BINDURA UNIVERSITY OF SCIENCE EDUCATION

CHEMISTRY DEPARTMENT

CH104: ANALYTICAL CHEMISTRY I

AUG 2023

TIME: 2 HRS

ANSWER QUESTION1 AND FOUR OTHER QUESTIONS. TWO FROM EACH OF SECTIONS A AND B. EACH QUESTION CARRIES 20 MAQRKS.

1   (a)   Normal alkanes are hydrocarbons with the formula C_nH_{2n+2}. Plants selectively synthesize alkanes with an odd number of carbon atoms. The concentrations of $C_{29}H_{60}$ in summer rainwater collected in Hannover, Germany, is 34 ppb. Calculate the molarity of $C_{29}H_{60}$ and express the answer in nM.   [5 marks]

      (b)   Consider the five results 12.53, 12.56, 12.47, 12.67, and 12.48. Is 12. 67 a bad result?   [5 marks]

      (c)   The carbohydrate content of glycoprotein with sugars attached to it is determined to be 12.6, 11.9, 13.0, 12.7, and 12.5 g of carbohydrate per 100 g of protein in replicate analyses. Find the 90% confidence intervals for the carbohydrate content.   [6 marks]

      (d)   Differentiate between a galvanic cell and an electrolytic cell.

                                              [4 marks]

## SECTION A: ANSWER TWO QUESTIONS

2.   (a)   Describe the method of standard addition.   [5 marks]

      (b)   An unknown sample of Ni^{2+} gave a current of 2.36 μA in an electrochemical analysis. When 0.500 mL of solution containing 0.0287 M Ni^{2+} was added in 25.0 mL of unknown, the current increased to 3.79 μA.

          (i)   Denoting the initial, unknown concentration as $[Ni^{2+}]_i$, write an expression for the final concentration, $[Ni^{2+}]_f$, after addition of 25.0

mL of unknown was mixed with 0.500 mL of standard. Use the dilution factor for this calculation. [3 marks

(ii) In a similar manner, write an expression for the final concentration of added standard Ni^{2+}, denoted as $[S]_f$. [3 marks]

(iii) Calculate $[Ni^{2+}]_i$ in the unknown. [5 marks]

(c) Describe internal standards as a calibration method in quantitative chemical analysis. [4 marks'

3. (a) Applying von Weimarn's theory of relative supersaturation, discuss the measures that can be taken to decrease relative supersaturation during a precipitation. [10 marks]

(b) What effect has the addition of 0.1 mol of anhydrous sodium acetate to 1 L of 0.1 M acetic acid upon the degree of dissociation of the acid?

[10 marks]

4. (a) Write the mass balance for a saturated solution of the slightly soluble Ag_3PO_4. [6 marks]

(b) (i) Calculate the pH of the solution produced by adding 10 mL of 1 M hydrochloric acid to 1 L of a solution which is 0.1 M in acetic acid and 0.1M in sodium acetate. [10 marks]

(ii) Comment on the pH regulatory effect of the buffer. [4 marks]

SECTION B: ANSWER ANY TWO QUESTIONS

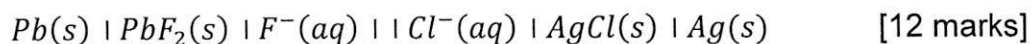5. (a) (i) Write Nernst equation for the following reaction:

$$\frac{1}{4}P_4(s, white) + 3H^+ + +5e^- \leftrightarrow PH_3 \quad E^0 = -0.046\ V$$
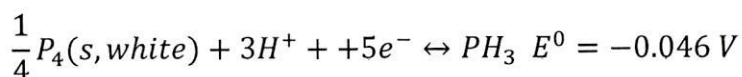
[3 marks]

(ii) Calculate the equilibrium constant for the following reaction:

$$Cu(s) + 2Fe^{3+} \leftrightarrow 2Fe^{2+} + Cu^{2+}$$ [5 marks}

(b) Calculate the cell voltage for the following cell in which the concentration of NaF and KCl were each 0.01 M.

$$Pb(s) \mid PbF_2(s) \mid F^-(aq) \mid\mid Cl^-(aq) \mid AgCl(s) \mid Ag(s)$$ [12 marks]

6. Consider the titration of 50.0 mL of 0.0200 M MES with 0.1000 M NaOH. MES is an abbreviation for 2 –(N – morpholino)ethanesulfonic acid, which is a weak acid with pKa = 6.27.

    (a) Calculate the pH of the solution after the addition of 0.0, 5.0, 9.99, 10.0, 10.1, 10.3 mL of NaOH solution.

    [14 marks]

    (b) Using the provided data, sketch the titration curve and comment on the different regions.　　[6 marks]

7. (a) Describe four types of EDTA titrations.　　[12 marks]

    (b) The formation constant for CaY^{2-} is $10^{10.65}$. Calculate the concentration of free Ca^{2+} in a solution of 0.10 M CaY^{2-} at pH 10.00 and at pH 6.00.

    [8 marks]

END