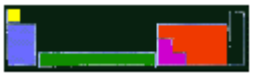
Revised August 2009



AP WORKSHEET 15b: 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)

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 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