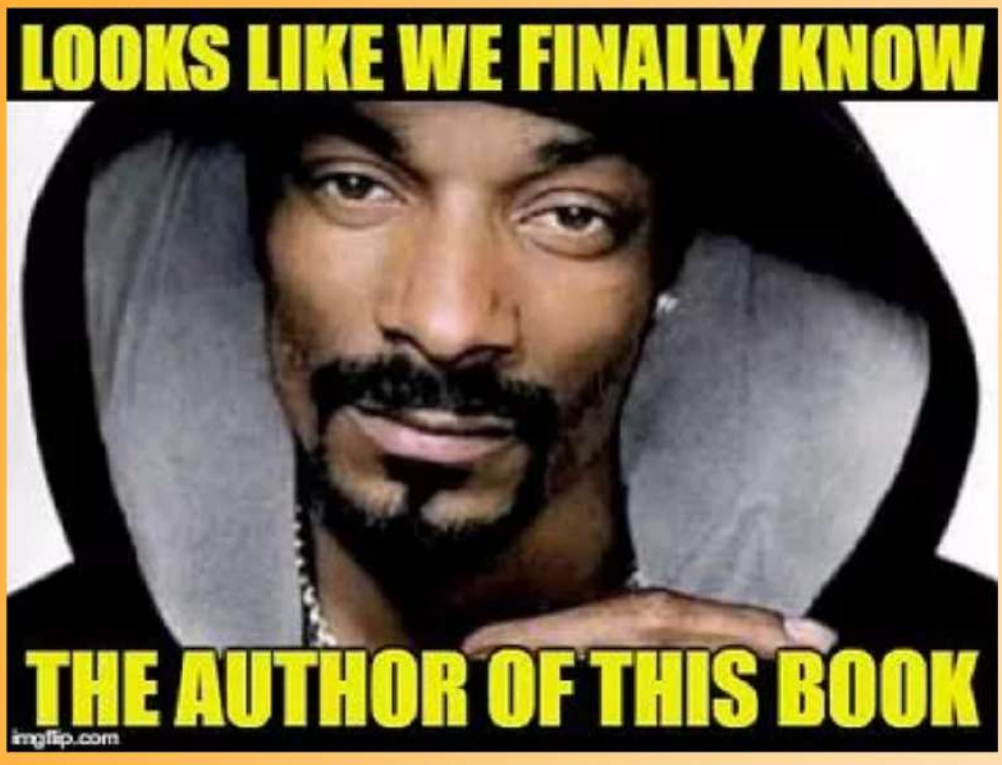
CHEMISTRY QB SOLUTION



ALL CREDITS TO SEAMBOOKS

Engineering Chemistry-II

MCQ with Answer Keys

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NOTE: Atomic Weights: C = 12, H = 1, O = 16, N = 14, S = 32, Na=23 and Br=80

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Q1.	**Choose the correct option for following questions. All the Questions are compulsory and carry equal marks(2 marks each)**
1.	Which of the following spectroscopy can be used to quantify the concentration of protein and DNA in solution
Option A:	Infra-Red spectroscopy
Option B:	UV spectroscopy
Option C:	NMR spectroscopy
Option D:	Raman spectroscopy
2.	The standard emf of the following cell is 0.012V Sn(s) | Sn2+ (aq)(1M) ‖ Pb2+(aq)1M | Pb(s) Calculate standard electrode potential of Sn electrode, if standard electrode potential for Pb electrode is -0.125V.
Option A:	-0.137
Option B:	-0.113
Option C:	-0.005
Option D:	-0.245
3.	In greener synthesis of indigo, traditionally used Aniline is replaced by the following substrate.
Option A:	D-glucose
Option B:	Benzene
Option C:	Toluene
Option D:	L-tryptophan
4.	Galvanization is preferred to tinning since, i) Zinc is more electro positive than iron ii) Zinc coating protects iron sacrificially iii) Punctured tin coating causes intense corrosion
Option A:	Only (i)
Option B:	Only (iii)
Option C:	(i), (ii) &(iii)
Option D:	Only (ii)
5.	Corrosion in welded stainless steel is an example of ……
Option A:	Galvanic corrosion
Option B:	Pitting corrosion
Option C:	Waterline corrosion
Option D:	Inter granular corrosion

6.	A sample of coal has following composition by mass C =70 %, O = 8 %, H = 10 %, N = 3 %, S = 2%, Ash = 7 %.Calculate H.C.V. using Dulong formula
Option A:	8805.80kcal/kg
Option B:	8277.80 kcal/kg
Option C:	8877.80 kcal/kg
Option D:	8205.80 kcal/kg
7.	Arrange n-octane, naphthalene and isooctane in the increasing order of their knocking tendency.
Option A:	n-octane <Naphthalene < isooctane
Option B:	Naphthalene < isooctane< n-octane
Option C:	Isooctane<Naphthalene<n-octane
Option D:	Isooctane=n-octane <Naphthalene
8.	A cell is constructed from Ni+ 2 / Ni and Cu+2/Cu half cells . The standard potential of the cell is -------. Given E0Ni = - 0.257 V and E0Cu = 0.337 V
Option A:	- 0.594 V
Option B:	0.008 V
Option C:	- 0.008 V
Option D:	0.594 V
9.	Which of the following reactions are Green in nature: Addition reactions, Substitution reactions, Elimination reactions, Rearrangement reactions
Option A:	Addition and Substitution reactions
Option B:	Rearrangement and Elimination reactions
Option C:	Rearrangement and Addition reactions
Option D:	Substitution and Elimination reactions
10.	An iron object is plated with a coating of Nickel to protect against corrosion. Does the Nickel protect iron by cathodic protection? Give suitable reason for your answer.
Option A:	No. The oxidation potential of Ni/Ni+2 is lower than that for Fe/Fe+2
Option B:	Yes. The oxidation potential of Ni/Ni+2 is lower than that for Fe/Fe+2
Option C:	No. The oxidation potential of Fe/Fe+2 is lower than that for Ni/Ni+2
Option D:	Yes. The oxidation potential of Fe/Fe+2 is lower than that for Ni/Ni+2
11.	In quantum Mechanics, a set of rule exist, known as 'Selection rules' that basically explains which transitions are 'allowed transitions'. Which amongst the following statements is an 'allowed transitions'?
Option A:	The spin quantum number of an electron doesnot change during the absorption or emission of light in an 'allowed transition'.
Option B:	The change in orbital quantum number during an 'allowed transition' is zero.
Option C:	There is no change in magnetic quantum number during an 'allowed transition'.
Option D:	The change in magnetic quantum number during a 'forbidden transition' is either zero, or +1, or -1.
12.	Small anodic area and large cathode area results in -
Option A:	Slow corrosion because of decreased demand of electrons by the small anode.
Option B:	Intense corrosion because of huge demand of electrons by the small anode.
Option C:	Slow corrosion because of decreased demand of electrons by the large cathode.
Option D:	Intense corrosion because of huge demand of electrons by the large cathode.

13.	Selection rule to produce rotational spectra is
Option A:	Dipole moment of molecule must change during vibrations
Option B:	Molecule must have permanent dipole moment
Option C:	Presence of chromophore in a molecule
Option D:	Presence of unpaired electron in a molecule
14.	Benzene is an important industrial solvent which is classified as
Option A:	Non-toxic
Option B:	Non-flammable
Option C:	Biodegradable
Option D:	Carcinogenic
15.	Which of the following statement is incorrect about an electrochemical cell
Option A:	Oxidation occurs at anode and reduction at cathode
Option B:	Chemical energy is converted into electrical energy
Option C:	Cell can work indefinitely
Option D:	Salt bridge maintains electrical neutrality of the electrolytes
16.	If a metal rod exhibits holes on its surface due to corrosion, the type of corrosion is
Option A:	Waterline
Option B:	Galvanic
Option C:	Pitting
Option D:	Stress
17.	A good fuel has
Option A:	Low ignition temperature and high calorific value
Option B:	Low ignition temperature and low calorific value
Option C:	High ignition temperature and high calorific value
Option D:	Moderate ignition temperature and high calorific value
18.	Spin multiplicity for the two unpaired electrons in excited singlet state is
Option A:	3
Option B:	2
Option C:	1
Option D:	4
19.	Which of the following green chemistry principles are applicable to the alternate synthesis of ibuprofen?
Option A:	Maximize atom economy, preventaion of waste and use of renewable feedstock
Option B:	Maximize atom economy, preventaion of waste and reduce unnecessary derivatisation
Option C:	Maximize atom economy, use of auxillary substances and increases energy effieciency
Option D:	Prevention of waste, renewable feedstock and increased energy efficiency.
20.	Proximate analysis of coal is used to determine
Option A:	% of Nitrogen
Option B:	% of Sulphur
Option C:	% of Hydrogen
Option D:	% of Moisture
21.	Season cracking is a special case of
Option A:	Chemical corrosion
Option B:	Stress corrosion
Option C:	Concentration cell corrosion
Option D:	Waterline corrosion

22.	By which process does the knocking starts in diesel engine?
Option A:	Due to sudden spontaneous combustion of last portion of fuel
Option B:	Due to delay in spontaneous combustion of last portion of fuel
Option C:	Due to the rise in temperature of diesel engine
Option D:	Due to the presence of straight chain paraffins in the diesel
23.	**Which of the metallic structure will require more impressed current density for cathodic protection?**
Option A:	Water boiler
Option B:	a ship hull
Option C:	Series of underground gas pipes
Option D:	an iron pipe buried in the soil
24.	In impressed current cathodic protection, anode is provided with a gypsum backfill because
Option A:	It enhances the rate of reaction
Option B:	It decreases metal to metal contact
Option C:	It enhances electrical contact with surrounding soil
Option D:	It decreases electrical contact with soil
25.	**Zn metal is corroding in the presence of acid. After sometimes corrosion stops.The reason is**
Option A:	addition of few drops of CuSO4
Option B:	Increased Hydrogen overvoltage of Zn
Option C:	Decreased Hydrogen Overvoltage of Zn
Option D:	Increased diffusion of H^+ ions
26.	As per Pilling- Bedworth rule, Greater the specific volume ratio,
Option A:	Higher is the oxidation corrosion
Option B:	Higher is the electrochemical corrosion
Option C:	Lower is the oxidation corrosion
Option D:	Lower is the electrochemical corrosion
27.	Calculate the emf of a concentration cell at 25°C consisting of two Ag electrodes immersed in solutions of Ag^+ions of 0.2M and 0.01M concentrations
Option A:	0.777V
Option B:	-0.077V
Option C:	0.0385V
Option D:	0.077V
28.	The number of waves which can pass through a point in one second. This statement justifies, from the following
Option A:	Wavelength
Option B:	Frequency
Option C:	Wave number
Option D:	Acceleration
29.	Which is not the selection rule for the electronic transitions from the following
Option A:	Spin selection rule
Option B:	Symmetry rule
Option C:	Hund's rule
Option D:	Angular momentum rule
30.	**To calculate the net calorific value, the products are _____**
Option A:	cooled

Option B:	collected
Option C:	allowed to escape
Option D:	heated

31.	Which one of the following is not applicable to a green reaction?
Option A:	Should not use hazardous reagents in manufacture of products.
Option B:	All the atoms of the reactancts should be incorporated to give only the atoms of products
Option C:	Should not use hazardous reagents but can produce toxic products
Option D:	Should prevent accidents in chemical industries
32.	The device in which electrical energy from an external source can be used to produce chemical reactions, such device is known as_____
Option A:	Voltaic Cell
Option B:	Electrolytic Cell
Option C:	Concentration Cell
Option D:	Fuel Cell
33.	From the following which is not used as a reference electrode
Option A:	Hydrogen electrode
Option B:	Calomel electrode
Option C:	Silver/Silver chloride electrode
Option D:	Glass electrode
34.	Mechanism of electrochemical corrosion occurs due to evolution of hydrogen gas when
Option A:	Corrosive environment is acidic
Option B:	Corrosive environment is alkaline
Option C:	Corrosive environment is neutral
Option D:	Corrosive environment is alkaline and neutral
35.	Moisture and volatile matter free 3.3 gm of coal sample was ignited in muffle furnace to a constant weight of 0.252 gm of residue. What will be the percentage of ash in coal sample
Option A:	1.84 %
Option B:	11.31 %
Option C:	8.00 %
Option D:	6.63 %
36.	Which of the following metallic coating method involves hot dipping?
Option A:	Metal cladding
Option B:	Metal Spraying
Option C:	Galvanizing
Option D:	cementation
37.	For estimation of moisture content in coal sample silica crucible is heated at ____ degree Celsius
Option A:	120 degree Celsius
Option B:	105-110 degree Celsius
Option C:	925 degree Celsius
Option D:	750 degree Celsius
38.	Caustic embrittlement is which type of electrochemical corrosion?
Option A:	Waterline corrosion
Option B:	Stress corrosion
Option C:	Pitting Corrosion
Option D:	Galvanic cell corrosion

39.	_____ is not the green chemistry principle from the following
Option A:	High atom economy
Option B:	Use of catalyst
Option C:	Use of Non-renewable feedstock
Option D:	Use of green solvent

40.	Nobel metals do not undergo oxidation corrosion because it forms_____
Option A:	Unstable oxide film
Option B:	Non-porous oxide film
Option C:	Porous stable film
Option D:	Volatile oxide film
41.	Which is used as a green solvent from the following?
Option A:	Alcohol
Option B:	Acetone
Option C:	Supercritical CO_2
Option D:	Concentrated Sulphuric acid (H_2SO_4)
42.	Dulong's Pettit formula is used for the theoretical calculations of
Option A:	Rating of coal
Option B:	Saponification value
Option C:	Calorific value
Option D:	Sulphur from coal
43.	In which spectrum, molecule falls from excited state to ground state with the emission of photon energy?
Option A:	Electromagnetic spectra
Option B:	Absorption spectra
Option C:	Emission spectra
Option D:	Scattering spectra
44.	Which of the following is not synthesized by greener way?
Option A:	Acetic acid
Option B:	Adipic acid
Option C:	Indigo
Option D:	Carbaryl
45.	Identify the true statement of the following:-
Option A:	EMF series includes non metals, metals and their alloys
Option B:	EMF series predicts the corrosion characteristics of metals and alloys correctly
Option C:	position of metals in EMF series changes with the change in the environment
Option	It talks about the relative displacement tendencies of metals and non metals

D:	
46.	Electromagnetic spectrum is nothing but the arrangement of electromagnetic radiations according to
Option A:	Increasing order of wavelength & Decreasing order of frequency
Option B:	Decreasing order of frequency & Decreasing order wave length
Option C:	Decreasing order of wavelength & Increasing order of frequency
Option D:	Not related to frequency and wavelength order

47.	Which of the following is not a principle of proper designing?
Option A:	Avoid the contact of dissimilar metals
Option B:	Anode should be smaller than cathode
Option C:	Corrosion should not be localized but uniform
Option D:	Anode should not be painted.
48.	In galvanic cell ------ energy is converted into ------ energy.
Option A:	Chemical into electrical energy
Option B:	Electrical into Chemical energy
Option C:	Chemical into Chemical energy
Option D:	Electrical into Electrical energy
49.	Corrosion between two dissimilar metals in electrical contact is which type of corrosion
Option A:	Differential aeration corrosion
Option B:	Galvanic corrosion
Option C:	Liquid metal corrosion
Option D:	Oxygen concentration cell corrosion
50.	Standard Hydrogen electrode is arbitrarily assigned ----- potential
Option A:	Zero
Option B:	Two
Option C:	One
Option D:	Three

51.	When cathodic area is large and anodic area is small then corrosion is known as
Option A:	Galvanic corrosion
Option B:	Concentration cell corrosion
Option C:	Pitting corrosion
Option D:	Dry corrosion
52.	In atmospheric corrosion, which film is developed over Aluminum, Titanium and Vanadium
Option A:	Stable porous film
Option B:	Volatile film
Option C:	Unstable film
Option D:	Stable Non porous film
53.	Intergranular corrosion is also known as
Option A:	Galvanic corrosion
Option B:	Dry corrosion
Option C:	Grain boundary corrosion
Option D:	Wet corrosion

54.	Which of the following constituent is measured in both proximate and ultimate analysis?
Option A:	Moisture
Option B:	Ash
Option C:	Volatile matter
Option D:	Nitrogen
55.	Which of the following are principal constituents of fuel
Option A:	Carbon and Hydrogen
Option B:	Oxygen and hydrogen
Option C:	Sulphur and Oxygen
Option D:	Sulphur and Hydrogen
56.	Quality of petrol is decided by it's
Option	Cetane number

A:	
Option B:	Octane number
Option C:	Carbon number
Option D:	Hydrogen number
57.	Which of thefollowing method is used for nitrogen estimation
Option A:	Precipitation method
Option B:	Combustion method
Option C:	Kjeldahl's method
Option D:	Titration method

Q1) A sample of coal has the following composition by mass: C = 85%, H = 6%, O = 8%, S = 0.5% and Ash = 0.5%. Calculate HCV and LCV using Dulong's Formula. Given Atomic Weights: C=12, H = 1, S = 32, O = 16

Q1/ QB/ Quesmid.com

C = 85%, H = 6%, O = 8%, S = 0.5% and Ash = 0.5%

Calculate HCV and LCV using Dulong's Formula:

→ Dulong Formula

$$HCV = \frac{1}{100}\left[8080C + 34500\left(H - \frac{O}{8}\right) + 2240S\right] \text{ Kcal/kg}$$

$$= \frac{1}{100}\left[8080 \times 85 + 34500\left(6 - \frac{8}{8}\right) + 2240 \times 0.5\right]$$

$$= \frac{1}{100}\left[686800 + 172500 + 1120\right]$$

$$= \frac{860420}{100}$$

$$\boxed{HCV = 8604.20 \text{ Kcal/kg}}$$

$$LCV = HCV - \left(\frac{9 \times H}{100} \times 587\right)$$

$$= 8604.20 - \left(\frac{9 \times 6}{100} \times 587\right)$$

$$\boxed{LCV = 8287.22 \text{ Kcal/kg}}$$

DQ2: ***Discuss differential aeration corrosion with the help of a suitable example.***

Solution:

This type of corrosion occurs when a metal is exposed to varying concentrations of electrolyte or oxygen which may be a result of inadequate agitation or slow diffusion of metal ions produced by corrosion. Differential aeration corrosion occurs when one part of metal to exposed to a different air concentration from the other part. This causes a difference in electrode potential between differently aerated areas. It has been found experimentally that poorly oxygenated parts form anodic area. Let us consider a metal (say Zn) is partially immersed in a neutral solution (dilute) of a salt (say NaCl) and the solution is not agitated properly, then the parts above and closely adjacent to the waterline are more strongly aerated (because of easy access of oxygen) and hence become cathodic. On the other hand, parts immersed to greater depth (i.e., at bottom which have less access of oxygen) show a smaller oxygen concentration and thus become anodic. So, at anodic parts liberation of electrons takes place as:

$$Zn \rightarrow Zn^{2+} + 2\bar{e} \text{ (oxidation)}$$

At cathode, the oxygen in solution will take up electrons and form hydroxide ions (OH^-).

$$\frac{1}{2} O2 + H2O + 2\bar{e} \rightarrow 2OH^- \text{ (Reduction)}$$

This type of corrosion occurs in areas which a are less oxygenated such as cracks & crevices. It takes place under accumulated rust, dirt, sand & scale. Metals exposed to aqueous medium corrode under blocks of pieces of glass.

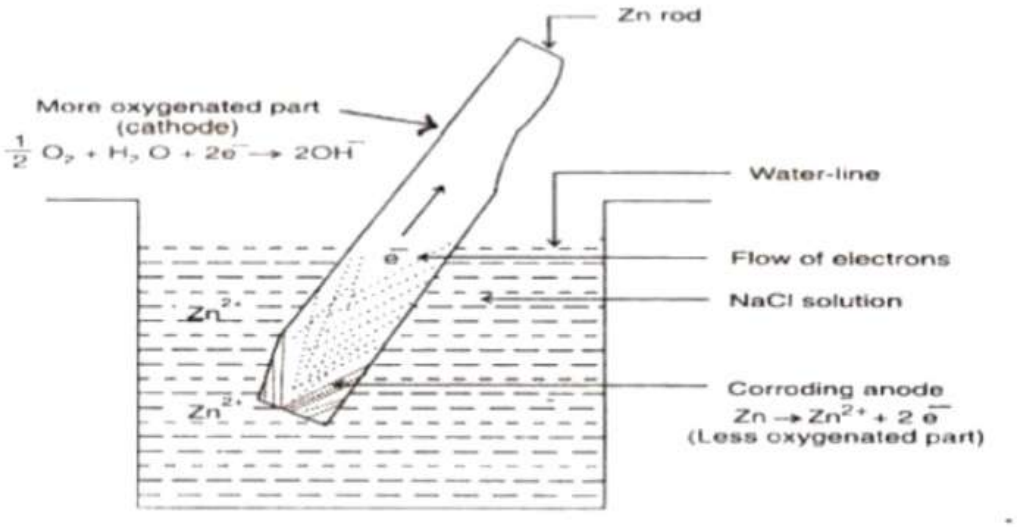
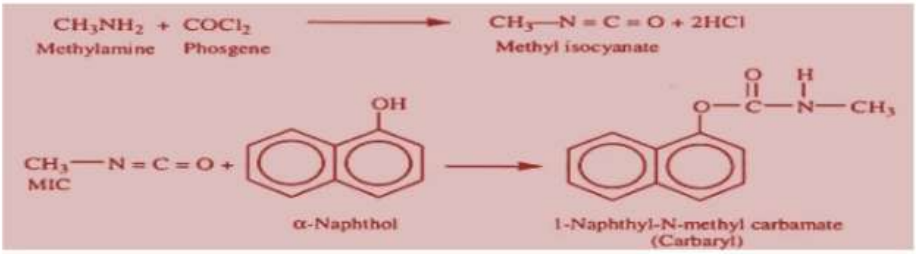


Fig: **Differential aeration corrosion**

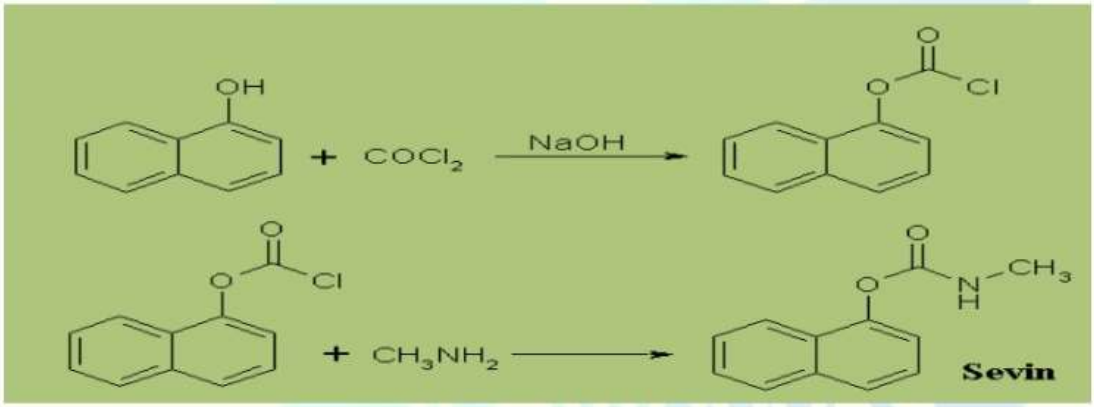
DQ3: ***Explain the conventional and Green route of manufacturing Carbaryl. Highlight the green chemistry principle involved.***

Solution: Conventional Route of manufacturing Carbaryl:



In the conventional method, toxic methyl isocyanate and phosgene were directly used in the manufacturing process of carbaryl an insecticide and pesticide. The two toxic chemicals were stored in large tanks. Accidental leakage of methylisocyanate lead to the tragedy.

B] Greener Route of manufacturing Carbaryl:



In greener route, direct use of toxic methylisocyanate is curtailed. Instead, chloroformate is used as raw material and treated with Methyl amine to give Carbaryl.

Principle involved: Inherently Safer Chemistry for Accidents Prevention:

For any of chemical process carried out at industrial level should have a proper maintenance of the parts of the chemical plant such as timely repair of knobs, leaking pipes, taps, control panels, tanks.

DQ4: ***Define Spectroscopy and Electromagnetic spectrum. Also explain the origin of spectrum.***

Solution: **Spectroscopy** is defined as "The analysis of the electromagnetic radiation scattered, absorbed or emitted by molecules. It deals with the transitions that an electron in a molecule undergoes between energy levels upon absorption of suitable radiations".

Electromagnetic spectrum is term used to specify different or entire spectral regions such as visible, UV, infra-red, radio-wave, etc., in increasing order of frequency in Hz and decreasing order of wavelength in meters.

Origin of spectrum:

Thus, there are two types of spectra:

1. Emission spectra: Molecules give emission spectra when subjected to intense heat or electric discharge. Due to this heat molecules get excited. On returning to their lower energy state, molecules may emit radiation, which is the result of transmission of molecule from an excited state to one of lower energy, usually the ground state. This excess energy is emitted as a photon and the corresponding frequency is recorded as the emission spectrum.

2. Absorption spectra: When a substance is irradiated with electromagnetic radiation, the energy of the incident photons may be transferred to the molecules, raising them from the ground state to an excited state. This, process is known as absorption and the resultant spectrum is known as absorption spectrum. The energy absorbed by a molecule may bring about changes in one or more of its energy levels such as rotational, vibrational and electronic. Absorption spectrum and Emission spectrum can be shown as follows:

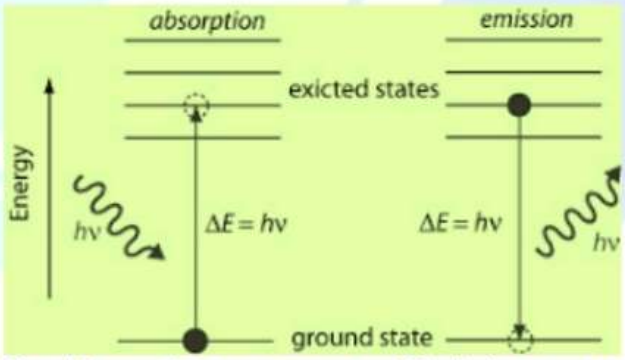


Fig: Absorption spectrum and Emission spectrum

DQ5: ***The standard emf of the following cell is 0.462 V.***
$Cu(s) / Cu^{+2}(aq)(1M) // Ag^{+}(aq)(1M) / Ag(s)$
Write the cell reaction. If the standard potential of Cu electrode is 0.337 V, what is the standard potential of Ag electrode?

Solution:

Given: $E^0Cu = 0.337V$

$E^0Ag=?$

$E^0cell=0.462V$

For this cell:

Oxidation half cell, at anode:

$Cu(s) \rightarrow Cu^{2+} + 2e^- \quad E^0Cu = 0.337V$

Reduction half cell, at cathode:

$2Ag^+ + 2e^- \rightarrow 2Ag \quad E^0Ag = ?$

E^0 cell = E^0cathode - E^0anode

$0.462 = E^0Ag - 0.337$

$E^0Ag = 0.462 + 0.337$

$= 0.799$ V

Ans- E^0Ag is 0.799V.

DQ6: ***What is cathodic protection? What are the two types of cathodic protection? Discuss any one with the help of a suitable diagram.***

Solution: Cathodic protection: The principle involved in this method is to make the metal to be protected to behave like a cathode.

Cathodic protection of metal from corrosion can done by two ways such as:

i. Sacrificial anodic protection.
ii. Impressed current cathodic protection.

Sacrificial anodic protection:

In this method, the metallic structure which is to be protected from corrosion, is connected by a wire to more anodic metal (i.e., metal which is higher in galvanic series), so that all corrosion takes place at this more active metal. By doing so the active metal connected to metallic structure to be protected gets corroded slowly whereas the metallic structure forming cathode is protected. The active metal employed is called sacrificial anode. The corroded sacrificial anode block is to be replaced by a fresh one, when consumed completely. Metals used as sacrificial anodes are Mg, Zn, Al and their alloys. To increase the conductivity with surrounding soil, sacrificial anode is placed in a backfill consisting of charcoal, coke or gypsum.

Applications: Sacrificial anode cathodic protection method is used for protection of buried pipelines, underground cables, marine structures, ship hulls, water tanks, piers, boring, bridgesetc.

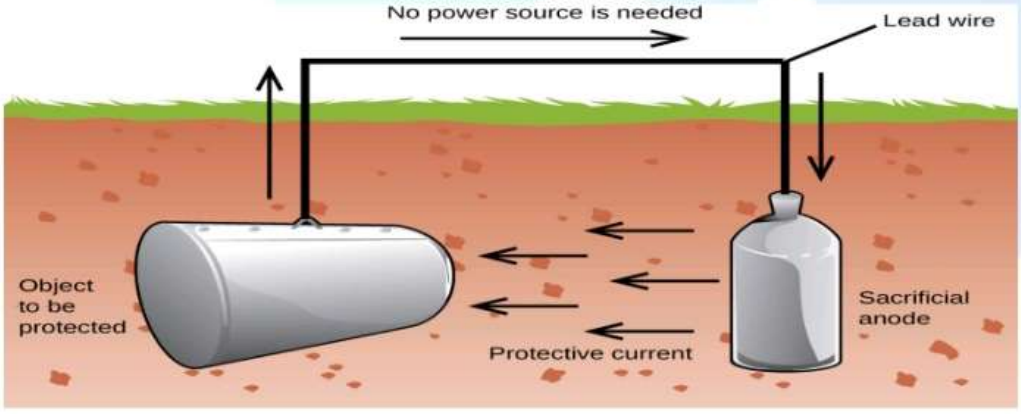


Fig: Sacrificial anode cathodic protection

DQ7: ***Calculate the percentage atom economy for the following reaction with respect to acetanilide.***

$C_6H_5NH_2 + (CH_3CO)_2O \longrightarrow C_6H_5NHCOCH_3 + CH_3COOH$

Given Atomic Weights: C = 12, H = 1, O = 16, N = 14

Solution:

$C_6H_5NH_2 + (CH3CO)_2O \rightarrow C_6H_5NHCOCH_3 + CH_3COOH$

MW=93 102 135

$$\% \text{ Atom Economy} = \frac{\text{Molecular weight of product} \times 100}{\text{Total Molecular weight of Reactants}}$$

$$= \frac{135 \times 100}{93+102}$$

$$= 69.23\%$$

%Atom Economy = 69.23

DQ8: ***Calculate the volume of air required for complete combustion of 1m³ of gaseous fuel having the following composition: CO = 5%, C_2H_4 = 10%, CH_4 = 40%, N_2 = 2.5 %, H_2 = 35%, CO_2 = 2%, O_2 = 2.5%***
Given Atomic Weights: C = 12, H = 1, O = 16, N = 14

SOLUTION:

Constituents	**% By volume**	**Volume of each per m³ of fuel**	**Combustion Reactions**	**Volume of Oxygen required in m³**
H_2	35	35/100 = 0.35	$H_2 + {}^1/_2\ O_2 \rightarrow H_20$	0·35 x 0.5 = 0.175
CO	5	5/100 = 0.05	$CO + ½\ O_2 \rightarrow CO_2$	0.05 x 0.5 = 0.025
C_2H_4	10	10/100 = 0.1	$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_20$	0.1 x 3= 0.3
CH_4	40	40/100 = 0.4	$CH_4 + 2\ O_2 \rightarrow CO_2 + 2H_20$	0.4 x 2 = 0.8 **=1.3**
O_2	2.5	2.5/100 = 0.025	O_2 in the fuel	**-0.025**
CO_2	2	Ignore, non-combustible	-	
N_2	2.5	Ignore, non-combustible		
				Total O_2 = 1.275

To Calculate Volume of air: ----------**Table: 3M**

Volume of Air required = $\frac{\text{Volume of } O_2 \text{ required x } 100}{21}$

$= \frac{1.275 \text{ x } 100}{21}$

$= 6.0714\ m^3$

Volume of air required for 1 m³ of gas = 6.0714 m³. ----------**1M**

DQ9: ***How do the following factors affect the rate of corrosion?***
(i) relative areas of anodic to cathodic part

(ii) position of metal in galvanic series.

Solution:

(i) Relative areas of anodic to cathodic part:

If the area of anode is large and area of cathode is small, corrosion will be slow whereas if area of anode is small and area of cathode is large then corrosion will be fast, this is because small anode has to produce a greater number of electrons to fulfill greater demand of electrons by large area of cathode. Thus, the rate of corrosion is directly proportional to the ratio of the cathodic part and anodic part as shown below:

$$\text{Rate of Corrosion} \propto \frac{\text{Cathodic Area}}{\text{Anodic Area}}$$

(ii) Position of metal in galvanic series.

a.) Ifthe position of metal in galvanic series is higher, it is active metal having low electrode potential and will undergo corrosion easily. Whereas if the metal is placed lower in galvanic series, it is noble having high electrode potential and will not undergo corrosion easily. Thus,Metals that are higher in the position in the galvanic series, tend to corrode faster whereas, metals lower in position in the galvanic series corrode slowly or resist it

b.) If two different metals are in contact, the metal higher in galvanic series suffers corrosion

DQ10: ***(i) Distinguish between anodic and cathodic coating.***

(ii) What is Biodiesel? Give the trans-esterification reaction of the preparation of Biodiesel.

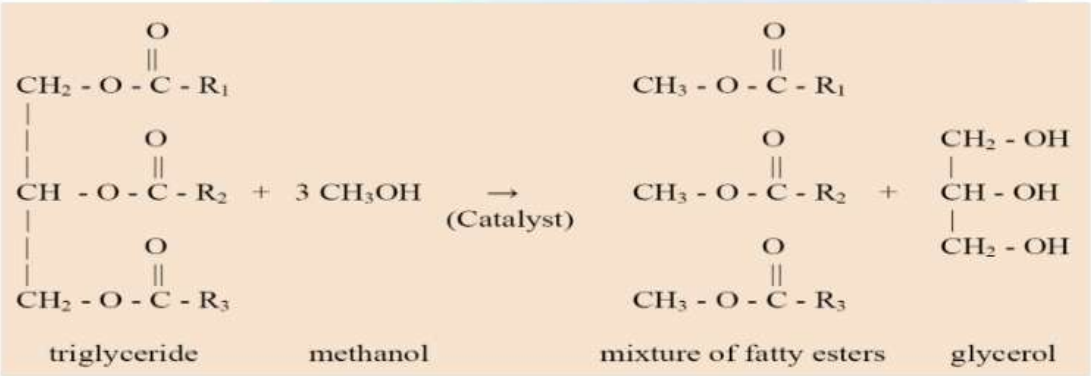
Solution:

(i) Distinguish between anodic and cathodic coating.

Anodic coating	Cathodic coating
1) Protects the underlying metal sacrificially.	1) Protects the underlying base metal due to its noble character or higher corrosion resistance.
2) Electrode potential of coating metal is lower than that of base metal.	2) Electrode potential of coating metal is higher than that of base metal.
3) If pores, breaks occur in such a coating, the base metal is not corroded, till all the coating metal is consumed.	3) If pores, breaks occur in such coating, the corrosion of the base metal is speeded up.
4) Example is coating of Zn on iron.	4) Example is coating ofSn on iron.
5) The process of coating of Zn on iron is known as Galvanizing.	5) The process of coating of Sn on iron is known as Tinning.

(ii) Biodiesel: Chemically it is methyl ester of higher fatty acid. Its chemical formula is $RCOOCH_3$, where R is higher hydrocarbon like $C_{17}H_{35}$, $C_{15}H_{31}$. CH_3 group can be ethyl or propyl in some cases.

Trans-esterification reaction of the preparation of Biodiesel:



Advantages of Biodiesel:

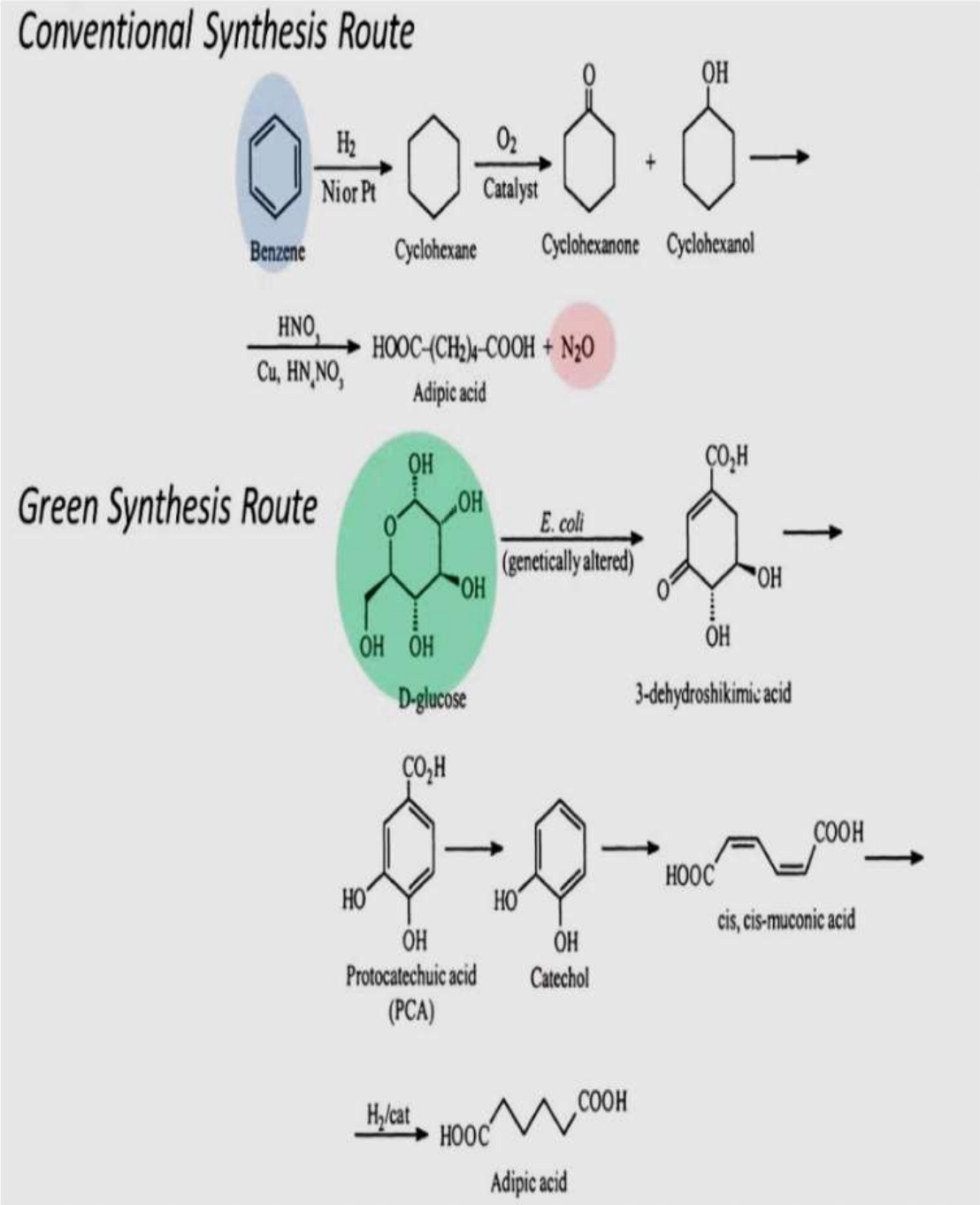
1) It is a clean burning alternative fuel.

2) Obtained from renewable source.

DQ11: ***Explain the conventional and Green route of manufacturing Adipic acid. Highlight the green chemistry principle involved.***

Solution: Principle involved: Use of Renewable Feed Stock.

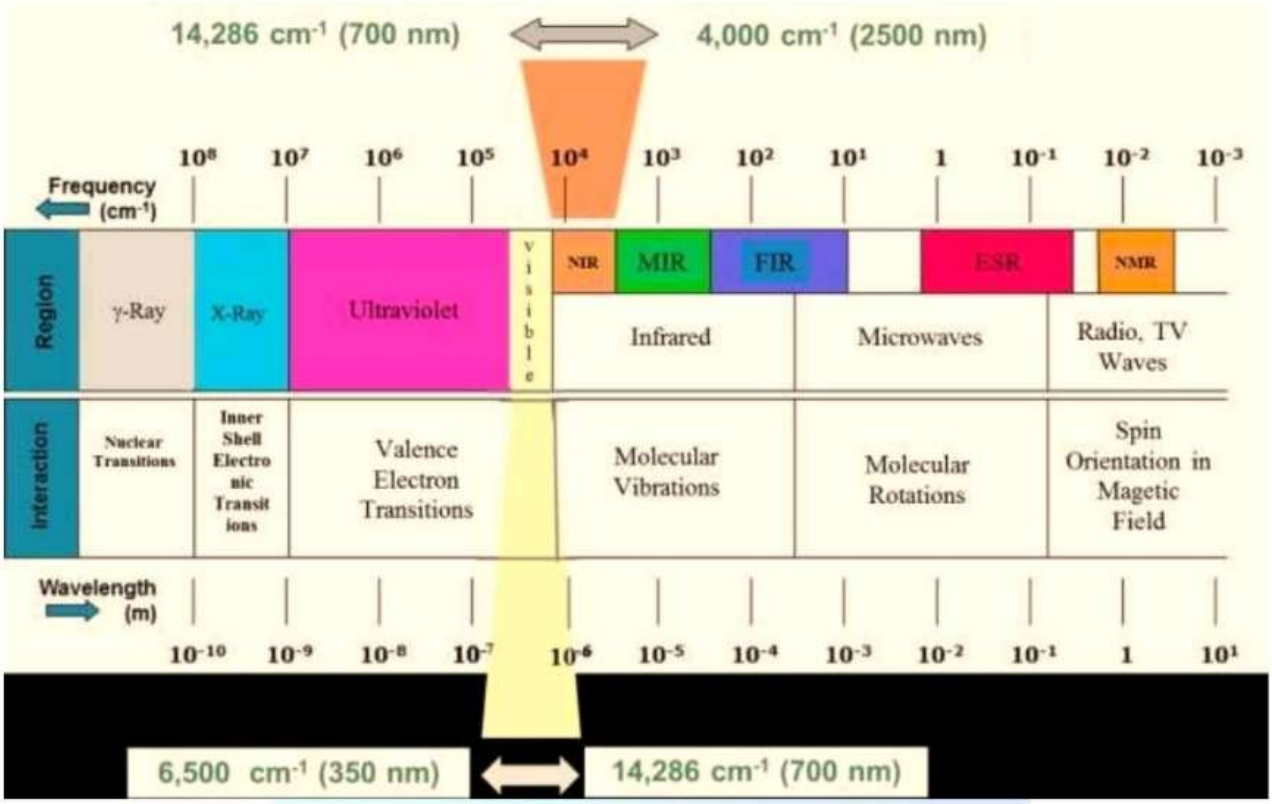
Feed Stock should be renewable that is one obtained from agricultural or biological process, so that it is easily available and non-exhaustible (as the petroleum oil).



DQ12: ***Give in tabular form the relation between electromagnetic spectrum, types of spectroscopy and corresponding energy changes.***

Solution:

Table showing the relation between electromagnetic spectrum, types of spectroscopy and energy changes is shown below.



DQ13: ***What is an electrochemical cell? What are the types of electrochemical cell? Briefly discuss the different types.***

Solution:

Electrochemical cells are the cells which either convert electrical energy into chemical energy or generate electrical energy from electrochemical reactions.

Electrochemical Cells are of two types which differ from each other as follows:

Type1: Electrolytic cell:

In this cell, an electric current is passed to bring out non-spontaneous reaction.
Electrical energy is converted into chemical energy.
Anode is positive and cathode is negative.
E.g.: Electrodialysis process of salty water etc. Electroplating process.

Type 2: Galvanic cell:

In this cell, a spontaneous chemical reaction produces or generates electric current.
Chemical energy is converted to electrical energy.
Anode is negative and cathode is positive.
E.g.: Battery (Dry cell) Lead acid storage cell, Fuel cell.

DQ14: ***What is green chemistry? Explain the principle of 'Designing safer chemicals and products' and the principle of 'Use of renewable feedstocks'.***

Solution:

Green chemistry is highly effective approach to pollution prevention because it applies innovative scientific solution to real world environmental situations.

Designing safer chemicals and products:

The reactions (chemical processes involved in industries are most of the time associated with certain by products which are harmful for the environment and cause severe pollution. Hence to minimize the environment pollution and hazardous -waste it was necessary to review and modify all the chemical processes used for manufacturing. Thus, design of harmless processes to produce various products has emerged as a new branch of chemistry commonly known as Clean Chemistry or Green Chemistry or Environmentally benign chemistry.

Any chemical or product such as medicine, insecticides, cosmetics etc. should be formulated such that it has maximum curing effect and nil or very fewer toxic effects on environment. For example, insecticide like DDT, Gammexane, Aldrin are highly toxic to human, hence their use should be curtailed and safer and greener alternative like neem leaves, seeds should be preferred.

Use of renewable feedstocks:

The raw material or starting material (reactant) for manufacturing a product is called as feedstock. This should be renewable that is one obtained from agricultural or biological process, so that it is easily available and non-exhaustible (as the petroleum oil). Let us take an example of synthesis of Adipic, conventional route of synthesis of Adipic acid which uses Benzene as the starting material or feedstock, this benzene chemical is non-renewable as well as carcinogenic to human being. Hence as per the green chemistry principle, to avoid toxic materials and prefer the use of safe and renewable feedstock, the greener route replaces benzene with D-glucose which is safe and renewable.

DQ15: ***(i) 1 g of coal sample was used for determination of nitrogen by Kjeldhal's method. The ammonia evolved was passed into 50ml of 0.1 N H_2SO_4. The excess acid required 42 mL of 0.1 N NaOH for neutralization. Calculate the percentage of N in the sample.***

(ii)One of the design and material selection principle is ' the anodic material should not be painted or coated' . Give reason for the same.

Solution:

1. Volume of acid required for blank titration (V_1) = 50 ml.

2. Volume required for back titration (V_2) = 42ml.

Discuss season cracking.

3. Normality of acid (N) = 0·1N.

4. Weight of coal taken (W) = 1g.

5. Volume of acid consumed by liberated ammonia

$$= V_2 - V_2$$
$$= 50 - 42$$
$$= 8$$

$$\%\text{Nitrogen} = \frac{\text{Volume of acid consumed by ammonia x Normality of acid x1.4}}{\text{Weight of coal}}$$

$$= \frac{(V_1 - V_2)\ X\ N\ x\ 1.4}{W}$$

$$= \frac{8\ x\ 0.1\ X\ 1.4}{1}$$
$$= 1.12$$

(ii)One of the design and material selection principle is ' the anodic material should not be painted or coated' . Give reason for the same.

Solution: Because if the paint on the surface gets removed off at certain area, that area of metal or point comes in direct contact with air or surrounding liquid and forms the anode whereas the well coated or painted part of metal forms the cathode. Thus, anodic area undergoes localized corrosion leading to formation of pit or hole on the surface of metal. The corrosion at small anodic area takes place at faster rate because the cathodic area being larger, demands more electrons.

DQ16: ***Discuss season cracking.***

Season Cracking is a term applied to stress corrosion of brass. If highly stressed brass is in contact with solution of ammonia or amines. The stressed part of brass form anode & selectively unstressed part forms cathode. The Zn & Cu at anodic part dissolve in the solution in the form of $Cu(NH_3)_4^{++}$& $Zn(NH_3)_4^{++}$ ions respectively. This is the real cause of dissolution of brass, initiating in fissure which ultimately propagates in the formation of cracks in metal piece.

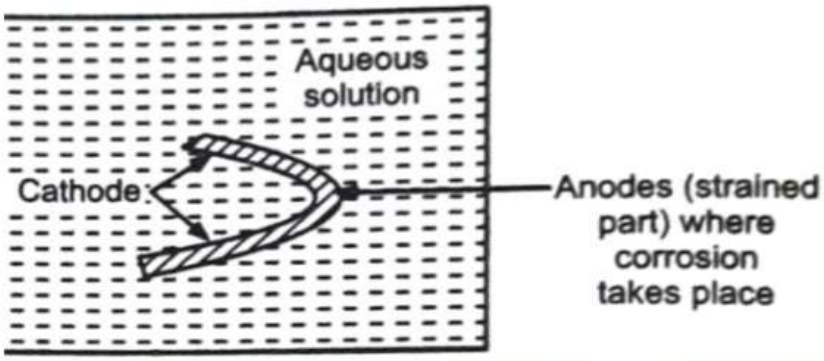


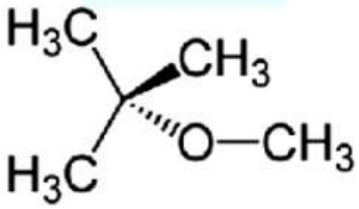
Fig: Season Cracking

DQ17: ***What are 'oxygenates' used in the fuel industry? Where and why are they added? Explain by giving examples.***

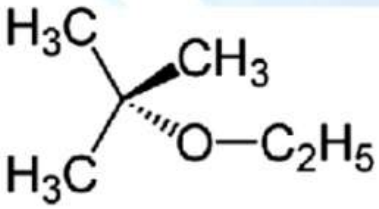
Solution:

Oxygenates are the fuel molecules which contain one or more oxygen atom. MTBE oxygenates is a clean burning, energy efficient and excellent anti-knocking properties. It is an attractive high octane blending component with favourable economics. It can be added or blended at the refinery and handled via the normal distribution chains.

Unleaded petrol is whose anti knocking characteristics are increased by altering compositions of gasoline by increasing its aromatic compound contents such as Benzene, Toluene and Xylene (known as BTX component) or by addition of certain oxygenates like methanol, ethanol, Methyl tertiary butyl ether (MTBE) and Ethyl tertiary butyl ether (ETBE) and not by addition of TEL like substances.



MTBE



ETBE

DQ18: ***By kjeldahl's method 3 gm of coal sample was analyzed. The ammonia evolved was absorbed in 40 ml of 0.5 N H2SO4. After absorption, the excess H2SO4 required 18.5 ml of 0.5N KOH for neutralization. A coal sample was subjected to ultimate analysis 2.45 g of coal on combustion in a Bomb-Colorimeter gave 0.67 of BaSO4. Calculate percentage of Nitrogen and Sulphur.***

Solution:

1. Volume of acid required for blank liberation (V_1) = 40 ml.

2. Volume required for back liberation (V_2) = 18.5ml.

3. Normality of acid (N)= 0·5 N.

4. Weight of coal taken (W) = 3g.

5. Volume of acid consumed by liberated ammonia

$$= V_2 - V_2$$
$$= 40 - 18.5$$
$$= 21.5$$

$$\%\text{Nitrogen} = \frac{\text{Volume of acid consumed by ammonia x Normality of acid x1.4}}{\text{Weight of coal}}$$

$$= \frac{(V_1 - V_2) \text{ X N x } 1.4}{W}$$

$$= \frac{21.5 \text{ x } 0.5 \text{ X } 1}{3}$$
$$= 5.01$$

Ans: The amount of nitrogen in coal = 5.01%

Solution:

$$\%\text{ Sulphur} = \frac{\text{Weight of } BaSO_4 \text{ ppt x } 32 \text{ x } 100}{\text{Weight of coal x } 233}$$

$$= \frac{0.67 \times 32 \times 100}{2.45 \times 233}$$

$$= 3.75$$

Ans: Sulphur content of coal = 3.75 %

DQ19: ***Discuss bimetallic corrosion with the help of a suitable example.***

Solution:

Galvanic Cell Corrosion also known as Bimetallic corrosion: This type of corrosion takes place when two dissimilar metals are in contact and exposed to an electrolytic solution, the metal higher in electrochemical series undergoes corrosion (dissolution). For example, if zinc and copper are in contact and dipped in electrolyte than Zinc being higher in electrochemical series forms the anode and is corroded that is get dissolved whereas copper being lower in electrochemical series or is more noble acts as cathode. The anodic reaction is always dissolution of anodic metal that is Zinc in this case.

At anode: $Zn \rightarrow Zn^{2+} + 2\bar{e}$ (oxidation)

*The nature of the corrosive environment decides the type of cathodic reaction such as:

- In acidic solution, the corrosion occurs by Evolution of hydrogen.

  At cathode: $2H^+ + 2\bar{e} \rightarrow H_2 \uparrow$ (Reduction)

- In neutral solution it occurs by absorption of oxygen. The electron current flows from the anodic metal zinc to cathodic metal copper and absorbed by dissolved O_2.

  At cathode: $\frac{1}{2} O2 + H2O + 2\bar{e} \rightarrow 2OH^-$ (Reduction)

Thus, it is evident that the corrosion occurs at the anodic metal while the catholic part remains intact & protected from the corrosion.

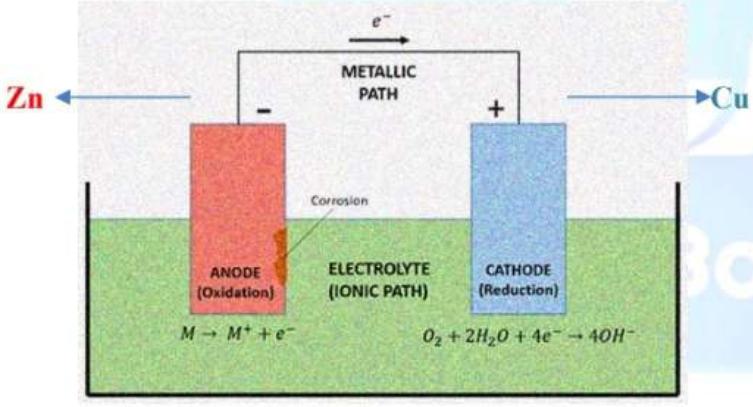


Fig: Galvanic Corrosion

DQ20: ***Explain the conventional and Green route of manufacturing indigo dye. Mention the green chemistry principles involved.***

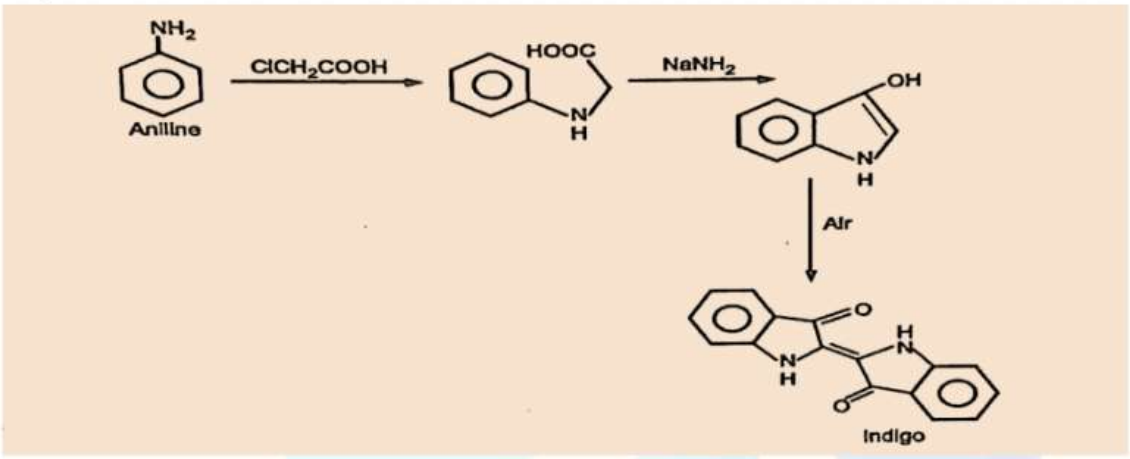
Ans:

Principle involved: **Non- Hazardous Chemical Synthesis:** The synthetic method should be such that whenever practicable, uses and generates substances having little or no toxicity to human health and the environment.

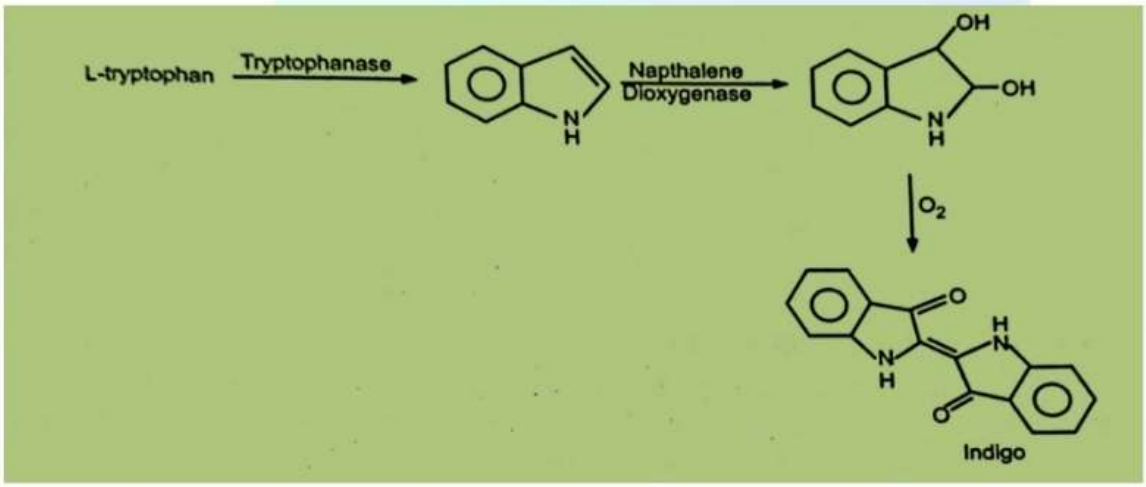
For e.g.: Synthesis of Indigo:

The conventional method uses aniline as starting material which is hazardous chemical and toxic to human & aquatic animals. Whereas greener route replaces toxic aniline with L-tryptophan which is safe and follows the enzymatic conversion path which is least or non- polluting as shown below:

A] Conventional Route:



B] Greener Route:

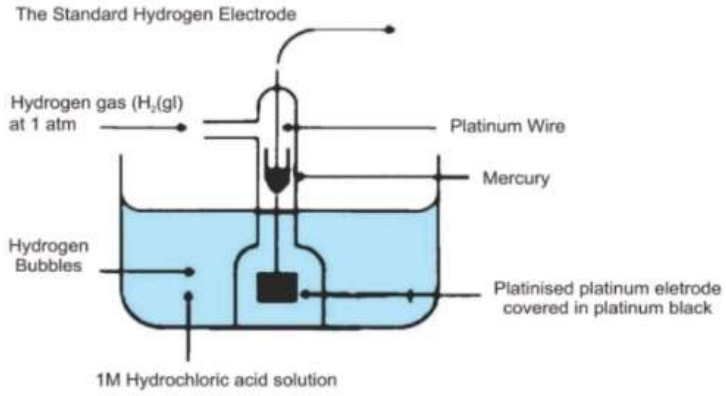


DQ21: ***Explain construction and working of SHE with neat and labeled diagram.***

Solution:

Standard Hydrogen Electrode (SHE):

It consists of platinum foil covered with platinum black attached with platinum wire for electrical contact. This is covered with bell shaped glass tube with a side arm for passing hydrogen gas. This whole thing is placed or dipped in 1N HCl solution, when hydrogen at 1 atmosphere is passed through side arm it forms a SHE having emf zero (arbitrarily fixed).



Cell can be represented as:

$H^+_{(aq)}(1M) \mid H_2(g)(1atm) \mid Pt(s)$

Oxidation reaction when the electrode is anode:

$H_2(g) \rightarrow 2H^+(aq)\,(1M) + 2e^-$ (Oxidation)

Reduction reaction when the electrode is cathode:

$2H^+(aq)\,(1M) + 2e^- \rightarrow H_2(g)(1atm)$ (Reduction)

Potential of both half -cell is arbitrarily assigned zero volt.

DQ22: *Explain different types of electromagnetic radiations.*

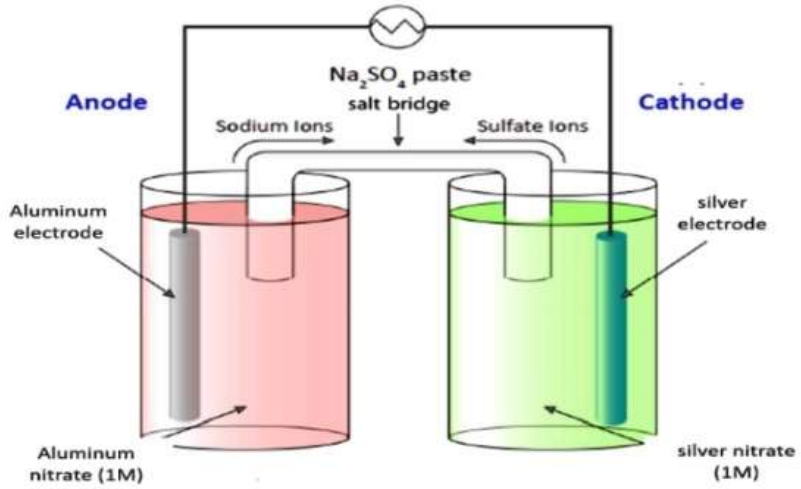
Solution:

The various types of electromagnetic radiations are

1. Gama rays: Gamma-rays have frequencies greater than about 10^{18} Hz and wavelengths of less than 100 picometers. Gamma radiation causes damage to living tissues; hence it is useful for killing cancer cells when applied in carefully measured doses to small regions. Nuclear transitions take place in this radiation.
2. X-rays: This range of the electromagnetic spectrum is between UV and gamma-rays. X-rays have frequencies of about 3×10^{16} to 10^{18} Hz and wavelengths of about 100 picometers to 10 nanometers. It gives rise to inner electronic transitions. These find medical applications mostly for bone damage
3. Ultraviolet: The ultraviolet radiation of electromagnetic spectrum ranges between 10 to 400 nm wavelength and frequency of 8×10^{14} to 3×10^{16} Hz. Valence electronic transitions takes place in this region. It is invisible to human and is a component of sun rays. It has many medical and industrial applications.
4. Visible: It lies in the middle of the electromagnetic spectrum, between IR and UV. It has frequencies of about 300 to 800 THz and wavelengths of about 380 to 740 nanometers. Gives rise to Valence electronic transitions.
5. Infra- red: IR is in the range of the electromagnetic spectrum between microwaves and visible light. It has frequencies from about 330 to 12500 cm^{-1} and wavelengths of about 740 nanometers to 50 micrometers. Responsible for vibrations in molecules. It is useful in detecting functional groups in organic compounds
6. Microwave: This radiation of the electromagnetic spectrum is between radio and IR. Ranging in frequencies from about 3 GHz to 30 trillion hertz, or 30 terahertz (THz), and wavelengths of about 0.1 to 10 mm. Molecules if exposed to this radiation show rotational transitions. Microwaves are used for high-bandwidth communications and radar, as well as for a heat source for microwave ovens and industrial applications.
7. Radio wave: These are lowest range of the electromagnetic spectrum, with frequencies of up to about 30 billion hertz, or 30 gigahertz (GHz), and wavelengths greater than about 0.4 inch (10 millimeters). Nuclear spin transitions take place in this radiation. Radio is used primarily for communications, including voice, data and entertainment media.

DQ23: ***Draw a diagram of a cell made up of aluminum and silver half cells. Give representation of the cell along with electrode reactions.***

Solution:



Cell representation: $Al/\ Al^{3+}\ (aq)(1M)//Ag^{+}/Ag(1M)\ (aq)/Ag$

Electrode reactions:

At anode: $Al \rightarrow Al^{+++} + 3e^{-}$ -------(Oxidation)

At cathode: $3Ag^{+} + 3e^{-} \rightarrow 3Ag$ ----(Reduction)

DQ 24: ***Calculate the volume and weight of air required for complete combustion of 1m3 of gaseous fuel having the following composition: CO = 10%, C3H8 = 12%, CH 4 = 30%, N 2 = 3 %, H 2 = 40%, CO2 = 3%, O2 = 2.0% (Molecular weight of air =28.949).***

Solution:

Constituents	% By volume	Volume of each per m^3 of fuel	Combustion Reactions	Volume of Oxygen required in m^3
H_2	40	40/100 = 0.4	$H_2 + {}^1/_2\ O_2 \rightarrow H_20$	0·4 x 0.5 = 0.2
CO	10	10/100 = 0.1	$CO + ½\ O_2 \rightarrow CO_2$	0.1 x 0.5 = 0.05
C_3H_8	12	12/100 = 0.12	$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_20$	0.12 x 5= 0.6
CH_4	30	30/100 = 0.3	$CH_4 + 2\ O_2 \rightarrow CO_2 + 2H_20$	0.3 x 2 = 0.6 **=1.45**
O_2	2.0	2/100 = 0.02	O_2 in the fuel	- **0.02**
CO_2	3	Ignore, non-combustible	-	
N_2	3	Ignore, non-combustible		
				Total O_2 = 1.43

To Calculate Volume of air:

Volume of Air required = $\frac{\text{Volume of } O_2 \text{ required x } 100}{21}$

$= \frac{1.43 \times 100}{21}$

$= 6.8095\ m^3$

Volume of air required for 1 m^3 of gas = 6.8095 m^3.

Weight of air required:

28.94 kg of Air occupies 22.4 m^3

Therefore, 6.8095 m^3 will be $\frac{6.8095 \times 28.94}{22.4}$ = 8.8004

Weight of air required = 8.8004 kg

DQ 25: ***How do the following factors related to nature of environment affect corrosion? i) Anodic and Cathodic area ii) Purity of metal.***

Solution:

i) Anodic to cathodic area:

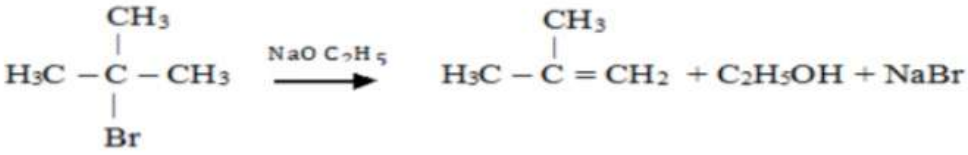
If the area of anode is large and area of cathode is small, corrosion will be slow whereas if area of anode is small and area of cathode is large then corrosion will be fast, this is because small anode has to produce a greater number of electrons to fulfill greater demand of electrons by large area of cathode. Thus, the rate of corrosion is directly proportional to the ratio of the cathodic part and anodic part as shown below:

$$\text{Rate of Corrosion} \propto \frac{\text{Cathodic Area}}{\text{Anodic Area}}$$

ii) Purity of metal:

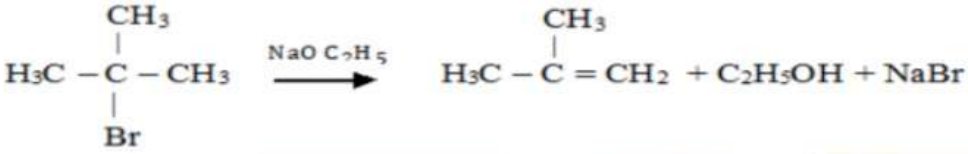
Higher the purity of metal less is the rate of corrosion. Because any heterogeneity causes formation of electrochemical cells and leads to corrosion.

DQ 26 :



Find atom economy of the reaction with respect to 2-methyl propene.

Solution:



Mol. Wt-137 56

% Atom Economy = $\frac{\text{Molecular weight of product x 100}}{\text{Total Molecular weight of Reactants}}$

$= \frac{56 \times 100}{137}$

= 40.87%

DQ.27: ***Explain 'Selection rules' that basically decide which transitions are 'allowed or forbidden' in spectroscopy.***

Solution:

In quantum mechanics, a set of rules, known as Section rule which basically explains which transition of electronsare allowed and which are forbidden. The rules are as:

Rule No.1: $\Delta s = 0$

According to this rule Spin angular momentum of an electron does not change during the absorption or emission of light and the change in the spin quantum number during a transition is zero Thus spin angular momentum must not change or alter.

Rule No. 2: $\Delta l = + - 1$

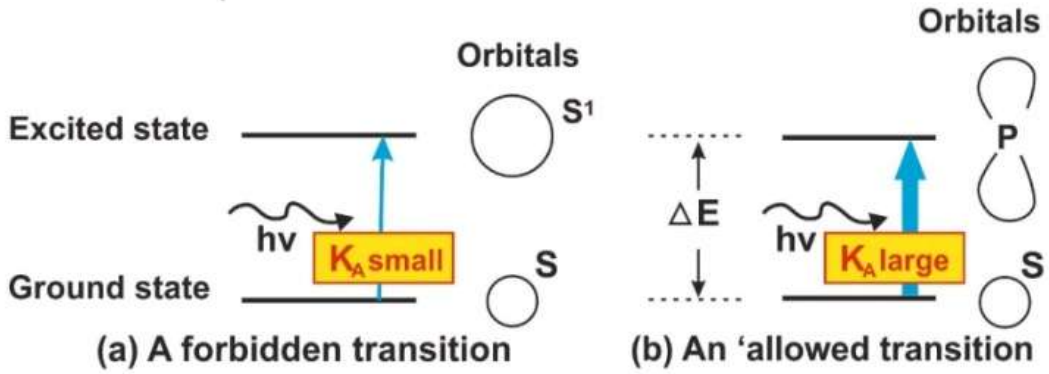
According to this rule the change in the orbital quantum during transition is either +1 or -1. When Δl = +1 an electron jumps from lower energy level to higher energy level.

When Δl = -1 an electron jumps from higher energy level to lower energy level.

Rule No.3 :$\Delta m = 0, +, -1$

According to this the change in the magnetic quantum number is either zero or +1 or -1.

That means transition of an electron among any of the 2p-orbitals within each other is not allowed and is called as forbidden transitions probability of such transitions is very small. Thus, electrons cannot jump from one 2p-orbital to another 2p-orbital. The transition from any three 2p-orbital to 2s-orbital is allowed.



DQ.28: ***Distinguish between Octane number and Cetane number***

Solution: Difference between Octane number and Cetane number:

Sr. No.	Octane number	Cetane number
1	The octane number of a fuel may be defined as, the percentage of iso-octane in a mixture of iso-octane and n-heptane that has the same knocking characteristics of the fuel under test in a standard one-cylinder engine operated under standard conditions.	The cetane number of a diesel is defined as the percentage by volume of cetane in a mixture of cetane and α-methyl naphthalene which exactly matches in its ignition delay characteristics with diesel under test
2	It helps to know the knocking characteristics in terms of spontaneous ignition of Petrol.	It helps to know the knocking characteristics in terms of ignition delay of Diesel.
3	Higher the octane number of petrol, better is the performance and quality of it	Higher is the cetane number better is the quality and performance of diesel.
4	The octane number of a petrol can be improved by addition of certain oxygenates like methanol, ethanol, Methyl tertiary butyl ether (MTBE) and Ethyl tertiary butyl ether. (ETBE).	The cetane number of a diesel can be improved by adding substance called dopants like ethyl nitrile, iso-amyl nitrate and acetone peroxide in small quantity such as 2%.

DQ 29 :*(i) Explain the principle of 'use of catalytic reagent' with respect to green chemistry.*
(ii) How would you synthesize benzimidazole using green catalyst?

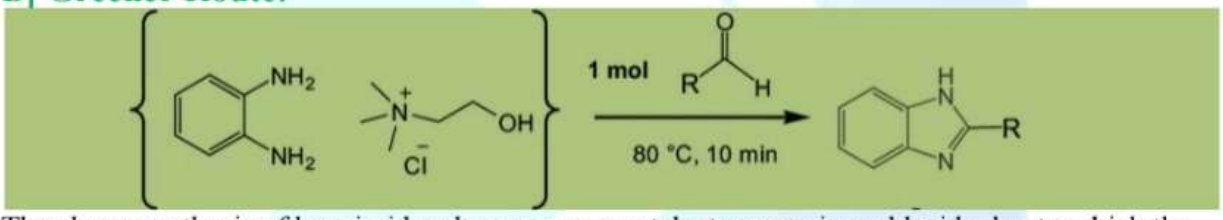
Solution:

i) Use Of Catalyst Should Be Preferred:

Advantages of using catalyst:

- Catalyst facilitates the transformations of reactants to product without being consumed.
- Gives only desired product as it is selective in action, this eliminates the waste.
- By using catalyst, starting material utilization is enhanced.
- Catalyst reduces activation energy of a reaction thus, temperature necessary for the reaction is also lowered which results in saving the energy.
- Catalyst will carry out thousands of transformations before being exhausted. Thus, a chemical process catalyzed by catalyst is more beneficial than a stoichiometric one.

B] Greener Route:



The above synthesis of benzimidazole uses green catalyst ammonium chloride due to which the reaction time is reduced from 12 hours to just 10 minutes.

DQ 30: ***Calculate the minimum amount of air required for the complete combustion of 1 kg of fuel containing C= 80%, H= 6%, O=8%, S= 1.5%, H2O= 1.0%, N= 1.5% and ash= rest.***

Solution:

Constituents	% By weight	Weight per kg of fuel
C	80	9/100 = 0.80
O	8	5/100 = 0.08
H	6	1/100 = 0.06
S	1.5	0.5/100 = 0.015
N	1.5	non combustible
H_2O	1	non combustible
Ash	2	non combustible

Weight of Air required = $\frac{100}{23}$ [2.67'C' + 8'H'+'S' -'O'] kg.

$= \frac{100}{23}$ [(2.67×0.8 + 8+.0.06 +0.015) - 0.08]

$= \frac{100}{23}$ [2.631 -0.08]

$= \frac{100}{23}$ (2.551)

= 11.0913 kg.

Now, 28.94 kg of Air occupies 22.4 m^3

Therefore, 11.0913Kg will occupy $\frac{11.0913 \times 22.4}{28.94}$ = 8.5848 m^3

Total volume of air required 8:5848 m^3

Ans: Weight of air required = 11.0913 kg &

Volume of air required = 8.5848 m^3

DQ 31: ***Explain why a "pure Zinc metal rod half immersed in saline water starts corroding at the bottom" Explain with neat diagram, reactions & corrosion product formation.***

Solution:

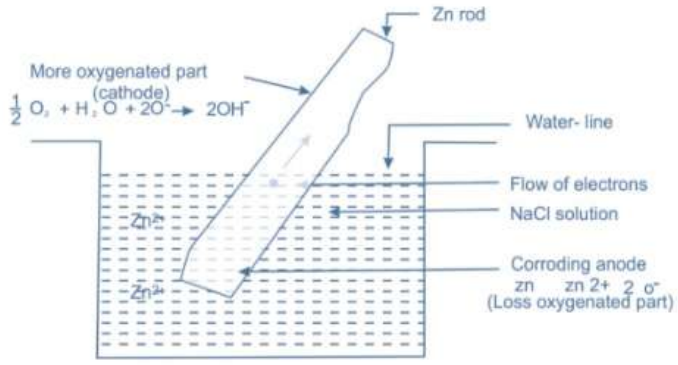
This type of corrosion occurs when a metal is exposed to varying concentrations of electrolyte or oxygen which may be a result of inadequate agitation or slow diffusion of metal ions produced by corrosion. Differential aeration corrosion occurs when one part of metal to exposed to a different air concentration from the other part. This causes a difference in electrode potential between differently aerated areas. It has been found experimentally that poorly oxygenated parts form anodic area. Let us consider a metal (say Zn) is partially immersed in a neutral solution (dilute) of a salt (say NaCl) and the solution is not agitated properly, then the parts above and closely adjacent to the waterline are more strongly aerated (because of easy access of oxygen) and hence become cathodic. On the other hand, parts immersed to greater depth (i.e., at bottom which have less access of oxygen) show a smaller oxygen concentration and thus become anodic. So, at anodic parts liberation of electrons takes place as:

$$Zn \rightarrow Zn^{2+} + 2\bar{e} \text{ (oxidation)}$$

At cathode, the oxygen in solution will take up electrons and form hydroxide ions (OH^-).

$$\tfrac{1}{2} O2 + H2O + 2\bar{e} \rightarrow 2OH^- \text{ (Reduction)}$$

This type of corrosion occurs in areas which a are less oxygenated such as cracks & crevices. It takes place under accumulated rust, dirt, sand & scale. Metals exposed to aqueous medium corrode under blocks of pieces of glass.

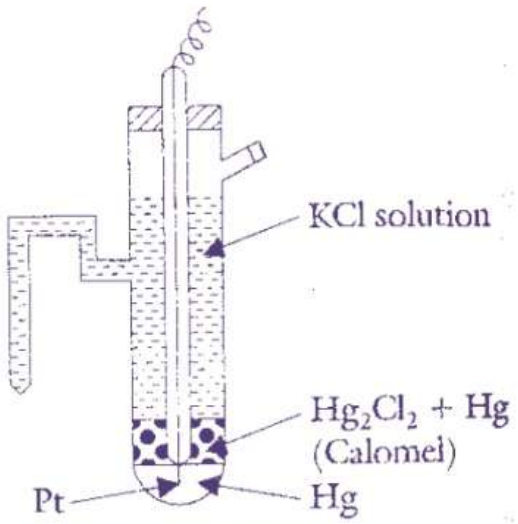


DQ.32: Explain construction and working of a reference electrode which is used in pH meter.

Solution:

It is mercury-mercurous chloride electrode and the most commonly used reference electrode used in pH meter.

It consists of a tube in the bottom of which is a layer of mercury, over which is placed a paste of Hg+ Hg_2Cl_2.The rest of the portion of cell or tube is filled up with above shown concentration (0.1,1N or saturated) KCl solution as per the type. A platinum wire, dipped into mercury layer is used for electrical contact. The side tube is used for making contact with salt bridge.



Calomel cell can be represented as:

KCl (aq)(sat) | Hg_2Cl_2(s) | Hg(l)

Oxidation reaction when the electrode is anode:

$2Hg(l) + 2Cl^-(sat) \rightarrow Hg_2Cl_2(s) + 2e^-$ (Oxidation)

Reduction reaction when the electrode is cathode:

$Hg_2Cl_2(s) + 2e^- \rightarrow 2Hg(l) + 2Cl^-(sat)$ (Reduction)

DQ 33: ***Write cell reaction and calculate the standard emf of the following cell.***

Cd(s)\| Cd +2 (aq)(1M)‖ Ni2+ (aq)(1M)\| Ni(s)

If the standard potential of Cd electrode is -0.40 V and the standard potential of Ni electrode is -0.25 V.

Solution:

Given: $E^0Cd = -0.40V$

$E^0Ni = 0.25V$

$E^0cell = ?$

$Cd(s) \mid Cd^{2+}(aq)(1M) \| Ni^{2+}(aq)(1M) \mid Ni(s)$

For this cell:

Oxidation half cell, at anode:

$Cd(s) \rightarrow Cd^{2+} + 2e^- \quad E^0Cd = -0.40V$

Reduction half cell, at cathode:

$Ni^{2+} + 2e^- \rightarrow Ni(s) \quad E^0Ni = -0.25V$

E^0 cell = E^0cathode - E^0anode

= 0.25 – (-0.40)

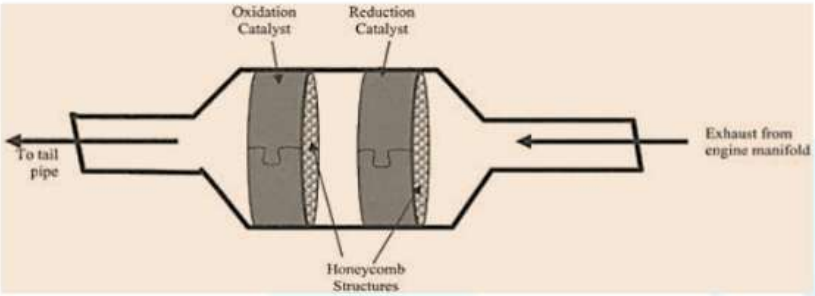
= 0.25 + 0.40

= 0.65V

DQ 34: ***Write a note on Catalytic converter with the help of chemical reactions.***

Solution:

Catalytic converter is fitted in the exhaust system after the exhaust manifold of petrol driven vehicles. It consists of tube with an inlet for exhaust gases and outlet for completely combusted gases. This tube is filled with rod coated with Rhodium and platinum catalyst in such a way that the exhaust gases come in contact with its surface.



When the exhaust gases flowing into the support channels come into contact with the catalyst coated surface (rod), the CO and HC and other half combusted materials (gases) of the exhaust gas get catalytically converted into CO_2& H_2O. The NOx emissions also get reduced under suitable conditions of engine operation. Reactions taking place in catalytic converter are as follows:

$$2\,CO + 2NO \longrightarrow 2\,CO_2\uparrow + N_2\uparrow$$

$$CO + O \longrightarrow CO_2\uparrow$$

DQ 35: ***(i) Give significance of determination if moisture in coal.***
(ii)What is season cracking?

Solution:

(i) Moisture in coal evaporates during the burning of coal and it takes some of the liberated heat in the form of latent heat of evaporation. Therefore, moisture lowers the effective calorific value of coal so lesser the moisture better the quality of coal as fuel. However, presence of moisture content up to 10% produces, more uniform fuel bed and less of "'fly- ash". Moisture content of a coal should not exceed 10%.

(ii) Season Cracking is a term applied to stress corrosion of brass. If highly stressed brass is in contact with solution of ammonia or amines. The stressed part of brass form anode & selectively unstressed part forms cathode. The Zn & Cu at anodic part dissolve in the solution in the form of $Cu(NH_3)_4^{++}$& $Zn(NH_3)_4^{++}$ ions respectively. This is the real cause of dissolution of brass, initiating in fissure which ultimately propagates in the formation of cracks in metal piece.

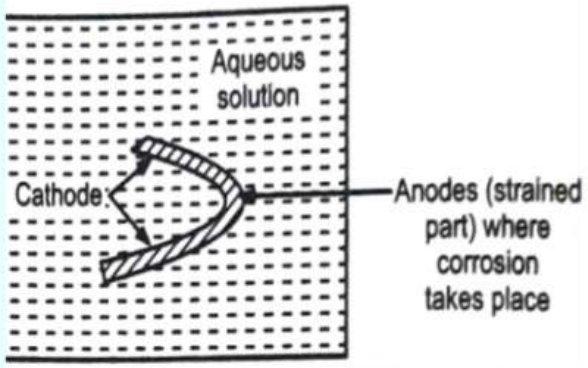


Fig: Season Cracking

DQ 36: ***Which molecule is used as a component in various therapeutic drugs? Give any one traditional and green synthesis of the same.***

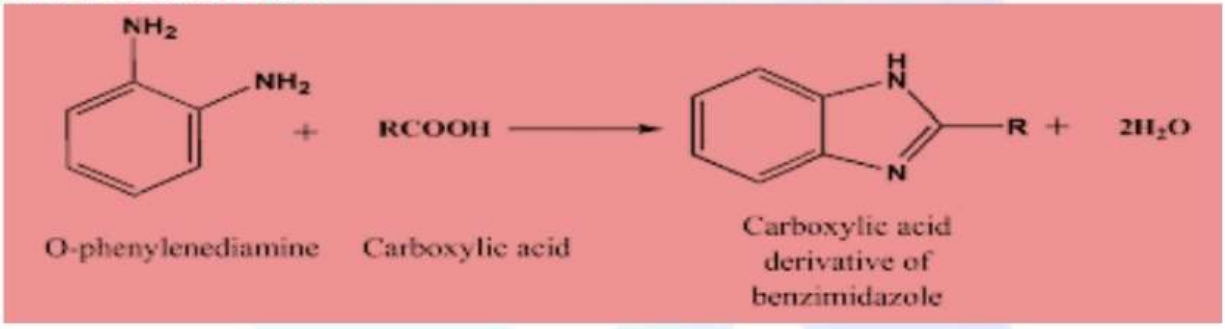
Solution:

Benzimidazole is an important molecule in medical field as it is effective anti-bacterial, anti-viral, anti-cancer, anti-fungal, anti-inflammatory and also serves as axial ligand for cobalt in vitamin B12.

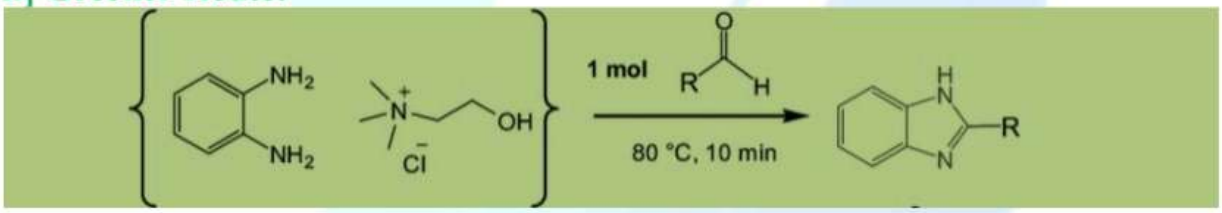
Synthesis of Benzimidazole:

The reaction is carried by heating the mixture of 0-phenylenediamine and carboxylic acid at elevated temperatures for 12hours which is tedious and energy consuming. Synthesis of benzimidazole explains the principle to prefer energy efficient process.

A] Conventional Route



B] Greener Route:



time is reduced to just 10 minutes, thus, making it energy efficient

DQ 37: ***Write the Nernst Equation and calculate Emf of the following cell at 298K: Mg(s)/Mg2+(0.001M) \|\| Cu2+(0.0001M)/Cu(s).***
Given: $E^0_{Cu2+/Cu}$ ***= 0.34 V and*** $E^0_{Mg2+/Mg}$ ***= -2.37 V***

Solution:

Nernst Equation:

$$E = E^0 - \frac{2.303}{nF} RT \log_{10} \frac{[Products]}{[Reactants]}$$

where E^0, E are as mentioned above,
n = Number of electrons in reaction
T = Temperature in Kelvin,
R = Gas constant = 8.314 $JK^{-1}mol^{-1}$
[Products] &[Reactants] are the concentration of products and reactants respectively.
F = Faraday's constant.

Mg(s)/Mg2+(0.001M) || Cu2+(0.0001M)/Cu(s).

Given: $E^0_{Cu2+/Cu}$ = 0.34 V and $E^0_{Mg2+/Mg}$ = -2.37 V

E^0 cell = E^0cathode - E^0anode
= 0.34– (-2.37)
= 2.71V

$$E = E^0 - \frac{2.303}{nF} RT \log_{10} \frac{[Products]}{[Reactants]}$$

$$E = 2.71 - \frac{2.303 \times 8.314 \times 298}{2 \times 96500} \log_{10} \frac{0.001}{0.0001}$$

$$= 2.71 - \frac{5705.85}{19300} \log_{10} [10]$$

$$= 2.71 - 0.296 \times 1$$

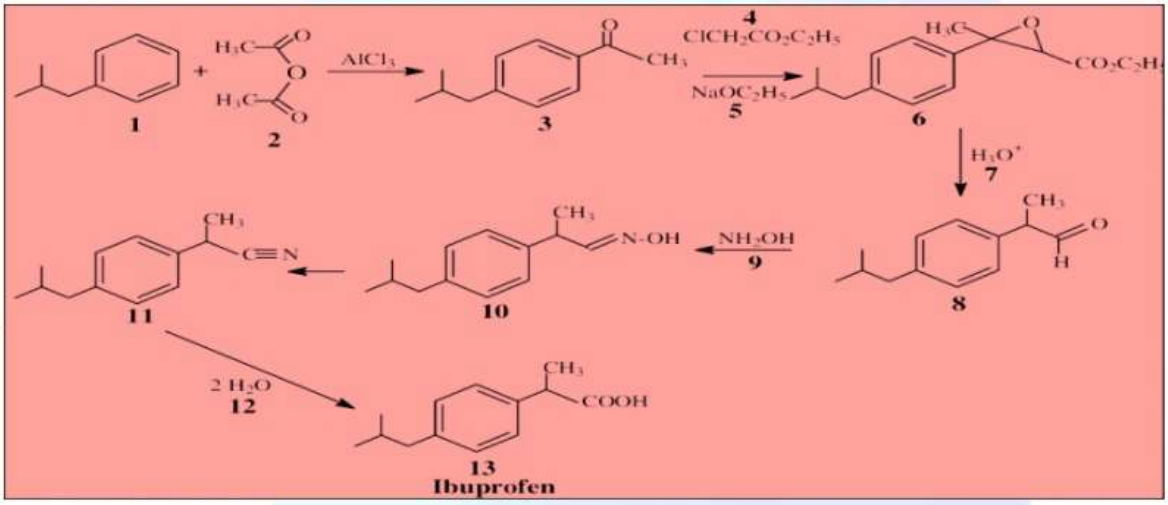
$$= 2.414 \text{ V}$$

DQ 38: ***With the help of traditional and green synthesis of ibuprofen, list the principles of green chemistry involved in it.***

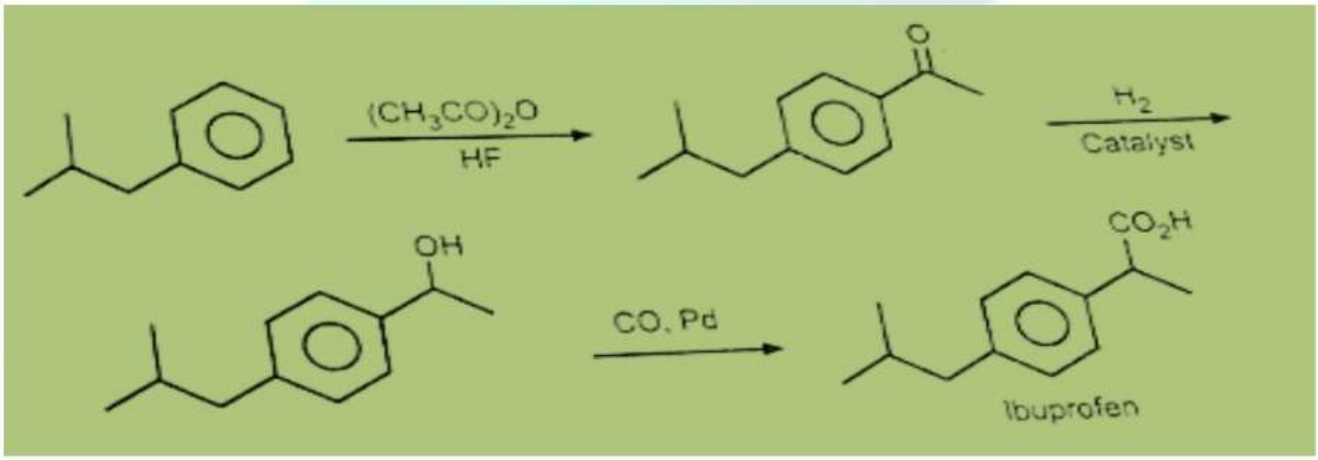
Solution:

The chemical process should be direct, not through derivative formation because derivatives increase the steps of the process, energy, chemical requirement also and make the process toxic. This can be explained by synthesis of ibuprofen, the conventional method for synthesis includes formation of five derivatives before the final products which makes it time consuming as well as uses lot of chemical reagents that are toxic in nature, hence it is toxic to environment whereas the greener route involves only two derivatives, hence its safe and fast.

A] Conventional Route:



B] Greener Route:



DQ 39: ***What is knocking? How is knocking of gasoline related to chemical structure of hydrocarbons present in it? Define octane rating.***

Answer:

Knocking is a sharp metallic sound similar to rattling of hammer, which is produced in the internal combustion engine due to immature ignition of air-gasoline mixture.

The petrol is a mixture of various lower hydrocarbons and the knocking of the engine depends upon the structure of hydrocarbons present in petrol. It is observed that the sudden burning of hydrocarbons produces large volume of gases in short time and leads to knocking. Thus, if a petrol consists of the straight chain saturated hydrocarbons show more knocking tendency than the straight chain unsaturated as it burns with little difficulty. Further, the cyclic compounds have fewer tendencies to knock than the straight chain compounds. The presence of double bonds and aromatic rings is also important. The aromatic hydrocarbons burn uniformly thus it has little tendency towards knocking. The position of double bond also matters, hydrocarbons having double bond, near the centre of chain have less knocking property. Thus, the tendency of a gasoline to knock can be related to structure of fuel in the following order.

Straight chain paraffins> Branched Chain Paraffins> olefins > Cycle paraffins> Aromatics.

Definition of Octane Number:

The octane number of a fuel may be defined as, the percentage of iso-octane in a mixture of iso- octane and n-heptane that has the same knocking characteristics of the fuel under test in a standard one-cylinder engine operated under standard conditions.

DQ.40: ***A sample of coal was found to contain C = 80%, H = 5%, O = 1%, N = 2%, Ash=12%. Calculate the minimum amount of air required for complete combustion of 1kg of coal sample.***

Solution:

$$\text{HCV} = \frac{1}{100}[8080\ \text{'C'} + 34500\ \frac{(\text{'H'}-\text{'O'})}{8} + 2240\text{'S'}]\ \text{Kcal/kg}$$

$$= \frac{1}{100}[8080 \times 80 + 34500\frac{(5-1)}{8}]$$

$$= \frac{1}{100}[6464000 + 168187.5]$$

$$= \frac{814587}{100}$$

$$= 8145.87\ \text{Kcal/kg}$$

$$\text{LCV} = \text{HCV} - \frac{9\ \text{'H'}}{100} \times 587\ \text{kcal/kg}$$

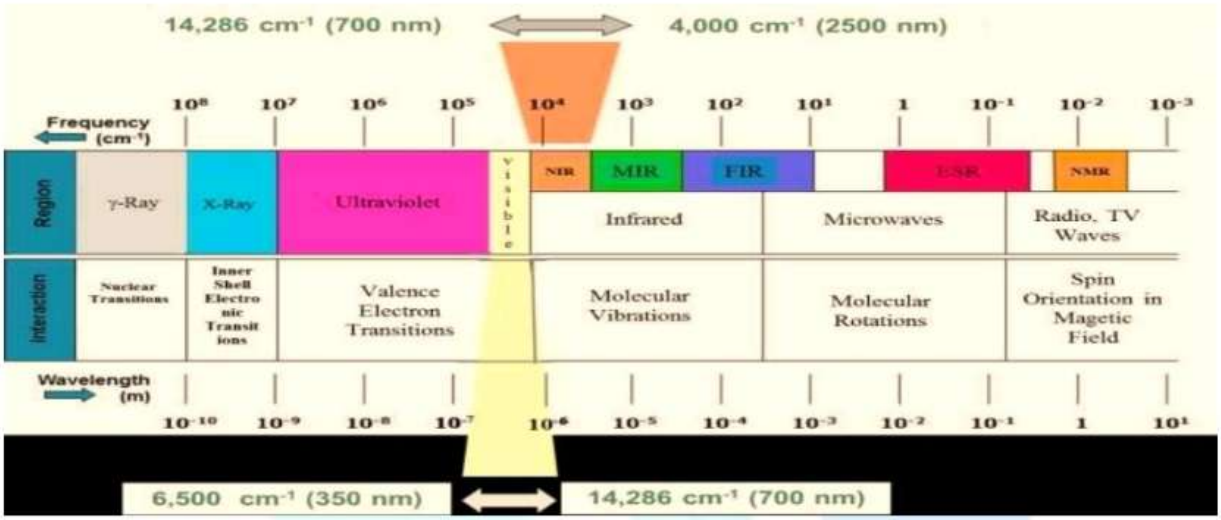
$$= 8145.87 - 0.09 \times 5 \times 5\ 8\ 7$$

$$= 8145.87 - 264.15$$

$$= 7881.72\ \text{kcal/kg.}$$

DQ 41: ***Draw the energy level diagram showing various molecular energies and explain why molecular spectra contains broad bands whereas atomic spectra consist of sharp lines.***

Solution:



When energy changes take place at atomic levels it is known as atomic spectroscopy. Atomic spectrum consists of sharp lines, because the transitions occur from one electronic energy level to the other. Atoms of different elements have distinct spectra.

It involves energy change taking place at molecular levels. Molecular spectrum consists of broad bands because electronic transitions in the molecules have associated vibrational and rotational transitions and radiations over a range of wavelengths are absorbed.

DQ 42: ***A cell uses Zn2+/Zn and Ag+/Ag electrodes. Write the cell representation, Half-cell reactions, Net cell reactions and calculate the standard Emf of the cell.***
Given: $E^0_{Zn2+/Zn}$ ***= -0.76 V and*** $E^0_{Ag+/Ag}$ ***= 0.8 V***

Solution:

For this cell: Zn2+/Zn and Ag+/Ag

Cell representation: $Zn / Zn^{2+}(aq)\ (1M)\ //\ Ag^{+}(aq)\ (1M)/ Ag$

Oxidation half-cell, at anode:

$2Ag\ (s) \rightarrow 2Ag^{+} + 2e^{-}$ E^0anode = 0.8V

Reduction half- cell, at cathode:

$Zn^{2+} + 2e^{-} \rightarrow Zn\ (s)$ E^0cathode = -0.76V

E^0 cell = E^0cathode - E^0anode
= – 0.76 -0.8
= - 1.56V

The standard Emf of the cell = - 1.56 V

DQ 43: ***Define Green chemistry. As per Green chemistry Principles, why is it essential to design energy efficient process. Explain with suitable examples.***

Solutions:

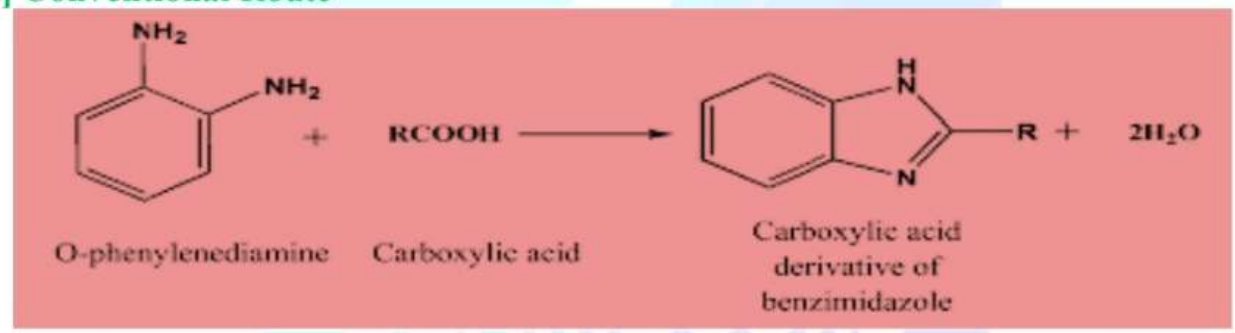
Definition: Green chemistry is highly effective approach to pollution prevention because it applies innovative scientific solution to real world environmental situations.

The synthetic method should be carried out at ambient temperature and pressure whenever possible to avoid the use of basic gaseous fuel which releases gaseous pollutants instead use of microwave, ultrasound and photochemical synthesis should be preferred. Fermentation process uses or requires low temperatures & pressure hence is environment friendly. Thus, a chemical process requiring less energy should be on top priority.

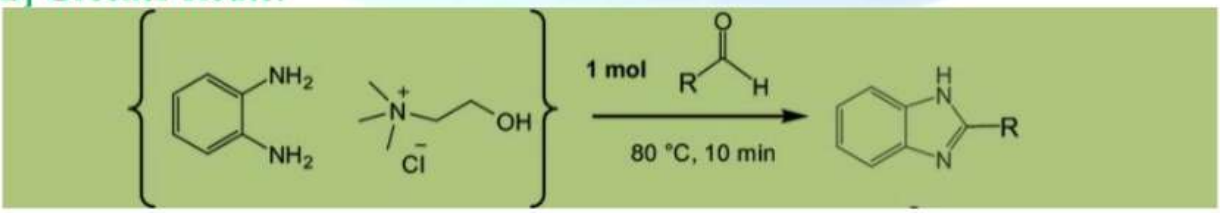
- **Explanation with example:**

Synthesis of Benzimidazole:
The reaction is carried by heating the mixture of 0-phenylenediamine and carboxylic acid at elevated temperatures for 12hours which is tedious and energy consuming. Synthesis of benzimidazole explains the principle to prefer energy efficient process.

A] Conventional Route



B] Greener Route:



In greener route the reaction is carried out in microwave, which curtails the use of solvents & reaction time is reduced to just 10 minutes, thus, making it energy efficient.

DQ 44: ***What is oxidation corrosion. Name the different types of oxide layer formed and state which oxide layers are non-protective in nature. Explain with suitable examples.***

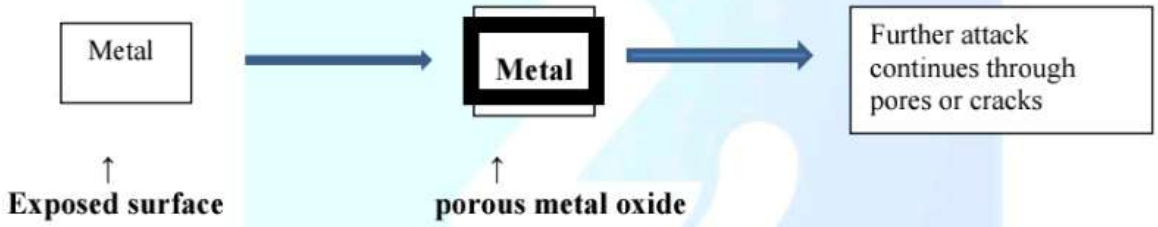
Solution:

When the metal is attacked directly by oxygen present in atmosphere,usually in absence of moisture, the process is termed as Atmospheric corrosion or Oxidation corrosion.

The nature of metal oxide films formed due to corrosion decides further rate of corrosion.
Depending on the type of metal, metal oxides films are of **four different types** as shown below:

a) Stable
b) Unstable
c) Volatile
d) Porous

Metals like Fe, Mg, Li, K, Na etc. undergo dry corrosion to form a porous metal oxide. Porous metal oxide is non-protective in nature due to pores in the layer, the metal is in contact with oxygen and hence it continues to corrode slowly but continuously.



DQ 45: ***Determine C, H, N elements as % from the following observations in experiments of analysis of coal. 0.25g coal on burning in a combustion tube and passing the gases through tubes containing anhydrous CaCl2 and KOH increases their weight by 0.09 g and 0.8g respectively. In Kjeldahl's method, ammonia evolved by 0.42g coal was absorbed in 49.5ml of 0.12 N HClsolution. After absorption, the excess acid required 36.5ml of 0.12 N NaOH for neutralization.***

Solution:

1. % H = $\frac{\text{Increase in weight of } CaCl_2 \text{ tube x 2 x 100}}{\text{Weight of coal sample x 18}}$

$= \frac{0.09 \text{ X 2 X 100}}{0.25 \text{ x 18}}$

$= 4$

2) % C = $\frac{\text{Increase in weight of KOH bulb x 12 x 100}}{\text{Weight of coal x 44}}$

$= \frac{0.8 \text{ X 12 X 100}}{0.25 \text{ x 44}}$

$= 87.27$

Ans: % C in coal = 87.27 & % H in coal = 4.

1. Volume of acid required for blank titration (V_1) = 49.5 ml.

2. Volume required for back titration (V_2) = 36.5ml.

3. Normality of acid (N) = 0·12N.

4. Weight of coal taken (W) = 0.42g.

5. Volume of acid consumed by liberated ammonia

$= V_2 - V_2$

$= 49.5 - 36.5$

$= 13$

$\%\text{Nitrogen} = \frac{\text{Volume of acid consumed by ammonia x Normality of acid x1.4}}{\text{Weight of coal}}$

$= \frac{(V_1 - V_2) \text{ X N x 1.4}}{W}$

$= \frac{13 \text{ x 0.12 X 1.4}}{0.42}$

$= 5.2$

Ans: The amount of nitrogen in coal = 5.2%

DQ 46: ***What are anti-knocking agents? Explain the factors affecting anti-knocking characteristics of a compound.***

Solution:

Anti-knocking agents are the compounds which help to increase the octane number. Thus, these compounds when added in small quantity to petrol or diesel reduces the knocking, hence improves the quality of petrol or gasoline.

E.g.,- methanol, ethanol, Methyl tertiary butyl ether (MTBE) and Ethyl tertiary butyl ether. (ETBE)

The factors affecting anti-knocking characteristics of a compound.

1. Presence of oxygen atom in structure facilitates the easy combustion of fuel in ICE.
2. It should contain hydrocarbon, so that it is similar to fuel content.
3. Easily miscible and should easily dissociate to combine with free radicals formed during knocking compound.
4. It should not be poisonous and polluting in nature.

.

DQ 47: ***What is electrochemistry? Write the cell reaction and Calculate the standard emf of the following cell*** $Zn_{(s)} \mid Zn^{2+}_{(aq)}\ (1M) \mid\mid Cu^{2+}_{(aq)}\ (1M) \mid Cu_{(s)}$

Given: $E^0_{Zn} = -o.763\ V$ ***and*** $E^0_{Cu} = 0.337\ V$

Solution:

Electrochemistry deals with the study of the processes involved in the inter-conversion of electrical energy and chemical energy.

For this cell:

Oxidation half cell: anode

At anode- $Zn\ (s) \rightarrow Zn^{2+} + 2e^-$ E^0anode = -0.763

Reduction half cell:

At cathode- $Cu^{2+} + 2e^- \rightarrow Cu(s)$ E^0cathode = 0.337

E^0 cell = E^0cathode - E^0anode

= 0.337 – (-0.763)

= 0.337 +0.763

= 1.1 V

DQ 48: ***What is Green Chemistry? Calculate percentage atom economy for the following reaction with respect to acetophenone.***

$$C_6H_6 + CH_3COCl \longrightarrow \underset{\textbf{Acetophenone}}{C_6H_5COCH_3} + HCl$$

(Atomic weights: C=12, H=1, O=16, Cl=35.5)

Solution:

C_6H_6	+	CH_3COCl	⟶	$C_6H_5COCH_3$	+	HCl
Benzene		Acetyl chloride		Acetophenone		
MW=78		**78.5**		**140.5**		

$$\% \text{ Atom Economy} = \frac{\text{Molecular weight of product} \times 100}{\text{Total Molecular weight of Reactants}}$$

$$= \frac{140.5 \times 100}{78+78.5}$$

$$= 89.78\%$$

Atom Economy = 89.78%

DQ 49: ***Define corrosion. Explain sacrificial anode method with suitable diagram.***

Solution:

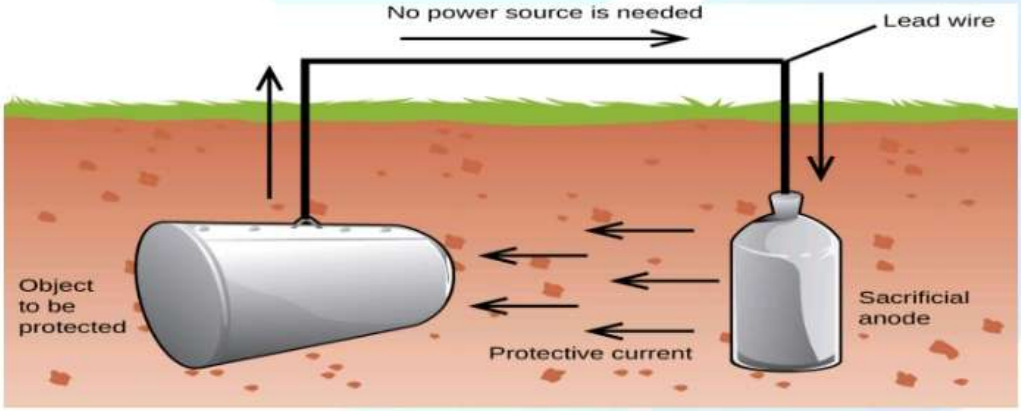
The process of deterioration or destruction and consequent loss of a solid metallic material, through an unwanted or unintentional chemical or electrochemical attack by its environment, starting at its surface, is called corrosion.

For e.g.

1. Rusting of iron, iron when exposed to the atmospheric conditions undergoes corrosion to form a thin layer reddish scale and powder of oxide (Fe_3O_4) and becomes weak.

The principle involved in this method is to make the metal to be protected to behave like a cathode. According to the mechanism of corrosion, corrosion occurs at anode & cathode remains intact or protected, forms the base of this method.

In this method, the metallic structure which is to be protected from corrosion, is connected by a wire to more anodic metal (i.e., metal which is higher in galvanic series), so that all corrosion takes place at this more active metal. By doing so the active metal connected to metallic structure to be protected gets corroded slowly whereas the metallic structure forming cathode is protected. The active metal employed is called sacrificial anode. The corroded sacrificial anode block is to be replaced by a fresh one, when consumed completely. Metals used as sacrificial anodes are Mg, Zn, Al and their alloys. To increase the conductivity, sacrificial anode is placed in a backfill consisting of charcoal, coke or gypsum.



Sacrificial anode cathodic protection method is used for protection of buried pipelines, underground cables, marine structures, ship hulls, water tanks, piers, boring, bridges etc.

DQ 50: ***Calculate the weight and volume of air required for complete combustion of 1 kg of coal containing***
C=65%, H=4%, O=7%, N=3%, moisture=15% and remaining is ash. (Molecular weight of air=28.94 gm)

Solution:

Constituent	% by weight	Weight of each per kg of fuel
C	65	0.65
H	4	0.04
O	5	0.05
S	2	0.02
N	4	-
moisture	10	-
ash	rest	-

Amount of air required= 100/23[2.67C + 8H + S - O

= 100/23[2.67 x 0.65 + 8 x 0.04 + 0.02 – 0.05]

= 100/23[1.7355 + 0.32 + 0.02 – 0.05]

= 100/23[2.0755 – 0.05]

=100/23[2.0255]

= 8.8065 kg

DQ 51: ***Give the classification of Spectroscopy based on atomic level of study. Distinguish between absorption and emission spectra.***

Solution:

Explanation of the classification:

1. **Atomic spectroscopy:**

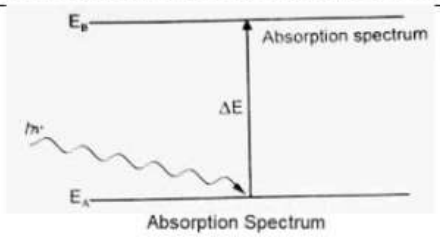
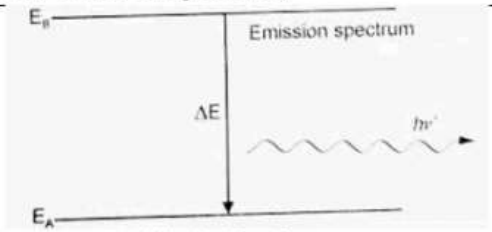
When energy changes take place at atomic levels it is known as atomic spectroscopy. Atomic spectrum consists of sharp lines, because the transitions occur from one electronic energy level to the other. Atoms of different elements have distinct spectra. The three main types of atomic spectroscopy are:

a. **AAS is Atomic Absorption Spectroscopy** in which atoms absorb UV or visible light and get excited to higher energy level. It is mainly used in detection of metals.

b. **AES is Atomic Emission Spectroscopy** in which atoms are excited by heat or flame to emit light. It is commonly used to detect multiple elements simultaneously.

c. **AFS is Atomic Fluorescence Spectroscopy** mostly used to analyze organic compounds. In this beam of light excites the atoms and further cause them emit light.

Difference between absorption and emission spectra:

Sr. No.	Absorption spectra	Emission spectra
1	Molecules give absorption when a substance is irradiated with electromagnetic radiation	Molecules give emission spectra when subjected to intense heat or electric discharge.
2	The energy of the incident photons may be transferred to the molecules, raising them from the ground state to an excited state. This process is known as absorption and the resultant spectrum is known as absorption spectrum. The energy absorbed by a molecule may bring about changes in one or more of its energy levels such as rotational, vibrational and electronic.	Due to this heat molecules get excited. On returning to their lower energy state, molecules may emit radiation, which is the result of transmission of molecule from an excited state to one of lower energy, usually the ground state. This excess energy is emitted as a photon and the corresponding frequency is recorded as the emission spectrum.
3	 Absorption Spectrum	 Emission Spectrum
4	Produced when atoms absorb energy of certain wavelength	Produced when atoms emit energy of certain wavelength

DQ 52: ***What is metallic coating? Differentiate between Galvanizing and Tinning.***

Solution:

Galvanizing	Tinning
1) Protects the underlying metal sacrificially.	1) Protects the underlying base metal due to its noble character or higher corrosion resistance.
2) Electrode potential of coating metal is lower than that of base metal.	2) Electrode potential of coating metal is higher than that of base metal.
3) If pores, breaks occur in such a coating, the base metal is not corroded, till all the coating metal is consumed.	3) If pores, breaks occur in such coating, the corrosion of the base metal is speeded up.
4) Example is coating of Zn on iron.	4) Example is coating ofSn on iron.
5) The process of coating of Zn on iron is known as Galvanizing.	5) The process of coating of Sn on iron is known as Tinning.

DQ 53: ***List 12 principles of Green Chemistry. Explain Biodiesel as a Green fuel.***

Solution:

Twelve Principles of Green Chemistry:

1. Prevention of waste.

2. Maximize atom economy.

3. Prefer Non- hazardous chemical synthesis.

4. Design safer chemicals and products

5. Avoid use of auxiliary substances.

6. Energy efficiency.

7. Use renewable feedstock.

8. Avoid chemical derivatization.

9. Prefer the use of catalyst.

10. Design degradable products.

11. Real time analysis for pollution prevention.

12. Inherently safer chemical process for accident prevention.

Green Fuel (Biodiesel)

Green fuel is a fuel obtained from biomass such as agricultural products & its waste, it is a good alternative for petroleum or petrochemicals such as petrol, diesel etc. It is renewable. Ex- Biodiesel

Biodiesel: Chemically it is methyl ester of higher fatty acid. Its chemical formula is $RCOOCH_3$, where R is higher hydrocarbon like $C_{17}H_{35}$, $C_{15}H_{31}$. CH_3 group can be ethyl or propyl in some cases.

Biodiesel can be synthesized from following oils: Rape seed oil, soybean oil (commonly used), mustard oil, jatropha oil, flax oil, sunflower oil, palm oil, coconut oil etc.

Advantages of Biodiesel:

1) It is a clean burning alternative fuel.

2) Obtained from renewable source.

3) Non-polluting in nature.

4) Biodegradable, non-toxic and free from Sulphur and aromatic compounds.

5) Posses better anti-knocking characteristics. i.e., shows minimum ignition delay.

6) It can be used in diesel engines with no modifications.

DQ 54: ***List the factors affecting the rate of corrosion. Explain Galvanic cell Corrosion.***

Solution:

Factors affecting the rate of corrosion:

Two major factors affecting rate of corrosion are:

I) Nature of metal

A. Position of metal in galvanic series
B. Nature of Metal oxide formed
C. Passivity of metal
D. Over voltage.
E. Relative areas of the anodic and cathodic part.

II) Nature of corroding environment.

A. Temperature.
B. Humidity.
C. Influence of pH:
D. Conductance of the corroding medium.

Galvanic Cell Corrosion: This type of corrosion takes place when two dissimilar metals are in contact and exposed to an electrolytic solution, the metal higher in electrochemical series undergoes corrosion (dissolution). For example, if zinc and copper are in contact and dipped in electrolyte than Zinc being higher in electrochemical series forms the anode and is corroded that is get dissolved whereas copper being lower in electrochemical series or is more noble acts as cathode. The anodic reaction is always dissolution of anodic metal that is Zinc in this case.

At anode: $Zn \rightarrow Zn^{2+} + 2\bar{e}$ (oxidation)

*The nature of the corrosive environment decides the type of cathodic reaction such as:

- In acidic solution, the corrosion occurs by Evolution of hydrogen.

  At cathode: $2H^+ + 2\bar{e} \rightarrow H_2 \uparrow$ (Reduction)

- In neutral solution it occurs by absorption of oxygen. The electron current flows from the anodic metal zinc to cathodic metal copper and absorbed by dissolved O_2.

  At cathode: $\frac{1}{2}O2 + H2O + 2\bar{e} \rightarrow 2OH^-$ (Reduction)

Thus, it is evident that the corrosion occurs at the anodic metal while the catholic part remains intact & protected from the corrosion.

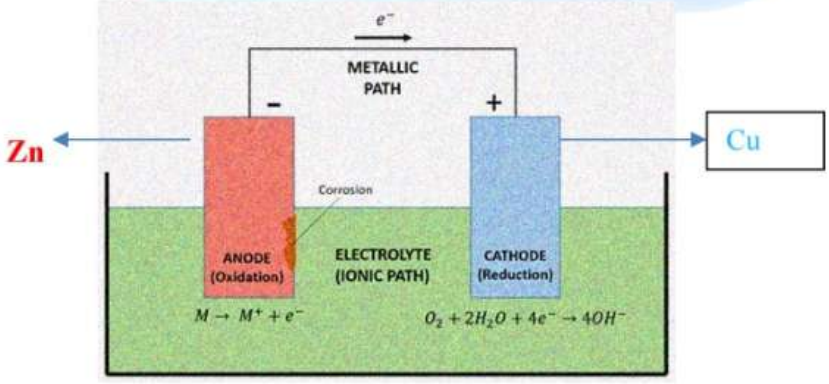


Fig: Galvanic Corrosio

DQ 55: ***By Kjeldahl's method 3 gm of coal sample was analyzed. The ammonia evolved was absorbed in 40 ml of 0.5 N H_2SO_4. After absorption, the excess H_2SO_4 required 18.5 ml of 0.5N KOH for neutralization. A coal sample was subjected to ultimate analysis 2.45 g of coal on combustion in a Bomb-Colorimeter gave 0.67 of BaSO4. Calculate percentage of Nitrogen and Sulphur.***

Solution:

1. Volume of acid required for blank titration (V_1) = 40 ml.

2. Volume required for back titration (V_2) = 18.5 ml.

3. Normality of acid (N)= 0·5 N.

4. Weight of coal taken (W) = 3g.

5. Volume of acid consumed by liberated ammonia

$$= V_2 - V_2$$
$$= 40 - 18.5$$
$$= 21.5$$

$$\%\text{Nitrogen} = \frac{\text{Volume of acid consumed by ammonia x Normality of acid x1.4}}{\text{Weight of coal}}$$

$$= \frac{(V_1 - V_2) \text{ X N x } 1.4}{W}$$

$$= \frac{21.5 \text{ x } 0.5 \text{ X } 1.4}{3}$$
$$= 5.0166$$

Ans: The amount of nitrogen in coal = 5.0166%

$$\%\text{ Sulphur} = \frac{\text{Weight of } BaSO_4\text{ppt x 32 x 100}}{\text{Weight of coal x 233}}$$

$$= \frac{0.67 \times 32 \times 100}{2.45 \times 233}$$

$$= 3.76$$

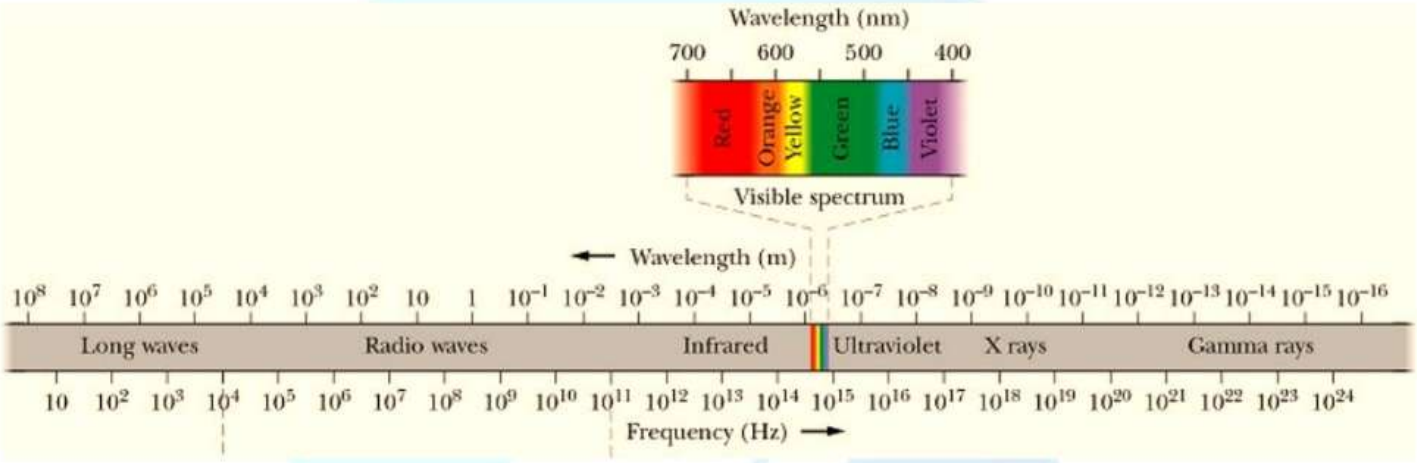
Ans: Sulphur content of coal = 3.76 %

DQ 56: ***Define spectroscopy and explain different regions of electromagnetic spectrum with the help of diagram.***

Solution:

Spectroscopy is defined as "The analysis of the electromagnetic radiation scattered, absorbed or emitted by molecules. It deals with the transitions that an electron in a molecule undergoes between energy levels upon absorption of suitable radiations". Spectroscopy is useful in finding out constituents of unknown chemical composition

The electromagnetic spectrum exhibiting various spectral regions is shown in the following diagram:



DQ 57: ***What is Electrochemistry? Differentiate between electrolytic cell and Galvanic cell.***

Solution:

Electrochemistry deals with the study of the processes involved in the inter-conversion of electrical energy and chemical energy.

Sr. No.	Type1: Electrolytic cell	Type 2: Galvanic cell
1.	In this cell, an electric current is passed to bring out non-spontaneous reaction.	In this cell, a spontaneous chemical reaction produces or generates electric current.
2.	Electrical energy is converted into chemical energy.	Chemical energy is converted to electrical energy.
3.	Anode is positive and cathode is negative.	Anode is negative and cathode is positive.
4.	E.g.: Electrodialysis process of salty water etc. Electroplating process.	E.g.: Battery (Dry cell) Lead acid storage cell, Fuel cell.

DQ 58: ***List the 12Principles of Green chemistry and calculate % atom economy for the following reaction with respect chlorobenzene***

$C_6H_6 + Cl_2 \longrightarrow C_6H_5Cl + HCl$

Atomic weight C = 12, H = 1, Cl = 35.5

Solution:

Twelve Principles of Green Chemistry:

1. Prevention of waste.
2. Maximize atom economy.
3. Prefer Non- hazardous chemical synthesis.
4. Design safer chemicals and products
5. Avoid use of auxiliary substances.
6. Energy efficiency.
7. Use renewable feedstock.
8. Avoid chemical derivatization.
9. Prefer the use of catalyst.
10. Design degradable products.
11. Real time analysis for pollution prevention.
12. Inherently safer chemical process for accident prevention.

Solution:

$C_6H_6 + Cl_2$ $C_6H_5Cl + HCl$ $\longrightarrow$ **$C_6H_5Cl + HCl$**

Mol. wt.- 78 71 112.5

$$\% \text{ Atom Economy} = \frac{\text{Molecular weight of product} \times 100}{\text{Total Molecular weight of Reactants}}$$

$$= \frac{112.5 \times 100}{78 + 71}$$

$$= 75\%$$

%Atom Economy = 75

DQ 59: ***What is Electrochemical corrosion? Explain Hydrogen evolution mechanism with the help of diagram.***

Solution:

When metals are exposed to wet atmosphere or liquid medium (conducting medium), it undergoes wet corrosion or electrochemical corrosion.

This type of corrosion causes displacement of hydrogen ion (H+) from acidic solution by metal ions. Hence all metals above hydrogen in the electrochemical series have a tendency to get dissolved in acidic medium with simultaneous evolution of hydrogen. Thus, the corrosion product may be $FeCl_2$, $FeSO_4$etc respectively depending on the acid present around the metal

Mechanism of Wet or Electrochemical corrosion by Evolution of Hydrogen:

Electrochemical or wet corrosion by evolution of H_2 takes place when the metal is in contact with acidic environment that is acidic liquid. Let us consider a block of metal Fe is in contact with acidic medium, and a part of it is covered with some impurity (sand, dust or rust) this will create two parts on metal block, one which is covered by impurity & is not in direct contact of acid will form cathode and other one which is in direct contact of acid will form anode. Thus, at anode dissolution of metal and liberation of electrons will take place as follows:

At anode: $\mathbf{Fe \rightarrow Fe^{++} + 2\bar{e}}$ **(Oxidation)**

Whereas, at the cathode which is not in direct contact of acid, consumption of electrons flowing from anode will be done by H^+ ions which penetrate through fine gaps or pores of the impurity leading to evolution of Hydrogen as follows:

At cathode: $\mathbf{2H^+ + 2\bar{e} \rightarrow H_2 \uparrow}$

The overall reaction: $\mathbf{Fe + 2H^+ \rightarrow Fe^{2+} + H_2 \uparrow}$

This type of corrosion causes displacement of hydrogen ion (H+) from acidic solution by metal ions. Hence all metals above hydrogen in the electrochemical series have a tendency to get dissolved in acidic medium with simultaneous evolution of hydrogen. Thus, the corrosion product may be $FeCl_2$, $FeSO_4$etc respectively depending on the acid present around the metal.

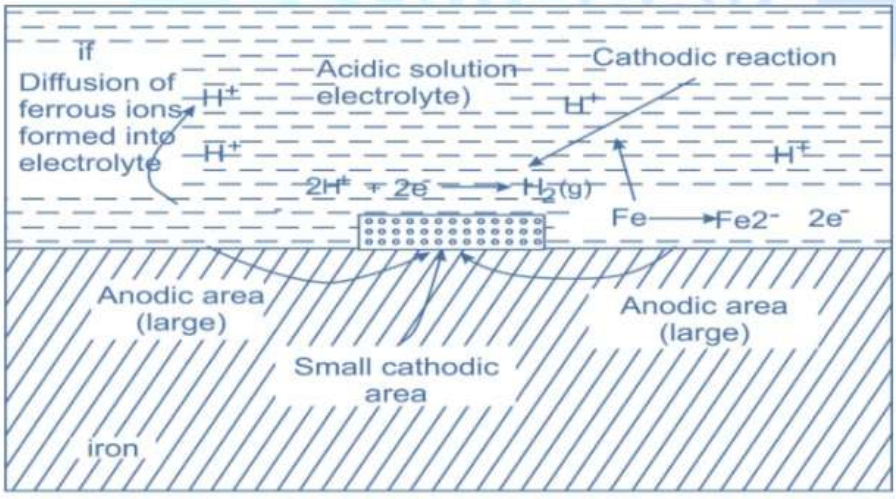


Fig: Mechanism of Wet corrosion by Hydrogen Evolution

DQ 60: ***Calculate the weight of air required for complete combustion of 1Kg coal containing C=65%, H=4%, O=5%, S=2%, N=4%, moisture=10% and remaining ash.***

Solution:

Constituent	% by weight	Weight of each per kg of fuel
C	65	0.65
H	4	0.04
O	5	0.05
S	2	0.02
N	4	-
moisture	10	-
ash	rest	-

Amount of air required= 100/23[2.67C + 8H + S - O

= 100/23[2.67 x 0.65 + 8 x 0.04 + 0.02 – 0.05]

= 100/23[1.7355 + 0.32 + 0.02 – 0.05]

= 100/23[2.0755 – 0.05]

=100/23[2.0255]

= 8.8065 kg

DQ 61: ***Give construction and working of hydrogen-oxygen fuel cell with the help of diagrams and reactions.***

OUT OF SYLLABUS

DQ 62: ***What is standard potential? Calculate standard emf of following cell.***

Solution:

$Zn(s)|Zn^{2+}_{(aq)}$ (1M) || $Cu^{2+}_{(aq)}$ (1M) $|Cu_{(s)}$

Given E^0 Zn =-0.763 V and E^0 Cu = 0.337V

For this cell:

Oxidation half cell: anode

At anode- $Zn(s) \rightarrow Zn^{2+} + 2e^-$ E^0anode = -0.763

Reduction half cell:

At cathode- $Cu^{2+} + 2e^- \rightarrow Cu(s)$ E^0cathode = 0.337

E^0 cell = E^0cathode - E^0anode

= 0.337 – (-0.763)

= 0.337 +0.763

= 1.1 V

DQ.63: ***Explain the mechanism of 'Rusting of iron in water' with the help of diagram and reactions.***

Solution:

Mechanism of Wet Corrosion by Absorption of Oxygen: [Rusting of iron in neutral aqueous solution of electrolytes (like NaCl solution)]:

Wet or electrochemical corrosion by absorption of oxygen takes place when metal is in contact with neutral aqueous solution of electrolyte like NaCl solution in the presence of atmospheric oxygen.

Let us consider iron is in contact with an aqueous solution of NaCl, the surface of iron is usually coated with a thin film of iron oxide. However, if this iron oxide film develops some cracks, creating anodic area on the surface, while the well covered metal parts form cathodic parts. The anodic parts are small and cathodic parts are large. The reactions and corrosion process proceeds as follows:

At anodic areas, the metal (iron) dissolves as ferrous ions with liberation of electrons.

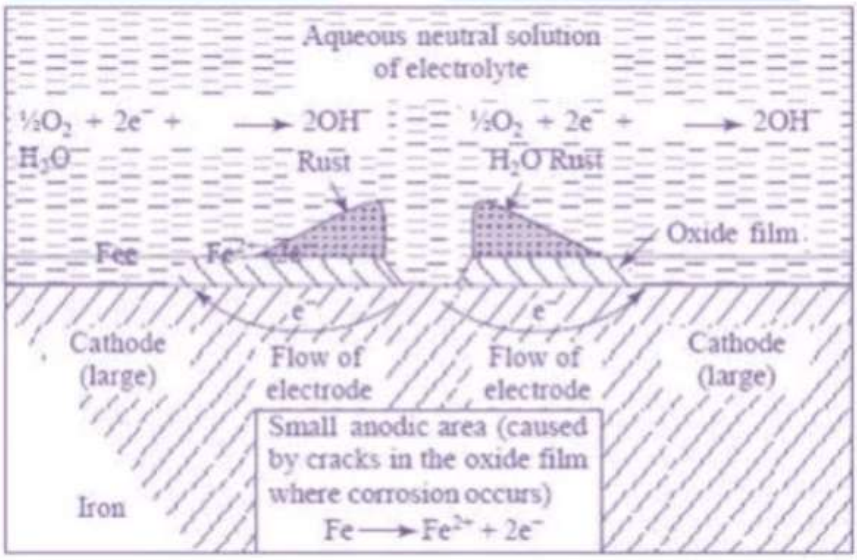
$Fe \rightarrow Fe^{++} + 2\bar{e}$ (Oxidation)

The liberated electrons flow from anodic to cathodic areas, through iron metal, where electrons are intercepted by the dissolved oxygen as:

$½\ O2 + H2O + 2\bar{e} \rightarrow 2OH^-$ (Reduction)

The Fe++ ions formed (at anode) and (OH-) formed ions (at cathode) diffuse and combine to form ferrous hydroxide precipitate

$Fe^{++} + 2OH^- \rightarrow Fe(OH)_2$



The above reactions can be also written in following way

$$Fe \rightarrow Fe^{2+} + 2\,e^- \text{ (Anodic)}$$

$$2\,H_2O + O_2 + 4\,e^- \rightarrow 4\,OH^- \text{ (Cathodic)}$$

$$Fe^{2+} + 2\,OH^- \rightarrow Fe(OH)_2 \text{ (Chemical)}$$

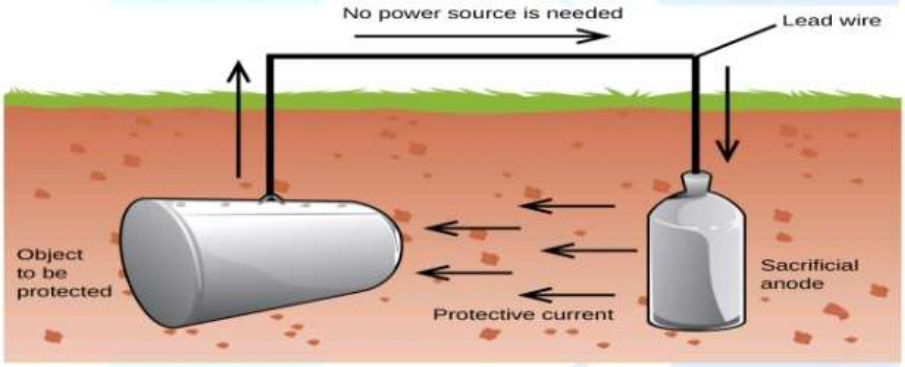
DQ 64: ***Explain sacrificial anode method for prevention of corrosion with the help of diagram and also distinguish between Galvanizing and Tinning***

Solution:

Sacrificial anodic protection:

The principle involved in this method is to make the metal to be protected to behave like a cathode. According to the mechanism of corrosion, corrosion occurs at anode & cathode remains intact or protected, forms the base of this method.

In this method, the metallic structure which is to be protected from corrosion, is connected by a wire to more anodic metal (i.e., metal which is higher in galvanic series), so that all corrosion takes place at this more active metal. By doing so the active metal connected to metallic structure to be protected gets corroded slowly whereas the metallic structure forming cathode is protected. The active metal employed is called sacrificial anode. The corroded sacrificial anode block is to be replaced by a fresh one, when consumed completely. Metals used as sacrificial anodes are Mg, Zn, Al and their alloys. To increase the conductivity, sacrificial anode is placed in a backfill consisting of charcoal, coke or gypsum



Applications: Sacrificial anode cathodic protection method is used for protection of buried pipelines, underground cables, marine structures, ship hulls, water tanks, piers, boring, bridges etc.

Difference between Galvanizing & Tinning:

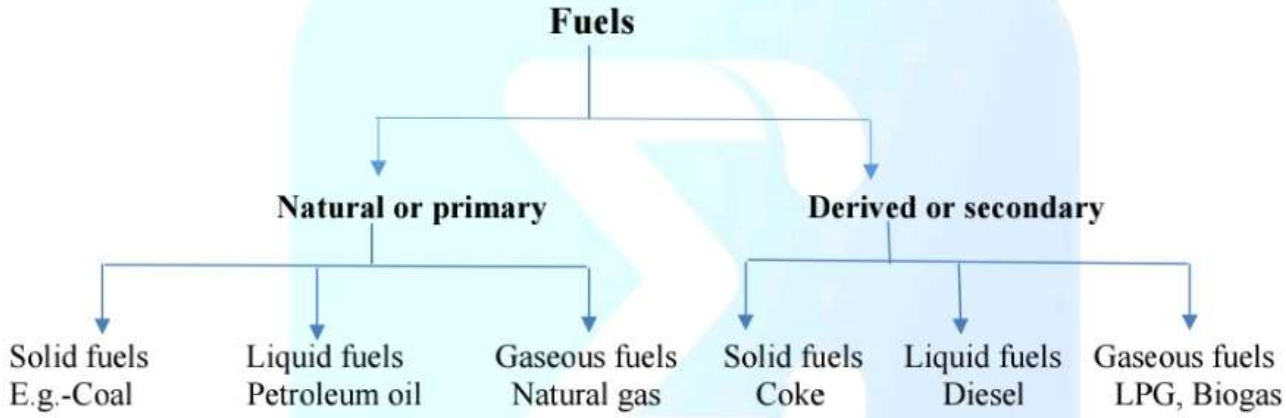
Galvanizing	Tinning
1) Protects the underlying metal sacrificially.	1) Protects the underlying base metal due to its noble character or higher corrosion resistance.
2) Electrode potential of coating metal is lower than that of base metal.	2) Electrode potential of coating metal is higher than that of base metal.
3) If pores, breaks occur in such a coating, the base metal is not corroded, till all the coating metal is consumed.	3) If pores, breaks occur in such coating, the corrosion of the base metal is speeded up.
4) Example is coating of Zn on iron.	4) Example is coating ofSn on iron.
5) The process of coating of Zn on iron is known as Galvanizing.	5) The process of coating of Sn on iron is known as Tinning.

DQ 65: ***What is Fuel? and what are ideal characteristics of fuel. Give classification of fuels.***

Solution:

Fuel is a combustible substance, containing carbon as a main constituent which on proper burning gives large amount of heat, which can be used economically for domestic and industrial purposes.
Ex. - Coal, Kerosene, Petrol, Diesel etc.

The fuels are classified according to their occurrence and state of aggregation. Depending on occurrence of fuels there are:
1.Natural or primary fuels such as coal
2.Artificial secondary fuels such as coke
Depending on state of aggregation it can be classified in to Solid, liquid and gaseous fuels. Thus, the classification of fuels can be represented as follows:



Characteristics of a good fuel:

1. Fuel should possess high calorific value.

2. It should have moderate ignition temperature.

3. It should be lower in moisture content.

4. Non-combustible matter content should be low.

5. It should have moderate velocity of combustion.

6. Products of combustion should not be harmful.

7. Low in cost.

8. Fuel should be easy to handle, store and transport.

9. Combustion should be easily controllable.