GCE A LEVEL CHEMISTRY

S21-A410

Assessment Resource E

Chemistry in Practice

1. This question relates to the following eight compounds.

A	$CH_3CH_2CH_2CH_2OH$	butan-1-ol
B	$CH_3CH_2CH_2CH_2Br$	1-bromobutane
C	$CH_3CH_2CH_2CHO$	butanal
D	$(CH_3)_3COH$	
E	$CH_3CH_2CH_2COOH$	butanoic acid
F	$CH_3CH_2CH(OH)CH_3$	butan-2-ol
G	$CH_3CH_2CH_2CH_2NH_2$	butylamine
H	$CH_3CH_2CH_2CH_2CN$	

(a) Give the systematic names of compounds **D** and **H**. [2]

D .....

H .....

(b) An isomer of compound **H** shows optical isomerism.

(i) Draw diagrams to represent both optical isomers. [1]

(ii) Give **one** difference between the properties of the two optical isomers. [1]

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(iii) Give **one** reaction common to both optical isomers. Give the reagent and the structural formula of the organic product formed. [2]

Reagent .....

Product

(c) For each pair of compounds shown below, complete the table to describe a chemical test that can be used to distinguish between them.

Where appropriate, give the

- reagent(s) and condition(s) used
- observation(s) for the compound that reacts
- structural formula of the organic compound(s) formed in the positive test [8]

Compounds	Reagent(s) and condition(s)	Observation(s)	Organic compound(s) formed
$CH_3CH_2CH_2CH_2OH$ and $CH_3CH_2CH_2CH_2Br$		orange to green solution	
$CH_3CH_2CH_2CHO$ and $(CH_3)_3COH$	Tollens' reagent (alkaline solution of ammoniacal silver nitrate) warm gently in hot water bath		
$CH_3CH_2CH_2COOH$ and $CH_3CH_2CH(OH)CH_3$			CHI_3 and CH_3CH_2COONa
$CH_3CH_2CH_2CH_2NH_2$ and $CH_3CH_2CH_2CH_2CN$	nitric(III) acid (HNO_2) room temperature		

(d) Butanoic acid and butan-2-ol can react to form an ester.

(i) Give the essential reaction conditions. [1]

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(ii) Give the equation for the reaction. Clearly show the structure of the ester formed. [1]

(iii) State how the ester is separated from the reaction mixture. [1]

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2. A student determined the concentration of a barium chloride solution using the following method.

Step	Method
1	$50.0\,cm^3$ of the barium chloride solution was transferred into a $250\,cm^3$ beaker and $50.0\,cm^3$ of $0.506\,mol\,dm^{-3}$ sodium carbonate solution (an excess) was added. Barium carbonate was precipitated: $Ba^{2+}(aq) + CO_3^{2-}(aq) \longrightarrow BaCO_3(s)$
2	The mixture was filtered into a conical flask, and the beaker and the precipitate were washed four times with small quantities of deionised water. The washings and filtrate were collected in a $200\,cm^3$ volumetric flask and made up to the mark with deionised water. The flask was shaken well to ensure the solution formed was homogeneous. The solution was labelled as solution **Y**.
3	$25.0\,cm^3$ of solution **Y** was transferred into a conical flask and the unreacted sodium carbonate in the filtrate determined by titration against $0.200\,mol\,dm^{-3}$ hydrochloric acid using screened methyl orange as an indicator.

(a) Describe how the student could have confirmed experimentally that all of the barium ions had been precipitated in step **1**. [1]

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(b) Write an **ionic** equation for the reaction of carbonate ions with hydrogen ions (H^+) from the hydrochloric acid in step 3, to form carbon dioxide as one of the products. [1]

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(c) The student obtained the following results using 25.0 cm^3 samples of solution **Y**.

	Titration 1	Titration 2	Titration 3	Titration 4
Initial burette reading / cm^3	0.50	18.45	2.10	19.70
Final burette reading / cm^3	18.45	35.95	19.70	37.25
Titre / cm^3				

(i) **Complete the table** to show the volume of hydrochloric acid used in each titration and calculate an appropriate mean titre. [2]

Mean titre = ... cm^3

(ii) Identify the titration that has the largest percentage error in the volume of hydrochloric acid used. Give a reason for your choice.

A calculation of the percentage error is **not** required. [1]

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(d) The five stages in the calculation of the concentration of the barium chloride solution are set out in the statements below.

(i) Number these stages in the correct order. [1]

	Correct order
Calculate the number of moles of HCl used in the titration of 25.0 cm^3 of solution **Y**	
Calculate the number of moles of CO_3^{2-} that reacted with 200 cm^3 of solution **Y**	
Use the balanced equation to calculate the number of moles of unreacted CO_3^{2-} in 200 cm^3 of solution **Y**	
Calculate the concentration of the barium chloride solution in g dm^{-3}	5
Calculate the total number of moles of CO_3^{2-} added to the 50.0 cm^3 of barium chloride solution	

(ii) Calculate the concentration of the barium chloride solution in **g dm^{-3}**. [5]

Concentration = ... g dm^{-3}

(iii) Calculate the mass of barium carbonate obtained on heating the precipitate to constant mass. [1]

Mass = ... g