6.1 Chemical Kinetics

Question Paper

Course	DP IB Chemistry
Section	6. Chemical Kinetics
Topic	6.1 Chemical Kinetics
Difficulty	Hard

Time allowed: 50

Score: /39

Percentage: /100

Question 1a

a)
A group of students planned how to investigate the effect of changing the concentration of H_2SO_4 on the initial rate of reaction with magnesium:

$$Mg(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2(g)$$

They decided to measure how long the reaction took to complete when similar masses of magnesium were added to acid.

Two methods were suggested:
Method 1 - Use small pieces of magnesium ribbon, an excess of acid and record the time taken for the magnesium ribbon to disappear
Method 2 - Use large strips of magnesium ribbon, an excess of magnesium and record the time taken for bubbles to stop forming

Deduce, giving a reason, which of method 1 and method 2 would be the least affected if the masses of magnesium ribbon used varied slightly between each experiment.

[2]

[2 marks]

Question 1b

b)
Neither method in part a) actually allows the initial rate to be calculated. Outline a method that would allow the calculation of initial rate.

[2]

[2 marks]

Question 1c

c)
The reaction is to be conducted across a few weeks.
State a factor that has a significant effect on reaction rate, which could vary between experiments across the weeks and therefore needs to be controlled.

[1]

[1 mark]

Question 1d

d)
One group collected the following data using 1.50 mol dm^{-3} acid:

Trial	Time/ s (± 0.01 s)
1	91.56
2	98.33
3	72.08
4	89.41

i)
Comment on the use of the uncertainty when calculating the mean.

[2]

ii)
Calculate the mean time for the set of results.

[2]

[4 marks]

Question 2a

a)
When investigating the reaction between sulfuric acid and calcium carbonate, it was observed that a small increase of temperature of around 10 °C caused a doubling in the rate of the reaction.
Sketch and label Maxwell-Boltzmann curve for the two temperatures T and T+10, and use this diagram to help to explain this effect of temperature on rate.

[5]

[5 marks]

Question 2b

b)
Why do some collisions at high temperatures still not result in the formation of the product?

[2]

[2 marks]

Question 2c

c)
Identify and explain another factor that affects the number of particles present in a solution with sufficient energy to react.

[3]

[3 marks]

Question 2d

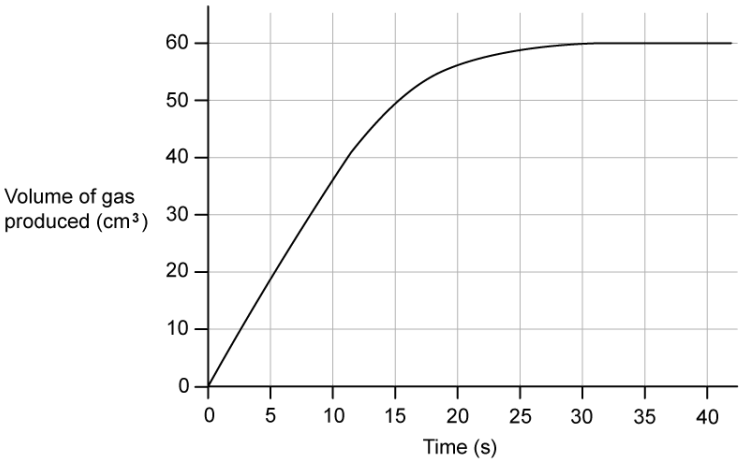
d)
Some groups investigating the effect of temperature on rate stirred their reactions, some did not.
Explain the effect of stirring upon the rate of the reaction.

[2]

[2 marks]

Question 3a

a)
0.5 g of magnesium reacts with 50 cm^3 of 0.01 $moldm^{-3}$ nitric acid. Magnesium is in excess.
A graph monitoring the volume of hydrogen gas produced is shown below:



i)
Calculate the mean rate of reaction over the first 15 seconds of the reaction

[1]

ii)
Calculate the actual rate of reaction at 15 seconds

[3]

iii)
Explain the difference in values for rate

[1]

[5 marks]

Question 3b

b)
Compare the expected rate and progress of the reaction if 25 cm^3 of 0.2 mol dm^{-3} nitric acid was used instead of 50 cm^3 of 0.1 mol dm^{-3} nitric acid.

[3]

[3 marks]

Question 3c

c)
Suggest one change to the reaction that could be made to produce more hydrogen gas in total and explain your choice.

[2]

[2 marks]

Question 3d

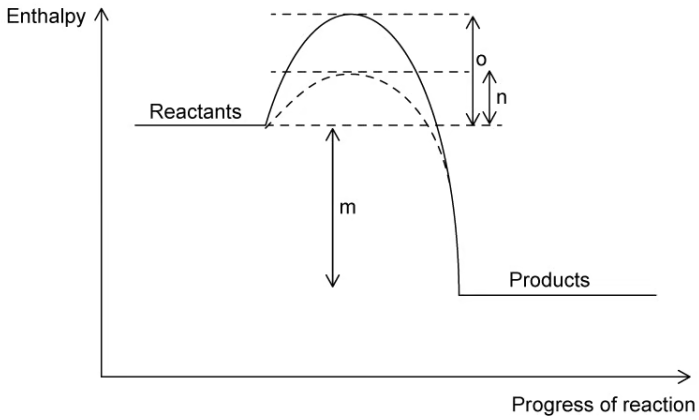
d)
Suggest why it is often better to study a slower reaction instead of a faster one.

[2]

[2 marks]

Question 4a

a)
The following energy profile diagram shows the pathways for both a catalysed and uncatalysed reversible reaction:



Identify the letter(s) representing the activation energy for the catalysed reverse reaction.

[1]

[1 mark]

Question 4b

b)
State and explain the effect that this catalyst will have on the equilibrium yield.

[2]

[2 marks]

Question 4c

c)
Vehicles with combustion engines usually have catalytic convertors added to catalyse the oxidation of carbon monoxide into carbon dioxide and to catalyse the reduction of nitrogen oxides to nitrogen. These catalysts are usually rhodium or platinum.

Leaded fuels were phased out as they were found to poison these catalysts, binding irreversibly to the metal surface.

Explain the problems for drivers of the catalysts being poisoned.

[2]

[2 marks]

Question 4d

d)
Suggest a situation in which using a catalyst would not be appropriate.

[1]

[1 mark]