Fayoum university
Faculty of science
Chemistry department

physical chemistry
Geo.Bot.&Bio/ Chem.students
1^{st}. semester

Model answers

1-Question 1:-

1-ii	2-ii	3-iii	4-iii	5-a
6-iii	7-ii	8-ii	9-b	10-c

2-Question 2:-

a- anodic reaction: $Ti = Ti^{2+} + 2e^-$

cathodic reaction: $2Ag^+ + 2e^- = 2Ag$

Net reaction: $Ti + 2Ag^+ = 2Ag + Ti^{2+}$

E_a=-1.6 + (0.0591/2) log 0.01

E_c=0.79 + (0.0591/2) log 0.01

emf= E_a- E_c

b- i-Silver oxide battery:

anodic reaction: $Zn + 2OH^- \longrightarrow Zn(OH)_2 + 2e^-$

cathodic reaction: $Ag_2O + H_2O + 2e \longrightarrow 2Ag + 2OH$

Net reaction: $Ag_2O + H_2O + Zn \longrightarrow Zn(OH)_2 + 2Ag$

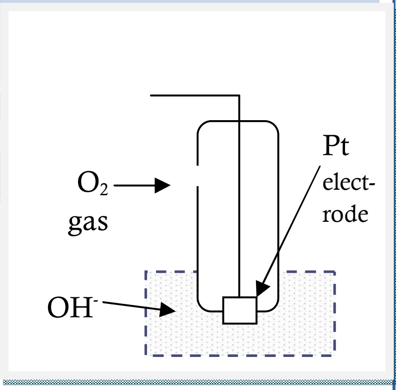
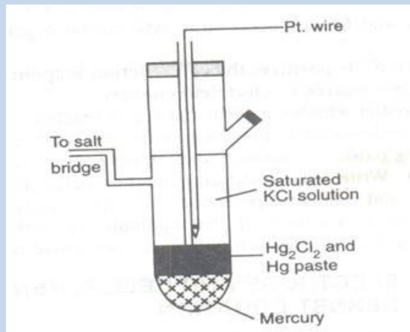
ii- Lead storage battery:

anodic reaction: $Pb + SO_4^{2-} \rightarrow PbSO_4 + 2e^-$

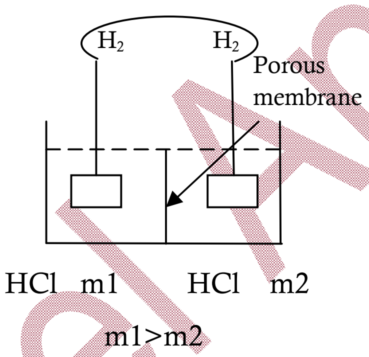
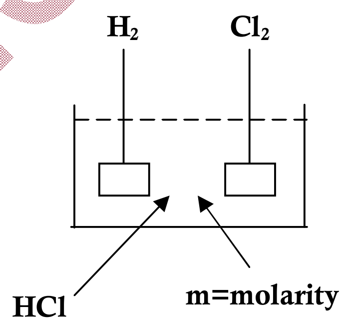
cathodic reaction: $PbO_2 + 4H^+ + SO_4^{2-} + 2e^- \rightarrow PbSO_4 + 2H_2O$

Net reaction: $PbO_2 + 4H^+ + 2SO_4^{2-} + Pb \rightarrow 2PbSO_4 + 2H_2O$

c- i-

	Oxygen Electrode	**Calomel Electrode**
Type	Indicator electrode	**Reference electrode**
Reaction	$O_2 + 2H_2O + 4e^- = OH^-$	**$2Hg + 2Cl^- = Hg_2Cl_2 + 2e^-$**
Nernst equation	$E_{O_2/OH} = 1.23 - 0.059PH$	$E_{Hg/Hg_2Cl_2} = E^\circ - 0.059 \log a_{cl-}$
The cell	$Pt/O_{2(g)}.P=1atm/OH^-$	$Hg/Hg_2Cl_2/Cl^-$
composition		 Fig. 12.15 Calomel electrode

ii-

	Concentration cells	
	With liquid junction	**Without liquid junction**
Anodic reaction	$H_2=2H^++2e^-$	$H_2=2H^++2e^-$
Cathodic reaction	$2H^++2e^-= H_2$	$Cl_2+2e^-=2Cl^-$
Cell reaction	No Net Reaction	$Cl_2+ H_2=2H^++2Cl^-$
emf	$=(2RT/f)\times\ln(m1/m2)$	$=E°-0.059Log(m)^2$
composition		**Chlorine-Hydrogen cell** 

3-Question 3:-

a- $E_{cell} = E°_{cell} - (RT/nF) \ln K$,

$\log K=(n\times E°_{cell}/0.0591)$ n=2

$E°_{cell}=E_c - E_a= E°_{fe3+/fe2+} - E°_{Sn4+/Sn2+}$

b- 1-Rate of discharge (cathodic):-

$V1=K1\ e^{-(\Delta G°1-\alpha\eta F)/RT}$

2-Rate of ionization (anodic):-

$V2=k2\ e^{-(\Delta G°2+(1-\alpha)\eta F)/RT}$

$V1=K1\ e^{-\Delta G°1/RT}\ e^{-\alpha\eta F/RT}$

$V1=V°1\ e^{-\alpha\eta F/RT}$ ------------------------------→ 1

$V2=K2\ e^{-\Delta G°2/RT}\ e^{(1-\alpha)\eta F/RT}$

$V2=V°2\ e^{(1-\alpha)\eta F/RT}$ ------------------------------→ 2

-At a reversible process:

$I_{net}=I_c - I_a$ and $I_c=I_a = I_◦$ So $I_{net}= I_◦$

Where $I_◦$ is the exchange current.

$V1\alpha\ I_c$ and $V2\alpha\ I_a$ and $V°1\alpha\ I_◦$ and $V°2= I_◦$

By substituting in equation 1&2

$I_c = I_◦\ e^{-\alpha\eta F/RT}$ and $I_a = I_◦\ e^{(1-\alpha)\eta F/RT}$

$I_{net}=I_c - I_a= I_◦\ e^{-\alpha\eta F/RT} - I_◦\ e^{(1-\alpha)\eta F/RT}$

-The 2nd term is so small compared to the 1st .so it can be neglected.

$I_{net}=I_c = I_◦\ e^{-\alpha\eta F/RT}$

$\ln I_{net}=\ln I_◦ - \alpha\eta F/RT$

$\eta= (2.303RT/\alpha F)\log I_◦ - (2.303RT/\alpha F)\log I_c$

$\eta= a - b \log I_c$

c- 1- Ohmic overpotentialη_r:results when an oxide film , agaseous film sets aresistance to the passage of the current across it .It is given by IR.Where I is the current strength and R is the resistance of the surface film.

2- Pseudo-ohmic overpotentialη_p: results from that the final tip of the calomel electrode (called luggen capillary tip) is placed at appreciable dictance from the polarized electrode surface.It becomes high at high current density and at low concentration. It is also given by IR where R is the resistance of the solution between the tip and the electrode surface, I is the polarizing current.

3-Concentration overpotentialη_c: when there is adifference in the concentration of the solution near the polarizing electrode and the reversible one (calomel electrode).If C_b is the original or bulk concentration,and C_e is the concentration near the electrode. C_e is less than C_b.

$$\eta_c=RT/ZF.\ Ln\ C_e/\ C_b$$

4-Activation overpotential η_a: some electrode process are associated with aslow step to bring the reaction to the final stage.this step is accelerated by change of the electrode potential from the reversible potential.thus this energy is given to activate the slow step.

With my best wishes

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