Question Paper

Exam Date & Time: 29-Sep-2023 (02:45 PM - 04:45 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

B.Tech. 1st Semester Mid-Term Examination September 2023

ENGINEERING CHEMISTRY [CHM 1071]

Marks: 30 **Duration: 120 mins.**

MCQ

Answer all the questions. Section Duration: 20 mins

1. _____ corrosion is autocatalytic in nature.

   Galvanic

   Pitting

   Intergranular

   Stress

2. The metal that is protected by its own oxide layer is _____.

   Copper

   Iron

   Gold

   Aluminium

3. Which is NOT true in galvanic corrosion?

   The metal having a lower standard reduction potential gets corroded.

   The metal placed higher in the electrochemical series get corroded.

   The rate of corrosion depends on the difference in electrode potential of anode and cathode.

   Copper piping undergoes deterioration when connected to steel tanks.

4. The greenish coating that develops on copper utensils is due to the formation of

   Copper oxide

   Copper carbonate

   Copper oxide carbonate

   Copper hydroxide carbonate

5. In electrochemical corrosion, which is NOT true?

   Dissolution of the metal occurs at the anodic area.

   Current flows between the anodic and cathodic areas.

Hydrogen evolution occurs in aerated neutral medium.

Both electronic and electrolytic conductors are required.

6. The chemical formula of yellow and black rusts, respectively are

   2 [Fe_2O_3. $3H_2O$] and 2 [Fe_3O_4. $3H_2O$]

   2 [Fe_3O_4. $3H_2O$] and 2 [Fe_2O_3. $3H_2O$]

   $2Fe_2O_3$. $3H_2O$ and $2Fe_3O_4$. $3H_2O$

   $2Fe_3O_4$. $3H_2O$ and $2Fe_2O_3$. $3H_2O$

7. Statement 1: In Zn-Al couple, Zn is corroded.

   Statement 2: The galvanic series was developed by studying corrosion of metals and alloys in unpolluted sea water with their oxide films.

   Statement 1 is true.

   Statement 2 is true.

   Both statements are true.

   Both statements are false.

8. Which is NOT an example for intergranular corrosion?

   Presence of traces of iron in the grain boundaries in an aluminium rod.

   High content of copper in the grain boundaries of a brass sample.

   Depletion of chromium in the grain boundaries of 18-8 stainless steel at 300℃.

   Depletion of chromium in the grain boundaries of high carbon grade steel at 300℃.

9. Identify the INCORRECT statement about stress corrosion of steel boilers.

   The stressed region acts as anode and the stress-free part serves as cathode.

   Sodium ferroate undergoes hydrolysis to form NaOH.

   The stressed region has lower NaOH concentration compared to the stress-free region.

   Hydrolysis of Na_2CO_3 at high temperature forms NaOH.

10. Aggressive pitting corrosion occurs in _____ medium.

    Chloride

    Phosphate

    Sulphate

    Nitrate

Descriptive

04 Marks x 2 questions - 08 Marks

11 Give reasons for the following statements. (4M) **CO1**

a. NaOH & Rochelle salt are added to the electroless plating bath of copper.

b. Calomel electrode serves as a secondary reference electrode and not a primary one.

c. Sulphuric acid is added to the electroplating bath during deposition of copper.

d. Fuel and oxidant in AFC should be free of CO_2.

12 Write two differences between the following. (4M) **CO1**

a. Galvanic and electrolytic cell

b. Concentration and activation polarisation

c. Electroplating and electroless plating

d. Hard and decorative chromium plating

03 Marks x 5 questions - 15 Marks

13. A) Write the cell reactions and calculate the EMF of the following cell at 298K.

$Mg \mid Mg^{2+}_{(0.001M)} \parallel Cu^{2+}_{(0.0001M)} \mid Cu$ [Given $E^o_{Cu^{2+}|Cu} = 0.34$ V & $E^o_{Mg^{2+}|Mg} = -2.37$V]

Calculate the standard free energy change in joules for the above cell. **CO1**

14. A glass electrode dipped in a soln. of pH = 3 offered an emf of 0.2066 V with normal calomel electrode at 298 K. When dipped in a solution of unknown pH at the same temperature, the recorded emf was 0.1076 V. Calculate the pH of the solution. [$E_{cal} = 0.2810$ V]. Explain Poggendorff's method to determine the EMF of a cell. **CO1**

15. Discuss the construction and discharging reactions of lithium-ion batteries. Why are they referred to as 'Swing Batteries'? Mention any two functions of salt bridge. (3M) **CO1**

16. Discuss the electrochemical theory of corrosion with suitable equations. (3M) **CO3**

17. Name and explain the corrosion that occurs in the following; (3M) **CO3**

a. Zinc block in contact with a copper sheet.

b. Peeling of tin coat on iron.

02 Marks x 1 question - 02 Marks

18. Differentiate between the following (2M) **CO3**

a. Dry and wet corrosion

b. Electrochemical and galvanic series

Scheme of evaluation

11. a. $Cu^{2+}_{(aq.)} + 2HCHO + 4OH^-_{(aq.)} \longrightarrow 2HCOO^-_{(aq.)} + 2H_2O_{(l)} + H_{2(g)}$ **0.5M**

The redox reaction involves consumption of hydroxyl ions and pH of the solution decreases as the reaction progresses. Addition of buffer is essential to maintain optimum pH. **0.5M**

b. The electrode potential of calomel electrode is not arbitrarily given a fixed value. Its potential value needs to be found out using SHE. **1M**

c. Reduced copper ion concentration favours a good quality deposit **0.5M**

To reduce the concentration of cupric ions due to common ion effect. **0.5M**

d. $KOH + CO_2 \longrightarrow K_2CO_3$, affects the efficiency of the cell **1M**

12. Any 2 differences **1M each**

13. anode: $Mg \rightarrow Mg^{2+} + 2e^-$ **0.5M**

cathode: $Cu^{2+} + 2e- \rightarrow Cu$ **0.5M**

$E^o_{cell} = E^o_{cathode} - E^o_{anode}$

$= 0.34 - [-2.37]$

$= 2.71V$ **0.5M**

$E_{cell} = E^o_{cell} - (0.0591/n) \log [Mg^{2+}]/[Cu^{2+}]$

$E_{cell} = 2.71 - (0.0591/2) \log [0.001]/[0.0001]$

$= 2.6805$ V **0.5M**

$\Delta G° = -2 \times 96500 \times 2.71 = -523030$ J **1M**

14. $pH = (E^o_g - E_{cell} - E_{cal(normal)}) / 0.0591$ **0.5M**

$3 = (E^o_g - 0.2066 - 0.2810) / 0.0591$

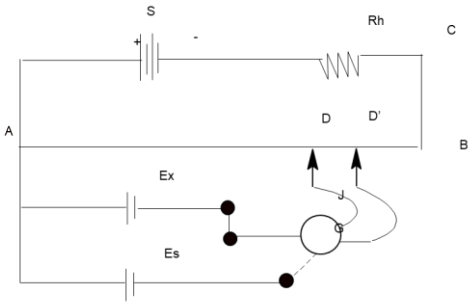
$0.1773 = (E^o_g - 0.2066 - 0.2810)$

$0.1773 = E^o_g - 0.4876$

$E^o_g = 0.6649$ V **0.5M**

$pH = (0.6649 - 0.1076 - 0.2810) / 0.0591$

$pH = 4.675$ **0.5M**



0.5M

Explanation with equation **1M**

15. Construction **0.5 M**

Discharging reactions **1 M**

Explain the to and fro movement of Li ions during charging and discharging **0.5M**

2 functions of salt bridge **1M**

16. Hydrogen evolution **0.5M**

$2H^+$ (aq) $+ 2e^- \rightarrow H_2$ (deaerated and acidic medium) **0.5M**

$2H_2O + 2e^- \rightarrow H_2\,(g) + 2OH^-\,(aq)$ (deaerated and neutral) **0.5M**

Oxygen absorption **0.5M**

$O_2\,(aq) + 2H_2O + 4e^- \rightarrow 4OH^-(aq)$ (aerated and neutral) **0.5M**

Metal ion reduction and metal deposition are other rare reactions. **0.5M**

17. Galvanic corrosion – **0.5 M** explanation **1M**

Pitting corrosion – **0.5 M** explanation **1M**

18. 2 differences each **2M**