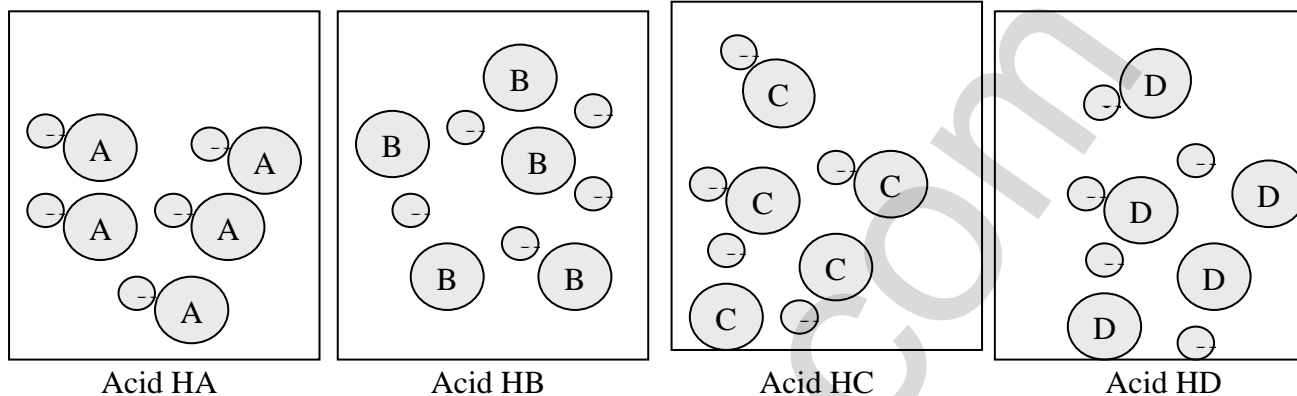### Section A. MULTIPLE CHOICE QUESTIONS (6 marks)

1. Each diagram below represents the number and type of chemical species (other than water molecules) present in the same volume of four different acidic solutions.

Acid HA   Acid HB   Acid HC   Acid HD

Which of the acidic solutions will show the highest pH?

(A) HA
(B) HB
(C) HC
(D) HD

2. In which of the following reactions is water acting as an acid?

(A) $H_3O^+_{(aq)} + HPO_4^{2-}_{(aq)} \Leftrightarrow H_2O_{(l)} + H_2PO_4^-_{(aq)}$
(B) $H_2O_{(l)} + HCO_3^-_{(aq)} \Leftrightarrow H_3O^+_{(aq)} + CO_3^{2-}_{(aq)}$
(C) $H_2O_{(l)} + NH_{3(g)} \Leftrightarrow NH_4^+_{(aq)} + OH^-_{(aq)}$
(D) $H_3O^+_{(aq)} + HS^-_{(aq)} \Leftrightarrow H_2S_{(aq)} + H_2O_{(l)}$

3. A lab assistant accidentally breaks a bottle of concentrated sulfuric acid on the Prep Room floor.
Which is the best method to neutralise the acid?

(A)   Wipe up the spilled acid with a roll of paper towels.
(B)   Add a large volume of water and then clean up the spill with a mop.
(C)   Sprinkle the spill with powdered zinc and allow to react completely.
(D)   Add powdered sodium hydrogen carbonate to the spill until it no longer fizzes.

1

4. Camellias grow well in soil of pH 4.5 – 5.0. Which indicators would you choose from the table below to check whether the pH of the soil in a particular area is suited for growing camellias?

Indicator	very acid		weakly acid	neutral		weakly basic		very basic
	pH							
	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14							
bromothymol blue	------------yellow------✸6.0 7.6✦----------blue---------------							
litmus	-----------red-------✸5.0 8.0✦--------blue--------------------							
methyl orange	----red---✸3.1 4.4✦----------------yellow----------------------------							
phenolphthalein	---------------colourless------------✸8.3 10.0✦-----red------------							

      (A) litmus and bromothymol blue
      (B) methyl orange and phenolphthalein
      (C) phenolphthalein and bromothymol blue
      (D) methyl orange and litmus

5. A soft drink company advertised that each of their 350mL bottles of soft drink contains 1.8L of carbon dioxide gas (measured at $25^{o}C$). What mass (in grams) of carbon dioxide would be lost by decarbonation of a bottle of soft drink?

      (A)   3.5
      (B)   3.2
      (C)   0.9
      (D)   1.0

6. Which of the apparatus would be used for the production and purification of an ester?

N.B. *Arrows show flow of cooling water.*
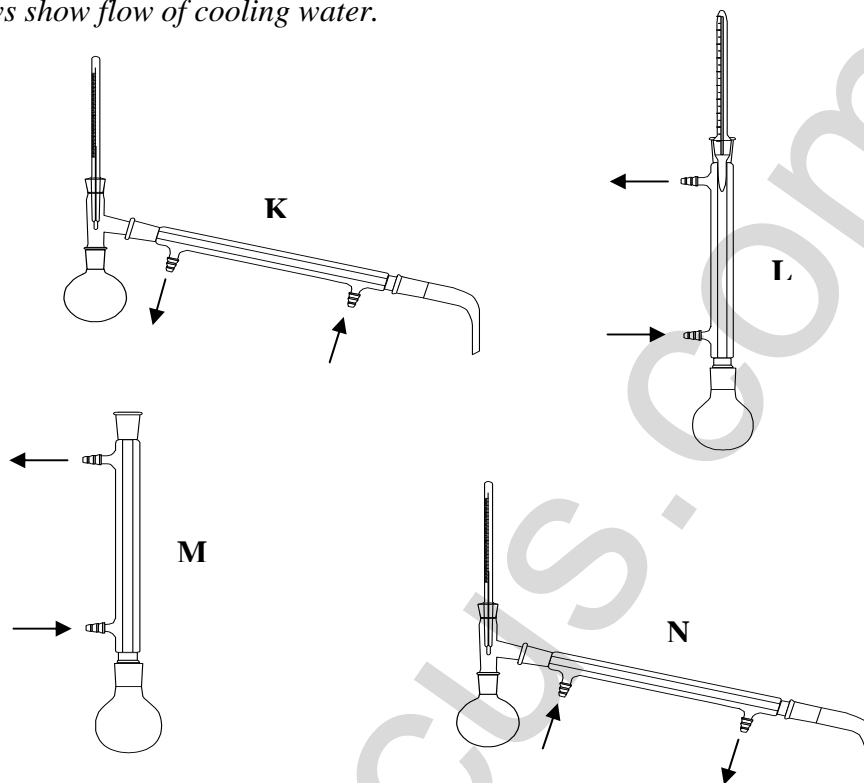
	Production of Ester	**Purification of Ester**
(A)	M	K
(B)	K	L
(C)	L	N
(D)	N	L

Answer Booklet for Sections A and B   **Student No.....................................**

Use the multiple choice answer sheet below.
Select the alternative A, B, C or D that best answers the question. Fill in the response square completely.

Sample   2+4= (A) 2   (B) 6   (C) 8   (D)9

A ○   B ▉   C ○   D ○

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ▉   B ✖   C ○   D ○

If you change your mind and have crossed out what you consider to be the correct answer, then indicate this by writing the word *correct* and drawing an arrow as follows:

correct

A ✖   B ✖   C ○   D ○

Section A

Multiple Choice Answer Sheet

1.   A ○   B ○   C ○   D ○

2.   A ○   B ○   C ○   D ○

3.   A ○   B ○   C ○   D ○

4.   A ○   B ○   C ○   D ○

5.   A ○   B ○   C ○   D ○

6.   A ○   B ○   C ○   D ○

Section B. Short–Answer Questions:

Question 7. (3 marks)

(a)   Give a specific example of a buffer in a natural system.. State the buffer
species and the natural system where it exists.   **(1 mark)**

………………………………………………………………………………·

(b)   1.0 mL of 0.50 mol L^{-1} HCl is added to 50 mL of distilled water.
Calculate the resultant pH of the solution.   **(1 mark)**

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(c)   Qualitatively describe the effect on the pH if 1.0 mL of 0.50 mol L^{-1} HCl was
added to 50 mL of a buffer solution with a pH of 7.0.   **(1 mark)**

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Question 8 (3-marks)

The melting points and boiling points of butanoic acid and 1–pentanol are shown in the table…

	Molecular Mass	**melting point (°C)**	**boiling point (°C)**
butanoic acid	88.1	– 5.2	163.2
1–pentanol	88.2	–78.2	138.0
Difference	0.1	73.0°C	25.3°C

Students X and Y make the following statements to explain the difference in the melting points and boiling points.

Student X:
The difference in the melting points and boiling points is due to differences in the dispersion force strength.

Student Y:
The difference in the melting points and boiling points is due to differences in the hydrogen bonding.

Give an explanation in support of **one** of the students using structural formula diagrams of butanoic acid and 1–pentanol to support your argument. **(3-marks)**

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Question 9 (2 marks)

Chemists are employed in diverse industries, e.g. mining, pharmaceutical, biochemical, food technology, materials science, environmental, material processing, agricultural, public utilities, petrochemical, textile, etc.

Choose a specific industry and complete the table concerning the chemist's role…

Industry where chemist is employed	Description of the role of a chemist working in this industry	Identify a chemical principle which the chemist applies in his work

Question 10 (3 marks)

(a) Write down an equation which describes the main ionisation reaction which occurs when a certain weak acid H_2A^- is added to water. **(1 mark)**

    ……………………………………………………………………………..

(b) H_2A^- reacts with nitric acid according to the following equilibrium equation.

$$H_2A^-_{(aq)} + HNO_{3(aq)} \Leftrightarrow H_3A_{(aq)} + NO_3^-_{(aq)}$$
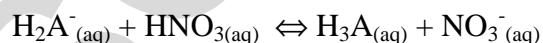
Decide which of the **reactants** is acting as an acid in this reaction and write down the formula of its conjugate base. **(1 mark)**

acid. ……………………………… conjugate base …………………………….

(c) The acid H_2A^- exhibits two different types of behaviour in (a) and (b) above. What term is used to describe a species with this ability? **(1 mark)**

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Question 11 (1 mark)

Explain the use of acids as food additives. In your answer, cite a specific example of an acid used for this purpose. **(1 mark)**

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Question 12 (2 marks)

Solutions of the salts $KHSO_4$ and $KHCO_3$ are acidic and basic respectively in aqueous solutions. Use net *ionic* equations to explain the observation. **(2 marks)**

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Question 13 *(4 marks)*

(a) Write an equation to describe the equilibrium reaction that occurs when carbon dioxide dissolves in water. This reaction is exothermic. Include states of matter and the enthalpy sign in the equation **(1 mark)**

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(b) Identify an ion which is produced as a result of this reaction which can affect the pH? **(1 mark)**

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(c) Complete the table below to identify the effects on equilibrium and pH of the following changes. **(2 marks)**

Change	Effect on Equilibrium (left, right, no effect)	Effect on pH (increase, decrease, no effect)
Increase the volume of the container		
Decrease the temperature of the reaction mixture		

Question 14   (*4 marks)*

Lightning can cause atmospheric oxygen and nitrogen to combine to form nitric oxide (NO). Nitric oxide slowly reacts with oxygen to form nitrogen dioxide NO_2.

(a) Write balanced chemical equations for these two reactions   **(2 mark)**

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 (b) What volume of nitric oxide (measured at 25^oC and 100kPa could be produced
    from 56g nitrogen?   **(1 mark)**

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(c) What mass of nitrogen dioxide could be produced from this volume of nitric
    oxide?   **(1 mark)**

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Question 15 (2 marks)

Compare and contrast the ideas about acids of Davy and Arrhenius.

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End of Test   A