



**Answer ALL the questions. Write your answers in the spaces provided.**

1. This question is about the reaction between calcium carbonate and hydrochloric acid.



One method of studying the kinetics of this reaction is to measure the volume of carbon dioxide given off at various timed intervals when using an excess of calcium carbonate.

- (a) Suggest TWO other methods for following this reaction. Explain your choices.

.....  
.....  
.....  
.....  
.....  
.....

**(2)**

- (b) Suggest why the volume of carbon dioxide given off in the first few seconds of the reaction is an unreliable measure of the initial rate of the reaction.

.....  
.....  
.....

**(1)**



(c) In an experiment, the following results were obtained.

Time /s	Volume of CO <sub>2</sub> V <sub>t</sub> /cm <sup>3</sup>	(V <sub>final</sub> - V <sub>t</sub> ) /cm <sup>3</sup>
5	3	85
35	42	46
65	62	26
95	72	
125	79	
155	84	
185	87	

(i) What was the final volume, V<sub>final</sub>?

.....

**(1)**

(ii) Complete the table.

**(1)**

(iii) To what is (V<sub>final</sub> - V<sub>t</sub>) proportional?

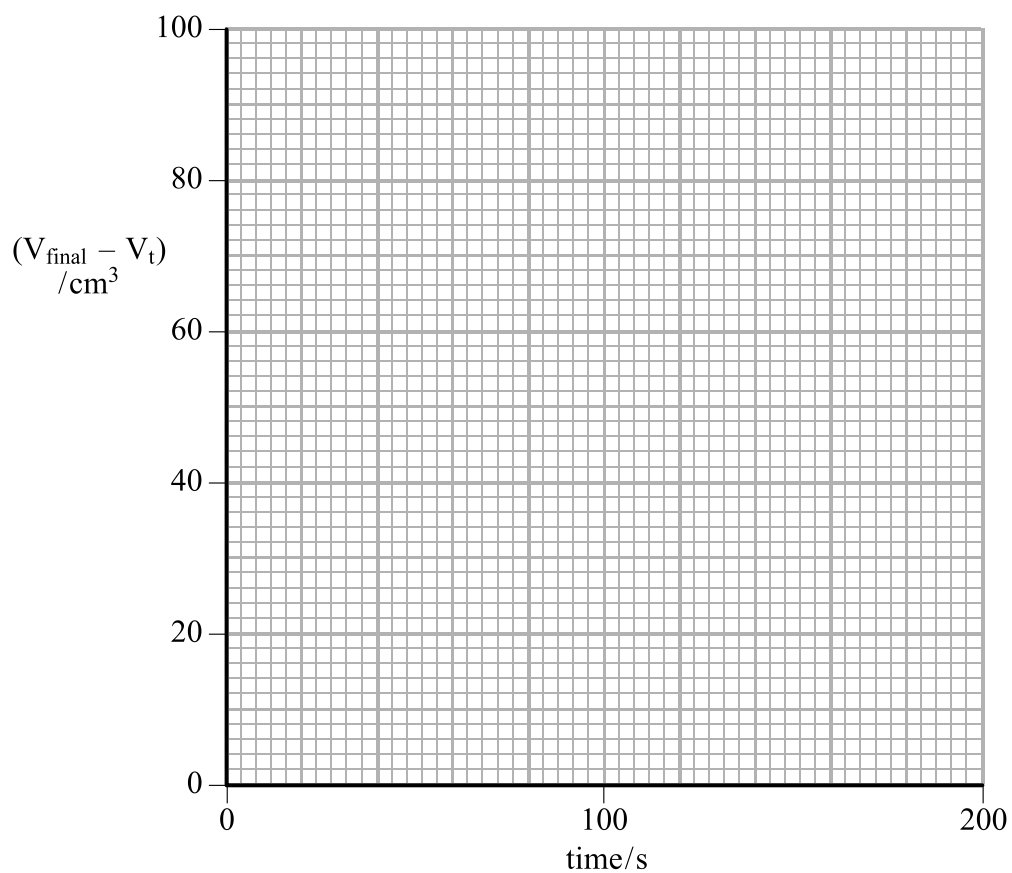
.....

**(1)**



Leave blank

(iv) Plot these results on the grid below.



(2)

(v) On your graph measure and record THREE successive half-lives. Deduce the order of the reaction. Justify your answer.

.....  
.....  
.....  
.....

(3)

(vi) Give the rate equation for this reaction.

(1)

(vii) What are the units of the rate constant?

.....

(1)



Leave  
blank

(d) What would you expect the signs of  $\Delta S_{\text{system}}$  and  $\Delta S_{\text{total}}$  to be for the reaction between calcium carbonate and hydrochloric acid? Justify your answers.

$\Delta S_{\text{system}}$  .....

.....

.....

.....

$\Delta S_{\text{total}}$  .....

.....

.....

.....

(4)

Q1

(Total 17 marks)

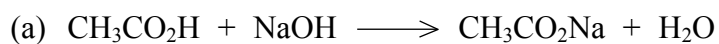
--	--



N 2 2 2 1 4 A 0 5 1 2

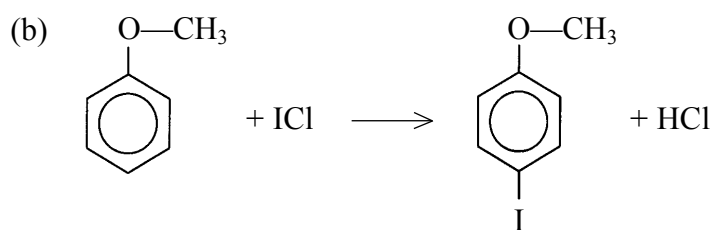
2. For each of the following reactions, give the names of all of the **organic products**.

Also give the **type** or **mechanism** as indicated for each reaction.



Name of organic product .....

Type of reaction ..... **(2)**



Name of organic product .....

Type of reaction ..... *substitution* .....

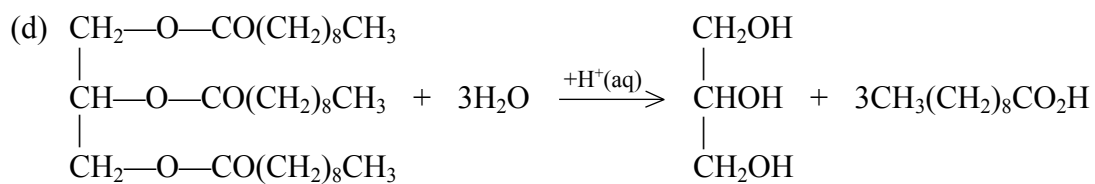
Mechanism ..... **(2)**



Name of organic product .....

Type of reaction ..... *substitution* .....

Mechanism ..... **(2)**



Names of products .....

Type of reaction ..... **(3)**

**(Total 9 marks)**

Q2



3. This question is about a compound, **A**, used as a food flavouring. It has the molecular formula,  $C_9H_8O$ .

(a) For each of the following pieces of information, state what can be deduced about the structure of **A**.

(i) **A** burns with a very sooty flame.

.....  
(1)

(ii) **A** reacts with Brady's Reagent (2,4-dinitrophenylhydrazine) to give an orange precipitate.

.....  
(1)

(iii) When **A** is heated with Benedict's solution, a red precipitate forms.

.....  
(1)

(iv) **A** decolorises bromine water.

.....  
(1)

(v) **A** is the cis isomer.

.....  
.....  
(1)

(vi) Use all of the above information to draw the displayed formula of **A**.

(2)







Leave  
blank

(c) (i) Write the equation for the reaction which occurs when solid benzoic acid is added to sodium carbonate solution. Include state symbols in your equation.

(2)

(ii) Benzoic acid is slightly soluble in water. Write the equation for the dissociation of benzoic acid and hence the expression for the acid dissociation constant,  $K_a$ .

(2)

(iii) Calculate the pH of a  $0.00100 \text{ mol dm}^{-3}$  solution of benzoic acid.  
[ $K_a$  for benzoic acid is  $6.30 \times 10^{-5} \text{ mol dm}^{-3}$ .]

(3)

(d) Give the name or formula of an organic compound which, when mixed with a solution of benzoic acid, forms a buffer solution.

(1)

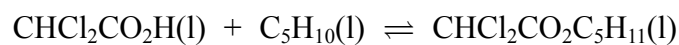
(Total 21 marks)

Q3

--	--



4. Dichloroethanoic acid reacts with pent-1-ene as shown by the following equation:



(a) Give the name of the product of this reaction and also the name for the new functional group it contains.

.....  
 .....

**(2)**

(b) In an experiment to determine the equilibrium constant, 1.00 mol of dichloroethanoic acid was mixed with 2.30 mol of pent-1-ene. The total volume remained at 300 cm<sup>3</sup> throughout. When equilibrium had been reached, it was found that 0.40 mol of dichloroethanoic acid was left.

(i) List the steps in the experiment you would carry out to determine the concentration of dichloroethanoic acid present at equilibrium.

.....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....  
 .....

**(4)**

(ii) Give the expression for the equilibrium constant, K<sub>c</sub>, for this reaction.

**(1)**



Leave  
blank

(iii) Complete the table for the number of moles and concentrations at equilibrium.

Substance	Number of moles at start	Number of moles at equilibrium	Concentration at equilibrium /mol dm <sup>-3</sup>
CHCl <sub>2</sub> COOH	1.00	0.40	1.33
C <sub>5</sub> H <sub>10</sub>	2.30		
CHCl <sub>2</sub> COOC <sub>5</sub> H <sub>11</sub>	0		

(3)

(iv) Calculate the value of  $K_c$ , and give its units.

(3)

Q4

(Total 13 marks)

**TOTAL FOR PAPER: 60 MARKS**

**END**



# THE PERIODIC TABLE

Group 1 2 3 4 5 6 7 0

Period

1	1	2	3	4	5	6	7	0										
1	1 H Hydrogen 1							2 He Helium 4										
2	3 Li Lithium 7	4 Be Beryllium 9						10 Ne Neon 20										
3	11 Na Sodium 23	12 Mg Magnesium 24						18 Ar Argon 40										
4	19 K Potassium 39	20 Ca Calcium 40	21 Sc Scandium 45	22 Ti Titanium 48	23 V Vanadium 51	24 Cr Chromium 52	25 Mn Manganese 55	26 Fe Iron 56	27 Co Cobalt 59	28 Ni Nickel 59	29 Cu Copper 63.5	30 Zn Zinc 65.4	31 Ga Gallium 70	32 Ge Germanium 73	33 As Arsenic 75	34 Se Selenium 79	35 Br Bromine 80	36 Kr Krypton 84
5	37 Rb Rubidium 85	38 Sr Strontium 88	39 Y Yttrium 89	40 Zr Zirconium 91	41 Nb Niobium 93	42 Mo Molybdenum 96	43 Tc Technetium (99)	44 Ru Ruthenium 101	45 Rh Rhodium 103	46 Pd Palladium 106	47 Ag Silver 108	48 Cd Cadmium 112	49 In Indium 115	50 Sn Tin 119	51 Sb Antimony 122	52 Te Tellurium 128	53 I Iodine 127	54 Xe Xenon 131
6	55 Cs Caesium 133	56 Ba Barium 137	57 La Lanthanum 139	72 Hf Hafnium 178	73 Ta Tantalum 181	74 W Tungsten 184	75 Re Rhenium 186	76 Os Osmium 190	77 Ir Iridium 192	78 Pt Platinum 195	79 Au Gold 197	80 Hg Mercury 201	81 Tl Thallium 204	82 Pb Lead 207	83 Bi Bismuth 209	84 Po Polonium (210)	85 At Astatine (210)	86 Rn Radon (222)
7	87 Fr Francium (223)	88 Ra Radium (226)	89 Ac Actinium (227)	104 Unq Unnil- quadium (261)	105 Unp Unnil- pentium (262)	106 Unh Unnil- hexium (263)												

**Key**  
Atomic Number  
Symbol  
Name  
Molar mass in  
g mol<sup>-1</sup>

► Lanthanide elements

► Actinide elements

