

UNIVERSITY OF RUHUNA

BACHELOR OF SCIENCE GENERAL DEGREE LEVEL III (SEMESTER II)
EXAMINATIONS- NOVEMBER/DECEMBER-2016

SUBJECT: Chemistry
COURSE UNIT: CHE 322a

TIME: One (01) hour

Answer Three (03) Questions.

01. Answer part (a) and one from part (b) or (c).

(a) Answer the following questions.

(i) Write down the method of collecting and preserving water samples on site to determine dissolved oxygen (DO) and biochemical oxygen demand (BOD₅).

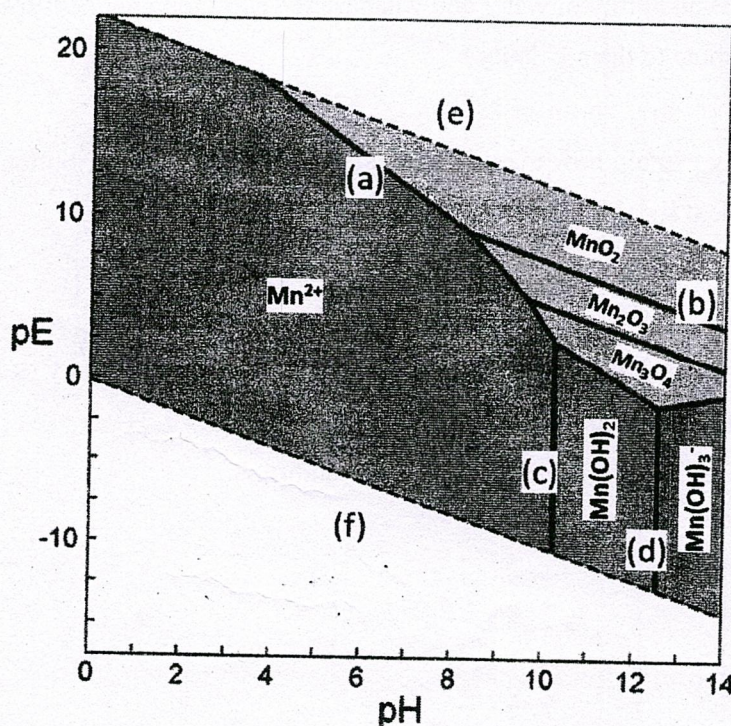
(25 marks)

(ii) What type of information can be obtained related to the quality of a water sample by measuring chemical oxygen demand (COD) and biochemical oxygen demand (BOD₅)?

(10 marks)

Answer only part (b) or (c)

(b) The pE-pH diagram given below shows the speciation of manganese in an aquatic system at 25°C.



(i) Write balanced chemical equations for the reactions taking place at the boundaries labeled as (a), (b), (c) and (d).

(28 marks)

(ii) What do the dotted lines (e) and (f) indicate? Write balanced chemical equations for the reactions taking place at the dotted lines.

(20 marks)

(iii) Calculate the concentration of Mn^{2+} in the above aquatic system under the conditions of boundary (c). K_{sp} of $\text{Mn}(\text{OH})_2 = 2.00 \times 10^{-13} \text{ M}^3$ at 25°C

(17 marks)

(c) Answer the following questions.

(i) Calculate the concentration of carbon dioxide (CO_2) in water at a temperature of 25°C , if air in equilibrium with this water contains 0.005 atm of CO_2 . Express your answer in both moles per liter and milligrams per liter (the molecular mass of CO_2 is 44.0 g/mol. The Henry's Law constant for carbon dioxide at 25°C is $3.38 \times 10^{-2} \text{ mol/L atm}$).

(20 marks)

(ii) (A) What is alkalinity of water and what are the common chemical species that contribute to the alkalinity?

(10 marks)

(B) Briefly explain how to experimentally determine the contribution from main chemical species for the alkalinity of a water sample.

(15 marks)

(C) A water sample has a pH of 9.8 and a measured total alkalinity of 35.0 mg/L CaCO_3 at 25°C . Calculate the total alkalinity in mol/L H^+ and the contribution from CO_3^{2-} and HCO_3^- for the total alkalinity.

(20 marks)

02. Answer *all* parts

(a) Write balanced chemical equations for

(i) Formation of ozone by photodissociation of O_2

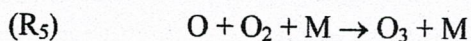
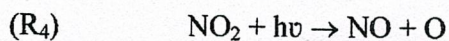
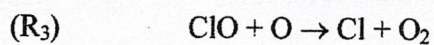
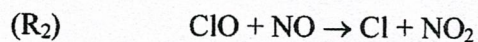
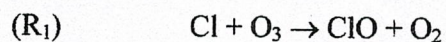
(ii) Regeneration of O_2 back from O_3

(30 marks)

(b) Define the terms primary air pollutants and secondary air pollutants

(15 marks)

(c) Consider the following photochemical reaction sequence involving chlorine compounds:



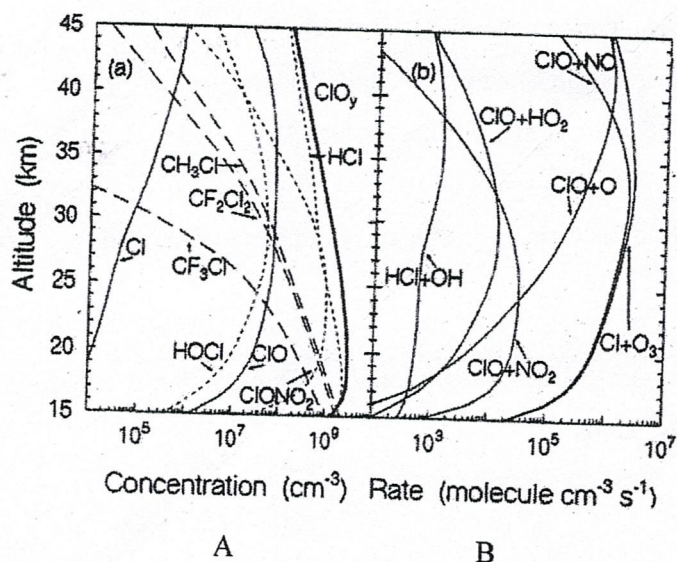
Using the above five reactions answer the following questions.

(i) What is the net result of above five reactions?

(ii) Select which reactions make a catalytic cycle for the destruction of ozone from above reactions.

(iii) Identify the reactions cycle to regenerate chlorine but do not destroy ozone.

Assume that all the above reactions in 2(c) are occurring at 30 km in the middle attitude stratosphere. The figure given below is the vertical diurnally-averaged distribution of (A) the concentrations (molecules cm^{-3}) (B) the reaction rates (molecules $cm^{-3} s^{-1}$) for chlorine chemical family.



Using the above five reaction sequences and the figure given above, answer the following questions.

- (iv) Out of the two reactions (R₂) and (R₃) given in 2(c), which one would be faster at 30 km.
- (v) Which compound has the highest concentration out of ClONO₂, CF₃Cl, Cl, CF₂Cl₂ and HCl at following altitudes?
- (I) 15 km
 (II) 25 km
 (III) 45 km

(55 marks)

03. Answer all parts.

(a) (i). "Lime is usually added to acid soils to increase soil pH" Discuss.

(30 marks)

(ii) Define cation exchange capacity (CEC) of soils. What are the units of CEC?

(15 marks)

(iii) Give a short account on effect of CEC on availability of nutrients to plants.

(20 marks)

(b) Write down the different ways that soil becomes polluted. Name the most common categories of chemicals involved in causing soil pollution.

(35 marks)

04. Answer all parts.

(a) (i) Write down the basic steps used in purification of water for drinking purposes.

(10 marks)

(ii) What are the advantages and disadvantages of the following disinfection methods?

(I) Chlorination

(II) Ozone and UV irradiation

(10 marks)

(iii) State major characteristics of textile dyeing wastewater

(10 marks)

(b) Assume that you are working as a chemist in a tanning processing industry located in the Southern province. You have been asked to prepare a proposal for treatment of tannery effluents.

(i) Briefly explain how you would test quality of tannery wastewater. (20 marks)

(ii) Suggest a suitable experiment to determine the optimum coagulation conditions for the above wastewater sample. (10 marks)

(iii) State five major steps you will propose under the above treatment process. (15 marks)

(iv) Explain how you would minimize bad odour due to the presence of H_2S gas. Give related chemical equations when necessary. (15 marks)

(c) Briefly explain the following.

i. Fenton oxidation ii. Membrane separation process

(10 marks)

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