

**Section A: Multiple Choice** (Nos. 1-4, 1-mark each))

Use the multiple choice answer sheet in the ANSWER BOOKLET

1. In an experiment in a particle accelerator with the isotope sodium-24, a neutron is captured by the Na-24 nucleus, forming a new isotope of sodium. This new isotope decays by alpha particle emission, producing a daughter nucleus. The daughter nucleus is:
- A. aluminium-28
  - B. fluorine-21
  - C. neon-20
  - D. fluorine-20

2. Which of the following is a conjugate acid/base pair?

- A.  $\text{H}_3\text{O}^+$  and  $\text{OH}^-$
- B.  $\text{HNO}_3$  and  $\text{H}_2\text{O}$
- C.  $\text{HNO}_3$  and  $\text{HNO}_2$
- D.  $\text{HNO}_3$  and  $\text{NO}_3^-$

3. Which of the following pairs of equations show the amphoteric behaviour of  $\text{H}_2\text{A}^-$

	Reaction 1	Reaction 2
A	$\text{H}_2\text{A}^- + \text{H}_3\text{O}^+ \rightleftharpoons \text{H}_3\text{A} + \text{H}_2\text{O}$	$\text{H}_2\text{A}^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{A} + \text{OH}^-$
B	$\text{H}_2\text{A}^- + \text{H}_3\text{O}^+ \rightleftharpoons \text{H}_3\text{A} + \text{H}_2\text{O}$	$\text{H}_2\text{A}^- + \text{OH}^- \rightleftharpoons \text{HA}^{2-} + \text{H}_2\text{O}$
C	$\text{H}_2\text{A}^- + \text{OH}^- \rightleftharpoons \text{H}_3\text{A} + \text{H}_2\text{O}$	$\text{H}_2\text{A}^- + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{A} + \text{OH}^-$
D	$\text{H}_2\text{A}^- + \text{H}_2\text{O} \rightleftharpoons \text{HA}^{2-} + \text{H}_3\text{O}^+$	$\text{H}_2\text{A}^- + \text{OH}^- \rightleftharpoons \text{HA}^{2-} + \text{H}_2\text{O}$

4. Use Le Chatelier's principle to predict the effect of various factors on the Haber process of ammonia production.

	Increase temperature	Increase pressure	Include catalyst
A	rate decreased	rate increased	rate increased
B	rate increased	rate decreased	rate not affected
C	yield increased	yield increased	yield increased
D	yield reduced	yield increased	no effect on yield

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

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) 9A ☐            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:A ☒            B ☒            C ☐            D ☐  
*correct* ↗**Section A****Multiple Choice Answer Sheet**

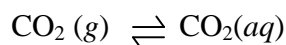
- |    |                         |                         |                         |                         |
|----|-------------------------|-------------------------|-------------------------|-------------------------|
| 1. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 2. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 3. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |
| 4. | A <input type="radio"/> | B <input type="radio"/> | C <input type="radio"/> | D <input type="radio"/> |

**Section B.** Answer the questions in the spaces provided. Show all relevant working in questions involving calculations

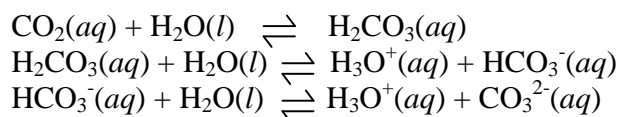
**MARKS**

**Question 5** (5 marks)

In water there is an equilibrium between gaseous and dissolved carbon dioxide according to the equation,



The dissolving process is exothermic. A series of equilibrium reactions occur as the dissolved carbon dioxide reacts with water.



a) Explain in terms of Le Chatelier's Principle why

i) fizzing occurs when a bottle of soft drink is opened?

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ii) a "flat" soft drink (ie from which all the bubbles escaped) has a higher pH than a newly opened bottle.

**1**

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b) A student measured the mass of carbon dioxide dissolved in a bottle of soft drink by weighing the bottle before opening and after all the gas had been liberated from solution. The measured mass change was 3.52g. Calculate the volume of carbon dioxide liberated at 25 °C and 101.3kPa.

**2**

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c) When excess carbon dioxide in the atmosphere dissolves in water, it can form acid rain. Describe one effect of acid rain.

**1**

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**Question 6** (3 marks)

MARKS

The salt, sodium hydrogen phosphate ( $\text{Na}_2\text{HPO}_4$ ) can be prepared by reacting sodium hydroxide solution with the required amount of phosphoric acid ( $\text{H}_3\text{PO}_4$ ) solution.

- a) Write a balanced equation for the reaction.

**1**

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- b) When some crystals of  $\text{Na}_2\text{HPO}_4$  were dissolved in water, the pH of the resulting solution was found to be 9.5. Calculate the hydrogen ion concentration of this solution.

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- c) Write an equation for the reaction of the  $\text{HPO}_4^{2-}$  ion with water to account for the measured pH.

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**Question 7** (3 marks)

- a) Give a balanced chemical equation to illustrate the process of esterification of methanoic acid with ethanol.

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- b) Explain the need for refluxing during esterification.

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**Question 8.** (5 marks)**MARKS**

A student tests the pH of three different monoprotic acid solutions of known concentrations. The results are shown in the table.

Monoprotic acid	Acid concentration (mol L <sup>-1</sup> )	Tested pH
HX	1.0	2.4
HY	0.02	1.7
HZ	0.5	2.3

- a) Outline what a weak acid is according to the Bronsted-Lowry theory. **1**

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- b) Which of the acids tested is the weakest acid based on your answer in (a)? **1**

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- c) Write an ionic equation showing the ionisation of HX in water. **1**

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- d) Which of the acids can be classified as a strong acid? Perform a simple calculation to support your answer. **1**

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- e) Name (i) an example of a weak, naturally occurring acid and (ii) a strong, manufactured acid. **1**

(i).....

(ii).....

Student No. ....

**Question 9** (5 marks)

**MARKS**

a. Outline the Lewis definition of an acid.

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b. A solution of sodium hydroxide is to be standardised with solid potassium hydrogen phthalate (KHP), a weak monoprotic acid. Outline the main steps required in the standardisation process, mentioning the main apparatus required for the process.

**3**

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c.. Describe the role of a buffer in maintaining the pH of a named natural system.

**1**

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**END OF TASK**