# KSU CET

## S1 & S2 Notes

2019 Scheme

Manifest the leadership in you

**SECOND SEMESTER B.TECH. (ENGINEERING) 2019-2020**
**FIRST SERIES EXAMINATION, FEBRUARY 2020**
**CYT100 ENGINEERING CHEMISTRY (CSE, EEE & IT)**

Maximum: **50 marks** Time: **2 hours**

CO* - Course outcome no ; Lvl – Revised Bloom's taxonomy level; Qn No-Question Numbers 1-8

## Part A

**Answer all questions (3 marks each) 6 X 3 = 18 marks**

| CO | Lvl | Qn No | |
|---|---|---|---|
| CO1 | R | 1 | Draw the structure of Saturated Calomel Electrode. Give the electrode reaction. |
| CO1 | A | 2 | Can you store silver nitrate solution in a copper vessel? Standard electrode potentials of silver and copper are **0.80 V** and **0.34 V** respectively. Justify your answer. |
| CO2 | R | 3 | While HCl is IR active, hydrogen molecule is not. Write the reason for the statement. |
| CO2 | R | 4 | Why TMS is taken as reference to determine the chemical shift value in $^{1}H$ NMR spectroscopy? |
| CO1 | R | 5 | Draw the structure of Li ion cell. Give the half cell reactions during charging. |
| CO1 | U | 6 | List the electronic transitions possible when UV light is absorbed by $CH_3Cl$ and HCHO |

## Part B

**Answer all questions (16 marks each) 2 X 16 = 32 marks**

| CO | Lvl | Qn No | | |
|---|---|---|---|---|
| CO1 | U,A | 7 | a) Briefly explain the determination of pH of a solution using glass electrode. Calculate the electrode potential of a hydrogen electrode constructed in the solution of pH=4 | **(5+3)** |
| | R,U | | b) Derive Nernst equation for iron redox electrode ($Fe^{3+}/Fe^{2+}$; Pt). | **(8)** |
| CO2 | U | 8 | a) How many modes of vibrations are there in carbon dioxide molecule? State whether all are IR active. | **(6)** |
| | U,A | | b) Draw and compare the $^{1}H$ NMR spectra of acetone ($CH_3COCH_3$) and methyl ethyl ketone ($CH_3COCH_2CH_3$) | **(10)** |

*CO1 Apply the basic concepts of electrochemistry and corrosion to explore its possible applications in various engineering fields.
*CO2 Understand various spectroscopic techniques like UV-Visible, IR, NMR and its applications

ANSWERS

ode

1.

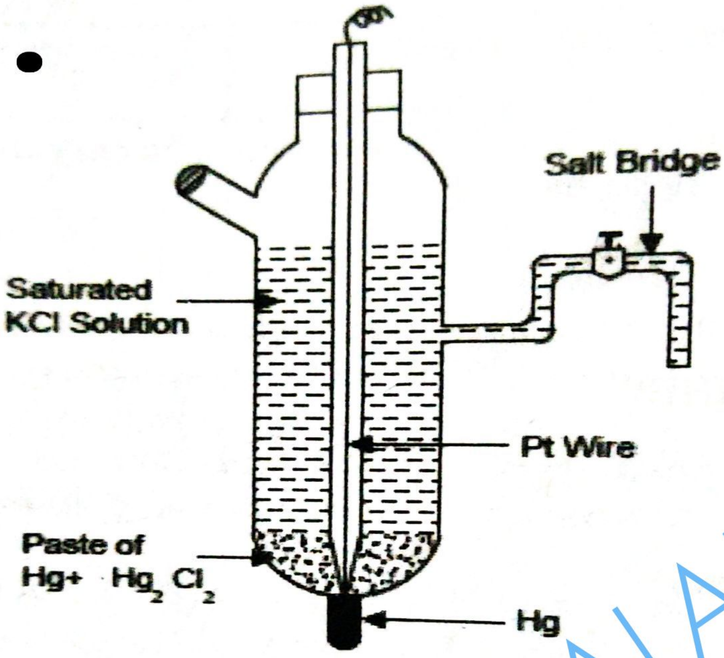



Fig.2.5 Calomel electrode



The electrode may be represented as $Hg / Hg_2Cl_{2\,(s)} / KCl$

The electrode reaction is given by

$$Hg_2Cl_{2\,(s)} + 2e^- \rightarrow 2Hg_{(l)} + 2Cl^- (aq.);\ E^0 = +0.2810V$$

The calomel electrode can act as anode or cathode depending on the electrode potential of the coupled electrode. If the electrode potential of the coupled electrode is lower than the calomel electrode, then calomel electrode undergoes reduction and act as cathode. If the potential of the coupled electrode is greater, calomel electrode will undergo oxidation and the reverse reaction takes place.

The Nernst equation of this electrode is given by

$$Ecal = E^0cal - \frac{2.303RT}{2F}\log[Cl^-]^2 = E^0cal - \frac{2.303RT}{F}\log[Cl^-]$$

2)

Copper is above silver in the electrochemical series and is thus more reactive than silver.So, copper displaces silver from silver nitrate. Hence, we cannot store $AgNO_3$.

solution in a copper vessel.Displacement Reaction taking place in the container:$Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$

3)Simple diatomic linear polar molecules have only one mode of vibration i.e. the stretching and contraction of bond. Therefore, hetero nuclear polar molecules like HCl, CO and NO are IR active.symmetrical diatomic molecules like nitrogen, oxygen and hydrogen, do not absorb infrared radiation, even though their vibrational frequencies are in the infrared region.

4)

why TMS as reference standard ?

1. It is chemically inert

2. Since it contain 12 equivalent protons, it give rise to a well defined signal. (single)

3. NMR spectrum of it occurs at a higher field than any protons in most of the common organic compound.

4. (Protons are more shielded)

* 
$$\text{chemical shift}, \delta = \frac{\nu_{sample} - \nu_{TMS}}{\nu_0} \times 10^6$$

$\nu_{sample}$ – Sample frequency (Frequency of unknown group of protons) in Hz

$\nu_{TMS}$ – Frequency of TMS in Hz

$\nu_0$ – Operating frequency of the instrument in Hz.

* $\delta$ unit is independent of field strength

* $\delta$ scale is a NMR scale in which the TMS peak is set at zero and peaks to the left of it (down field) have increasingly positive values, in ppm.

5)

5

19 a) Li ion cell is a rechargeable battery in which Li ion moves between anode and cathode during charging or discharging.

Positive electrode is made by using a crystalline mixed oxide $Li_2O.CO_2O_3$ or $LiCoO_2$. The crystalline contains both $Li^+$ and $Co^{3+}$ ions occupying voids of the oxide array.

Negative electrode is made of graphite. The electrolyte is a solution Li-salt ($LiPF_6$, $LiBF_4$ or $LiCPO_4$) in an organic solvent such as ether or a solid phase polymer electrolyte which can transport $Li^+$ ion.

Charging : Cell act as an electrolytic cell; electrical energy □ chemical energy

At anode: $LiCoO_2$ □ $Li_{1-x}CoO_2 + xLi^+ + xe^-$

At cathode: $C_G + xLi^+ + xe^-$ □ $Li_xC_G$

Discharging: Cell act as an electrochemical cell; chemical energy □ electrical energy

At anode: $Li_xC_G$ □ $C_G + xLi^+ + xe^-$

At cathode: $Li_{1-x}CoO_2 + xLi^+ + xe^-$ □ $LiCoO_2$

6)

6. $CH_3Cl$: contain both σ electrons and lone pair (n).

So it shows $\sigma \rightarrow \sigma^*$ and $n \rightarrow \sigma^*$ transitions.

HCHO: contain σ electrons, π electrons and lone pairs

{π electrons due to the presence of aldehyde group and lone pair on oxygen atom.}

So it shows all four types of transitions.

ie, $\sigma \rightarrow \sigma^*$, $n \rightarrow \sigma^*$, $\pi \rightarrow \pi^*$ and $n \rightarrow \pi^*$



7)a)

By measuring cell emf $E_{Cu^{2+}/Cu}$ can be calculated.

### 1.2.2 Glass electrode

A glass electrode is a type of ion-selective electrode made of a doped glass membrane that is sensitive to a specific ion. It consists of low melting glass having high electrical conductivity. The composition of $Na_2O$ in this glass is slightly more than ordinary soda glass. It is the universally employed electrode for pH measurement. There is also specialized ion sensitive glass electrodes used for determination For pH measurement $H^+$ ion selective glass electrode is used. It consists of low melting glass having high electrical conductivity. The glass electrode assembly consists of a long glass tube with a thin glass bulb filled with 0.1 M HCl. The inner surface of the glass is in contact with a AgCl coated silver electrode or simply a platinum contact electrode. HCl in the bulb furnishes a constant $H^+$ ion concentration. For measuring the pH of a test solution the glass bulb is immersed in the test solution such that the outer surface of the glass bulb comes in contact with the test solution. The glass membrane functions as an ion-selective resin, and an equilibrium is set up between the $Na^+$ ions of glass and $H^+$ ions in solution.of concentration of lithium, sodium, and ammonium ions.

**Construction:** For pH measurement $H^+$ ion selective glass electrode is used. It consists of low melting glass having high electrical conductivity. The glass electrode assembly consists of a long glass tube with a thin glass bulb filled with 0.1 M HCl. The inner surface


Figure 1.7: Glass electrode

of the glass is in contact with a AgCl coated silver electrode or simply a platinum contact electrode. HCl in the bulb furnishes a constant $H^+$ ion concentration. For measuring the pH of a test solution the glass bulb is immersed in the test solution such that the outer surface of the glass bulb comes in contact with the test solution. The glass membrane functions as an ion-selective resin, and an equilibrium is set up between the $Na^+$ ions of glass and $H^+$ ions in solution. the electrode reaction is $H^+ + Na^+_{(glass)} \longrightarrow Na^+ + H^+_{(glass)}$ and electrode representation is : $Ag/AgCl/0.1MH^+/glass/H^+_{(c=?)}$ The Nernst equation for the electrode can be written as

$$E_G = E^0_G - 0.0591 log\frac{1}{[H^+]}$$
$$E_G = E^0_G - 0.0591pH$$

Where $E^0_G$ is a constant for a particular variety of glass, $E^0_G$=0.6 or 0.5 depending on the variety of glass.

**Measurement of pH** In order to measure the potential of glass electrode, it has to be coupled with secondary reference electrode like saturated calomel electrode. The cell can be represented as $Hg/Hg_2Cl_2/KCl_{(satd)}//H^+_{(unknown)}/glass/H^+_{(0.1M)}/Pt$ The emf of the cell is measured and the pH can be calculated as follows

$$E_{cell} = E_{right} - E_{left}$$

7b)

consider the electrode reaction,

$Fe^{3+}_{(aq)} + 1\bar{e} \longrightarrow Fe^{2+}_{(aq)}$ (Reduction).

hence $n=1$,

eqbm constant $k_c$ for the reaction is related to $\Delta G$ as,

$$\Delta G = \Delta G^\circ + RT \ln k_c \quad \text{—— ①}$$

$$\Delta G = -nFE$$

$$\Delta G^\circ = -nFE^\circ$$

Substituting $\Delta G$ & $\Delta G^\circ$ in eq —①

$$-nFE = -nFE^\circ + RT \ln k_c.$$

(here $n=1$, so)

$$-FE = -FE^\circ + RT \ln k_c.$$

$\div$ by $-F$

$$\therefore E = E^\circ - \frac{RT}{F} \ln k_c$$

$$k_c = \frac{[Fe^{2+}]}{[Fe^{3+}]}$$

$$\therefore E_{Fe^{3+}|Fe^{2+}} = E^\circ_{Fe^{3+}/Fe^{2+}} - RT/F \ln \frac{[Fe^{2+}]}{[Fe^{3+}]}$$

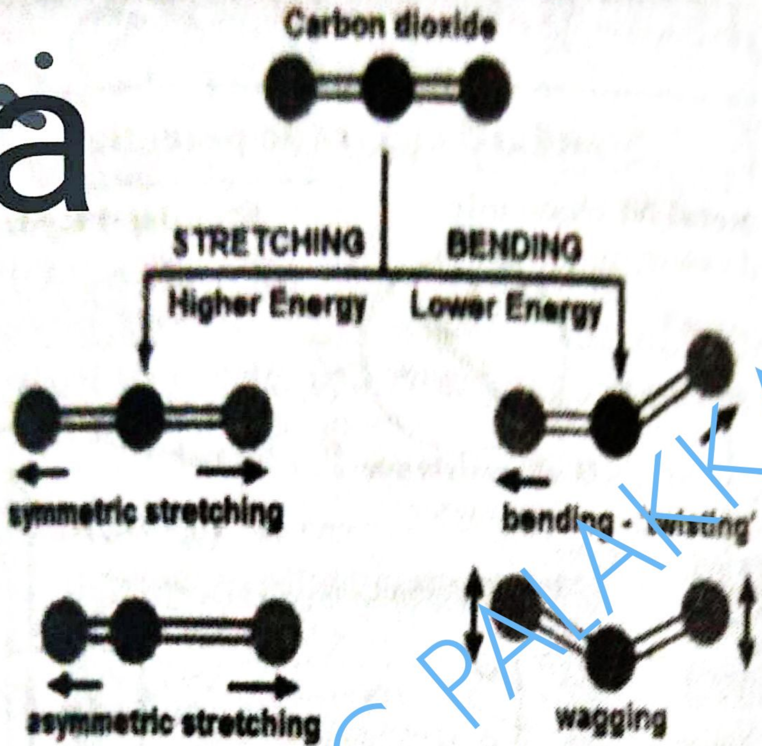
$$\left[ \therefore E_{Fe^{3+}/Fe^{2+}} = E^\circ_{Fe^{3+}/Fe^{2+}} + 2.303 \frac{RT}{F} \log \frac{[Fe^{3+}]}{[Fe^{2+}]} \right]$$

$R = 8.314\ J K^{-1} mol^{-1}$, $T = 298K$, $F = 96500$

8)a)

spectroscopically active in the infrared.

8.a




molecular vibrations of $CO_2$

- The symmetric stretching mode at 1600cm$^{-1}$ does not result in a change (of the initially zero dipole moment), so it is ir-inactive.
- The asymmetric stretching at 2349cm$^{-1}$ does result in a change in dipole moment so it is ir-active.
- The bending in plane (wagging) at 667cm$^{-1}$ and bending out plane (twisting) at667cm$^{-1}$ also results in a change in dipole moment so it too is ir-active.

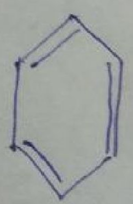
8b)

8. b. In methan all H atom have only 1 NMR signal.

$CH_3$ (a) \ C = O (only H atom) / $CH_3$ (a)

(Acetone)

Only 1 NMR signal.

- $CH_3 - CH - Cl$ (b, a) ⟶ 2 NMR signals.
- $CH_3 - OH$ (a, b) ⟶ 2
- $CH_3 - CH_2 - CH_3$ (a, b, a) ⟶ 2
- $(CH_3)_2C = CH_2$ ($CH_3$ b, $CH_3$ b, H a, H a) ⟶ 2
- $CH_3 - CH_2 - CH_2 - Cl$ (a, b, c) ⟶ 3
- $CH_3 - CH_2 - NH_2$ ⟶ 3
- $CH_3 - CH(OH) - CH_3$ (a, b, a, OH c) ⟶ [illegible]
- $CH_3 - C(CH_3)(CH_3) - NH_2$ ⟶ 2.
- $CH_3 - CH_2 - CH_2 - OH$ (a, b, c, d) ⟶ 4.
-  ⟶ 1



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ENGINEERING CHEMISTRY (ECE & ME)

**Maximum: 50 marks** **Time: 2 hours**

CO* - Course outcome no.; Lvl – Revised Bloom's taxonomy level; Qn No-Question Numbers 1-8

## Part A

**Answer all questions (3 marks each)** **6 X 3 = 18 marks**

| CO | Lvl | Qn No | Question |
|---|---|---|---|
| CO1 | R | 1 | Draw the structure of saturated calomel electrode. Give the electrode reaction. |
| CO1 | A | 2 | Can you store silver nitrate solution in a zinc container? Justify your answer |
| CO2 | R | 3 | What is meant by IR active compounds? Give examples. |
| CO2 | R | 4 | Define chemical shift and give expression. |
| CO4 | R | 5 | What is functional group isomerism? |
| CO4 | U | 6 | Explain geometric isomerism in double bonds with an example |

## Part B

**Answer all questions (16 marks each)** **2 X 16 = 32 marks**

| CO | Lvl | Qn No | Question | Marks |
|---|---|---|---|---|
| CO1 | U | 7 | a) Briefly explain the working of a Li ion cell with diagram. | (6) |
| | A | | b) The potential of a hydrogen electrode measured against SHE is 0.26 V. Calculate the pH of the electrolyte. | (2) |
| | R,U | | c) Derive Nernst equation for silver (Ag) electrode. Explain the effect of temperature and concentration on electrode potential. | (5+3) |
| CO2 | U | 8 | a) How many modes of vibrations are there in water molecule? State whether all are IR active. | (5) |
| | A | | b) A monochromatic radiation is incident on a solution of 0.05 M concentration of an absorbing substance. The intensity of the radiation is reduced to one fourth of the initial value after passing through 10 cm length of the solution. Calculate the molar extinction coefficient of the substance. | (5) |
| | U | | c) Explain the $^{1}H$ NMR spectrum of ethanol ($CH_3CH_2OH$) | (6) |

*CO1 Apply the basic concepts of electrochemistry and corrosion to explore its possible applications in various engineering fields.
*CO2 Understand various spectroscopic techniques like UV Visible , IR, NMR and its applications
*CO4 Learn about the basics of stereochemistry and its application. Apply the knowledge of conducting polymers and advanced polymers in engineering

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# ENGINEERING CHEMISTRY

Question paper
University exam.

⇒ a) Explain the construction and working of a Calomel electrode as a reference electrode. What is the variation in the potential of a Calomel electrode with change in chloride ion concentration.

b) Why Mg corrodes in both acidic and alkaline oxygen deficient conditions whereas Fe doesnot corrode in alkaline oxygen defficient condition.

$Mg^{2+} + 2e^- \rightarrow Mg$, $E^\circ = -2.36V$, $Fe^{2+} + 2e \rightarrow Fe$ $E^\circ = -0.44V$, $H^+ + e \rightarrow \frac{1}{2}H_2$, $E^\circ = 0$

⇒ ~~Li-ion ce~~ Li-Ion cell, Construction, working, advantages

⇒ What are the products of electrolysis at cathode and anode when NaCl solution is electrolysed using Cu electrodes.

$Na^+ + e \rightarrow Na$, $E^\circ = -2.71V$

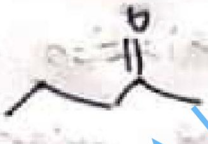
$Cu^{2+} + 2e \rightarrow Cu$, $E^\circ = 0.34V$

$Cl_2 + 2e \rightarrow 2Cl^-$, $E^\circ = 1.36V$

$H^+ + e \rightarrow 1/2\ H_2$   $E = -0.41\ V$ (at pH = 7)

$O_2 + 2H_2O + 4\bar{e} \rightarrow 4OH^-$   $E = 0.82V$ (at pH = 7)

⇒ Predict the no. of signals, their relative positions and splitting pattern in the nmr spectrum of following.

i)    ii) 

⇒ Compare the strength of C-H bond and C=O bond if the absorption frequencies are 3000 $cm^{-1}$ and 1700 $cm^{-1}$ respectively.

⇒ Give the instrumentation of UV spectrophotometer and explain the components in it. Comment on the role of conjugation in the wavelength of absorption with the help of ~~examination~~ examples.

b) MRI, principle involved in it, applications

# Module-1

1. The absorbance of a 0.01M dye solution in Ethanol is .62 in a 2 cm cell for light of wave length 5000A°. If path length of the light through the sample is doubled and the concentration is made half, what will be the value of absorbance (2mark)

Ans: Absorbance $A = \varepsilon c l$.

when concentration is halved and length is doubled.

$$\varepsilon = \frac{A}{(\frac{1}{2}c)\,2l} = \frac{A}{cl} ;$$

So there will be no change in absorbance.



2(a) what is chemical shift? write the causse of chemical shift.

(b) CO Molecule absorbs at 2140 $cm^{-1}$! Calculate the force constant of the molecule, given atomic masses of 'C' & 'O' are 12u and 16u respectively. $1u = 1.67 \times 10^{-27}$ kg.

(c) what are the various energy transitions possible in a molecule. why does electronic spectrum appear broad.

Ans: (a) when a molecule is placed in a magnetic field its electrones are caused to circulate and this they produce Secondary Magnetic field. This induced magnetic field may oppose or reinforce the applied field. Different protons in a Molecule give Signals at different field strengths. Thus the shift in position of NMR spectrum, due to the chemical environment of the proton, as compared to a standard reference is called chemical shift. chemical shift is due to:

(1) Shielding: High Electrondensity around a nucleus deshields the nucleus from the external Magnetic field. The net magnetic field felt by the nucleus in a molecule will be lessthan the applied (external) Magnetic field and the nucleus is said to be shielded. Thus, the NMR Signals are upfield (lower Value) in the NMR spectrum.

(2) Deshielding: If the induced magnetic field reinforces the applied field, the net field felt by a proton in a molecule will be greater than the applied field, and the proton in a molecule will be or said to be deshielded. Deshielding increases the delta value of aromatic and vinylic protons.

(b) $\nu = \frac{1}{2\pi}\sqrt{\frac{k}{\mu}} \rightarrow ①$

$$\mu = \frac{m_1 m_2}{m_1 + m_2}$$

$$\mu = \frac{12 \times 1.66\times10^{-27} \times 16 \times 1.66\times10^{-27}}{12\times1.66\times10^{-27} + 16\times 1.66\times10^{-27}} = 1.14\times10^{-21}\,kg$$

$\nu = c\times\bar{\nu}$

$\left\{ c = 3\times10^{8}\,m/s, \quad \bar{\nu} = 2140\times10^{2}\,m^{-1} \right.$

from eqn (1) $K = 4\pi^2 \nu^2 \mu$

$$= 4\pi^2 c^2 \bar{\nu}^2 \mu$$

$$= 4(3.14)^2 \times (3\times10^8\, m/s)^2 \times (2140\times10^2\, m^{-1})^2 \times 1.14\times10^{-26}\, kg$$

$K = 1853\ Nm^{-1}$

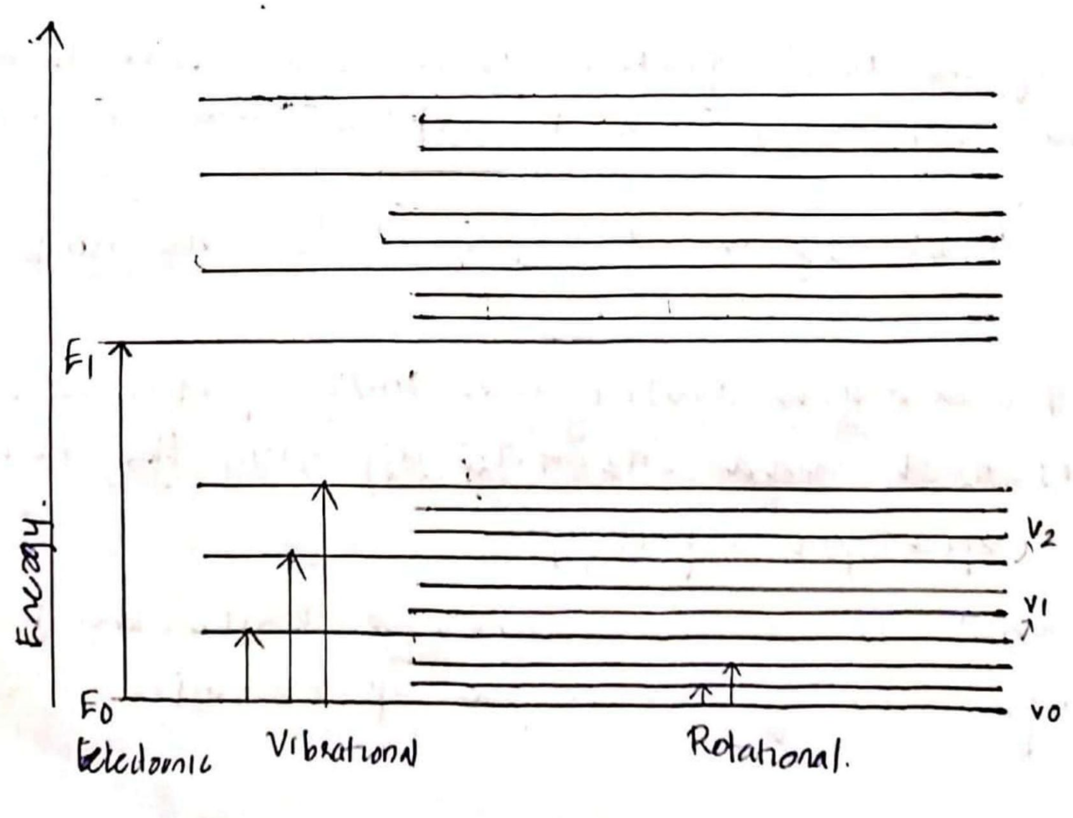
(c) following are the various energy transistion in a Molecule:

(i) Electronic transitions: It is the transitions in a molecules acting between electronic energy levels.

ii) Vibrational transistions: takes places between vibrational energy levels in a Molecule.

Electronic transistions are always accompanied by vibrational & rotational transistions, So it appears broad





3. write 3 points of comparison between UV and IR Spectrum (3 marks)

Ans: (i) UV spectra is obtained by the absorbtion of UV radiations in the range 200–400nm. IR spectra is obtained by, absorbing IR radiations (500–4000 $cm^{-1}$)
(ii) UV-spectra is obtained as a result of transistion between the electronic energy levels whereas IR spectrum is due to the transitions between Vibrational energy levels of a molecule.
(iii) UV-spectra is mainly used for studying about conjugated systems whereas IR spectrum is used to establish the identity of a compound or to determine the structure of a new compound.



4. which of the following nuclei can give NMR spectrum. give reason (a) $^{1}_{1}H$ (b) $^{12}_{6}C$ (c) $^{19}_{9}F$ (d) $^{16}_{8}O$

Ans: If the no: of protons and no: of neutrons both are even (I=0). Such nuclei are NMR inactive.

(a) $^{1}_{1}H$ ($I = \frac{1}{2}$) & (c) $^{19}_{9}F$ ($I = \frac{1}{2}$) are nmr active.

5. (a) How can you distinguish NMR spectrum of $CH_3CH_2Cl$ and $CH_3CHCl_2$ applying the Concept of spin-spin splitting.
(b) what is a Spectrometer. write the principle components of UV-visible Spectrometer.

Ans (a) NMR spectrum of both the compounds have two peaks In $CH_3-CH_2-Cl$, $CH_3$ has lower delta value than $CH_2$ due to the presence of electronegative Cl atom and the peak area ratio is 3:2 whereas in $CH_3-CH-Cl_2$, the $CH_3$ group has lower delta value than CH protons and peak area ratio is 3:1

Spin-spin splitting in $CH_3-CH_2-Cl$:

The $CH_3$ signal split into a triplet (1:2:1) under the influence of $CH_2$ protons. The $CH_2$ protons, split into a quartet (1:3:3:1) under the influence of $CH_3$ protons.

Spin-spin splitting in $CH_3CHCl_2$;

The $CH_3$ signal split into a ~~triplet~~ doub let (1:1) under the influence of CH protons. the CH protons split into a quartet (1:3:3:1) under the influence of $CH_3$ protons.

(b) It is an instrument for analysing the light intensity of different wavelength of light (in a spectral region). Light source, monochromator, beam splitter - sample and reference cell - detector, recorder.

6. which of the following Molecules can give an IR spectrum. Give reason.

(a) $H_2$ (b) $N_2$ (c) HCl (d) $Cl_2$

ans: Molecules having permanent dipole Moment or change of dipole moment with vibrations are IR active. HCl in IR active.

7. The vibrational frequency of HCl Molecule is $2886 cm^{-1}$. Calculate the force constant of the Molecule. Reduced mass of HCl is $1.63 \times 10^{-27}$ kg.

$$\nu = \frac{1}{2\pi}\sqrt{\frac{K}{\mu}}$$

$K = 4\pi^2 \mu \nu^2$ , But $\nu = c\bar{\nu}$

$$K = 4 \times (3.14)^2 \times 1.63 \times 10^{-27} \times (3 \times 10^8)^2 \times (2886 \times 10^2 m^{-1})^2$$

$= 481.8 Nm^{-1}$

8. Calculate the molar absorption coefficient of a $10^{-4}$M solution, the absorbance of which is .20, when the path length is 2.5cm.

given, $A = 0.2$.

$c = 1 \times 10^{-4} M$

$x = 2.5 cm$.

$A = \epsilon x c$.

$$\epsilon = \frac{A}{xc} = \frac{.20}{1 \times 10^{-4} \times 2.5} = 800 mol^{-1} dm^3 cm^{-1}$$

# Module 2.

1. write three advantages of $H_2-O_2$ fuel cell

Ans: * high Efficiency.
* it does not cause any pollution.
* They are free of noise, vibration, heat transfer etc.
* Biproduct is only pure water.
* It is light, compact, simple and easy to maintain.

2. (a) what is meant by standard electrode potential? How would you measure the single electrode potential of a electrode using a saturated calomel electrode?

Ans: The tendency of an electrode to loss or gain electron when it is in contact with its own solution of 1M concentration at 25°c is called standard electrode potential.

To measure the single electrode potential of an unknown electrode using SCE, it is coupled with SCE through salt bridge and resulting emf can be measured and using the equation

$E_{cell} = E_{calomel} - E_{unknown}$, the unknown potential can be calculated

[ eg: Zn - electrode coupled with SCE - diagram]
$E_{Zn} - 1.0025$.

ie $E_{cell} - E_{calomel} - E_{unknown} (Zn)$

∴ $E_{unknown} = E_{SCE} - E_{cell}$

ie, $E_{Zn} = 0.2422 - 1.0025 = -0.76V$.

(b) find the single electrode potential for copper metal in contact with 0.1M $Cu^{2+}$ Solution at 298K.

$E^0_{Cu^{2+}/Cu} = 0.34V$

Ans: $E_{cell} = E^0_{cell} + \frac{0.0591}{2} \log [Cu^{2+}]$

$= 0.34 + \frac{0.0591}{2} \log [0.1]$

$= 0.34 + 0.0295 \times -1$

ie $E_{cell} = 0.3105V$.



3. How is glass electrode constructed? what is its use?

It is universally employed electrode for pH determination and is made up of a special type of glass of relatively low temperature and high Electrical conductivity.

It consist of $SiO_2$ – 72%, $Na_2O$ – 22% CaO – 6%, Ag wire is coated with AgCl, immersed in it. AgCl act as an internal reference electrode

The cell can be represented as:

Ag | AgCl | 0.1N HCl | glass

(Diagram of glass electrode).

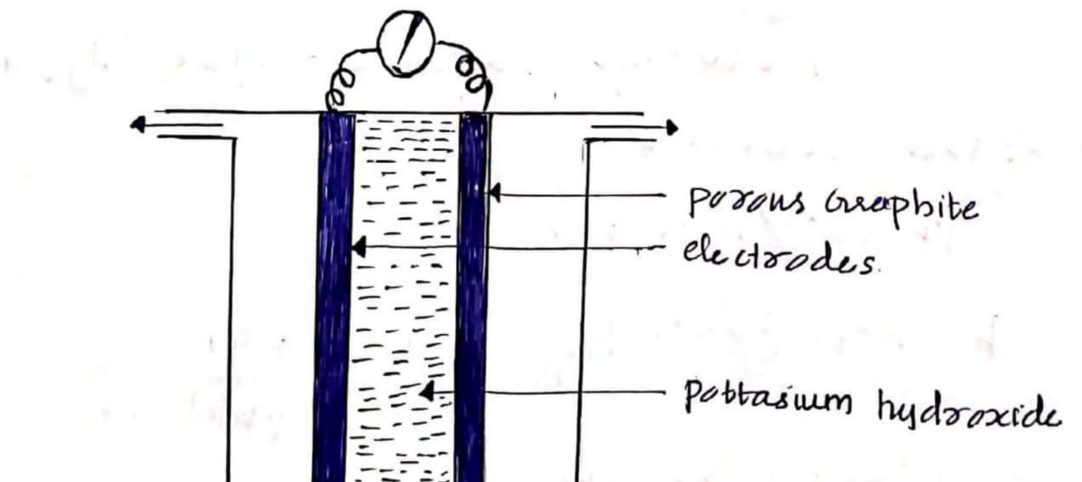
4 What is meant by potentiometric titration? Mention two merits?

Ans: In potentiometric titration, the change in the electrode potential upon the addition of the titrant is noted. ~~potential~~ The volume of the titrant added is plotted against EMF. At the endpoint the rate of change of potential is maximum.

Merits:
- No indicators are used for titration.
- canbe used in the case of coloured solution
- More accurate than indicator using titration



5. Give the working principle of $H_2-O_2$ fuel cell? Draw a neat labelled diagram of the cell.




Ans: Fuel cell is a device in which chemical energy is directly converted to electrical energy.

$H_2-O_2$ fuel is simplest and most Succesfull sell, it make used of electrolyte- 25% KOH and two inert pair electrode. $H_2$ and $O_2$ are bubbled through anode and cathode respectively.

Anode reacn: $2H_2 + 4OH^- \longrightarrow 4H_2O + 4\bar{e}$

cathode reacn: $O_2 + 2H_2O + 4\bar{e} \longrightarrow 4OH^-$

Net reacn: $2H_2 + O_2 \rightarrow 2H_2O$



6. Write electrode reaction and expression for any five electrodes?

(i) Metal - Metal ion electrode.

eg: $Zn/Zn^{2+}$,

$$E_{Zn} = E^0_{Zn} - \frac{0.0591}{2} \log \frac{1}{[Zn^{2+}]}$$

2) Gas electrode

eg: $Pt/H_2/H^+$, $E_H = E^0_{H/H^+} - 0.0591 \log \frac{1}{[H^+]}$

3) Reference electrode

~~eg: Silver - Silver chloride electrode.~~

eg: calomel electrode - $Hg(l)|Hg_2Cl_2|Cl^-$

4) Redox electrode:

$Pt/Fe^{2+}/Fe^{3+}$; $Pt/Ce^{4+}/Ce^{3+}$

$$E = E^0 + \frac{0.0591}{n} \log \frac{[\text{oxidised (state)}]}{[\text{reduced (state)}]}$$

(5) Metal - Metal insoluble electrode

eg: Silver - Silver chloride electrode.

- $Ag/AgCl/Cl^-$.

7. A hydrogen electrode at 25°c in a solution of pH 2.5 and coupled with the half cell. Find the emf of the cell.

Ans: $E_{cell} = E^{\circ}_{cell} + \frac{0.0591}{n} \log [H^+]$.

$= 0 + 0.0591 \log [H^+]$

$= -0.0591\ pH$.

$= -0.0591 \times 2.5 = -0.147V$



8. How does a Li-ion cell work? write its cell reaction.

Ans: it is a rechargable battery in which Li-moves between anode and cathode during charging discharging.

it has higher -ve value for reduction potential and lower atomic mass.

charging:-

At anode: $LiCoO_2 \rightarrow LiCoO_2 + xLi + xe$

At cathode: $Cu + xLi^+ + xe^{-n} \rightarrow Li_xCu$

Discharging:

At cathode: $Li_{1-x}CoO_2 + xLi + xe^{-n} \rightarrow LiCoO_2$.

At anode: $Li_xCu \longrightarrow Cu + xLi^+ + xe^{-n}$.

9. Calculate the emf of the following cell at 25°c

$Zn/Zn^{2+} (a = 0.0004) \,//\, Cd^{2+}_{(a=0.2)} / Cd$.

Given $E^0_{Zn^{2+}/Zn} = -0.76V$, $E^0_{Cd^{2+}/Cd} = -0.403V$.

Ans: $E_{cell} = E^0_{cell} + \frac{0.0591}{n} \log \frac{[cathode]}{[Anode]}$

$E^0_{cell} = -0.403 + 0.76 = 0.357V$

$E_{cell} = 0.357 + \frac{0.0591}{2} \log \frac{[0.2]}{[0.0004]}$

$= 0.4367V$

10. Calculate the single electrode potential of $Zn^{2+}/Zn$, when the concentration of $Zn^{2+} = 0.1M$ and temperature at $50^\circ C$, $E^0_{Zn} = -0.76V$.

Ans: $E = E^0 + \frac{2.303\,RT}{nF} \log [Zn^{2+}]$

$= -0.76 + \frac{2.303 \times 8.314 \times 323}{2 \times 96500} \log \left(\frac{1}{0.1}\right) = -0.792V$