

**UNIVERSITY OF SWAZILAND**  
**DEPARTMENT OF CHEMISTRY**

**C516/ ERM 641 Chemical Pollution Studies**

**Final Examination May 2010**

**Instructions:** Do not open the question paper until the examiner gives permission to do so.

**This examination paper has 6 questions, each worth 25 marks.**

**Answer any 4 questions.**

**Special Requirements:** None

**QUESTION 1 [25]**

Water quality is deteriorating all over the world due to pollution, and especially in urban areas, domestic effluent escapes untreated into rivers.

- (a) Briefly describe why each of the following domestic wastewater constituents is considered a water pollutant
- i) Phosphorus (2)
  - ii) Nitrates (2)
  - iii) Coliforms (2)
  - iv) Heavy metals (2)
  - v) Total dissolved solids (2)
- (b) Describe how oxidation pond technology works, and list two disadvantages of using this technology in wastewater treatment (7)
- (c) Explain the role of chlorination in domestic wastewater treatment, and describe one disadvantage of using chlorine gas for this purpose. (3)
- (d) In relation to ascaris in wastewater,
- (i) What is ascaris (2)
  - (ii) Why is it a problem in the environment (2)
  - (iii) How is it eliminated in wastewater? (1)

**QUESTION 2 [25]**

Conventional biological wastewater treatment of industrial effluents is inefficient, and in many cases, physical/chemical treatment of industrial sewerage is necessary.

- (a) In each of the following types of industrial effluent, identify two problematic constituents, how they arise, and why they are considered environmental pollutants.
- i) Textile effluent (4)
  - ii) Metallurgy effluent (4)
  - iii) Mine acid drainage (4)
  - iv) Distillery effluent (4)

- (b) Use chemical equations to explain how activated sludge technology is effective in treatment of distillery effluent. (4)
- (c) Describe the technique of reverse osmosis as applicable to textile effluent treatment and outline two disadvantages associated with its use. (5)

**QUESTION 3 [25]**

- (a) Describe the major differences between a "dumpsite" and a "landfill". (2)
- (b) In relation to a landfill,
- i) what is meant by "leachate" in a landfill? (1)
  - ii) what is the chemical composition of leachate? (1)
  - iii) what is the criterion used in the design of a leachate dam? (2)
  - iv) how is leachate managed in a landfill? (2)
- (c) Describe any two (2) minimum requirements to be considered in the design of a landfill according to "best environmental practice". (4)
- (d) List and discuss any two (2) reasons why recycling of solid waste is an essential activity for landfill sustainability. (4)
- (e) Landfilling results in the generation of greenhouse gases. Describe how one of the gases is formed, how it is currently disposed off in Swaziland, and how it can be collected and used for co-generation of electricity. (4)
- (f) "Environmental monitoring of a landfill should take place bi-monthly for a period of up to 30 years after decommissioning". Explain the role of establishing a water quality baseline data during planning of a landfill in relation to environmental monitoring. (5)

**QUESTION 4 [25]**

- (a) The World Meteorological Organization operating the Global Atmospheric Watch is a UN agency responsible for monitoring green house gases in the atmosphere in 183 countries.
- i) Explain what is meant by a "green house gas". (3)
  - ii) List four (4) greenhouse gases monitored by the World Meteorological Organization. (4)
  - iii) In each of the four greenhouse gases listed in (ii) above, explain the man-made main causes of its elevation by the manufacturing industry. (4)

- (b) Landfills and effluent treatment plants produce copious amounts of green house gases.
- i) Describe the chemical processes that lead to the generation of any one (1) of the green house gases in a landfill. (4)
  - ii) Describe the chemical processes that lead to the generation of any one (1) of the green house gases in an activated sludge treatment plant. (4)
- (c) The ecological consequences of green house emissions on the ecosystem of the planet earth are disastrous.
- i) Describe the likely causes of coastal city flooding as a result of greenhouse gas emissions and its socio-economic implications in Southern Africa. (3)
  - ii) Describe the likely causes of desertification of inland agricultural lands as a result of greenhouse gas emission and its socio-economic impact on agriculture in sub-Saharan Africa. (3)

QUESTION 5 [25]

- (a) The *nitrogen cycle* is one of nature's most vital dynamic processes. Discuss. (5)
- (b) Next to phosphorus, nitrogen is the algal nutrient most commonly removed as part of advanced water treatment. Summarize the techniques most often used for nitrogen removal. (5)
- (c) Summarize, with the aid of a diagram, the primary features of oxygen exchange among the atmosphere, lithosphere, hydrosphere, and biosphere. (5)
- (d) Summarize the principal reactions among  $\text{NO}$ ,  $\text{NO}_2$ , and  $\text{HNO}_3$  in the atmosphere. (5)
- (e) Outline a generalized scheme for the formation of photochemical smog. (5)

QUESTION 6 [25]

- (a) Ample evidence exists of the damaging effects of acid rain. Discuss the major such effects. (4)
- (b) Humankind is engaged in a number of activities that are altering the atmosphere profoundly. Explain (4)
- (c) Some of the most important micro organism-mediated chemical reactions in aquatic and soil environments are those involving nitrogen compounds. Summarize. (4)
- (d) Of the organochlorine insecticides, the most notable has been DDT. Discuss. (4)

- (e) Many processes have been proposed or studied for the removal of sulphur dioxide from stack gas scrubbing systems. Summarize 3 major gas scrubbing systems. (3)
- (f) Of all environmental hazards, there is little doubt that major disruptions in the atmosphere and climate have the greatest potential for catastrophic and irreversible damage. What measures can be taken to deal with this problem? (6)