



Oxford Cambridge and RSA

Tuesday 13 October 2020 – Morning

AS Level Chemistry B (Salters)

H033/02 Chemistry in depth

Time allowed: 1 hour 30 minutes



You must have:

- the Data Sheet for Chemistry B

You can use:

- a scientific or graphical calculator
- an HB pencil



Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

Last name

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. If you need extra space use the lined pages at the end of this booklet. The question numbers must be clearly shown.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.

INFORMATION

- The total mark for this paper is **70**.
- The marks for each question are shown in brackets [].
- Quality of extended response will be assessed in questions marked with an asterisk (*).
- This document has **20** pages.

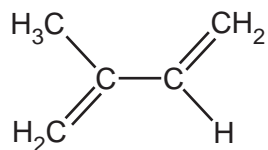
ADVICE

- Read each question carefully before you start your answer.

2

Answer **all** the questions.

- 1 Natural rubber is a polymer of 2-methylbuta-1,3-diene.



2-methylbuta-1,3-diene

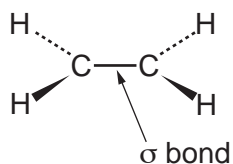
- (a) Draw the **skeletal** formula of 2-methylbuta-1,3-diene.

[1]

- (b) The carbon-carbon double bond consists of both a sigma(σ) and a pi(π) bond.

- (i) The diagram of ethene below shows the position of the sigma(σ) bond between the carbon atoms.

On the diagram sketch the shape and position of the pi(π) bond.



[1]

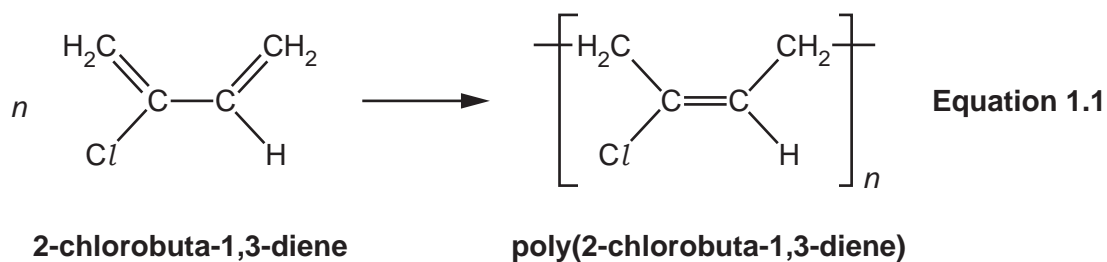
- (ii) Explain the meaning of the wedge bond (\blacktriangleright) in terms of the 3-D shape of ethene.

.....
 [1]

3

- (c) 2-chlorobuta-1,3-diene, $\text{CH}_2=\text{CClCH}=\text{CH}_2$ is made in industry.

It polymerises, as shown in **equation 1.1**.



- (i) Polymerisation of buta-1,3-diene, $\text{CH}_2=\text{CHCH}=\text{CH}_2$, occurs in the same way to form a synthetic rubber.

Draw the structural formula for poly(buta-1,3-diene).

[1]

- (ii) The poly(2-chlorobuta-1,3-diene) shown in **equation 1.1** is the *cis*-stereoisomer.

Draw the structure of the *trans*-stereoisomer for poly(2-chlorobuta-1,3-diene).

[1]

- (iii) Explain how the two stereoisomers for poly(2-chlorobuta-1,3-diene) occur.

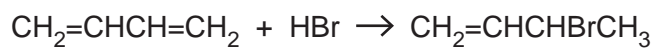
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..... [2]

4

(d) The reaction between 1 mol of buta-1,3-diene and 1 mol of hydrogen bromide is shown below.



(i) Name the mechanism of this reaction.

..... [1]

(ii) Draw the mechanism for this reaction.

Show curly arrows and full and partial charges.

[3]

5

- 2 Solid barium carbonate, BaCO_3 , is used as a rat poison.

In a rat's stomach, barium carbonate reacts with the hydrochloric acid to produce soluble barium chloride, BaCl_2 , which is poisonous.

- (a) Write an equation for the reaction of solid barium carbonate with hydrochloric acid. Carbon dioxide is produced in the reaction.

Include state symbols.

[2]

- (b) (i) Barium carbonate produces carbon dioxide gas when heated strongly. Calcium carbonate is less thermally stable.

Describe an experiment, using limewater, that you could do to show this.

Include a labelled diagram, how you would make it a valid test and what you would observe.

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.....

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..... [4]

7

- (iii) Calculate the energy change of an electron, in kJ, that causes the line at 6.20×10^{-7} m in the spectrum of calcium.

energy change = kJ [3]

8

- (d) A student uses a titration to measure the solubility of calcium hydroxide, $\text{Ca}(\text{OH})_2$.

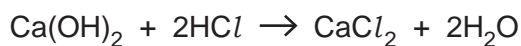
The student uses a volumetric pipette to transfer 25.0 cm^3 of a saturated solution of calcium hydroxide into a conical flask. A saturated solution is used because it contains the maximum mass of solute in a given volume of solution.

- (i) The uncertainty in using a 25.0 cm^3 pipette is 0.06 cm^3 .

Calculate the percentage uncertainty in using this pipette.

percentage uncertainty = % [1]

- (ii) The student titrates the 25.0 cm^3 of saturated $\text{Ca}(\text{OH})_2$ with hydrochloric acid of concentration $0.100 \text{ mol dm}^{-3}$.



A mean titre of 11.70 cm^3 is obtained.

Calculate the concentration of the saturated calcium hydroxide solution in g dm^{-3} .

concentration = g dm^{-3} [4]

- (e) The titration described in part (d) is repeated with 25.0 cm^3 of saturated barium hydroxide solution.

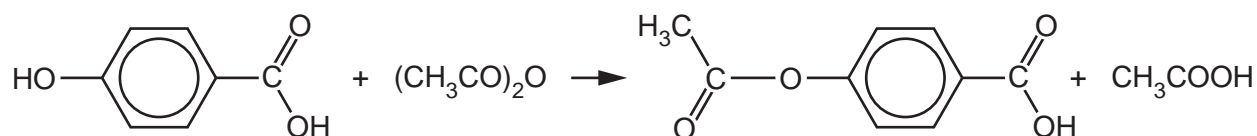
Suggest how the mean titre of $0.100 \text{ mol dm}^{-3}$ hydrochloric acid would differ from that for the saturated calcium hydroxide solution. Explain your answer.

.....

 [1]

10

The reaction from (b) is shown again here.



4-hydroxybenzoic acid

$M_r = 138$

4-acetoxybenzoic acid

$M_r = 180$

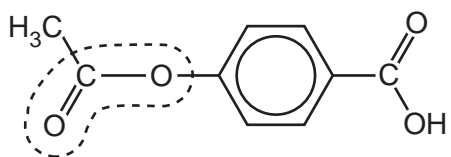
- (ii) The student reacts 3.5 g of 4-hydroxybenzoic acid with an excess of ethanoic anhydride. After purifying the crude product the student obtains 2.8 g of 4-acetoxybenzoic acid.

Calculate the percentage yield of 4-acetoxybenzoic acid.

Give your answer to an **appropriate** number of significant figures.

percentage yield = % [3]

- (c) Give the name of the functional group enclosed by the dashed line in the structure of 4-acetoxybenzoic acid.



..... [1]

(g)* The hydrolysis of parabens into 4-hydroxybenzoic acid may occur in slightly acidic or slightly alkaline household wastewater.

Some students investigate this hydrolysis. They make 4 solutions:

- a slightly alkaline solution of 4-acetoxybenzoic acid, **X**
- a slightly acidic solution of 4-acetoxybenzoic acid, **Y**
- a solution of pure 4-acetoxybenzoic acid, **P**
- a solution of pure 4-hydroxybenzoic acid, **B**

They run thin layer chromatograms of **X**, **P** and **B** (Fig. 3.1) and **Y**, **P** and **B** (Fig. 3.2).

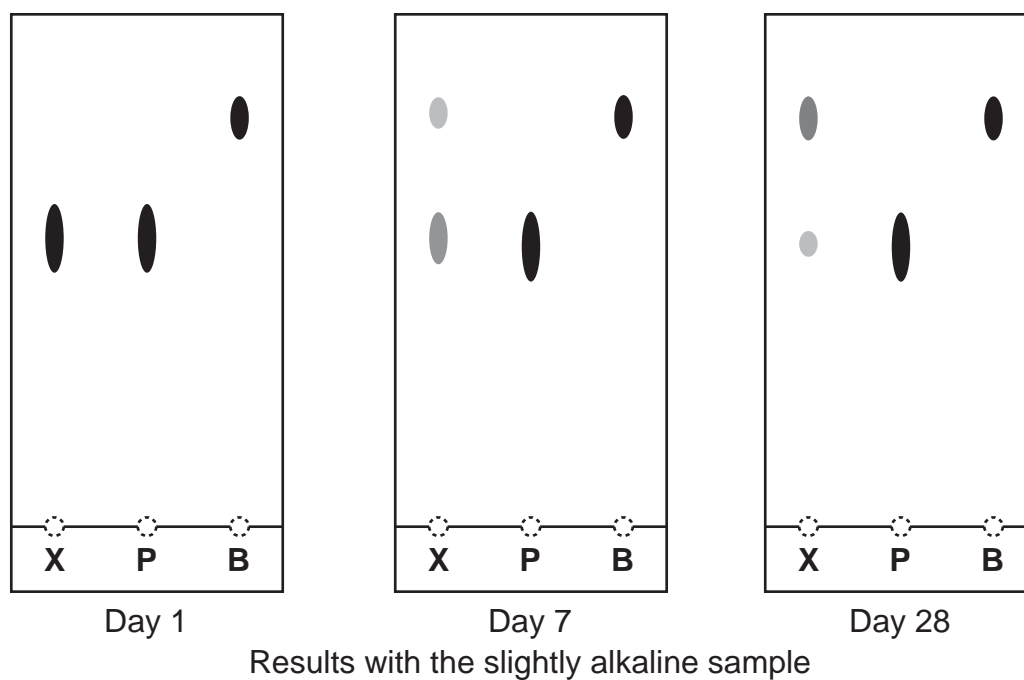


Fig. 3.1

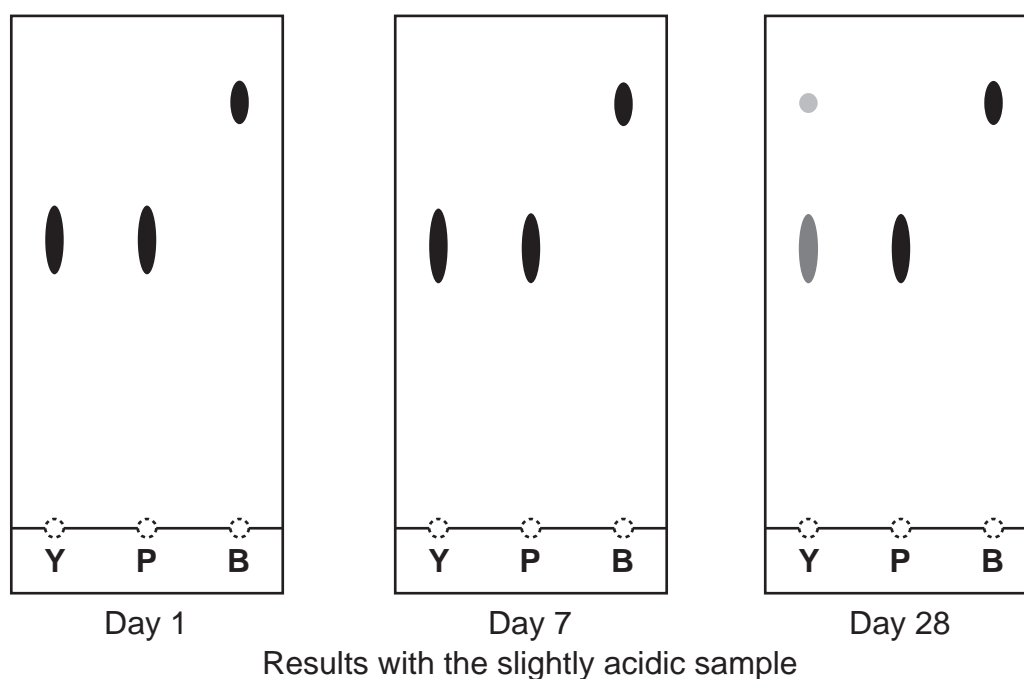
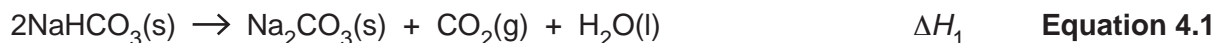


Fig. 3.2

14
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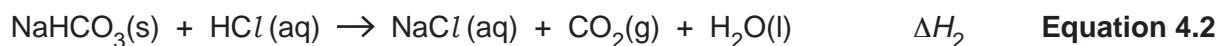
- 4 Sodium hydrogencarbonate is used in baking powder. When it is heated above about 80°C it begins to break down as shown in **equation 4.1**.



The enthalpy change for the thermal decomposition of sodium hydrogencarbonate, ΔH_1 , is difficult to determine directly by experiment.

Instead the enthalpy change for the reaction is determined indirectly using Hess' law.

The enthalpy changes ΔH_2 and ΔH_3 are determined separately.



- (a) Suggest why it is difficult to measure ΔH_1 directly.

.....
 [1]

- (b) A student does an experiment to measure ΔH_2 .

The student adds 7.50×10^{-2} mol of NaHCO_3 to 50.00 cm^3 (an excess) of 2.00 mol dm^{-3} HCl . The temperature **decreases** by 7.50°C .

Use this data to calculate ΔH_2 in kJ per mol of NaHCO_3 .

Assume the density and the specific heat capacity of the solution are the same as those of water.

$$\Delta H_2 = \dots\dots\dots \text{ kJ mol}^{-1} \quad [2]$$

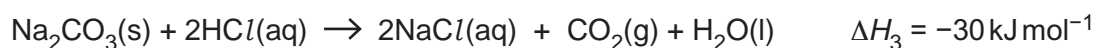
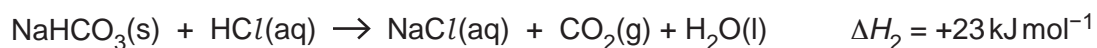
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- (d) In separate accurately performed experiments the following enthalpy changes were determined.



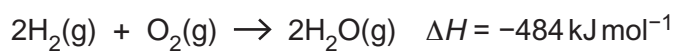
Draw a Hess' law enthalpy cycle and use these values for ΔH_2 and ΔH_3 to calculate a value for ΔH_1 .



enthalpy change $\Delta H_1 = \dots\dots\dots \text{ kJ mol}^{-1}$ [4]

18

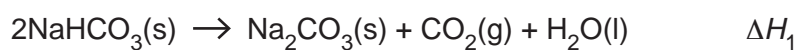
- (e) Bond enthalpies can be used in some calculations involving ΔH values. Use the data below to calculate a value for the bond enthalpy of the H–O bond.



Bond	Bond enthalpy/kJ mol ⁻¹
H–H	+436
O=O	+498

bond enthalpy of H–O = kJ mol⁻¹ [2]

- (f) Why can bond enthalpies **not** be used to estimate ΔH_1 ?



.....
 [1]

END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

A large rectangular area for writing, bounded by a solid vertical line on the left and horizontal dotted lines on the top, bottom, and right. The dotted lines are spaced evenly down the page.

A large rectangular area with a solid vertical line on the left side and horizontal dotted lines across the rest of the page, intended for writing answers.



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