



<b><u>PROGRAM</u></b>	: B ENG TECH PHYSICAL METALLURGY
<b><u>SUBJECT</u></b>	: <b>CORROSION TECHNOLOGY 3A</b>
<b><u>CODE</u></b>	: <b>CORMTA3</b>
<b><u>DATE</u></b>	: MAIN EXAMINATION 29 MAY 2019
<b><u>DURATION</u></b>	: 08:30 - 11:30
<b><u>WEIGHT</u></b>	: 40 : 60
<b><u>FULL MARKS</u></b>	: 100
<b><u>TOTAL MARKS</u></b>	: 100
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<b><u>EXAMINER</u></b>	: MR G A COMBRINK
<b><u>MODERATOR</u></b>	: DR H MOLLER
<b><u>NUMBER OF PAGES</u></b>	: 4 PAGES
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<b><u>INSTRUCTIONS</u></b>	: ALL THE ANSWERS MUST BE COMPLETED IN THE EXAM SCRIPT
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<b><u>REQUIREMENTS:</u></b>	: ONE ANSWER SCRIPT ONE POCKET CALCULATOR <b><u>NO</u></b> CORRECTION FLUID SHALL BE USED
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**QUESTION 1**

An airtight and watertight sealed heavy-duty steel case is recovered from the seabed where it has been lying at a depth of 4000metres (i.e. it is covered by 4000metres of salty sea water). It has been there for 50 years yet despite the steel being exposed (i.e. the protective paint has come off its surface) in many superficial places very little rust is evident. Explain how this can be?

[7]

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**QUESTION 2**

You are on holiday on one of the remote islands of the Maldives and you go for a walk along a deserted beach when you find a steel chest halfway submerged in the sea water on the beach with the sea water waves breaking over it. You notice that the steel chest has been painted with a thin and see-through organic coating (a lacquer that is transparent i.e. you can see the steel surface through the paint coating). The sea-water is water that has lots of dissolved salt and ions and is thus an excellent electrolyte. From your assessment it looks as if the steel chest has been lying there for several weeks as it is showing some spots of rust that have formed under the paint film. (Remember that the paint coating is still intact!). How is this possible for the rust to take place under the paint layer? Surely paint is there to stop the steel from rusting? Please explain how this could happen. Also explain which half reaction (anode reaction or the cathodic reaction) is the rate-determining step?

[10]

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**QUESTION 3**

Give 4 types of surface contaminants that may be present on bare steel and should be removed prior to coating the steel. How/in each case) would you remove it?

[8]

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**QUESTION 4**

- 4.1 You have a cubic shaped specimen sample of pure iron that is 120mm by 10mm by 50mm in dimension that you put in a 1N sulphuric acid solution for 30 days. After 30 days you weigh the specimen and find that it now weights exactly 300grams, calculate what the specimen's mass loss was as a result of it being in the sulphuric acid for the 30 days. Using this information calculate the amount of current that was produced by the corrosion process during the 30 day period. What is the corrosion rate in milligrams per annum of the iron in this strength sulphuric acid?
- 4.2 If a similar sample (same original size and same composition and shape) of pure iron was exposed to 0.5N Sulphuric acid and after 30 days the part that

(7)

has not dissolved has a mass of exactly 400grams calculate the corrosion rate of the iron in 0.5N Sulphuric acid and give the answer in milligrams per annum. (5)

- 4.3 Using the information from questions 4.1 and 4.2 above, if you exposed 10.5kg of pure iron in 0.75N Sulphuric acid how much of it would be left after exposing it in the 0.75N sulphuric acid for 24 months. (5)

Information that **MAY** be useful in answering this question: Faradays law:  $W = Zit/nF$ ,  $Z = 56\text{g/mol}$ ,  $F = 96500\text{ C/mol}$ . SG iron = 7.8 and W is the mass of iron lost, n is the amount of charge units transferred (such as a single electron that would make  $n = 1$  and if two electrons were transferred then  $n = 2$  etc.)

[17]

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### **QUESTION 5**

Name the five ingredients that are blended together to make up an organic coating (paint)

Give the function of each ingredient. [10]

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### **QUESTION 6**

- 6.1 What is Cathodic Protection? (4)

- 6.2 Explain by means of an Evans diagram how protection is achieved by cathodic protection. (6)

[10]

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### **QUESTION 7**

- 7.1 What is the relationship (formula) between pH and potential called and by what method is it represented schematically. (3)

- 7.2 Draw a typical example (use iron in water) identifying all the regions and the conditions (7)

- 7.3 List three limitations of these Diagrams (3)

[13]

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**QUESTION 8**

- 8.1 Briefly explain by using labelled sketches of the anodising process, how a piece of aluminium is anodised. (8)
- 8.2 Draw with labels the profile of the anodised film (i.e. side view) indicating the various structures and components of the film. (10)
- 8.3 How does the anodising film reduce corrosion? (2)
- 8.4 Is the freshly anodised surface (i.e. the anodised film on the metal surface) anodic or cathodic to the underlying metal substrate. Thus explain what processes relevant to corrosion occur when the film is perforated exposing the underlying substrate. (5)

**[25]**

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Total Marks	[100]
Full Marks	[100]

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