

NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF INDUSTRIAL TECHNOLOGY
BACHELOR OF ENGINEERING (HONS) DEGREE
Part One Examination May 2011

TCE 1202 Materials and Containments 1B

Duration of Examination 3Hours

Instructions to Candidates

1. Answer question **ONE** and any other **THREE** questions.
 2. Show all your steps clearly in your calculation.
 3. Start the answers for each question on a new page.
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1. a) Define corrosion and state three effects of corrosion. [5]
- b) What do you understand by the following terms? [5]
 - i) wet corrosion
 - ii) corrosion inhibitors
 - iii) pitting corrosion
 - iv) crevice corrosion
 - v) passivation
- c) Compare and contrast HDPE with LDPE. [5]
- d) What are the pros and cons of the use of plastics? [4]
- e) Fill in the table below

Rubber	Production method	Weakness	Uses
Polychloprene		Higher resistance to oils	
			Tyres, tubes, adhesives
Nitrite rubbers	Copolymerization of crylonitrite and butadiene		

[6]

2. a) Explain what are the main differences between direct and indirect costs associated to corrosion damage? [4]
- b) A sheet of carbon steel one meter wide by three meter long has lost 40 g to corrosion over the past six months. Convert that mass loss to a penetration rate of the steel in mm units. What would be the total corrosion current associated with such a corrosion rate? (carbon steel density = 7.8 g/cm³). [5]
- c) 24 g of zinc metal are dissolved in a 1 M HCl solution. How many coulombs have been produced by the anodic process? [3]
- d) Rank the following ions in order of their thermodynamic ease of plating out of a solution: Cu²⁺, Co²⁺, Fe²⁺, Fe³⁺, Na⁺, Pb²⁺, Cu⁺? [5]
- e) Using standard potentials and molarity for ion concentrations calculate the open circuit potential of the following electrochemical reactions (balance the equations with water related chemical species when necessary, i.e. H⁺, OH⁻ and H₂O): [8]
- a. $\text{H}_2\text{O}_2 + \text{Ni} \rightarrow \text{H}_2\text{O} + \text{Ni}^{2+}$
 - b. $\text{H}_2\text{O} + \text{Mg}^{2+} \rightarrow \text{H}_2\text{O}_2 + \text{Mg}$
 - c. $\text{Ni} + \text{PbO}_2 \rightarrow \text{Pb}^{2+} + \text{Ni}^{2+}$
 - d. $\text{Al}^{3+} + \text{OH}^- \rightarrow \text{Al} + \text{O}_2$
3. a) Chemical composition of glass determines the category it falls under. State the five categories of glass and explain each category in detail? [10]
- b) Explain in detail the process of vulcanization? [5]
- c) Write detailed notes on thermosets, elastomers and thermoplastics? [10]
4. a) State and explain four new applications of ceramics? [4]
- b) What is the relation between the overpotential and standard potential of an electrochemical reaction? [3]
- c) Explain the main differences between the ohmic drop in an aqueous environment and the ohmic drop in an electrical conductor? [5]
- d) Why would pitting corrosion be much more prone to provoke a catastrophic failure than uniform corrosion generally does? [5]
- e) What is the best technique for corrosion protection? Justify your answer. [8]

5. a) Using a table explain the general uses of plastics outlining the design requirement, application and the name of the plastic? [10]
- b) The ISO 9223 standard indicates that there should be no corrosion at temperature below 0°C. Independent researchers have however proposed to lower the minimum temperature stated in the standard to lower values in order to account for the actual corrosion observed in Nordic climates. Provide a detailed explanation for the observed corrosion at temperature below the freezing point? [10]
- c) Why are there always a minimum of two electrochemical reactions to explain even the simplest corrosion reaction? [5]

END OF EXAM