

- v) It has low combustibility. It has high melting point. It melts around 265 °C.
- vi) Polycarbonates have limited chemical and scratch resistance and it has a tendency to yellow with long term ultraviolet exposure.
- vii) It has a good thermal and oxidative stability in melt.

- Applications of polycarbonate :

- A] Construction material : Polycarbonates have high light transmittance, high impact strength and tensile strength. They are used as a substitute for window glass. They are also used in domelights, flat or curved glazing and sound walls.
- B] Electrical and electronic components : Being good electric insulator, having heat resistant and flame retardant properties, it is used in various products associated with electrical and telecommunication hardware.

They can be used for making electrical insulators, industrial plugs, sockets, switches, covers of cell phones, laptops, pagers etc.

Q.3 What are biodegradable polymers ? Give important features of biodegradable polymer. How biodegradable polymers are classified ? Give suitable example for each type. [SPPU : Marks 7]

(Marking scheme : Definition - 1M, important features - 3M, Classification with example - 3M)

Ans. : • Biodegradable polymers : Biodegradable polymers are the polymers which are degraded by biological means such as microorganisms.

- Important features of biodegradable polymer :

- i) Naturally occurring polymers are biodegradable.
- ii) Synthetic addition polymers with only carbon atom main chain are not biodegradable at molecular weight above 500.
- iii) If polymer chain contains atom other than carbon in the backbone, it may biodegrade depending on attached functional groups.

- iv) Synthetic polycondensation polymers are generally biodegradable to different extent depending on functional groups involved (ester > ether > amide).
- v) Amorphous polymers are more susceptible for biodegradation compared to crystalline polymers.
- vi) Generally lower molecular weight polymers undergo biodegradation easily compared to high molecular weight polymers.
- vii) Hydrophilic polymers degrade faster than hydrophobic.

• **Classification of biodegradable polymers :** Biodegradable polymers can be divided into 3 classes.

- 1) **Natural biopolymers** - Originating from plant or animal resources,. For e.g. cellulose, starch, protein etc.
- 2) **Biosynthetic biopolymers** - Produced by fermentation process by micro organisms. For e.g. polyhydroxy alkanotes (Polyhydroxy butyrate, polyhydroxy valerate).
- 3) **Synthetic biopolymers** - Polymers possessing biodegradable properties are produced synthetically.
For e.g. polycaprolactone, polylactic acid.



State

Q.22 What are nanomaterials? Explain following properties of nanomaterials with suitable example: a] Optical property, b] Electrical property, c] Mechanical property. [SPPU : Marks 7]

(Marking scheme : Definition-1M, Each property explanation with example-2M each)

Ans. : • Nanomaterials : Nanomaterials are defined as a set of substances where at least one dimension is less than approximately 100 nanometers.

Properties of nanomaterials :

a] **Optical property :** The optical properties of nanomaterials depend on parameters such as size, shape, surface characteristics and other variables including doping and interaction with the surrounding environment or other nanostructures. The shape can have dramatic influence on optical properties of metal nanostructures. For example, simple change in size of CdSe semiconductor to nano-size particle alters the optical properties of the CdSe nanoparticles

b] **Electrical property :** Electrical properties of nanomaterials are different than their bulk materials. In nanomaterials especially nanotubes/wires with decreasing diameter of the wire, the number of electron wave modes contributing to the electrical conductivity become increasingly smaller by well-defined quantized steps.

For example, in electrically conducting carbon nanotubes only one electron wave mode is observed which transport the electrical current.

c] **Mechanical property :** Mechanical properties of metallic and ceramic nanomaterials are influenced by porosity, grain size and the filler used.

For example, filling polymers with nanoparticles or nanorods and nanotubes, respectively, leads to significant improvements in their mechanical properties. Such improvements depend heavily on the type of the filler and the way in which the filling is conducted. Composites consisting of a polymer matrix and silicates exhibit excellent mechanical and thermal properties.

of pore size on their surface. This increases not only its sorption capabilities, but also its sorption efficiency.

Q.25) What are quantum dots ? What are the main properties of quantum dots ?

OR Explain with suitable example different types of semiconductor quantum dots.  [SPPU : Marks 7]

(Marking scheme : Definition-1M, Properties-2M, Types with example : 4M)

Ans. : • Quantum dots : Quantum dots are semiconductor nanoparticles that glow a particular colour after being illuminated by light.

- Properties of quantum dots (semiconductor nanoparticles)
- Quantum dots have properties intermediate between bulk semiconductors and discrete atoms or molecules.
 - The properties of a quantum dot are determined by size, shape, composition and structure.
 - Their optoelectronic properties change as a function of both size and shape. Many semiconductor substances can be used as quantum dots. Nanoparticles of any semiconductor substance have the properties of a quantum dot.
 - Commonly used semiconductor materials for preparing quantum dots are silicon, cadmium sulphide, cadmium selenide and indium arsenide. These materials behave differently as quantum dots, giving rise to very high tunability and wide variety of applications.
 - Quantum dots have unique property i.e. they exhibit interesting phenomena. i.e. size dependent emission wavelength narrow emission peak and broad excitation



A Guide for Engineering Students



Scanned with OKEN Scanner

range. The gap between the valence band and the conduction band, which is present for all semiconductor materials, causes quantum dots to fluoresce. The main property of quantum dots is they show colour glow when illuminated by UV light.

Types of Quantum dots

There are three main types of Quantum dots :

1) **III - V - Semiconductor Quantum dots** : They are made up of elements from Gr. III of the periodic table of elements (boron, aluminium, gallium, indium) and from Gr. V (nitrogen, phosphorous, arsenic, antimony, bismuth)

Example : gallium arsenide (GaAs). It is used as a light source in optical data processing and used as an amplification medium in lasers.

2) **II - VI - Semiconductor Quantum dot** : They are made up of elements from Gr. II i.e. transition metals (Zinc, cadmium) and from group VI (oxygen, sulphur, selerium, tellurium).

Example : cadmium selenide (CdSe), cadmium telluride (CdTe) and Zinc oxide (ZnO). They show outstanding fluorescence properties and widely used in electronics, photonics, photovoltaics and biomedicine.

3) **Silicon (Si) Quantum dots** : They are made up of element silicon, which is the standard material of semiconductor and chip industry.

Example : Silicon quantum dots have great potential to be used as a component of optical chip, optical sensors etc.

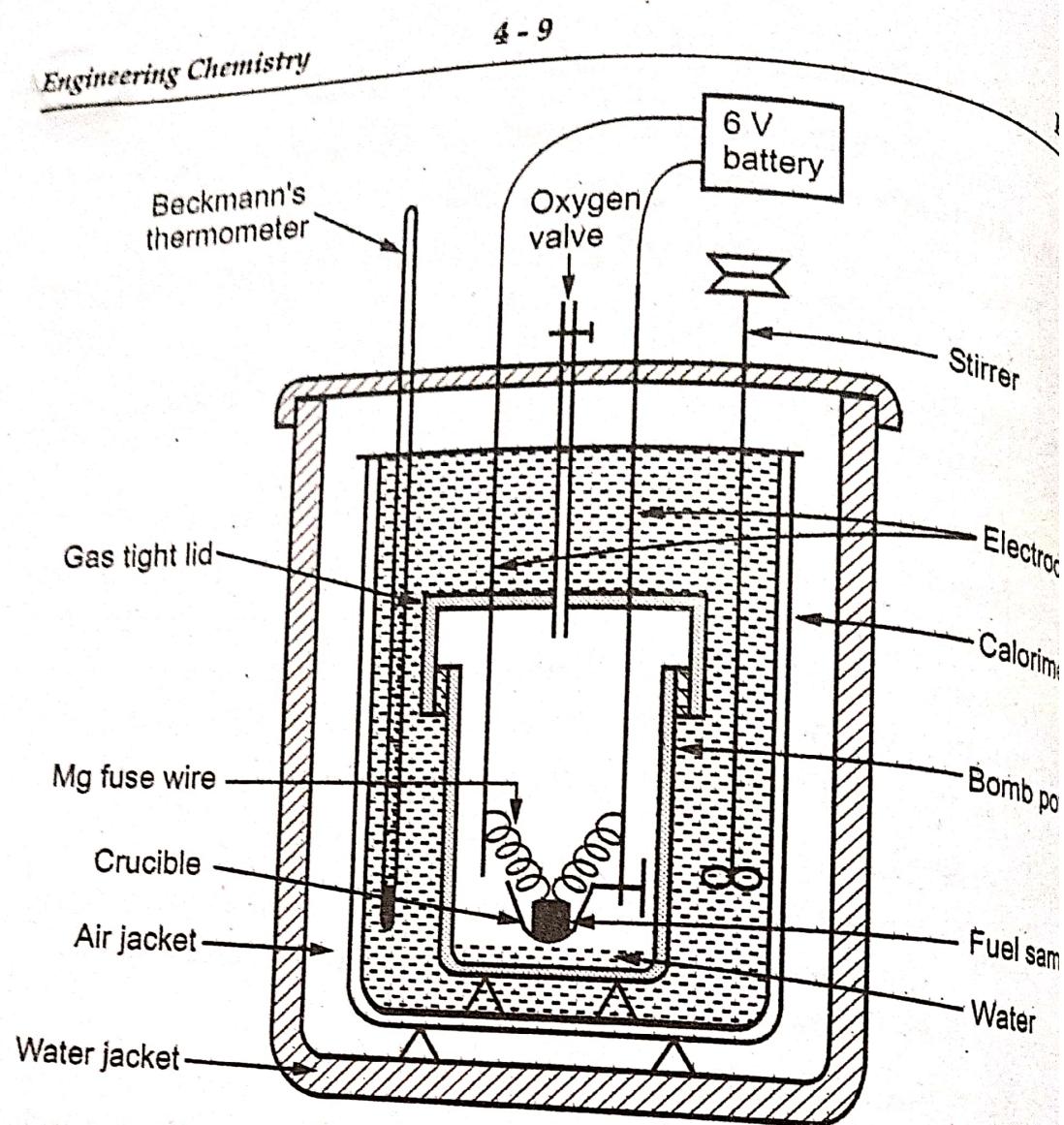


Fig. Q.7.1 : Bomb calorimeter

Ans. : Figure : Refer Fig. Q.7.1.

Construction :

- Bomb calorimeter consists of strong cylindrical stainless steel bomb in which combustion of the fuel is carried out.
- Stainless steel bomb has gas tight lid screwed to the body. Lid consists of two stainless steel electrodes and oxygen valve.
- A small ring is attached to one of the electrodes. In this nickel or stainless steel crucible can be supported, in which known mass/volume is taken.
- The entire bomb pot is placed in a copper calorimeter containing known mass of water.

- Copper calorimeter is surrounded by air-jacket and water jacket to prevent heat losses due to radiation.
- The calorimeter also contains electric stirrer and Beckmann's thermometer (accuracy upto 0.001°C).

Working :

- A known mass (about 0.5 to 1.0 gm) of fuel is taken in a crucible. This crucible is placed over the ring. A fine magnesium wire, is stretched across the electrodes, touching the fuel sample.
- About 10 ml of distilled water is added at the bottom of the bomb pot. The lid of the bomb pot is tightly screwed and the bomb pot is filled with oxygen to 25 atmospheric pressure.
- The bomb pot is then placed in the copper calorimeter containing known mass of water. The water in the calorimeter is stirred and initial temperature of water is noted. The electrodes are connected to 6 volts battery and current is passed for 5-10 seconds. This ignites the magnesium fuse wire which provides ignition to the fuel.
- The fuel sample burns completely and heat is liberated. The heat liberated on combustion of the fuel is absorbed by the water in the calorimeter. Stirring of water in calorimeter is continued for uniform distribution of heat and the maximum temperature attained is noted.

Corrected formula :

$$\text{GCV of fuel (L)} = \frac{(W + \omega)(t_2 - t_1 + t_c) - (t_a + t_f)}{x} \text{ cal/gm or kcal/kg}$$

or

$$\text{GCV of fuel (L)} = \frac{4.187(W + \omega)(t_2 - t_1 + t_c) - (t_a + t_f)}{x} \text{ J/gm or kJ/kg}$$

iv) It adds to handling, storage and transportation cost by its weight.

Hence, lower the % moisture, better is the quality of coal.

Q.18 Explain proximate analysis of coal.

[SPPU : Marks 5]

OR Discuss the procedure with formula in the determination of each constituent in the proximate analysis of coal. [SPPU : Marks 5]

(Marking scheme- Procedure and formula for moisture, volatile matter and ash - 1 $\frac{1}{2}$ M each, Formula for fixed carbon - $\frac{1}{2}$ M)

Ans. : Definition : Proximate analysis of coal deals with the determination of percentage moisture, volatile matter, ash and fixed carbon.

a) % Moisture (M) :

Refer Q.17

b) % Volatile Matter (VM) :

Procedure:

- Moisture - free coal sample left in the crucible from part a (determination of moisture) is covered with a vented lid.
- It is then placed in muffle furnace, maintained at 925 ± 20 °C and heated for 7 minutes.
- The crucible is first cooled in air, then inside the desiccator and weighed.
- The loss in weight of the sample corresponds to the volatile matter content.

Formula :

$$\% \text{ volatile matter} = \frac{\text{Loss in weight due to removal of VM}}{\text{Weight of coal sample}} \times 100$$

Let the weight of coal sample obtained after heating be ' m_2 ' grams.

$$\% \text{ VM} = \frac{m_1 - m_2}{m} \times 100$$

c) % Ash (A) :

Procedure :

- The residual coal in the crucible is then heated without lid in a muffle furnace at $700 \pm 50^{\circ}\text{C}$ for half an hour.
- The crucible is then taken out, cooled and weighed. Heating, cooling and weighing is repeated, till the constant weight (m_3) is obtained. The residue remaining in the crucible is the ash.

Formula:

$$\% \text{Ash} = \frac{\text{Weight of ash left}}{\text{Weight of coal sample}} \times 100$$

Let the weight of ash left in the crucible be ' m_3 ' grams then,

$$\% \text{Ash} = \frac{m_3}{m} \times 100$$

d) % Fixed carbon :

It is calculated as,

$$\% \text{ Fixed carbon} = 100 - (\% \text{ moisture} + \% \text{ volatile matter} + \% \text{ ash})$$

Q10 What is meant by calorific value?

6.	Diesel	250-320 °C	C ₁₆ to C ₁₈
7.	Heavy oil On refractionation gives i)Lubricating oil ii)Petroleum jelly iii)Grease iv)Paraffin wax	320-400 °C	C ₁₇ to C ₁₈
8.	Residue May be i) Asphalt ii) Petroleum coke	Above 400 °C	C ₃₀ and above

Q.35 Give the principle involved in fractional distillation of petroleum. Explain in brief the process with diagram.

[SPPU : Marks 5]

(Marking scheme- Principle - 1M, Process - 2M, Figure - 2M)

Ans. : Principle of fractional distillation : The vapours of higher boiling point fractions condense first during the stepwise cooling.

- Crude oil is a mixture of hydrocarbons. These hydrocarbons are converted into their vapours and then allowed to enter into the fractional distillation column where they are separated according to their boiling point range by stepwise cooling. The gradual cooling of vapours takes place along the height of distillation column in such a way that vapours of higher boiling points condense first and are collected from the bottom of the column. The vapours having lower boiling points are collected at higher levels in the column.

Process of fractional distillation:

- The crude oil is heated to about 400 °C in an iron retort, the volatile constituents are vaporized leaving the asphalt or coke as residue.

- The hot vapours are then passed through a fractionating column which is a tall, cylindrical tower in which a number of horizontal stainless steel trays are fixed at short distance.
- Each tray is provided with a small chimney (or bubble cup) which is covered with a loose cap.
- As vapours move up through bubble cups, they gradually get cooled.
- Higher boiling fractions will condense first while lower boiling fraction will condense later.
- The vapours ascending the tower are exposed to progressively lower temperatures as they pass from one tray to another.
- The heavier components with higher boiling points condense and the excess condensate flows down to the next lower tray through 'down spout' pipes and gets evaporated.

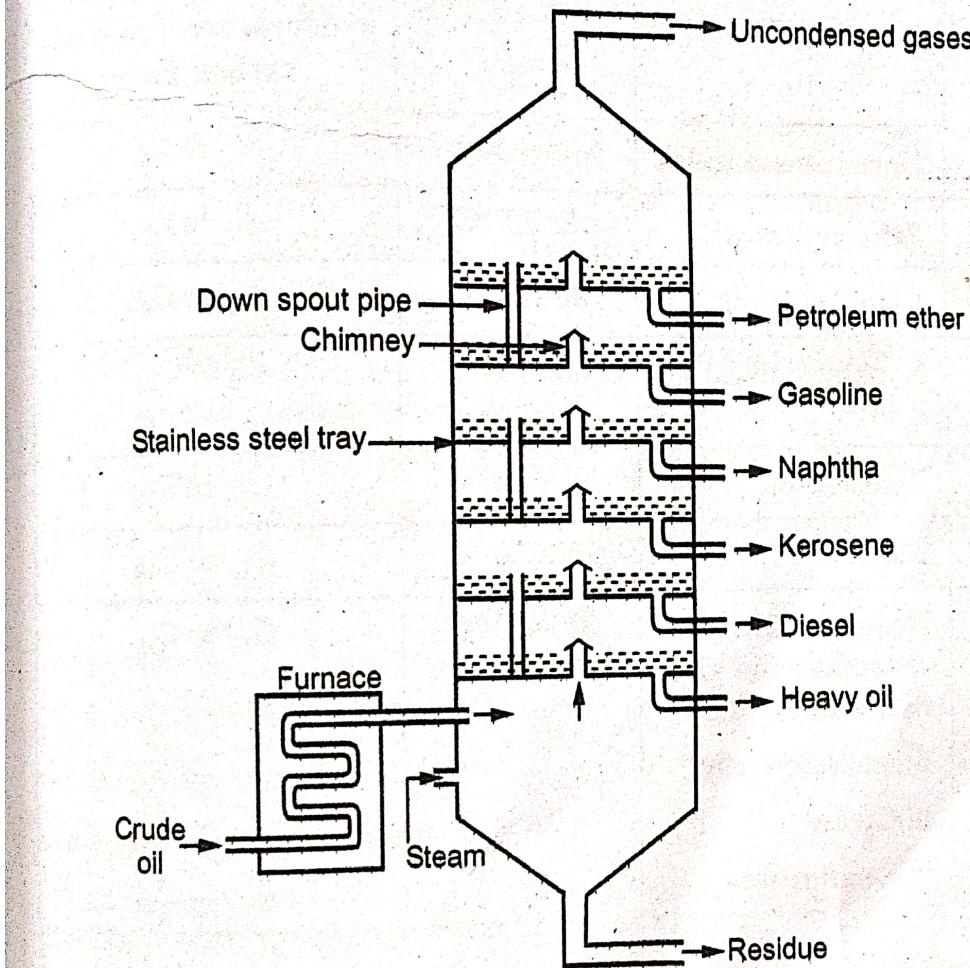


Fig. Q.35.1 Fractional distillation of crude oil

Q.44 What is power alcohol? Give the procedure involved in the preparation of ethanol from molasses. [SPPU : ... advantages of power alcohol.]

(Marking scheme- Definition of power alcohol - 1M, Procedure and reactions - 3M, 2 advantages - 1M)

Ans. : Definition : When ethyl alcohol is blended with petrol (about 20-25 %) and is used as a fuel for internal combustion engines, it is known as power alcohol.

Production of ethyl alcohol from molasses:

Refer Q.43

Advantages of Power alcohol (any2):

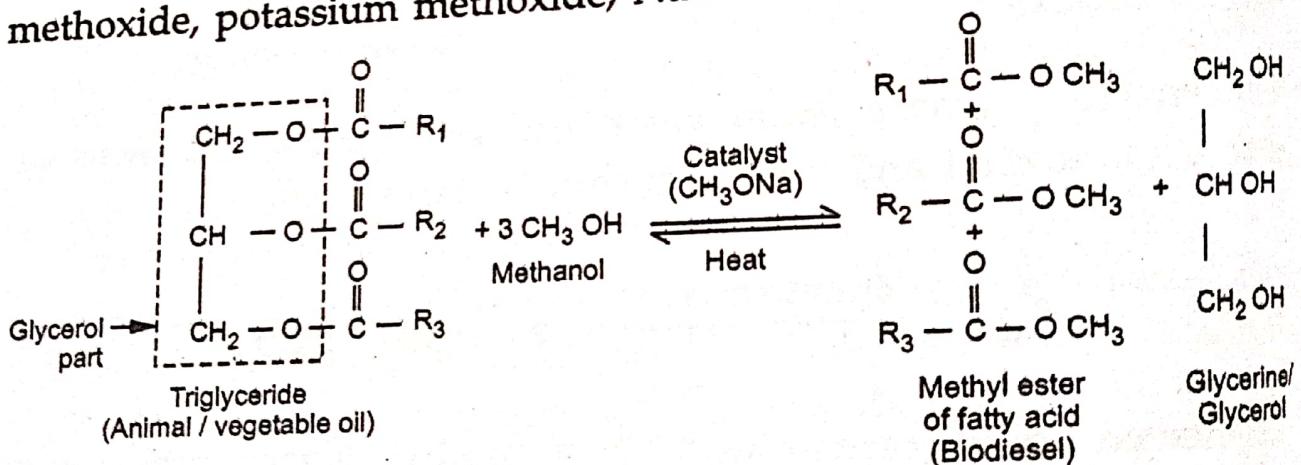
Refer Q.42

Q.45 Give the reaction for preparation of biodiesel. State two advantages of biodiesel. [SPPU : Marks 3]

(Marking scheme- Preparation reaction - 2M, 2 advantages - 1M)

Ans. : Preparation of Biodiesel :

Vegetable/animal oils can be converted into biodiesel by the process known as trans-esterification (conversion of one type of ester to other). In this process, animal/ vegetable oils are heated with excess of methanol in presence of catalysts like sodium methoxide, potassium methoxide, NaOH/KOH.



R_1 , R_2 and R_3 are the fatty acid alkyl groups. They can be same or different, depending on the type of oil.

Advantages of Biodiesel (any 2) :

- 1) It is non-conventional, renewable source of energy obtained from domestic sources. It reduces dependency on foreign countries for diesel.
- 2) It is non-toxic, free from sulphur.
- 3) It burns clean. Oxygen present in the fuel helps in burning.
- 4) It has higher flash point therefore safer for storage.
- 5) It has better lubricity.
- 6) It has higher cetane number than that of oils.
- 7) It is a good solvent and may clean out fuel lines and tank sediments

Q.46 What is biodiesel ? Give the preparation reaction of biodiesel with reaction conditions. Give advantages and limitations of biodiesel. [SPPU : Marks 5]

(Marking scheme- Definition - 1M, Preparation Reaction - 2M, Advantages and limitations - 2M)

Ans. : Definition : Biodiesel is a biofuel obtained from renewable sources of energy such as vegetable oils or animal oils by transesterification.

Preparation of Biodiesel : Refer Q.45.

Advantages of Biodiesel : Refer Q.45.

Limitations of Biodiesel:

- 1) Biodiesel has higher cloud and pour point than conventional diesel.
- 2) Biodiesel is not compatible with some rubber hoses and gaskets.
- 3) It is not compatible with some metals and plastics.

Q.47 Give the procedure and reaction for preparation of biodiesel. [Marks 3]

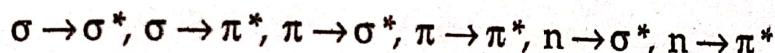
(Marking scheme - Preparation reaction - 2M, Procedure - 1M)

are accompanied by vibrational and rotational changes that results in relatively broad spectra.

- Absorption spectra is a graph of absorption i.e. amount of light absorbed versus wavelength of light. (Fig. Q.4.1)
- Information derived from absorption spectra is useful in determination of structure of molecule.

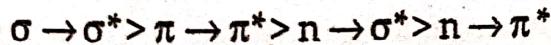
B) Absorption of UV Radiation by Organic Molecule leading to different electronic transitions :

- When energy is absorbed by a molecule in uv-visible region, it brings changes in electronic energy of molecule because of transition of valence electrons from lower energy to higher energy.
- 3 types of electrons are involved in organic Molecule - σ electrons, π electrons and n electrons.
- When energy is absorbed in uv-visible region, possible electronic transitions are :



Out of these, $\sigma \rightarrow \pi^*$ and $\pi \rightarrow \sigma^*$ are considered as forbidden transitions.

- The wavelength absorbed by molecule depends on energy difference ΔE between orbital originally occupied by electron (bonding orbital) and the energy of higher energy orbital (antibonding orbital) to which electron is promoted.
- The relative energies are in the following order :



- 1) $\sigma \rightarrow \sigma^*$ Transition : σ - electron from bonding orbital is excited to the corresponding antibonding orbital. The energy required is large for this transition.

For example : Methane (CH_4) which has only C - H bonds and can only undergo $\sigma \rightarrow \sigma^*$ transition. Thus, methane shows absorbance maxima at 125 nm.

Absorption maxima due to $\sigma \rightarrow \sigma^*$ transitions are not seen in typical UV-visible spectra (200 - 800 nm). Thus saturated hydrocarbons absorb very short wavelength below 185 nm and therefore this absorption is beyond the range of ordinary UV-visible spectrophotometer.

- 2) $\pi \rightarrow \pi^*$ Transition : π - electrons in a bonding orbital is excited to corresponding antibonding orbital π^* . Compounds containing multiple bonds like alkenes, alkynes, nitriles, aromatic compounds undergo $\pi \rightarrow \pi^*$ transitions.

Alkenes generally absorb in the region 170 - 205 nm and are difficult to record by spectrophotometer. However, molecules containing two or more conjugated double bonds absorb above 200 nm and can be easily recorded.

- 3) $n \rightarrow \sigma^*$ Transition : Saturated compounds containing atoms with lone pairs (non-bonding electrons) like O, N, S and halogens are capable of $n \rightarrow \sigma^*$ transition. These transitions usually require less energy than $\sigma \rightarrow \sigma^*$ transitions.

The number of organic functional groups with $n \rightarrow \sigma^*$ peaks in UV region is small (150 - 250 nm).

- 4) $n \rightarrow \pi^*$ Transition : An electron from nonbonding orbital is promoted to antibonding π^* orbital. Compounds containing double bond involving hetero atoms (C = O, C - S, C ≡ N, N = O) undergo such transitions. $n \rightarrow \pi^*$ transitions require minimum energy and show absorption at longer wavelength around 300 nm.

Thus, $n \rightarrow \pi^*$ and $\pi \rightarrow \pi^*$ electronic transitions, show absorption in region above 200 nm which is accessible with UV-visible spectrophotometer.

✓

Energy

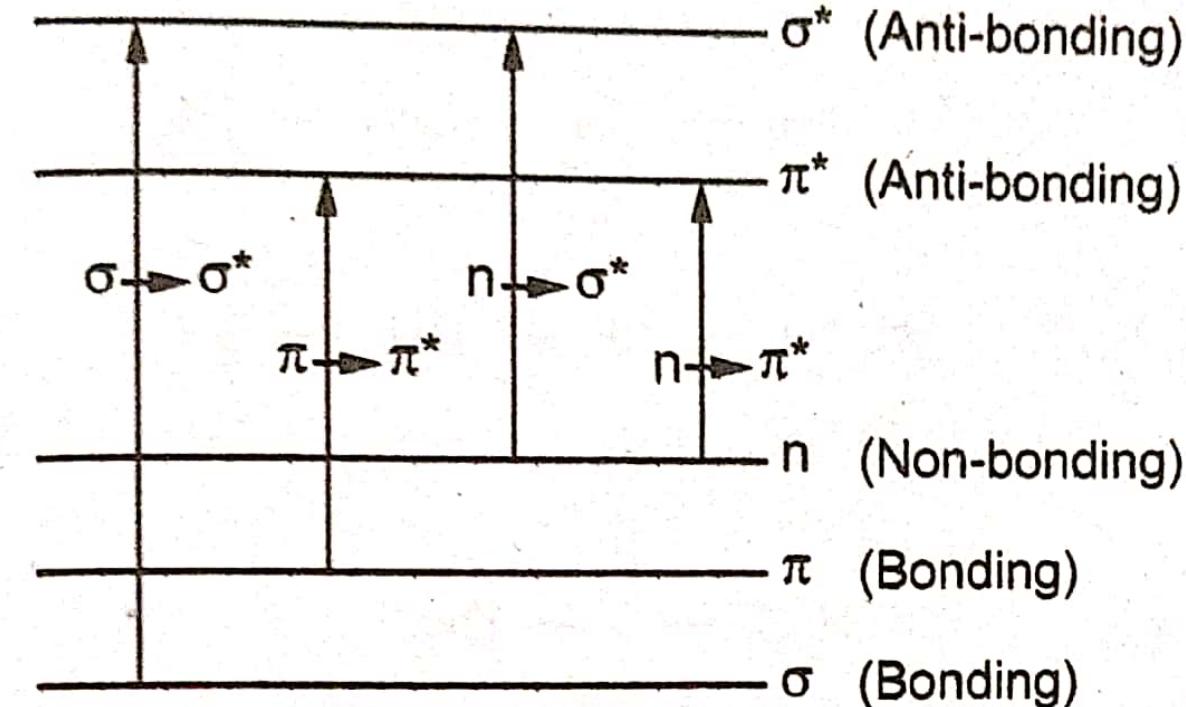


Fig. Q.4.2 Electronic transitions

[Marking scheme : block diagram - 1 Mark, 5 components - 5 Marks]

Ans. :

A) Block diagram of single beam UV-Visible spectrophotometer :

- The instrument that is used to measure the amount of electromagnetic radiation absorbed by the substance is called spectrophotometer or spectrometer.

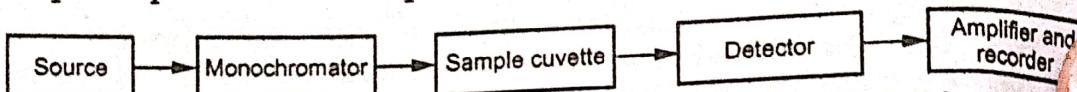


Fig. Q.20.1 Block diagram of single beam UV-visible spectrophotometer

B) Instrumentation of single beam UV-visible spectrophotometer :

i) Light source (Source of radiation) :

- Function :** It generates a beam of polychromatic radiation which covers the desired range of wavelengths. It has high intensity.
- Tungsten filament lamp is most commonly used for visible radiations (wavelength range 400 nm to 800 nm)
- Quartz hydrogen lamp or deuterium lamps are used for UV-radiations (Wavelength range 200 to 400 nm)

ii) Monochromator :

- Function :** Radiation source provides polychromatic light which is passed through monochromator through entrance slit. Monochromator disperses radiations according to wavelength. By moving the dispersing element or the exit slit, radiation of only particular wavelength leaves the monochromator through exit slit.
- Quartz prism or grating are used as dispersing elements in monochromator. Coloured filters also help in converting polychromatic radiations into monochromatic radiations.

iii) Slits :

Function : Entrance slit and exit slit are placed on opposite sides of prism or grating. Entrance slit help in channelizing beam of

incident light to prism or grating. Exit slit can be movable. Exit slit help in selecting desired wavelength from dispersed light obtained from prism or grating.

iv) Sample holder / cuvette :

- **Function :** Sample holders or cuvettes are used to hold sample or reference solution. They are constructed of transparent material which does not absorb radiation in UV or visible range.
- Optically matched fused silicate glass cuvettes can be used for visible spectroscopy whereas corex glass or quartz cuvettes are used for UV spectroscopy. (Glass absorbs radiations of wavelength less than 350 nm hence not used for UV spectroscopy but can be used for visible spectroscopy)

v) Detectors :

- **Function :** Transmitted light from sample cuvette falls on the detector where it is converted into electric current. It converts light energy directly into electrical energy. The output current of photodetector is directly proportional to the intensity of light falling on it.
- For UV-visible spectroscopy, photomultiplier tube (PMT), phototubes, photovoltaic cells are commonly used.

vi) Amplifiers and recorder :

- **Function :** Signal received from detector is amplified and read on recorder.
- Recorder can record output either in the graphical manner as absorption spectra or in the form of digital values as absorbance or transmittance.

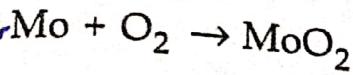
c) Basic Principle of Single Beam UV-Visible Spectrophotometer :

Spectrophotometer measures the amount of electromagnetic radiations emitted or absorbed by the solute or sample.

- Source of light provides the entire range of radiation. Monochromators disperse polychromatic light received from source and converts it into monochromatic radiation.

iv) **Volatile oxide film** : When oxide film formed is volatile i.e. it vaporizes as soon as it is formed, the underlying metal surface is exposed for further attack of oxygen and causes continuous and excessive corrosion of the metal.

Example : Oxide of molybdenum (Mo).



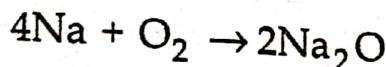
Q.4 Explain corrosion by oxygen in case of Na, Cr, Mo, Zn and Au metals with respect to chemical reaction and nature of oxide film formed.

(Marking scheme : Nature of oxide formed with reaction in stated metals-1M each)

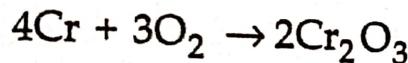
[SPPU : Marks 5]

Ans. Corrosion by oxygen in case of

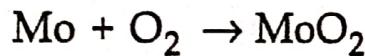
1. **Na metal** : Sodium metal is an alkali metal undergoes oxidation corrosion even at room temperature forming porous oxide film which is non-protective film as follows,



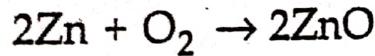
2. **Cr metal** : Chromium metal is transition metal undergoes oxidation corrosion at high temperature forming non porous oxide which is protective in nature as follows,



3. **Mo metal**: Molybdenum metal is transition metal undergoes oxidation corrosion at high temperature forming volatile oxide which is non-protective in nature as follows,



4. **Zn metal** : Zinc metal is transition metal undergoes oxidation corrosion at high temperature forming non porous oxide which is protective in nature as follows,



5. Au metal : Gold is a noble metal reacts with atmospheric oxygen and form unstable oxide film which decomposes back into metal and oxygen so the net corrosion is zero.



A can be dipped in dil. HCl, dil. H_2SO_4 or dil. HNO_3 solutions.

Q.30 What is electroplating? Explain the process with suitable diagram. Give any two applications of electroplating.

Marking scheme : Definition-1M. Process-2M, diagram-1M, two applications-1M)

Ans. : Definition : Electroplating

Electroplating or electrodeposition is the process, by which the coating metal is deposited on the base metal by passing a direct current through the solution of an electrolyte, containing the soluble salt of coating metal.

Electroplating process :

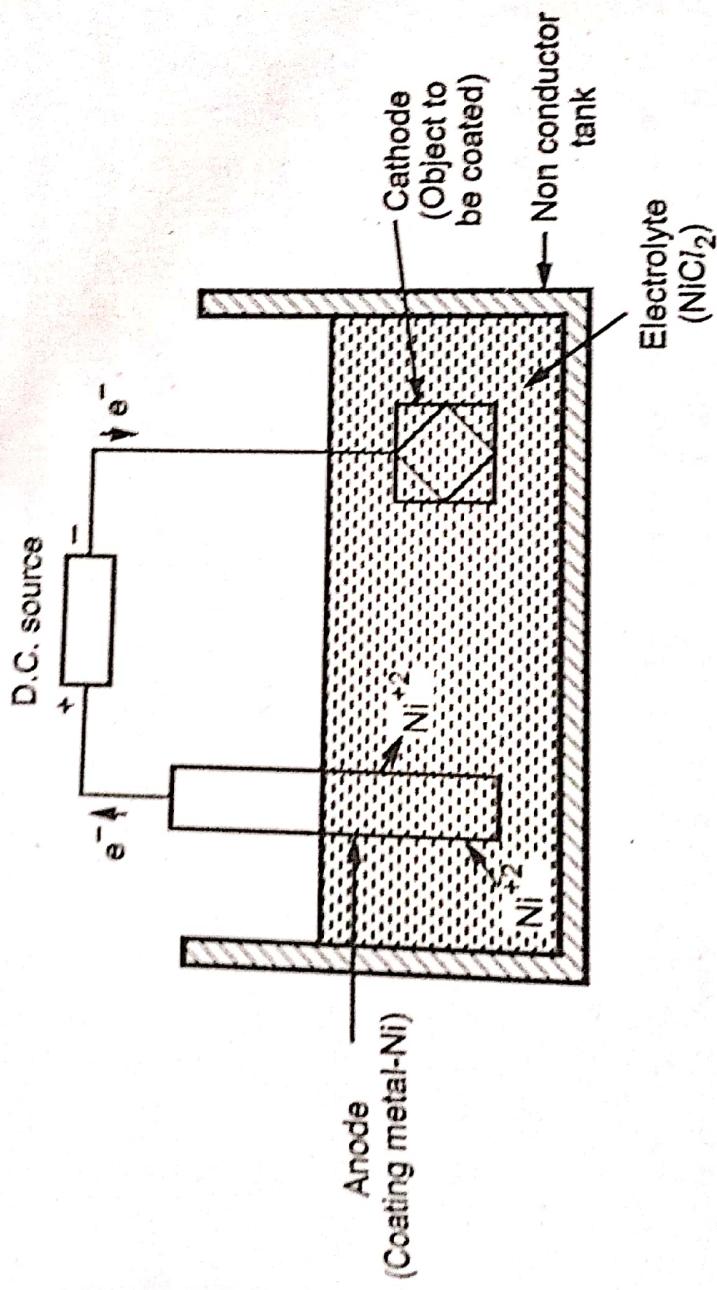


Fig. Q.30.1 Electroplating

- The base metal article to be coated is cleaned to remove oils, greases, oxides, scales etc.
- Electroplating is carried out in electroplating bath.
- The metal article to be plated is made cathode.
- Coating metal is made anode.

- e) Number of cathodes and anodes can be suspended alternately for getting uniform deposition over the entire surface.
- f) Cathode and anode are dipped in the electrolyte (normally a salt solution of coating metal), containing suitable concentration of mineral acid. Mineral acids increase the electrical conductivity and suppress the hydrolysis of salt.
- g) pH of electrolyte is adjusted and suitable current density is chosen for electrolysis.
- h) As the electrolysis proceeds, the anode metal gets oxidized and enters the electrolytic solution. The metal ions get reduced and deposited on cathode to give uniform coating on the surface of base metal article.
- i) The metal ions getting reduced and deposited at cathode are reformed by anode metal oxidation. Thus, there is no change in salt concentration of electrolyte.

Applications of electroplating :

- i) Electroplating can be used for getting decorative surface. For e.g. gold, chromium, brass coating on steel are used in ornaments, wrist watches, belts, pens etc.
- ii) Non-metallic materials like wood, paper, glass, leather, resins can be electroplated for decoration, preservation of surface, for obtaining conducting surface and increasing strength of non-metallic material. For e.g. radar antenna mats made of hard wood or synthetic resin are electroplated with copper.

(Q.36) What is anodic and cathodic coating ? Which is more protective and why ?

 [SPPU : Marks 4]

(Marking Scheme : definition of anodic & cathodic coating - 2M, state better coating-1M, reason- 1M)

Ans. : • Definition : Anodic coating

Anodic coatings are the coatings which are produced from coating metals which are anodic to base metal i.e. which have higher position in the electrochemical series than the base metal.



Scanned with OKEN Scanner

- **Definition : Cathodic coating**

Cathodic coatings are the coatings which are obtained when the coating metal is cathodic to the base metal. Coating metal has lower position in the electrochemical series than the base metal. Coating metal, being more noble metal than base metal, protect base metal because they offer higher corrosion resistance than base metal.

- **Anodic coatings are more protective than cathodic coatings** because in case any pores, breaks or discontinuities occur in such anodic coating, a galvanic cell is formed between coating metal and exposed part of base metal, the coating metal is more anodic than base metal therefore it will undergo corrosion, protecting underlying base metal. Whereas, in cathodic coating if coating is broken, a galvanic cell is formed between the coating and the exposed part of the base metal in the moist atmosphere. Coating metal is cathodic to base metal therefore, coating forms cathode and exposed base metal form anode undergoes corrosion.