (height) and then remove the rubber tube from glass tube.
- 6. Measure the amount of water accumulated in the beaker by graduated cylinder ( $\mathbf{b}$  cm<sup>3</sup>).
- 7. Measure accurately the weight of the cooled test tube (with reaction products in it) by chemical balance (**c** g).
- 8. Check the lab temperature ( $\uparrow$  °C) and atmospheric pressure ( $\blacklozenge$  mmHg)

Q1: Please show the change by chemical reaction equation when the mixture of potassium chlorate (KClO<sub>3</sub>) and manganese dioxide (MnO<sub>2</sub>) was heated.

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Q2: In step 5 of experimental procedure, why is it necessary to let water surface in both bottle and beaker at same level (height) when removing rubber tube from glass tube?

Q3: What is the role (function) of MnO<sub>2</sub> which was added to KClO<sub>3</sub>?

#### Measured data

Mass of test tube with KClO <sub>3</sub> and MnO <sub>2</sub> before reaction ( $\mathbf{d}$ g)	g
Mass of test tube with things left in after reaction ( <b>C</b> g)	g
Volume of water accumulated in the beaker ( $\mathbf{b}$ cm <sup>3</sup> )	cm <sup>3</sup>
Room temperature († °C)	°C
Atmospheric pressure ( <b>P</b> mmHg)	mmHg
Saturated vapor pressure of water at room temperature	mmHg

#### Results

- 1. Mass of generated oxygen gas  $O_2$  (**a** g) (**c** g)
- g 2. Partial pressure of oxygen gas O<sub>2</sub>
- mmHg
- 3. Calculate the volume of  $O_2$  under standard condition

$$V_0 = V \times \frac{P - P_{H_2O}}{760} \times \frac{273}{273 + t}$$

*V*: volume of  $O_2$  accumulated at  $\dagger$  °C

*P*: atmospheric pressure  $P_{H_2O}$ : saturated vapor pressure at  $\dagger$  °C

cm<sup>3</sup>

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4. Calculate the mass (density) of 1L O<sub>2</sub> under standard condition

density  $d = \frac{a-c}{V_0} \times 1000$  $V_0$ : volume of O<sub>2</sub> at 0°C, 1 atm

a - c : mass of O<sub>2</sub> generated

5. Calculate molecular weight of O<sub>2</sub> by getting the mass of 22.4L O<sub>2</sub> under standard condition  $M_{O_2} = d \times 22.4$ 

#### Discussion

Calculate the error (%) of measured molecular weight to the theoretical data and discuss the reason

 $error = \frac{defference\ between\ measured\ value\ and\ theoretical\ value\ theoretical\ value}{theoretical\ value} imes 100$ 

## Appendix

Saturated Vapor Pressure of Water (mmHg)

Temp.	0	1	2	3	4	5	6	7	8	9
10°C	9.21	9.84	10.52	11.23	11.99	12.79	13.63	14.53	15.48	16.48
20°C	17.54	18.65	19.83	21.07	22.33	23.76	25.21	26.74	28.35	30.04
30°C	31.82	33.70	35.66	37.73	39.90	42.18	44.56	47.07	49.69	52.44

Chem is try!





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Bunsen burner	ガスバーナー	mixture	混合物
test tube	試験管	beaker	ビーカー
rubber tube	ゴム管	oxygen	酸素
spoon	さじ	molecular weight	分子量
weigh	はかる	chemical balance	化学天平
potassium chlorate	塩素酸カリウム	atmospheric pressu	re 大気圧
manganese dioxide	二酸化マンガン	error	誤差

#### List of important English words for this experiment

#### Useful phrases and sentences for conducting chemical experiments

- Take down the chair from table.
- Clean the table thoroughly with mop.
- Check the information on white board.
- Be careful when you ...
- Please pass XXX to me.
- Don't chat when doing experiments.
- Take memo when the teacher is giving you important instructions.
- Put cellophane film on the top of test tube.
- You must put on your safety goggles before starting experiment.
- You must wear white coating when doing experiment.
- Pay attention to the teacher's instruction.
- Be sure take all of your belongings with you when you leave this lab (room).
- Submit your report in the morning when you have next experiment.
- Put your report into the black case outside this room which is labeled with 1C.
- Don't touch the hot test tube or other glass wares.
- If chemicals are spilled on you, wash it quickly with water.
- There is an eye-washer at the that corner of this room.
- Don't run in this room.
- Do the simulation before starting this experiment.
- Exchange the experiment data with the member in your group.
- Wash all the glass wares carefully with detergent after experiment.
- Observe carefully the phenomenon and take memos.
- Group X is in charge of cleaning the lab this week.
- Wash your hands before leaving this room.