Reaction Kinetics

Question Paper 4

Level	International A Level
Subject	Chemistry
Exam Board	CIE
Topic	Reaction Kinetics
Sub-Topic	
Paper Type	Theory
Booklet	Question Paper 4

Time Allowed: **44 minutes**

Score: **/36**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E	U
>85%	777.5%	70%	62.5%	57.5%	45%	<45%

1 Sulfuric acid is an important chemical with a variety of uses.

It is manufactured by the Contact process, the first stage of which involves the conversion of sulfur or a sulfide ore, such as galena, PbS, into sulfur dioxide, SO_2.

(a) **(i)** Write an equation for the reaction between galena and oxygen to form sulfur dioxide and lead(II) oxide.

..... [2]

(ii) Identify the oxidation number changes that take place during this reaction.

.....

..... [2]

(b) The second stage of the Contact process involves the production of sulfur trioxide, SO_3, from sulfur dioxide.

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) \qquad \Delta H = -197\,kJ\,mol^{-1}$$

(i) State the temperature usually chosen for this conversion and explain this in terms of reaction rates and Le Chatelier's principle.

temperature .....

explanation .....

.....

.....

..... [3]

(ii) State and explain the pressure conditions that would give the best rate and best yield of sulfur trioxide. Explain why these conditions are **not** actually used.

.....

.....

.....

.....

..... [3]

(c) In the third stage of the process the sulfur trioxide is dissolved in 98% sulfuric acid followed by carefully controlled addition of water.

(i) Explain why the sulfur trioxide is not dissolved directly in water to produce sulfuric acid.

.....

..... [1]

(ii) Write equations for the reaction of sulfur trioxide with sulfuric acid and for the subsequent reaction with water.

.....

..... [2]

(d) Explain why sulfur dioxide is used as an additive in some foods and wines.

.....

.....

..... [2]

(e) The sulfur dioxide content of wine is most commonly measured by the Ripper Method which involves titration with iodine in the presence of starch as an indicator.

$$SO_2(aq) + I_2(aq) + 2H_2O(l) \rightarrow 2I^-(aq) + SO_4^{2-}(aq) + 4H^+(aq)$$

A 50.0 cm^3 sample of wine required 12.35 cm^3 of 0.010 mol dm^{-3} $I_2(aq)$ for complete reaction with the SO_2.

(i) How many moles of SO_2 are present in 50.0 cm^3 of wine?

moles of SO_2 in 50.0 cm^3 = ... [1]

(ii) How many moles of SO_2 are present in 1 dm^3 of wine?

moles of SO_2 in 1 dm^3 = ... [1]

(iii) How many milligrams, mg, of SO_2 are present in 1 dm^3 of wine? Give your answer to **three** significant figures. (1 g = 1000 mg)

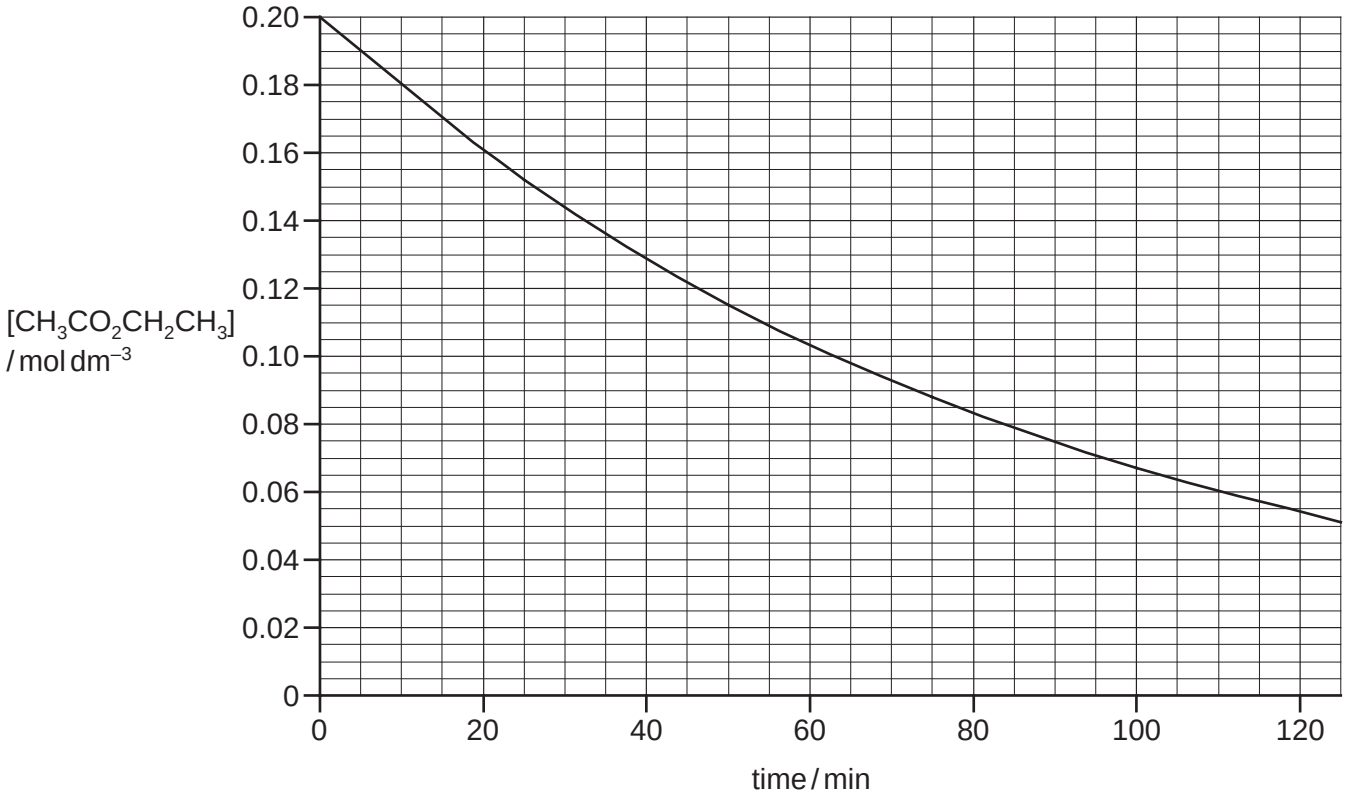
mass of SO_2 in 1 dm^3 = ... mg [1]

[Total: 18]

2 Ethyl ethanoate is hydrolysed slowly by water in the following acid-catalysed reaction.

$$CH_3CO_2CH_2CH_3 + H_2O \xrightarrow{H^+} CH_3CO_2H + CH_3CH_2OH$$

The concentration of ethyl ethanoate was determined at regular time intervals as the reaction progressed.
Two separate experiments were carried out, with different HCl concentrations.
The following graph shows the results of an experiment using [HCl] = 0.1 mol dm^{-3}.



(a) When the experiment was carried out using [HCl] = 0.2 mol dm^{-3}, the following results were obtained.

time / min	[$CH_3CO_2CH_2CH_3$] / mol dm^{-3}
0	0.200
10	0.160
25	0.115
50	0.067
75	0.038
100	0.022
125	0.013

(i) Plot these data on the axes above, and draw a line of best fit.

(ii) Use one of the graphs to show that the reaction is first order with respect to $CH_3CO_2CH_2CH_3$.

Show all your working, and show clearly any construction lines you draw on the graphs.

(iii) Use the graphs to calculate the order of reaction with respect to HC*l*.

Show all your working, and show clearly any construction lines you draw on the graphs.

(iv) Write the rate equation for this reaction, and calculate the value of the rate constant.

rate =

[7]

(b) (i) Why is it **not** possible to determine the order of reaction with respect to water in this experiment?

.....

.....

(ii) Although [$CH_3CO_2CH_2CH_3$] decreases during each experiment, [HC*l*] remains the same as its initial value.

Why is this?

.....

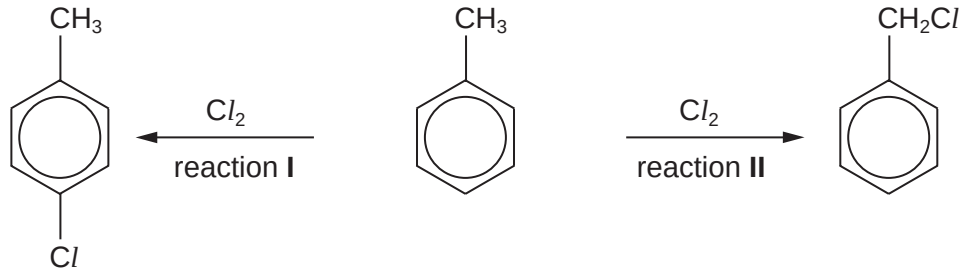
.....

[2]

[Total: 9]

3 This question is concerned with organochlorine compounds.

(a) State the conditions needed to produce the two compounds **A** and **B.**



A **B**

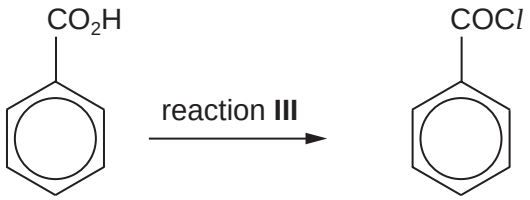
(i) conditions for reaction **I**

.....

(ii) conditions for reaction **II**

..... [2]

(b) State the reagent needed to carry out the following reaction.



C

reagent for reaction **III**: ..... [1]

(c) The three chloro-compounds **A**, **B** and **C** vary in their ease of hydrolysis.

(i) Place a tick in the box corresponding to the correct relative rates of hydrolysis. [the symbol '**>**' means 'faster than']

	place **one** tick only in this column
A > **B** > **C**	
A > **C** > **B**	
B > **A** > **C**	
B > **C** > **A**	
C > **B** > **A**	
C > **A** > **B**	

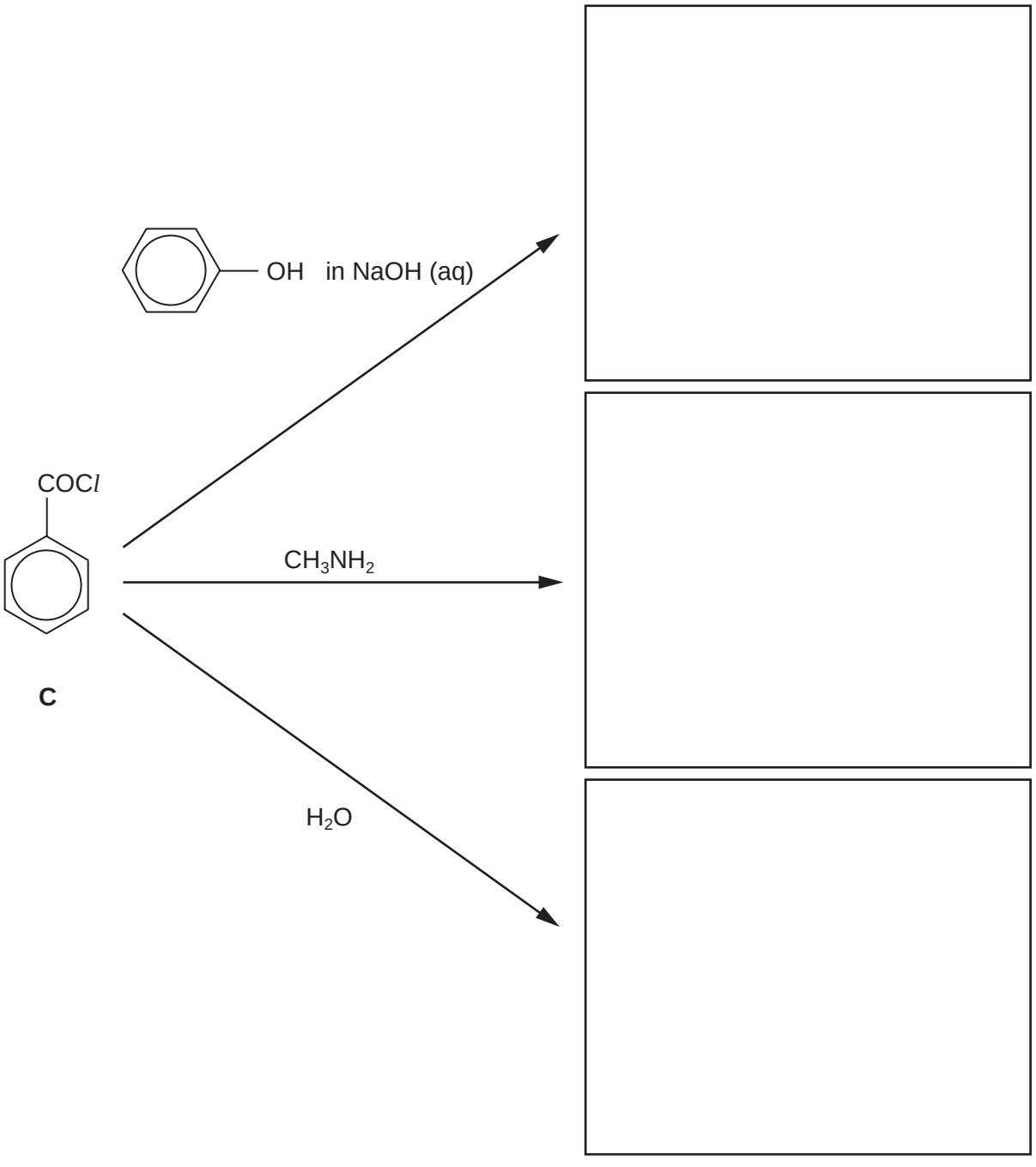
(ii) Suggest an explanation for these differences in reactivity.

.....

.....

..... [3]

(d) Draw the structural formulae of the organic products of the following reactions of compound **C**.



[3]

[Total: 9]