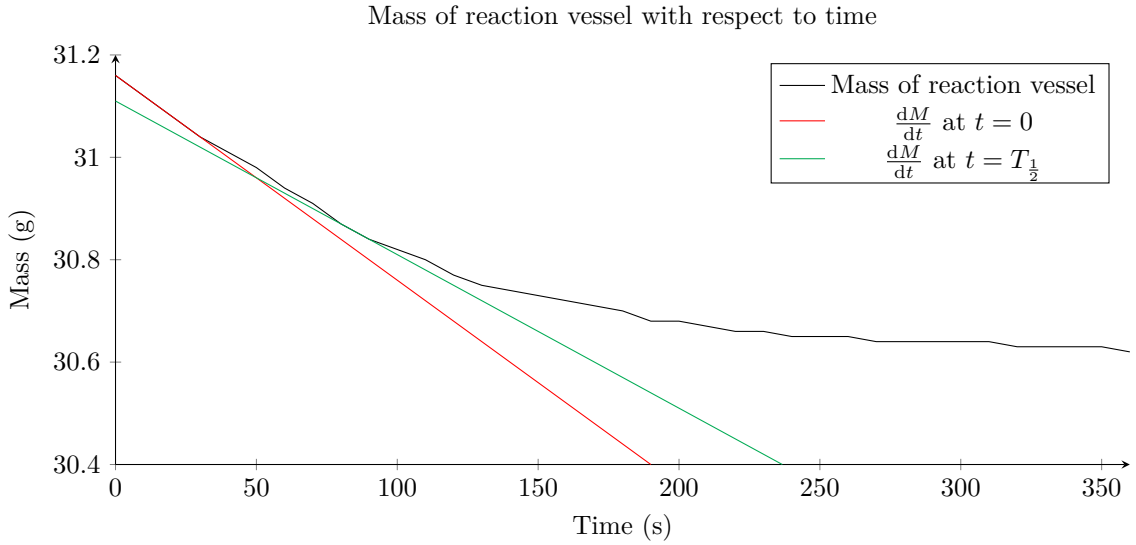
PAG 9.2

The rate of reaction of calcium carbonate and hydrochloric acid

Rosie Bartlett

1 Mass experiment

1.1 Results



1.2 Analysis of results

1. Half life 1 → 75s
   Half life 2 → 55s
   Half life 3 → 55s

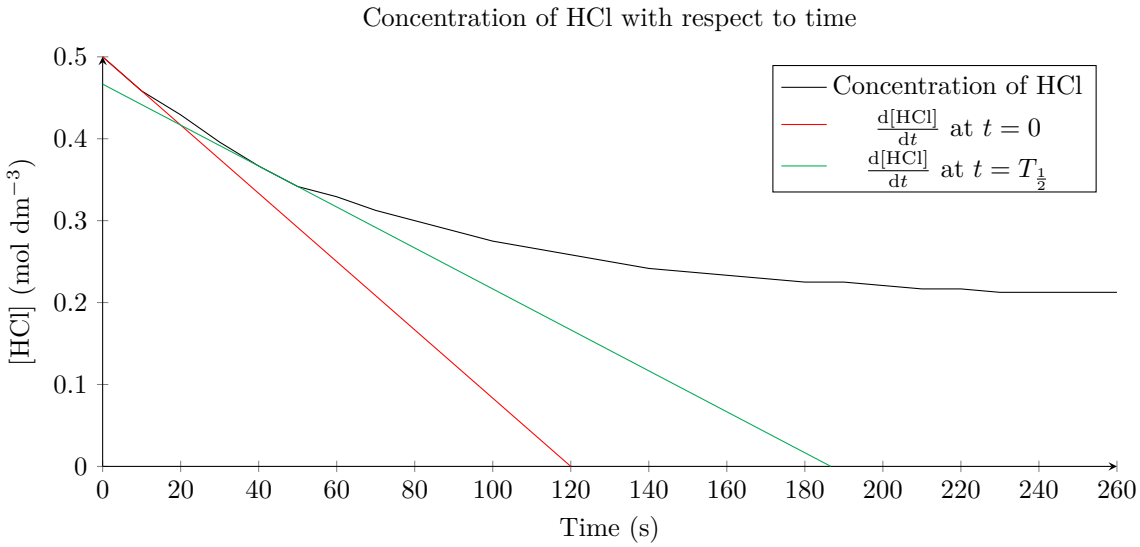
2. The half live values above include one anomaly, which when excluded give a constant half life.

2 Gas reaction

2.1 Results

By using the formula below, we can calculate the concentration of HCl from the volume of gas produced. Where $V(CO_2)$ is the volume of CO_2 produced.

$$[HCl] = \frac{120 - V(CO_2)}{240}$$



2.2 Analysis of results

1. Half life 1 → 43.5s
   Half life 2 → 50s
   Half life 3 → 45.5s

2. Since all the half lives are similar, we can suggest that the reaction is first order.

3 Extension opportunities

1. (a) Mass lost:
   Since there was an excess of $CaCO_3$, when the reaction reached completion, there would have been 0.04 mol of CO_2 produced. this would hav had a mass of 0.88g, meaning 0.88g would have been lost. In the reaction we only saw a loss of 0.5g, so the reaction did not go to completion.
   Gas produced:
   Again the $CaCO_3$ was in excess, so at the end of the reaction, 0.01 mol of CO_2 would have been produced, with a volume of 120cm^3. we only saw a maximum volume of 69cm^3, so the reaction did not go to completion.

   (b) As the reaction progresses, the concentration of HCl is constantly decreasing, which constantly decreases the rate, meaning a very long long time would be required to run the reaction to completion.

   (c) For the reaction to go to completion, we would need a larger gas syringe to account for the extra 20cm3 of CO2 produced.

2. Mass lost:
   At $t = 0$, $\frac{dM}{dt}$ was -4×10^{-3} g s^{-1}. At $t = T_{\frac{1}{2}}$, $\frac{dM}{dt}$ was -3×10^{-3} g s^{-1}.
   Gas produced:
   At $t = 0$, $\frac{d[HCl]}{dt}$ was $\frac{1}{240}$ mol dm^3 s^{-1} or approximately 4.17×10^{-3} mol dm^3 s^{-1}. At $t = T_{\frac{1}{2}}$, $\frac{d[HCl]}{dt}$ was 2.5×10^{-3} mol dm^3 s^{-1}.
   In both cases, the gradient at $T_{\frac{1}{2}}$ is approximately half of what t was at $t = 0$, giving further evidence that the reaction is first order.