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University of Ruhuna- Faculty of Technology

Bachelor of Biosystems Technology Honors Degree
Level 1 (Semester I) Examination, December 2025
Academic year 2024/2025

Course Unit: BST 1172 Analytical Chemistry (Written) -Repeat
Duration: 1 and ½ hours

- Answer only **three (3)** questions. Write your answers in a separate answer book.
- Each question should start on a new page.
- If you answer more than three questions, only the **first three** will be marked.

1. Lactic acid ($HC_3H_5O_3$) is a weak acid commonly used in the food and pharmaceutical industries, with a dissociation constant K_a=1.38 ×10⁻4 at 25 °C. The dissociation is given by:

$$HC_3H_5O_3\ (aq) + H_2O\ (l) \rightleftharpoons C_3H_5O_3^-\ (aq) + H_3O^+\ (aq)$$

   a. Describe an experimental method to determine the acid dissociation constant (K_a) of lactic acid ($HC_3H_5O_3$) in aqueous solution. (20marks)
   b. Calculate the pH of a 0.25 $molL^{-1}$ lactic acid solution at 25 °C . (30 marks)
   c. Determine the pH of a 0.18 $molL^{-1}$ sodium lactate solution at 25 °C. (50 marks)
   (At 25 °C Kw = $1.0\times10^{-14}\ mol^2\cdot dm^{-6}$)

(Total: 100 marks)

2. Phosphoric acid (H_3PO_4) is a triprotic acid commonly used in fertilizers and food additives. A concentrated technical grade solution has the following specifications.

85% w/w H_3PO_4 **Density = 1.69 g/mL** **Purity = 90%**

   a. Briefly describe difference of Primary standard and Secondary standard solutions with relevant examples. (20 marks)
   b. Calculate the molarity of the concentrated H_3PO_4 solution as provided. (40 marks)
   c. Calculate the volume of the concentrated H_3PO_4 solution required to prepare 750.00 mL of a 0.02 M H_3PO_4 solution. (40 marks)
   *(Molar mass of H_3PO_4 = 98 $g\cdot mol^{-1}$)

(Total: 100 marks)

3. Answer to all parts

   a. Explain the fundamental difference between accuracy and precision.

   (20 marks)

   b. Discuss the importance of significant figures in analytical chemistry. (20 marks)

   c. Discuss the sources of errors that can affect accuracy and precision in analytical measurements. (20 marks)

   d. In an iodometric titration, a 0.912 g sample containing ascorbic acid ($C_6H_8O_6$) is dissolved and titrated with 0.0505 $molL^{-1}$ KIO_3 in acidic medium with excess KI. The titration requires 24.65 mL to reach the starch endpoint.

   Calculate the percentage (w/w) of ascorbic acid in the sample.

   The relevant reaction is:

   $$C_6H_8O_{6\,(aq)} + IO_3^-{}_{(aq)} + 5I^-{}_{(aq)} + 6H^+{}_{(aq)} \rightarrow C_6H_6O_{6\,(aq)} + 3I_{2\,(g)} + 3H_{2\,(aq)}$$

   (40 marks)

(Total: 100 marks)

4. Industrial wastewater contaminated with sulfuric acid (H_2SO_4) requires neutralization before discharge. Sulfuric acid fully dissociates in two steps in dilute solution. The overall dissociation is as follows.

$$H_2SO_4(aq) \rightarrow 2H^+(aq) + SO_4^{2-}(aq)$$

A 100.000 L batch of wastewater has an initial pH of 2.50.

   a. Calculate the initial concentration of H^+ ions (in mol/L) and the total moles of H^+ present in the wastewater tank. (30 marks)

   b. Determine the mass of solid sodium carbonate (Na_2CO_3, Molar mass. = 105.99 g/mol) required to completely neutralize the acidic wastewater. The neutralization reaction is:

$$Na_2CO_3(s) + 2H^+(aq) \rightarrow 2Na^+(aq) + CO_2(g) + H_2O(l)$$

   (30 marks)

   c. A buffer solution is prepared by mixing equal volume of 0.25 M ammonia (NH_3) and 0.15 M ammonium chloride (NH_4Cl). Calculate the pH of the buffer. (Kb of $NH_3 = 1.8 \times 10^{-5}$) (40 marks)

(Total: 100 marks)

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