NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED CHEMISTRY

ANALYTICAL CHEMISTRY II

SCH 2106

First Semester Examination Paper

December 2016

This examination paper consists of 4 pages

Time Allowed: **3 hours**

Total Marks: **100**

Examiner's Name: Dr. A. Maringa

INSTRUCTIONS

1. Answer ALL questions in section A and any three (3) questions in section B
2. Each question in section A carries 10 marks and each question in section B carries 20 marks

MARK ALLOCATION

QUESTION	MARKS
SECTION A: 1.	**10**
2.	**10**
3.	**10**
4.	**10**
SECTION B: 5	**20**
6	**20**
7	**20**
8	**20**
TOTAL POSSIBLE MARKS	**100**

SECTION A

1. Define the following terms found in Atomic spectroscopy:
   i. Atomization
   ii. Doppler broadening
   iii. Chemical interferences
   iv. Protective agents
   v. plasma

[10 marks]

2. a) In a hot flame, the emission intensities of sodium lines at 589 nm and 589.6 nm are greater in a solution that contains KCl than when this compound is absent. Suggest an explanation? [5 marks]

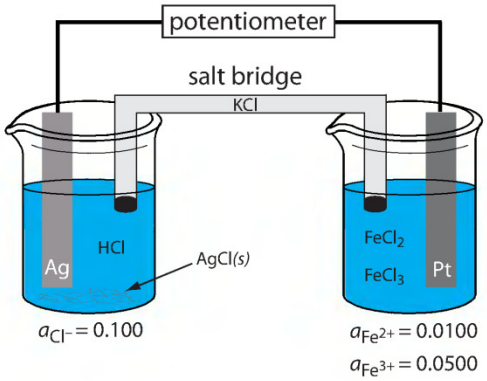
   b) In the concentration range of 500 ppm to 2000 ppm U, there is a linear relationship between absorbance at 351.5 nm and concentration. At lower concentration the relationship is non-linear unless about 2000 ppm of alkali metal is introduced into the sample. Explain? [5 marks]

3. a) Write the reaction occurring at the anode and the cathode for electrochemical cell with the following shorthand notation:

   Pt (s) | H_2 (g), H^+ (aq) ||Cu^{2+} (aq) | Cu (s)

   $Cu^{2+} + 2e^- \rightleftharpoons Cu(s)$ $E^o = 0.337$ V, $2H^+ + 2e^- \rightleftharpoons H_2(g)$ $E^o = 0.000$ V [4 marks]

   b) Calculate the potential of the electrochemical cell shown below. [6 marks]



4. At 580 nm, the wavelength of its maximum absorption, the complex $Fe(SCN)^{2+}$ has a molar absorptivity of 7.00×10^3 L cm^{-1} mol^{-1}. Calculate:
    i. The absorbance of a 3.40×10^{-5} M solution of the complex at 580 nm in a 1.00-cm cell. [3 marks]
    ii. The absorbance of a solution in which the concentration of the complex is twice that in (i). [3 marks]
    iii. The transmittance of the solutions described in (i) and (ii). [4 marks]

SECTION B

5. a) With the aid of labeled diagrams explain the difference between single-beam and double beam spectrophotometers. [7 marks]
    b) Discuss the limitations of Beer's Law. [13 marks]

6. a) How can we reduce the concentration overpotential in coulometry and electrogravimetry? [4 marks]
    b) Explain the factors that decrease the output voltage of a galvanic cell? [6 marks]
    c) Discuss the advantages of using coulometric titrations [10 marks]

7. Copper is to be deposited from a solution that is 0.250 M in Cu(II) and is buffered to a pH of 4.00. Oxygen is evolved from the anode at a partial pressure of 730 torr. The cell has a resistance of 3.60 Ohms and the temperature is 25°C. Calculate:
    a) The theoretical potential needed to initiate deposition of copper from this solution. [5 marks]
    b) The IR drop associated with a current of 0.15 A in this cell. [5 marks]
    c) The initial potential, given that the overvoltage of oxygen is 0.50 V under these conditions. [5 marks]
    d) The potential of the cell when $[Cu^{2+}]$ is 7.00×10^{-6}, assuming that IR drop and O_2 overvoltage remain unchanged. [5 marks]

8. a) Calculate the potential of copper electrode immersed in

i. 0.0380 M $Cu(NO_3)_2$. [5 marks]

ii. 0.0560 M in NaCl and saturated with CuCl. [5 marks]

iii. 0.0350 M in NaOH and saturated with $Cu(OH)_2$. [5 marks]

Given that: $Cu^{2+} + 2e^- \rightleftharpoons Cu(s)$ $E^o = 0.337$ V

$Cu^+ + e^- \rightleftharpoons Cu(s)$ $E^o = 0.521$ V

$K_{CuCl} = 1.9\ x\ 10^{-7}$, $K_{Cu(OH)_2} = 4.8\ x\ 10^{-20}$

b) A 2.00-mL urine specimen was treated with reagent to generate a colour with phosphate, following which the sample was diluted to 100 mL. To a second 2.00-mL sample, exactly 5.00 mL of a phosphate solution containing 0.0300 mg phosphate/mL was added, which was treated in the same way as the original sample. The absorbance of the first solution was 0.428, and that of the second was 0.538. Calculate the concentration of phosphate in milligrams per millimetre of the specimen. [5 marks]

End of question paper!!!!