



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

1. Most tests to identify compounds are based on their reactions with a reagent. In this question you are given the test, the observation and the inference.

Name the reagents, **P**, **Q**, **R** and **S**.

Test	Observation	Inference
A gas is passed into solution of <b>P</b> .	A white precipitate.	The gas is <b>carbon dioxide</b> .
A gas is passed into a solution of <b>Q</b> in dilute sulphuric acid.	Solution turns from orange to green.	The gas is <b>sulphur dioxide</b> .
Nitric acid plus a solution of <b>R</b> was added to a solution of a salt.	White precipitate soluble in dilute ammonia solution.	The salt contains a <b>chloride</b> .
A solution of a salt is boiled with <b>S</b> and sodium hydroxide solution.	Gas evolved turns damp red litmus blue.	The salt contains a <b>nitrate</b> .

**P** .....

**Q** .....

**R** .....

**S** .....

**Q1**

**(Total 4 marks)**



2. Salt **B** contains a **Group 2** cation.

(a) (i) Complete the inference column by writing the **formulae** of the ions present.

Test	Observation	Inference
Dilute sulphuric acid was added to a solution of <b>B</b> .	White precipitate produced.	TWO possible <b>cations</b> in <b>B</b> are ..... .....
A sample of <b>B</b> was heated strongly in a dry tube.	Brown gas, <b>D</b> , and a gas which ignites a glowing splint were evolved.	The <b>anion</b> in <b>B</b> is .....

(3)

(ii) Identify the brown gas **D**.

.....

(1)

(b) Suggest a further test that could be used to distinguish between the two cations that you suggested could be present in salt **B**. Give results for **both** possible cations.

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(3)

Q2

(Total 7 marks)



3. This question concerns a halogenoalkane,  $C_3H_7X$ , where **X** is a halogen atom.

- (a) A solution of  $C_3H_7X$  reacts with a solution of silver nitrate mixed with dilute nitric acid to give a **cream precipitate**. The precipitate is insoluble in dilute ammonia solution, but soluble in concentrated ammonia solution.

Identify the halogen atom **X**.

.....  
(1)

- (b)  $C_3H_7X$  reacts with reagent **Y** to give either  $C_3H_8O$  or  $C_3H_6$ , depending upon whether the solvent is water or ethanol.

Identify reagent **Y**.

.....  
(1)

- (c)  $C_3H_8O$  reacts with phosphorus pentachloride to produce steamy fumes which turn blue litmus red.

Identify the functional group present in  $C_3H_8O$ .

.....  
(1)

- (d)  $C_3H_6$  reacts with bromine water to give a colourless solution.

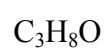
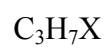
Identify the functional group present in  $C_3H_6$ .

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(1)



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- (e) Suggest a structural formula, which is consistent with the results obtained in (a), (b), (c) and (d) for each of the following.



(3)

Q3

(Total 7 marks)

5

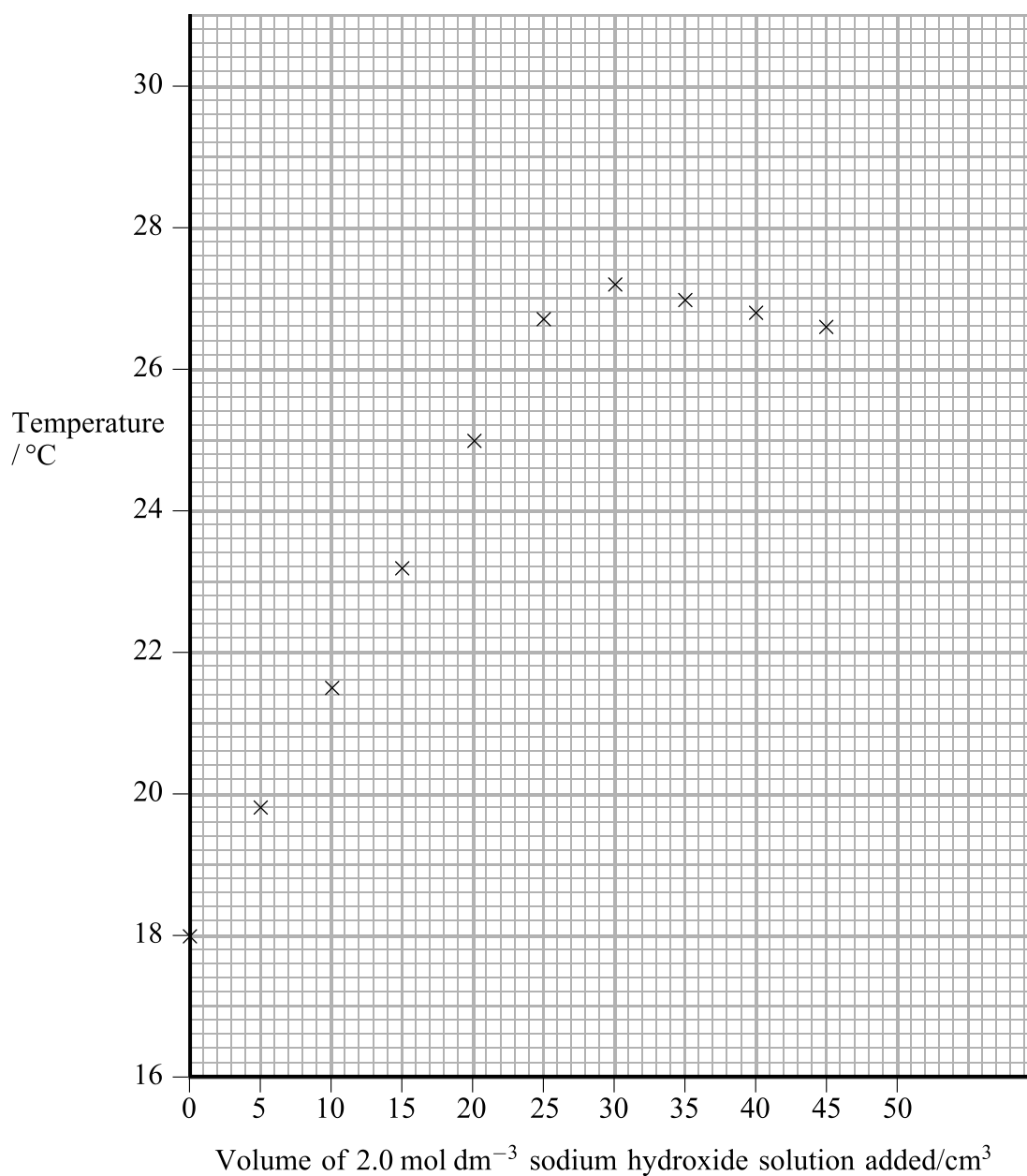


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4. A student carried out an experiment to find the concentration of a solution of nitric acid and also its enthalpy of neutralisation.

- The solutions of nitric acid and sodium hydroxide were allowed to reach the same temperature.
- 50.0 cm<sup>3</sup> of the nitric acid was pipetted into a polystyrene cup.
- A burette was filled with a solution of 2.0 mol dm<sup>-3</sup> sodium hydroxide, NaOH.
- The initial temperature of the acid was recorded.
- The sodium hydroxide was added to the acid in 5.0 cm<sup>3</sup> portions.
- After each addition, the mixture was stirred and the maximum temperature recorded.
- This was repeated until 45 cm<sup>3</sup> of the sodium hydroxide solution had been added.

The student plotted the results, as shown below.



(a) Complete the graph by drawing two intersecting straight **lines** of best fit. **(1)**

(b) The point where the lines cross represents the neutralisation of the nitric acid by the sodium hydroxide solution.

Use the graph to find:

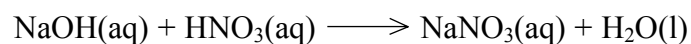
(i) the volume of  $2.0 \text{ mol dm}^{-3}$  sodium hydroxide solution, NaOH, that reacts exactly with the  $50 \text{ cm}^3$  of the nitric acid.

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

(ii) the maximum temperature **change**,  $\Delta T$ , in the reaction.

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

(c) The information in (b)(i) and the equation below can be used to calculate the concentration of the nitric acid.



(i) Calculate the amount (moles) of sodium hydroxide used to neutralise the  $50 \text{ cm}^3$  of nitric acid.

**(1)**

(ii) Write the amount (moles) of nitric acid in  $50.0 \text{ cm}^3$  of the solution.

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

(iii) Hence calculate the concentration of nitric acid,  $\text{HNO}_3$ , in  $\text{mol dm}^{-3}$ .

**(2)**



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(d) (i) Use the data from (b) to calculate the heat change for this reaction.

The density of the mixture produced at neutralisation is  $1.0 \text{ g cm}^{-3}$  and the specific heat capacity of the mixture is  $4.2 \text{ J g}^{-1} \text{ }^\circ\text{C}^{-1}$ .

$$\text{Heat change} = \text{mass} \times \text{specific heat capacity} \times \Delta T$$

(2)

(ii) Use your answer from (d)(i) and (c)(iii) to calculate the enthalpy of neutralisation per mole of nitric acid,  $\text{HNO}_3$ . Include a sign and units with your answer.

(3)

(e) The enthalpy of neutralisation found by this method may be **less exothermic** than the data book value because of heat loss.

Suggest ONE way to reduce the error due to heat loss.

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(1)

(Total 13 marks)

Q4



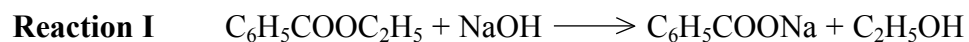


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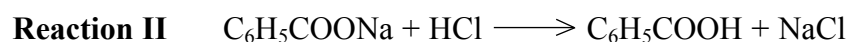


5. This question is about laboratory techniques used in organic chemistry.

The hydrolysis of ethyl benzoate,  $C_6H_5COOC_2H_5$ , produces ethanol and sodium benzoate,  $C_6H_5COONa$ .



The sodium benzoate can be converted to benzoic acid,  $C_6H_5COOH$ , by the addition of dilute hydrochloric acid.



**Method**

- Place 4.5 g of ethyl benzoate in a flask and add an excess of sodium hydroxide solution.
- Heat the mixture under reflux for fifteen minutes.
- Distil off the ethanol formed.
- Add hydrochloric acid to the sodium benzoate solution left in the flask.
- Allow the mixture to cool to room temperature.
- Filter off the solid benzoic acid.

Data	Ethyl benzoate	Benzoic acid	Ethanol
Molar mass /g mol <sup>-1</sup>	150	122	46
Solubility in water	Insoluble	Soluble in hot water. Insoluble in cold water.	Soluble

- (a) The reaction mixture was heated under reflux. Suggest why it was:

- (i) heated

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(1)

- (ii) under reflux.

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(1)



(b) Draw a labelled diagram to show the apparatus used for **heating under reflux**.

**(4)**

(c) (i) Suggest why hydrochloric acid is added in Reaction II.

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**(1)**

(ii) Explain why the flask was cooled before filtering off the benzoic acid.

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**(1)**



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(d) (i) The benzoic acid produced weighed 2.93 g.

Calculate the percentage yield.

**(3)**

(ii) What would be the effect on the yield of benzoic acid if the mixture was **not** cooled thoroughly before filtering? Justify your answer.

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**(1)**

(e) The presence of the —OH group in ethanol can be shown by testing the dried distillate with phosphorus pentachloride.

Why must the distillate be dry?

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**(1)**

**Q5**

**(Total 13 marks)**



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6. Lithium nitrate, rubidium nitrate and strontium nitrate are white solids which all give similar colours in a flame test, so this test cannot be used to identify each with certainty.

You are required to outline a procedure that will allow you to identify a sample of each of the white solids.

**Your procedure must be based on the effect of heat on the three nitrates and the precipitation reactions of the compounds.**

You are not required to give details of the experimental techniques, but you must give the expected results in each case.

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**THERE IS MORE SPACE ON PAGE 14 IF YOU NEED TO CONTINUE YOUR ANSWER.**

**Q6**

**(Total 6 marks)**

**TOTAL FOR PAPER: 50 MARKS**

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# THE PERIODIC TABLE

Period **1** **2** **3** **4** **5** **6** **7** **0** Group

**Period**

1	H	He
Hydrogen	1	Helium
2	Li	Be
Lithium	3	4
3	Na	Mg
Sodium	11	12
4	K	Ca
Potassium	19	20
5	Rb	Sr
Rubidium	37	38
6	Cs	Ba
Caesium	55	56
7	Fr	Ra
Francium	87	88

Molar mass g mol <sup>-1</sup>
Symbol
Name
Atomic number

7	Li	Be	B	C	N	O	F	Ne
Lithium	3	4	5	6	7	8	9	10
8	Be	B	C	N	O	F	Ne	Ar
Beryllium	4	5	6	7	8	9	10	18
9	Li	Be	B	C	N	O	F	Ne
Lithium	3	4	5	6	7	8	9	10
10	Na	Mg	Al	Si	P	S	Cl	Ar
Sodium	11	12	13	14	15	16	17	18
11	K	Ca	Sc	Ti	V	Cr	Mn	Fe
Potassium	19	20	21	22	23	24	25	26
12	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru
Rubidium	37	38	39	40	41	42	43	44
13	Cs	Ba	La	Hf	Ta	W	Re	Os
Caesium	55	56	57	72	73	74	75	76
14	Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs
Francium	87	88	89	104	105	106	107	108

140	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
Cerium	58	59	60	61	62	63	64	65	66	67	68	69	70	71

232	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
Thorium	90	91	92	93	94	95	96	97	98	99	100	101	102	103

