



**UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA**  
**FIRST SEMESTER EXAMINATIONS, May 2018**

**COURSE NO: ES 370**  
**COURSE NAME: COMPUTER APPLICATION**  
**CLASS: ES III** **TIME: 3.5 HOURS**

Name: \_\_\_\_\_ Index Number: \_\_\_\_\_

**ANSWER QUESTION ONE AND ANY OTHER TWO QUESTIONS (60 MARKS)**

**QUESTION ONE**

The following standardization data were provided for a series of external standards of Cd<sup>2+</sup> that had been buffered to a pH of 4.16.

[Cd <sup>2+</sup> ] (nM)	15.4	30.4	44.9	59.0	72.7	86.0
S <sub>meas</sub> (nA)	4.8	11.4	18.2	26.6	32.3	37.7

- (a) Determine the standardisation relationship by a linear regression analysis and report the 95% confidence intervals for the slope and y-intercept. **(8 marks)**
- (b) Construct a plot of the residuals and comment on their significance. **(5 marks)**

At a pH of 3.7 the following data were recorded

[Cd <sup>2+</sup> ] (nM)	15.4	30.4	44.9	59.0	72.7	86.0
S <sub>meas</sub> (nA)	15.0	42.7	58.5	77.0	101	118

- (c) How much more or less sensitive is this method at lower pH? **(4 marks)**
- (d) A single sample is buffered to a pH of 3.7 and analysed for cadmium, yielding a signal of 66.3. Report the concentration of Cd<sup>2+</sup> in the sample and its 95% confidence interval. **(3 marks)**

**NB:** Please use Microsoft excel and its associated functions to perform an interactive spread sheet. The

following formulae may be useful:  $m = \frac{S_{xy}}{S_{xx}}$ ,  $b = \bar{y} - m\bar{x}$ ,  $S_r = \sqrt{\frac{S_{yy} - m^2 S_{xx}}{N-2}}$ ,  $S_m = \sqrt{\frac{s_r^2}{S_{xx}}}$ ,  $S_b =$

$$S_r \sqrt{\frac{1}{N - (\sum x_i)^2 / \sum x_i^2}}, S_c = \frac{s_r}{m} \sqrt{\frac{1}{M} + \frac{1}{N} + \frac{(\bar{y}_c - \bar{y})^2}{m^2 S_{xx}}}$$

## QUESTION TWO

A lake with an initial zero concentration, receives a load of a slowly reacting pesticide (trallate) at a certain rate. The concentration of this pollutant in the lake started to increase. The following are triallate concentration in the lake as a function of time (year, concentration in  $\mu\text{g/L}$ );

Time (year)	Conc. ( $\mu\text{g/L}$ )
1	1153.6
2	1490.7
3	1589.3
4	1618.1
5	1626.5
6	1628.9

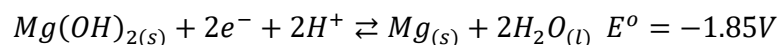
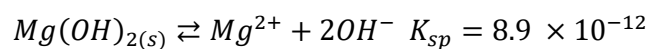
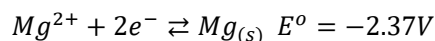
The discharge from the lake averages  $2.832 \text{ m}^3/\text{s}$  and the volume is  $8.92 \times 10^7 \text{ m}^3$ . Using the dynamic pollutant fate and transport modelling in excel, determine the following;

- (i) the equilibrium concentration of this pollutant in the lake (4.5 marks)
- (ii) first order removal rate of the pollutant from the lake (4.5 marks)
- (iii) the half-life of the pollutant (3 marks)
- (iv) the load of this pollutant into the lake in kg/day (2 marks)
- (v) the time until a level of  $100 \mu\text{g/L}$  is reached (2 marks)
- (vi) the model graph (4 marks)

## QUESTION THREE

Calculate and draw the Pourbaix diagram for magnesium in aqueous solution at  $25^\circ\text{C}$ , assuming that the only three species of Mg present are  $\text{Mg}_{(s)}$ ,  $\text{Mg}^{2+}$  and  $\text{Mg}(\text{OH})_{2(s)}$  and that the total concentration of dissolved magnesium species,  $[\text{Mg}]_{\text{tot}} = 1 \text{ M}$ .

- (a) Using the following three equilibria reactions and the Sigma plot software with export to MS word technique indicate the stability field of each Mg species. Develop all the equations for equilibria reactions (15 marks)



- (b) Is  $\text{Mg}^{2+}$  ion stable in the whole pH interval? Explain your answer. (2 marks)

- (c) State the conditions and label the diagram to show the regions where magnesium corrodes and is immune to corrosion. **(3 marks)**

#### QUESTION FOUR

A water has the following chemical analysis;

Na <sup>+</sup>	120 mg/L
K <sup>+</sup>	15 mg/L
Ca <sup>2+</sup>	380 mg/L
Mg <sup>2+</sup>	22 mg/L
Cl <sup>-</sup>	15 mg/L
SO <sub>4</sub> <sup>2-</sup>	1115 mg/L
pH	7.4
Alkalinity	130 mg/L CaCO <sub>3</sub>
Temperature	15°C

Using Visual Minteq software on your computer with export to Excel, determine the following;

- (a) The total negative and positive charges. Do the charges balance? **(3 marks)**
- (b) The concentrations of the ionic species in mol/L. **(5 marks)**
- (c) The ionic strength of the solution **(1 mark)**
- (d) The activity coefficient for Ca<sup>2+</sup> and SO<sub>4</sub><sup>2-</sup> using the Davies equation **(2 marks)**
- (e) What are the major complexes for Calcium and Sulphate? Some species are almost entirely present as free species; other species form more complexes. Is there a pattern to this? Why? **(4 marks)**
- (f) State the mineral phases that are thermodynamically favoured to precipitate or dissolve in this water. **(5 marks)**

*Examiners: Dr S. Fosu/Dr I. Quaicoe*