



UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA
SECOND SEMESTER EXAMINATIONS, MAY 2019

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

Name: _____ Index Number: _____

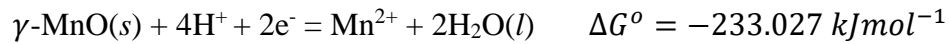
ANSWER ALL QUESTIONS (60 MARKS)

QUESTION ONE (20 MARKS)

- (a) Define pollutant degradation half-life. **(1 mark)**
- (b) Explain biodegradation with respect to organic pollutants. **(1 mark)**
- (c) Under what circumstances does a contaminant become a pollutant? **(1 mark)**
- (d) Explain how toxicological chemistry differs from environmental biochemistry. **(2 marks)**
- (e) How may volatility, hydrophobic tendency and hydrophilic tendency be involved in environmental fate and transport in the atmosphere? **(3 marks)**
- (f) Explain the two major ways in which a substance may be *sequestered* by another phase in the environment. **(2 marks)**
- (g) A field has been treated with DDT and rainwater percolating down through the soil contains 3 ppb DDT. Organic carbon makes up 3% of the soil. Calculate the amount of DDT adsorbed per gram of soil. For DDT, $\log K_{oc} = 5.18$. **(5 marks)**
- (h) Assume an organic contaminant is introduced into an aquifer. Right after the spill, the concentration of the organic contaminant is 12 mgL^{-1} . A measurement made 20 days later reveals that the concentration of the contaminant has decreased to 1 mgL^{-1} . Assuming that this is a first order reaction, what is the half-life for this particular organic contaminant? **(5 marks)**

QUESTION TWO (20 MARKS)

- (a) Define Eh . (1 mark)
- (b) What is an electroactive species? (1 mark)
- (c) A natural water at pH = 8 containing 10^{-5} M Mn^{2+} is in equilibrium with γ - $MnO_2(s)$ according to the following chemical equation;

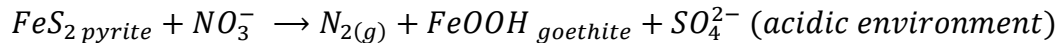


Show that;

$$pe = 20.42 + \frac{1}{2} \times \log \frac{[H^+]^4}{[Mn^{2+}]}$$

(7 marks)

- (d) Calculate pe using the information in part (c) and indicate whether this water environment with the manganese species is oxidizing or reducing. (1.5 marks)
- (e) Balance the oxidation-reduction reaction in the following environment and state the oxidizing and reducing agent;



(6.5 marks)

- (f) Describe what happens when an organic-rich effluent enters aerobic groundwater.

(3 marks)

QUESTION THREE (20 MARKS)

- (a) pH is referred to as an *environmental parameter*. What does this mean? (1 mark)
- (b) Explain why pH of surface waters increases when green plants in the water are actively photosynthesizing. (2 marks)
- (c) State the Henry's Law. (2 marks)
- (d) Water from a septic tank drainage field enters an aquifer. The water contains a significant amount of dissolved organic carbon. Oxidation of this dissolved organic carbon adds CO_2 to the groundwater. The system is effectively isolated from the atmosphere and after the breakdown of the dissolved organic carbon, $P_{CO_2} = 10^{-2.5}$ atm. The temperature of the groundwater is $15^\circ C$. Calculate the pH of the groundwater. Given that at $15^\circ C$ the pK_{a1} for

carbonic acid is 6.42 and Henry's Law constant for CO₂ is $4.55 \times 10^{-2} \text{ molL}^{-1}\text{atm}^{-1}$.

(8 marks)

- (e) What can water's polar nature be attributed to? Describe why water is a powerful solvent giving rise to various types of reactions in aquatic environment. **(3 marks)**
- (f) What percentage of total ammonia (i.e., NH₃ + NH₄⁺) is present as NH₃ at pH of 7? The pK_a for NH₄⁺ is 9.3. Which form of the total ammonia is toxic to aquatic life.

(4 marks)

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