SCH 4U1-a

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Chapter 6 Test - Rates of Reaction

Knowledge	Thinking	Communication
/10	/18	/9

PART A: THINKING/INQUIRY (18 MARKS)

1. For the reaction $A + 2B \rightarrow 3C + 4D$,
the initial concentration of A was 0.0415 mol/L, and after 14.7 min the concentration of A was 0.0206 mol/L. What is the average rate of consumption in moles per litre per second of reactant B? (3 marks)

① $A_{ar} = \frac{c_2 - c_1}{\Delta t}$

$= \frac{0.0206 \text{ mol/L} - 0.0415 \text{ mol/L}}{882 s}$

$= -2.37 \times 10^{-5}$ mol/L·s

14.7 min = 840 sec + 42 sec
= 882 sec

② -2.37×10^{-5} mol/L·s $\Rightarrow 2.37 \times 10^{-5}$ mol/L·s
rate of consumption A

③ $B_{ar} = A_{ar} \times \frac{2 \text{ mol } B}{1 \text{ mol } A}$

$= 2.37 \times 10^{-5}$ mol/L·s $\times \frac{2 \text{ mol } B}{1 \text{ mol } A}$

$= 4.74 \times 10^{-5}$ mol/L·s

2. The following data was collected for four trials of an experiment:

Experiment	Initial [A] mol/L	Initial [B] mol/L	Initial [C] mol/L	Rate mol/L·s
1	0.10	0.20	0.30	9.0×10^{-5}
2	0.30	0.20	0.30	8.1×10^{-4}
3	0.10	0.30	0.30	9.0×10^{-5}
4	0.10	0.20	0.90	2.7×10^{-4}

(a) Use this information to determine the rate law expression/equation. Show your work! (3 marks)

Con = concentration

① rate law $= k[A]^a[B]^b[C]^c$

a = 2 as when Con of A was tripled, rate increased by $\times 3^2$

b = 0 as increasing concentration had no effect on rate

c = 1 as when Con of C was tripled, rate was also tripled

∴ rate law $= k[A]^2[B]^0[C]^1$

(b) What is the value of the rate constant, k? (2 marks)

$k = \frac{\text{rate law}}{[A]^2[B]^0[C]^1}$

$= \frac{9.0 \times 10^{-5} \text{ mol/L·s}}{[0.10 \text{ mol/L}]^2[0.20 \text{ mol/L}]^0[0.30 \text{ mol/L}]^1}$

$= 0.03$ L²/mol²·s

(c) what is the overall order for the reaction? (1 mark) 3

3. A chemist proposes the following reaction mechanism:

$OCl^- + H_2O \rightarrow HOCl + OH^-$		(fast)
$I^- + HOCl \rightarrow IOH + Cl^-$		(slow)
$IOH + OH^- \rightarrow IO^- + H_2O$		(fast)

(a) Write the overall reaction equation. (1 mark)

$OCl^- + I^- \rightarrow IO^- + Cl^-$

(b) List any reaction intermediate(s) and/or catalyst(s). (2 marks)

Intermediate(s): HOCl, OH^-, IOH

Catalyst(s): H_2O

(c) Given a proposed reaction mechanism, can you differentiate between a reaction intermediate and a catalyst? Explain. (2 marks)

yes. An intermediate is a product that is produced and then later used in another step while a catalyst is a reactant that is used up and later appears as a product.

(d) A new catalyst is discovered that decreases the activation energy for step 3. How will this affect the overall rate of the reaction? Give a reason for your answer. (1 mark)

It will have no affect as step 2 is the slowest and is the rate-determining step. decreasing activation energy for step 3 will speed up the reaction rate but does not determin reaction law.

(e) The rate law equation was determined to be rate=$k[I^-]^1[HOCl]^2$. Is the proposed mechanism plausible? Support your answer. (1 mark)

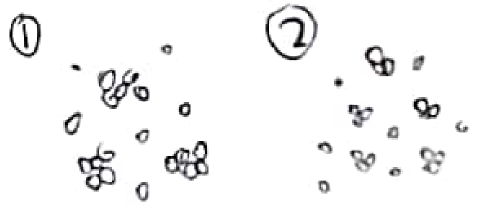
no as HOCl is a reaction intermediate and therefore cannot be used in the rate law.

(f) Suggest one property OTHER than concentration that could be used to monitor the rate of a reaction over time. Explain your choice. (2 marks)

if any products are solid or gases you can compare the initial mass of a reactant and a mass of a product to determine at what rate the reaction is proceeding. You can also use ph if the reactants are base/acids or involved in creating base/acids. 2
If a product is a gas you can also measure the volume of gas released in a certain amount of time.

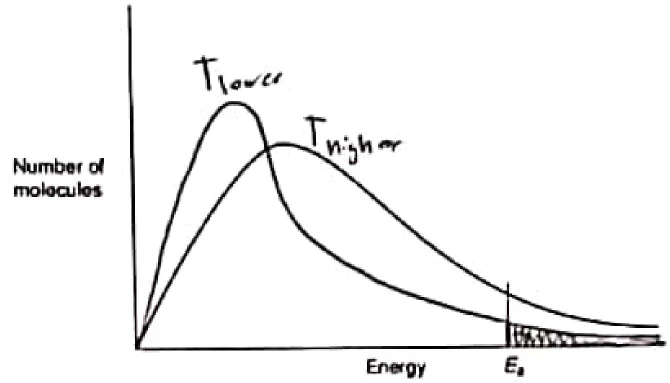
PART B: COMMUNICATION (9 MARKS)

1. Use collision theory and diagrams to explain how changing the surface area can affect the rate of a reaction. (3 marks)



-when the surface area is increased, enlits are able to have more area to produce effective collisions
-in 1 the particles are larger and therefore do not react as effectively
-in 2 particles are smaller and therefore more surface area for reaction increasing rate

2. The diagram below shows the Maxwell-Boltzmann distribution for a sample of a gas at a fixed temperature. E_a is the activation energy for the decomposition of this gas.



(a) On this diagram, sketch a new distribution for the same sample of gas at a LOWER temperature. (2 marks)

(b) With reference to the Maxwell-Boltzmann distribution, explain what a decrease in temperature will do to the rate of decomposition of this gas. (2 marks)

-decreasing temperature decreasing movement and kinetic energy in the gas which will result in having a slower reaction rate as less molecules will have the required activation energy to react

3. You are performing an investigation that involves the following reaction: 2A + B -> products
For this reaction, the following information is known:
   i) Rate law equation: $r = k[A][B]^2$
   ii) Rate of reaction = 4.5×10^{-2} mol/L•s

The rate is doubled from rate shown in (II) by increasing the temperature. How would the concentration of A have to be changed, if the concentration of B is held constant, in order to bring the rate back to the original value (shown in II) at the increased temperature? (2 marks)

if rate of reaction is doubled, Concentration of A needs to decrease by $\frac{1}{2}$ as the order of A is 1 which means anything done to C of A is also done to the rate. therefore decreasing C of A by $\frac{1}{2}$ also decreases the rate by $\frac{1}{2}$.

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