G10 IB Bridging Year Chemistry

Measurement and Data Processing Assignment **Total : 13 marks**

*1 mark will be penalized once for wrong number of significance figures throughout the assignment.*

In one chemistry practical session, Matthew was asked to determine the density of oxygen gas in the school laboratory. He used hydrogen peroxide solution, H2O2(aq) to produce oxygen gas by decomposition; the gas was then collected by displacement of water. The reaction can be speeded up by adding manganese(IV) oxide, MnO2(s). The following is the chemical equation for the decomposition reaction.

2H2O2 (aq) → 2H2O (l) + O2 (g)

He added 50.0 cm3 (± 0.5 cm3) of 0.10 M H2O2(aq) in a conical flask. He added 1/3 of a spatula of MnO2(s) in the H2O2(aq) then and quickly stoppered the flask by a rubber stopper with a delivery tube.

At the same time, another end of the tube was put inside an inverted 100 cm3 cylinder (± 1 cm3), its mass was weighed before being used, which was already completely filled with water. The water temperature was 20.0°C (± 0.5°C).

When all water was displaced by the gas, he stoppered the cylinder carefully. He dried and weighed it. He repeated the experiment for 4 more times. The following diagram shows the set-up and the table on P. 2 shows the results.

Diagram

Description automatically generated

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Mass of the empty 100.0 cm3 of cylinder and the stopper / g  (± 0.001 g) | | | 168.052 | | |
| Trial | **1** | **2** | **3** | **4** | **5** |
| Mass of the cylinder, the stopper and the gas / g (± 0.001 g) | 168.197 | 168.186 | 168.188 | 168.185 | 168.185 |
| Mass of oxygen gas / g |  |  |  |  |  |

1. (i) Complete the last row of the results table. *[2]*

(ii) Matthew suspected that the value in trial 1 is an outlier, using the Q-test to deduce and justify whether the value should be rejected. Show your working. *[2]*

Given : The following table shows the critical Q values at 95% confidence level.

|  |  |
| --- | --- |
| No. of trials | Critical value, *Qc* |
| 3 | 0.970 |
| 4 | 0.829 |
| 5 | 0.710 |

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1. Calculate the average mass of oxygen produced in the experiment. Determine the absolute uncertainty of the result. *[2]*

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1. Calculate the density of oxygen at 20.0°C. *[1]*

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1. Calculate the absolute uncertainty of the density of oxygen. *[2]*

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(b) Matthew found that the 1literature value of the density of oxygen at 20.0°C is   
1.18 × 10-3 g cm-3. Calculate the percentage error of the density of oxygen. *[2]*

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(c) If Matthew’s teacher allows 5% error for the result, comment on\* the accuracy of the result. Apart from the random error, describe one possible source of errors. *[2]*

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1 Source from <http://www.rsc.org/periodic-table/element/8/oxygen>

2 “Comment” requires students to “***give a judgment based on a given statement or result of a calculation***”.