UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA

SECOND SEMESTER EXAMINATIONS, MAY, 2018

COURSE NO: **ES 274**
COURSE NAME: **ENVIRONMENTAL CHEMISTRY**
CLASS: **ES II** TIME: 3 HOURS

Name**:** _____Index Number: _____

ANSWER ALL QUESTIONS (60MARKS)

QUESTION ONE

(a) Define *Eh* and sate the relationship between *Eh* and p*E*. (**3 marks**)

(b) Consider the reduction of nitrate ion to nitrite ion in a natural water system.

(i) Write the balanced one-electron half-reaction for the process if it occurs in acidic media. (**3 marks**)

(ii) Given that for this reaction, $E^o = +0.881$ V, calculate pE^o. (**2 marks**)

(iii) From your answer to (i), deduce the expression relating pE to pE^o, pH and ion concentrations. (**4 marks**)

(iv) From your result in part (iii), obtain an equation relating the pE and pH conditions under which the ratio of nitrate to nitrite is 100:1. (**2 marks**)

(v) From your result in part (iii), deduce the ratio of nitrite to nitrate under conditions of pE = 12, pH = 5. (**2 marks**)

(vi) Explain the difference between *nitrification* and *denitrification* and state the microorganisms that facilitate these reactions. (**4 marks**)

QUESTION TWO

(a) What is pollutant transport and pollutant fate? (**2 marks**)

(b) List four (4) major transformation reactions of pollutants and give a two-to-three sentence description of each. (**8 marks**)

(c) The average concentration of total phosphorus (TP) in a lake is 30 µg/L and an attempt is to be made to reduce the phosphorus level in the lake by reducing phosphorus inflows into the lake. The target phosphorus concentration is 15 µg/L.

(i) If the discharge from the lake averages 0.09 m^3/s, the first-order decay rate for phosphorus is $0.01d^{-1}$, and the volume of the lake is 300,000 m^3, estimate the maximum allowable phosphorus inflows in kg/yr. (**4 marks**)

(ii) If this loading is maintained for 3 years but suddenly doubles in the fourth year, estimate the phosphorus concentration in the lake 1 month into the fourth year. (**6 marks**)

QUESTION THREE

(a) Explain *eutrophication* and its effect in an aquatic ecosystem. (**5 marks**)

(b) Nitrogen gas (N_2) is the most abundant gas in the atmosphere, comprising nearly 78% of the air we breathe. However, N_2 is not readily available to most living organisms. Explain why and what is needed to convert to more biologically relevant forms. (**4 marks**)

(c) Define alkalinity? (**1 marks**)

(d) Calculate the concentration of each carbonate species in solution at 25°C when total dissolved inorganic carbon (C_T) = 1 $x10^{-3}$ $molL^{-1}$ and pH = 5.7. State the dominant species at this pH? Given that K_{a1} = 4.45 x 10^{-7} is the first dissociation constant for weak carbonic acid and K_{a2} = 4.69 x 10^{-11} is the second dissociation constant for bicarbonate. (**10 marks**)

***Examiners: Dr S. Fosu**/Assoc. Prof. S. Ndur*