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**Pearson Edexcel**  
**International**  
**Advanced Level**

Centre Number

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# Chemistry

**Advanced Subsidiary**

**Unit 3: Chemistry Laboratory Skills I**

Wednesday 25 January 2017 – Morning

**Time: 1 hour 15 minutes**

Paper Reference

**WCH03/01**

**Candidates may use a calculator.**

Total Marks

## Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided  
– *there may be more space than you need.*

## Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets  
– *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

## Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ►

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

- 1** A student carried out the tests described to distinguish between the pairs of compounds named in parts (a) to (d).

State what you would **see** when the test is carried out. Identify by name or formula any **gases** evolved during the reactions in parts (b) to (d).

- (a) Solid potassium chloride and solid sodium chloride.

**Test:** A flame test.

(2)

Observation with potassium chloride.....

Observation with sodium chloride.....

- (b) Aqueous potassium sulfate and aqueous potassium carbonate.

**Test:** Addition of excess dilute hydrochloric acid followed by aqueous barium chloride. Identify any **gas** evolved.

(2)

Observation with potassium sulfate.....

Observation with potassium carbonate.....

- (c) Solid ammonium sulfate and solid potassium sulfate.

**Test:** Warm the solid with aqueous sodium hydroxide and use damp red litmus paper to test any gas released. Identify any **gas** evolved.

(3)

Observation with ammonium sulfate.....

Observation with potassium sulfate.....



(d) Solid sodium chloride and solid sodium bromide.

**Test:** Add concentrated sulfuric acid.  
Identify all of the **gases** evolved.

(4)

Observation with sodium chloride.....

.....

.....

.....

.....

Observation with sodium bromide.....

.....

.....

.....

.....

(Total for Question 1 = 11 marks)



- 2 A halogenoalkane, **G**, has the molecular formula  $C_4H_9X$ , where X represents a halogen atom.

On heating **G** with excess dilute aqueous sodium hydroxide, compound **G** is converted into compound **J**,  $C_4H_{10}O$ .

Complete the tables.

(a)

| Test                                                                                                                                                                   | Observation              | Inference                     |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------|-------------------------------|
| To the solution remaining after heating <b>G</b> with excess dilute aqueous sodium hydroxide,<br><br>add .....<br><br>.....<br><br>followed by aqueous silver nitrate. | White precipitate forms. | The <b>atom X</b><br>is ..... |

(2)

(b)

| Test                                                                                                     | Observation | Inference                                                                                     |
|----------------------------------------------------------------------------------------------------------|-------------|-----------------------------------------------------------------------------------------------|
| Add phosphorus(V) chloride to pure <b>J</b> .<br><br>Test any gas evolved with<br><br>.....<br><br>..... | White smoke | The <b>formula</b> of the white smoke is<br><br>.....<br><br>Compound <b>J</b> is an alcohol. |

(2)



(c)

| Test                                                            | Observation    | Inference                                                                          |
|-----------------------------------------------------------------|----------------|------------------------------------------------------------------------------------|
| Warm <b>J</b> with acidified potassium dichromate(VI) solution. | .....<br>..... | Compound <b>J</b> is not oxidised.<br><br>Compound <b>J</b> is a<br>..... alcohol. |

(2)

(d) On the basis of the observations and inferences made in parts (a) to (c), draw the structure of compound **J**.

(1)

(Total for Question 2 = 7 marks)



- 3 A student carried out two similar, separate experiments to determine the enthalpy changes for the reactions of sodium hydrogencarbonate and sodium carbonate with excess dilute hydrochloric acid.

(a) The first experiment was to find the enthalpy change  $\Delta H_1$  for the reaction



### Results

| Measurement                                                                                | Value                                   |
|--------------------------------------------------------------------------------------------|-----------------------------------------|
| Mass of solid sodium hydrogencarbonate added to hydrochloric acid                          | 4.20 g                                  |
| Volume of hydrochloric acid                                                                | 50.0 cm <sup>3</sup>                    |
| Initial temperature of hydrochloric acid before addition of solid sodium hydrogencarbonate | 21.0 °C                                 |
| Final temperature of solution                                                              | 14.0 °C                                 |
| Molar mass of sodium hydrogencarbonate                                                     | 84.0 g mol <sup>-1</sup>                |
| Specific heat capacity of solution                                                         | 4.18 J g <sup>-1</sup> °C <sup>-1</sup> |



- (i) Calculate the number of moles of sodium hydrogencarbonate used in the experiment. (1)

moles of  $\text{NaHCO}_3 = \dots\dots\dots$  mol

- (ii) Calculate the heat energy absorbed in the reaction between sodium hydrogencarbonate and hydrochloric acid.

Use the expression:

Energy absorbed (J) =  $50.0 \times \text{specific heat capacity of solution} \times \text{temperature change}$  (1)

energy absorbed =  $\dots\dots\dots$  J

- (iii) Calculate the value of  $\Delta H_1$ .

Your answer should be in units of  $\text{kJ mol}^{-1}$ , expressed to **three** significant figures, and include a sign.

(3)

$\Delta H_1 = \dots\dots\dots$   $\text{kJ mol}^{-1}$



- (b) In the second experiment, the enthalpy change for the reaction between sodium carbonate and dilute hydrochloric acid was determined.



The molar enthalpy change of this reaction  $\Delta H_2$  was found to be  $-36.0 \text{ kJ mol}^{-1}$ .

- (i) Describe **two** ways in which the temperature change differs when equal numbers of moles of sodium hydrogencarbonate and sodium carbonate are reacted separately with the same volume of excess dilute hydrochloric acid.

(2)

First difference.....

.....

Second difference.....

.....

- (ii) State **one** assumption that has been made when calculating the values of  $\Delta H_1$  and  $\Delta H_2$  from the experimental results.

(1)

.....

.....

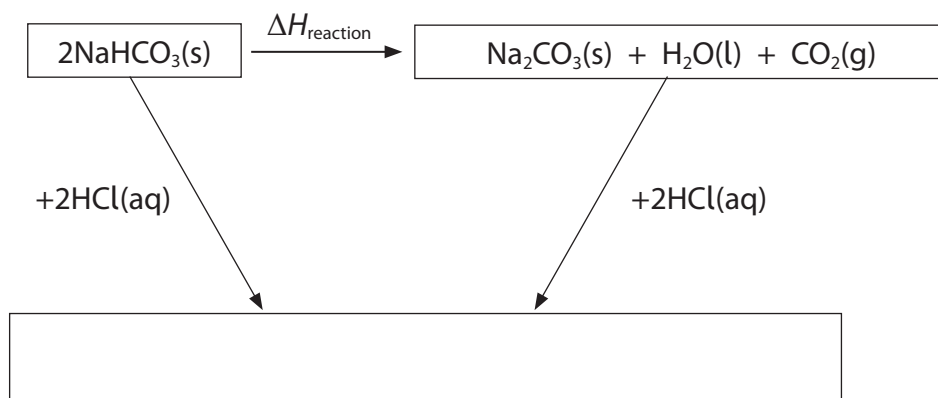


- (c) The results of the experiments in parts (a) and (b) may be used to calculate the enthalpy change of reaction for the thermal decomposition of sodium hydrogencarbonate. The equation for the reaction is



- (i) Complete the Hess cycle. Include state symbols with any formulae.

(2)



- (ii) Using the Hess cycle, or otherwise, complete the expression for  $\Delta H_{\text{reaction}}$  in terms of enthalpy changes  $\Delta H_1$  and  $\Delta H_2$ .

(1)

$$\Delta H_{\text{reaction}} =$$

- (iii) Use your value for  $\Delta H_1$  calculated in part (a)(iii), the value of  $\Delta H_2 = -36.0 \text{ kJ mol}^{-1}$  and your expression in (c)(ii), to calculate a value for  $\Delta H_{\text{reaction}}$  in  $\text{kJ mol}^{-1}$ .

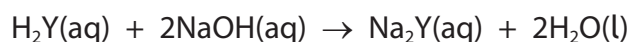
(1)

$$\Delta H_{\text{reaction}} = \dots\dots\dots \text{ kJ mol}^{-1}$$

**(Total for Question 3 = 12 marks)**



- 4 A titration is carried out to determine the concentration of a solution of sodium hydroxide, NaOH(aq), using the organic acid H<sub>2</sub>Y. The equation for the reaction is



Sodium hydroxide solution is added from a burette to 25.0 cm<sup>3</sup> of a 0.0500 mol dm<sup>-3</sup> solution of H<sub>2</sub>Y, to which several drops of phenolphthalein have been added.

- (a) State the colour change for the phenolphthalein indicator at the end-point of this titration.

(2)

From ..... to .....

- (b) A student obtained the readings shown.

| Titration number                            | 1     | 2     | 3     |
|---------------------------------------------|-------|-------|-------|
| Burette reading (final) / cm <sup>3</sup>   | 24.90 | 23.60 | 23.65 |
| Burette reading (initial) / cm <sup>3</sup> | 1.00  | 0.00  | 0.15  |
| Volume of NaOH used / cm <sup>3</sup>       | 23.90 | 23.60 | 23.50 |
| Used to calculate mean (✓)                  |       |       |       |

- (i) Calculate the mean titre in cm<sup>3</sup>.

Show which titres you have used in your calculation by putting a tick (✓) in the appropriate boxes.

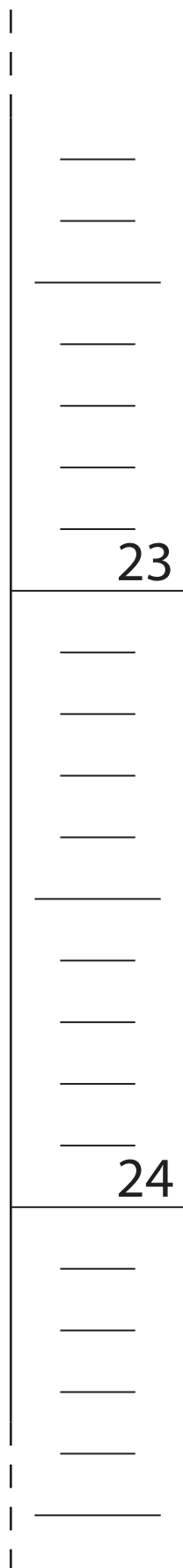
(2)

Mean titre = ..... cm<sup>3</sup>



- (ii) On the diagram below, show how the level of the sodium hydroxide solution appears when the final burette reading of  $23.65 \text{ cm}^3$  is recorded in titration 3.

(2)



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(c) (i) Calculate the number of moles of the acid,  $\text{H}_2\text{Y}$ , in  $25.0 \text{ cm}^3$  of a  $0.0500 \text{ mol dm}^{-3}$  solution. (1)

(ii) Calculate the number of moles of sodium hydroxide,  $\text{NaOH}$ , in the mean titre. (1)

(iii) Calculate the concentration of the sodium hydroxide solution in  $\text{mol dm}^{-3}$ . (1)

(iv) Describe **two** things you would do when using a burette to ensure that a particular reading is as accurate as possible. (2)

.....

.....

.....

.....

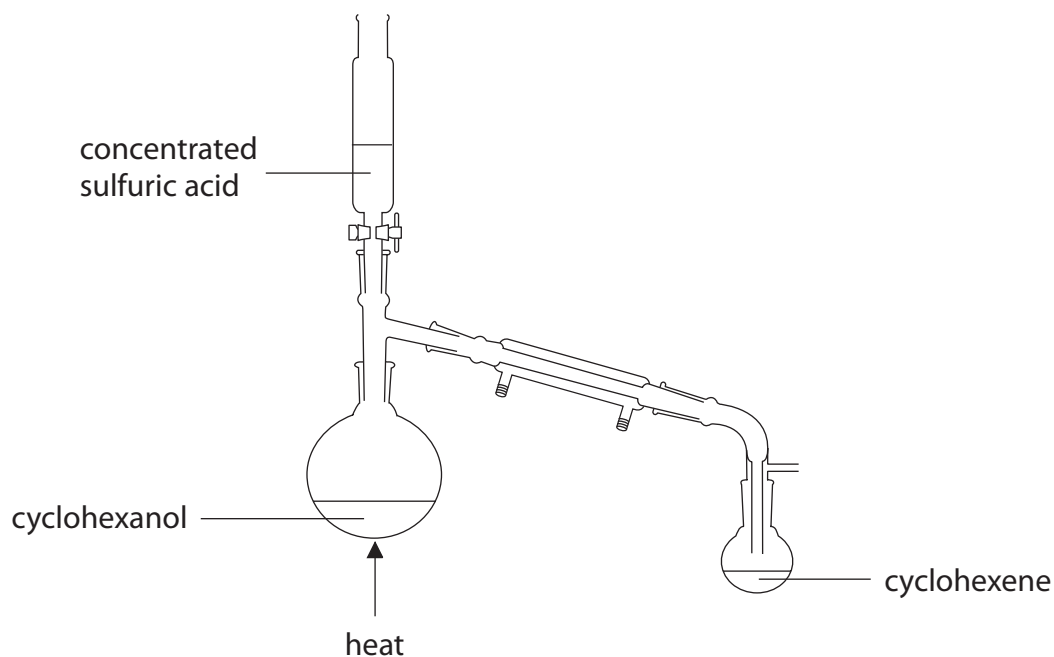
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(Total for Question 4 = 11 marks)

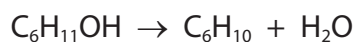


- 5 In an experiment to prepare cyclohexene,  $C_6H_{10}$ , concentrated sulfuric acid,  $H_2SO_4$ , was added slowly to 6.24 g of cyclohexanol,  $C_6H_{11}OH$ , in the apparatus shown in the diagram. The mixture was heated.



As the reaction took place, an impure liquid distilled over into the collection flask.

The equation for the preparation of cyclohexene is



- (a) (i) Calculate the volume of cyclohexanol used in this experiment.  
The density of cyclohexanol is  $0.962 \text{ g cm}^{-3}$ .

(2)



- (ii) Calculate the mass of cyclohexene that would be formed if **all** 6.24 g of cyclohexanol were converted into cyclohexene.

(2)

- (iii) After purifying the liquid, 1.64 g of cyclohexene was collected.  
Calculate the percentage yield of cyclohexene in this preparation.

(1)

- (b) The mixture in the collection flask contains impure cyclohexene, which is immiscible with water.

- (i) Three steps, shown in the table below, are then carried out for the purposes shown.

Complete the table by identifying suitable substances for each step.

(3)

| Step | Purpose of step                | Suitable substance to use |
|------|--------------------------------|---------------------------|
| 1    | To remove acidity              |                           |
| 2    | To remove inorganic impurities |                           |
| 3    | To dry the product             |                           |

- (ii) Identify the final step required in order to obtain pure cyclohexene from the dry product.

(1)

(Total for Question 5 = 9 marks)

TOTAL FOR PAPER = 50 MARKS



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