Rates of Reactions: Assignment 1

1. A 5.0 g sample of magnesium reacts completely with a hydrochloric acid solution after 150 s. Express the average rate of consumption of magnesium, in units of g/min.

\[
\left( \frac{5.0 \text{ g}}{150 \text{ s}} \right) \left( \frac{60 \text{ s}}{\text{ min}} \right) = 2.0 \text{ g/min}
\]

2. How long will it take to completely react 45.0 g of CaCO₃(s) with dilute HCl(aq) if the reaction proceeds at an average rate of 2.35 g CaCO₃(s)/min under a given set of conditions?

\[
45.0 \text{ g} \left( \frac{1 \text{ min}}{2.35 \text{ g}} \right) = 19.1 \text{ min}
\]

3. The electrolysis of water produces oxygen gas at the rate of 32.5 mL/min in a certain experiment. What volume of oxygen gas can be produced in 7.50 min?

\[
7.50 \text{ min} \left( \frac{32.5 \text{ mL}}{\text{ min}} \right) = 244 \text{ mL}
\]

4. Which of the following are acceptable units for expressing reaction rate? (Circle)

- (a) moles/second
- (c) (moles/litre)/second
- (e) millilitres/hour
- (b) minutes/metre
- (d) grams/litre
- (f) grams/minute

5. Hydrogen and oxygen gas react in a fuel cell to produce water according to the equation:

\[
2 \text{ H}_2(g) + \text{ O}_2(g) \rightarrow 2 \text{ H}_2\text{O}(l)
\]

If the rate of water production is 1.34 mol/min, what is the rate of oxygen gas consumption expressed in mol/min?

\[
\left( \frac{1.34 \text{ mol H}_2\text{O}}{\text{ min}} \right) \left( \frac{1 \text{ mol O}_2}{2 \text{ mol H}_2\text{O}} \right) = 0.67 \text{ mol O}_2/\text{ min}
\]
6. The following data was obtained for the reaction (mass includes beaker and contents):

\[ \text{NaHCO}_3(s) + \text{H}^+(aq) \rightarrow \text{CO}_2(g) + \text{Na}^+(aq) + \text{H}_2\text{O}(l) \]

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Mass (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>150.00</td>
</tr>
<tr>
<td>10</td>
<td>149.94</td>
</tr>
<tr>
<td>20</td>
<td>149.86</td>
</tr>
<tr>
<td>30</td>
<td>149.82</td>
</tr>
</tbody>
</table>

Plot the above data on the graph below.

Now answer the following questions.

(a) Why is the mass decreasing?

\[ \text{CO}_2 \text{ is being lost} \]

(b) What is the slope of the line in the above graph, using: slope = RISE / RUN?

\[ -0.006 \]

(c) What are the units of: (i) the RISE? (ii) the RUN? (iii) the slope?

\[ \text{i)}\ g \quad \text{ii)}\ s \quad \text{iii})\ g/s \]

(d) What units would you expect to use for the rate of this reaction?

same as slope: g/s

(e) What relationship exists between the slope of the graph and the rate of the reaction?

they are the same

(f) State the value found for the experimentally-determined reaction rate.

\[ -0.006 \text{g/s (a loss of 0.006 g per s)} \]