

AP WORKSHEET 05C: Kinetics and Graphs

Introduction

For each question, answer part (a) by using Excel to plot and print a graph. Answer all the remaining parts of each question in the blank space provided underneath the question.

QUESTION 1

An experiment was carried out in order to investigate the rate of reaction between magnesium and dilute nitric acid. 0.07 g of magnesium ribbon was reacted with excess dilute acid. The volume of gas produced every 5.00 seconds was recorded.

| Time (s) | Volume of gas (mL) |
|----------|--------------------|
| 0 | 0 |
| 5 | 18 |
| 10 | 34 |
| 15 | 47 |
| 20 | 57 |
| 25 | 63 |
| 30 | 67 |
| 35 | 69 |
| 40 | 70 |
| 45 | 70 |

- (a) Use Excel to plot and print a graph of these results. (2)
- (b) When is the reaction fastest? How can the graph be used to tell? (2)
- (c) How long does it take for the 0.07g of magnesium to react completely? (1)

- (d) Sketch another curve on to your graph that might have been obtained if 0.07g of magnesium **powder** had been used instead of magnesium ribbon. (3)
- (e) Suggest two other factors that would alter the rate of this reaction. (2)
- (f) Write a chemical reaction for this process. (2)



QUESTION 2

The table below shows how the volume of carbon dioxide collected varied against time when small and large calcium carbonate chips were added to an excess of hydrochloric acid.

| Time (s) | 0 | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 | 135 | 150 | 165 | 180 |
|---|---|----|----|----|----|----|----|-----|-----|-----|-----|-----|-----|
| Volume of gas generated by small chips (mL) | 0 | 35 | 53 | 63 | 70 | 74 | 77 | 78 | 79 | 80 | 80 | 80 | 80 |
| Volume of gas generated by large chips (mL) | 0 | 15 | 27 | 37 | 47 | 54 | 61 | 67 | 72 | 75 | 78 | 80 | 80 |

- (a) Use Excel to plot and print a graph of these results. (2)
- (b) What can you deduce about the total mass of the chips relative to one another in each of the experiments? (2)
- (c) How long did each experiment take to go to completion? How can you tell from the graph? (1)
- (d) What are possible units of rate of reaction in this experiment? (1)
- (e) Write a chemical reaction for this process. (2)
- (f) Why is gas produced at different rates in the two different experiments? (1)

QUESTION 3

Kinetic results for a reaction involving substance A are shown below.

| Time (mins) | [A] in mol L ⁻¹ |
|-------------|----------------------------|
| 0.000 | 1.00 |
| 2.00 | 0.82 |
| 4.00 | 0.67 |
| 7.00 | 0.49 |
| 10.0 | 0.37 |
| 14.0 | 0.24 |
| 20.0 | 0.14 |
| 25.0 | 0.08 |

(a) Use Excel to plot and print a graph of these results. (2)

(b) What is the order of this reaction with respect to A? (1)

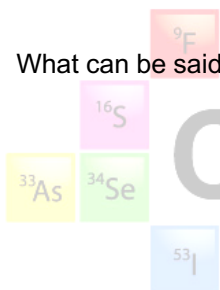
(c) Use your graph to calculate the half-life for this reaction. (2)

(d) Given that in this reaction, A reacts with G, and that the order with respect to G is second, write the rate equation for this reaction. (2)

QUESTION 4

| Time in minutes | [B] in mol L ⁻¹ |
|-----------------|----------------------------|
| 0.00 | 1.00 |
| 2.00 | 0.790 |
| 4.00 | 0.590 |
| 7.00 | 0.300 |
| 10.0 | 0.000 |

- (a) Use Excel to plot and print a graph of these results. (2)
- (b) What is the order with respect to B in this reaction? (1)
- (c) What can be said about the rate of consumption of B in this reaction? (1)



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QUESTION 5

| | | | | | | |
|----------------------------------|--------|--------|--------|--------|--------|--------|
| [X] in mol L⁻¹ | 0.0032 | 0.0064 | 0.0096 | 0.0100 | 0.0111 | 0.0200 |
| Rate in moles per minute | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 | 9.2 |

- (a) Use Excel to plot and print a graph of these results. (2)
- (b) What is the order with respect to X in this reaction? (1)



QUESTION 6

The Arrhenius equation relates the Rate Constant, k , to other factors such as Collision Frequency (A), Activation Energy (E_a), the Gas Constant ($R = 8.314 \text{ J/K mol}$) and Temperature (T in Kelvin), and its integrated form is given below.

$$\ln k = \left(-\frac{E_a}{R} \right) \left(\frac{1}{T} \right) + \ln A$$

In this form, the equation takes on the format of the equation of a straight line, i.e. $y = mx + b$.

- (a) Use the data below in order to find a value for the Activation Energy for the reaction. (4)

| k | T in Kelvin |
|----------|--------------------|
| 0.0109 | 698 |
| 0.0348 | 731 |
| 0.1049 | 762 |
| 0.3429 | 788 |
| 0.7888 | 811 |