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NATIONAL INSTITUTE OF TECHNOLOGY GOA

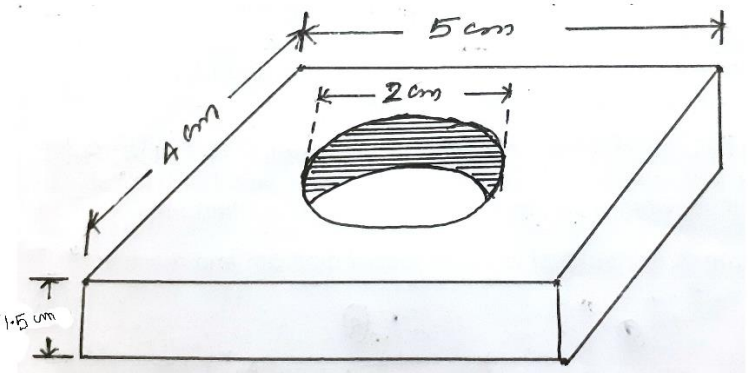
Farmagudi, Ponda, Goa 403 401

Programme Name: B.Tech

Mid Semester Examination, Feb-2021

Course Name: Chemistry **Course Code: CY150**
Date: 02/02/2021 **Time: 9:30 AM**
Duration: 1.5 hour **Max. Marks: 50**

1. Answer all the questions
2. Answer for sub questions have to be labeled properly
3. Find reduction potential data as an annexure

1	A watch contains a silver button battery having 16.0 g of zinc in it. It can work until 85% of the zinc metal has been consumed. (i) How many days this battery can run if it continuously deliver 4.8 mA current. (ii) When the battery dies, 90% of the Ag has been consumed. How many grams of Ag has been used to make the battery? (iii) What is the cost of Ag consumed per day the watch runs, If Ag cost Rs. 392 per 8 gm? A_{Ag} = 108, A_{Zn} = 65, D_{Ag} = 10.5 g/cm^3, D_{Zn} = 7.13 g/cm^3	4 Marks
2	A Ni rod and a Fe nut are placed in a solution containing 1M Nickel(II) ion and connected to a battery. The Fe nut has the shape shown below. How long the electrolysis be continued with a current of 1.50 A to build a 0.05 mm thick deposit of nickel on the iron? D_{Ni} = 8.9 g/cm^3 	4 Marks
3	A voltaic cell constructed in my laboratory is represented as follows Ag(s) | Ag^+(Sat Ag_2CrO_4) || Ag^+(0.125M) | Ag(s) What is the cell potential, if K_{sp} of Ag_2CrO_4 is 1.1×10^{-12}	4 Marks
4	Industrially, copper is purified by electrolysis. The impure copper acts as the anode, and the cathode is made of pure copper. The electrodes are immersed in a $CuSO_4$ solution. During electrolysis, copper at the anode enters the solution as Cu^{2+} while Cu^{2+} ions are reduced at the cathode. (a) Write half-cell reactions and the overall reaction for the electrolytic process. (b) Suppose the anode was contaminated with Zn and Ag. Explain what happens to these impurities during electrolysis. (c) How many hours will it take to obtain 1.00 kg of Cu at a current of 18.9 A?	4 Marks

5	Lead storage batteries are rated by ampere hours, that is, the number of amperes they can deliver in an hour. (a) Show that 1A.h = 3600 C. (b) The lead anodes of a certain lead-storage battery have a total mass of 406 g. Calculate the maximum theoretical capacity of the battery in ampere hours. (c) Calculate $E°$cell and $\Delta G°$ for the battery	3 Marks
6	In an electrolysis experiment, a student passes the same quantity of electricity through two electrolytic cells, one containing a silver salt and the other a gold salt. Over a certain period of time, she finds that 2.64 g of Ag and 1.61 g of Au are deposited at the cathodes. What is the oxidation state of gold in the gold salt?	3 Marks
7	For a number of years it was not clear whether mercury(I) ions existed in solution as Hg^+ or as Hg_2^{2+}. To distinguish between these two possibilities, we could set up the following system: Hg(*l*) | soln A || soln B | Hg(*l*) where soln A contained 0.263 g mercury(I) nitrate per liter and soln B contained 2.63 g mercury(I) nitrate per liter. If the measured emf of such a cell is 0.0289 V at 18°C, what can you deduce about the nature of the mercury(I) ions?	4 Marks
8	A piece of magnesium ribbon and a copper wire are partially immersed in a 0.1 *M* HCl solution in a beaker. The metals are joined externally by another piece of metal wire. Bubbles are seen to evolve at both the Mg and Cu surfaces. (a) Write equations representing the reactions occurring at the metals. (b) What visual evidence would you seek to show that Cu is not oxidized to Cu^{2+}? (c) At some stage, NaOH solution is added to the beaker to neutralize the HCl acid. Upon further addition of NaOH, a white precipitate forms. What is it?	4 Marks
9	a) What necessary step should be taken for plumbosolvency? b) Compare BOD with COD by four points.	1+2 Marks
10	Compare lime soda process with a deionization method by atleast five points.	3 Marks
11	Draw roughly and explain electrodialysis method using two cation and two anion exchange membranes.	3 Marks
12	Write a short note on principle of reverse osmosis. Compare RO method with a deionizer method by four points.	1+2 Marks
13	a) Write a short note on septic tank. b) Compare trickling filter method with activated sludge method by four points.	1+2 Marks
14	25 ml of sewage water sample was diluted to 500 ml and equal volumes were filled in BOD bottles. 100 ml of one BOD bottle diluted sewage required 5.3 ml of N/40 $Na_2S_2O_3$ solution in immediate DO estimation. The second BOD bottle was incubated for 5 days and in DO estimation 100 ml of this diluted and incubated sewage required 1.4 ml of N/40 $Na_2S_2O_3$ solution. Calculate BOD of the sewage water.	5 Marks

****ALL THE BEST****

Potentials in Alphabetical Order

Reduction half-reaction	$E°$ (V)	Reduction half-reaction	$E°$ (V)
$Ag^+ + e^- \rightarrow Ag$	+0.80	$In^{2+} + e^- \rightarrow In^+$	−0.40
$Ag^{2+} + e^- \rightarrow Ag^+$	+1.98	$In^{3+} + e^- \rightarrow In^{2+}$	−0.49
$AgBr + e^- \rightarrow Ag + Br^-$	+0.07	$In^{3+} + 2\ e^- \rightarrow In^+$	−0.44
$AgCl + e^- \rightarrow Ag + Cl^-$	+0.22	$In^{3+} + 3\ e^- \rightarrow In$	−0.34
$AgF + e^- \rightarrow Ag + F^-$	+0.78	$K^+ + e^- \rightarrow K$	−2.93
$AgI + e^- \rightarrow Ag + I^-$	−0.15	$La^{3+} + 3\ e^- \rightarrow La$	−2.52
$Al^{3+} + 3\ e^- \rightarrow Al$	−1.66	$Li^+ + e^- \rightarrow Li$	−3.05
$Au^+ + e^- \rightarrow Au$	+1.69	$Mg^{2+} + 2\ e^- \rightarrow Mg$	−2.36
$Au^{3+} + 3\ e^- \rightarrow Au$	+1.40	$Mn^{2+} + 2\ e^- \rightarrow Mn$	−1.18
$Ba^{2+} + 2\ e^- \rightarrow Ba$	−2.91	$Mn^{3+} + e^- \rightarrow Mn^{2+}$	+1.51
$Be^{2+} + 2\ e^- \rightarrow Be$	−1.85	$MnO_2 + 4\ H^+ + 2\ e^- \rightarrow Mn^{2+} + 2\ H_2O$	+1.23
$Bi^{3+} + 3\ e^- \rightarrow Bi$	+0.20	$MnO_4^- + e^- \rightarrow MnO_4^{2-}$	+0.56
$Br_2 + 2\ e^- \rightarrow 2\ Br^-$	+1.09	$MnO_4^- + 8\ H^+ + 5\ e^- \rightarrow Mn^{2+} + 4\ H_2O$	+1.51
$BrO^- + H_2O + 2\ e^- \rightarrow Br^- + 2\ OH^-$	+0.76	$MnO_4^{2-} + 2\ H_2O + 2\ e^- \rightarrow MnO_2 + 4\ OH^-$	+0.60
$Ca^{2+} + 2\ e^- \rightarrow Ca$	−2.87	$NO_3^- + 2\ H^+ + e^- \rightarrow NO_2 + H_2O$	+0.80
$Cd^{2+} + 2\ e^- \rightarrow Cd$	−0.40	$NO_3^- + 4\ H^+ + 3\ e^- \rightarrow NO + 2\ H_2O$	+0.96
$Cd(OH)_2 + 2\ e^- \rightarrow Cd + 2\ OH^-$	−0.81	$NO_3^- + H_2O + 2\ e^- \rightarrow NO_2^- + 2\ OH^-$	+0.01
$Ce^{3+} + 3\ e^- \rightarrow Ce$	−2.48	$Na^+ + e^- \rightarrow Na$	−2.71
$Ce^{4+} + e^- \rightarrow Ce^{3+}$	+1.61	$Ni^{2+} + 2\ e^- \rightarrow Ni$	−0.23
$Cl_2 + 2\ e^- \rightarrow 2\ Cl^-$	+1.36	$Ni(OH)_3 + e^- \rightarrow Ni(OH)_2 + OH^-$	+0.49
$ClO^- + H_2O + 2\ e^- \rightarrow Cl^- + 2\ OH^-$	+0.89	$O_2 + e^- \rightarrow O_2^-$	−0.56
$ClO_4^- + 2\ H^+ + 2\ e^- \rightarrow ClO_3^- + H_2O$	+1.23	$O_2 + 4\ H^+ + 4\ e^- \rightarrow 2\ H_2O$	+1.23
$ClO_4^- + H_2O + 2\ e^- \rightarrow ClO_3^- + 2\ OH^-$	+0.36	$O_2 + H_2O + 2\ e^- \rightarrow HO_2^- + OH^-$	−0.08
$Co^{2+} + 2\ e^- \rightarrow Co$	−0.28	$O_2 + 2\ H_2O + 4\ e^- \rightarrow 4\ OH^-$	+0.40
$Co^{3+} + e^- \rightarrow Co^{2+}$	+1.81	$O_3 + 2\ H^+ + 2\ e^- \rightarrow O_2 + H_2O$	+2.07
$Cr^{2+} + 2\ e^- \rightarrow Cr$	−0.91	$O_3 + H_2O + 2\ e^- \rightarrow O_2 + 2\ OH^-$	+1.24
$Cr_2O_7^{2-} + 14\ H^+ + 6\ e^- \rightarrow 2\ Cr^{3+} + 7\ H_2O$	+1.33	$Pb^{2+} + 2\ e^- \rightarrow Pb$	−0.13
$Cr^{3+} + 3\ e^- \rightarrow Cr$	−0.74	$Pb^{4+} + 2\ e^- \rightarrow Pb^{2+}$	+1.67
$Cr^{3+} + e^- \rightarrow Cr^{2+}$	−0.41	$PbSO_4 + 2\ e^- \rightarrow Pb + SO_4^{2-}$	−0.36
$Cs^+ + e^- \rightarrow Cs$	−2.92	$Pt^{2+} + 2\ e^- \rightarrow Pt$	+1.20
$Cu^+ + e^- \rightarrow Cu$	+0.52	$Pu^{4+} + e^- \rightarrow Pu^{3+}$	+0.97
$Cu^{2+} + 2\ e^- \rightarrow Cu$	+0.34	$Ra^{2+} + 2\ e^- \rightarrow Ra$	−2.92
$Cu^{2+} + e^- \rightarrow Cu^+$	+0.15	$Rb^+ + e^- \rightarrow Rb$	−2.93
$F_2 + 2\ e^- \rightarrow 2\ F^-$	+2.87	$S + 2\ e^- \rightarrow S^{2-}$	−0.48
$Fe^{2+} + 2\ e^- \rightarrow Fe$	−0.44	$SO_4^{2-} + 4\ H^+ + 2\ e^- \rightarrow H_2SO_3 + H_2O$	+0.17
$Fe^{3+} + 3\ e^- \rightarrow Fe$	−0.04	$S_2O_8^{2-} + 2\ e^- \rightarrow 2\ SO_4^{2-}$	+2.05
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	+0.77	$Se + 2\ e^- \rightarrow Se^{2-}$	−0.67
$Ga^+ + e^- \rightarrow Ga$	−0.53	$Sn^{2+} + 2\ e^- \rightarrow Sn$	−0.14
$2\ H^+ + 2\ e^- \rightarrow H_2$	**0,** by definition	$Sn^{4+} + 2\ e^- \rightarrow Sn^{2+}$	+0.15
$2\ HBrO + 2\ H^+ + 2\ e^- \rightarrow Br_2 + 2\ H_2O$	+1.60	$Sr^{2+} + 2\ e^- \rightarrow Sr$	−2.89
$2\ HClO + 2\ H^+ + 2\ e^- \rightarrow Cl_2 + 2\ H_2O$	+1.63	$Te + 2\ e^- \rightarrow Te^{2-}$	−0.84
$2\ H_2O + 2\ e^- \rightarrow H_2 + 2\ OH^-$	−0.83	$Ti^{2+} + 2\ e^- \rightarrow Ti$	−1.63
$H_2O_2 + 2\ H^+ + 2\ e^- \rightarrow 2\ H_2O$	+1.78	$Ti^{3+} + e^- \rightarrow Ti^{2+}$	−0.37
$H_4XeO_6 + 2\ H^+ + 2\ e^- \rightarrow XeO_3 + 3\ H_2O$	+3.0	$Ti^{4+} + e^- \rightarrow Ti^{3+}$	0.00
$Hg_2^{2+} + 2\ e^- \rightarrow 2\ Hg$	+0.79	$Tl^+ + e^- \rightarrow Tl$	−0.34
$Hg^{2+} + 2\ e^- \rightarrow Hg$	+0.85	$U^{3+} + 3\ e^- \rightarrow U$	−1.79
$2\ Hg^{2+} + 2\ e^- \rightarrow Hg_2^{2+}$	+0.92	$U^{4+} + e^- \rightarrow U^{3+}$	−0.61
$Hg_2Cl_2 + 2\ e^- \rightarrow 2\ Hg + 2\ Cl^-$	+0.27	$V^{2+} + 2\ e^- \rightarrow V$	−1.19
$I_2 + 2\ e^- \rightarrow 2\ I^-$	+0.54	[redacted]	[redacted]
$I_3^- + 2\ e^- \rightarrow 3\ I^-$	+0.53	$Zn^{2+} + 2\ e^- \rightarrow Zn$	−0.76
$In^+ + e^- \rightarrow In$	−0.14		