Internal Assessment Test 2 – February 2022

Sub:	Engineering Chemistry			Sub Code:	21CHE12	Branch:	ECE, EEE, AIML and AI&DS	
Date:	28-02-2022	Duration:	90 min's	Max Marks:	50	Sem / Sec:	I / I to O	OBE

Question no. 1 is COMPULSORY and answer any THREE FULL Questions from the rest.

		MARKS	CO	RBT
1 (a)	Define metallic corrosion? Explain electrochemical theory of corrosion taking rusting of iron as an example.	[7]	CO2	L4
(b)	What is potable water? Explain the determination of hardness of water by EDTA complexometric method.	[7]	CO5	L3
2 (a)	Explain the role of following factors on the rate of corrosion. (i) Ratio of anodic and cathodic areas (ii) nature of corrosion product	[6]	CO2	L2
(b)	A thick steel sheet of area 350 cm² is exposed to air near the ocean. After a one year period it was found to experience a weight loss of 485 g due to corrosion. If the density of the steel is 7.9g/cm², calculate the corrosion penetrating rate in mpy and mm/y (given K= 534 in mpy and 87.6 in mm/y).	[6]	CO2	L4
3 (a)	What is meant by metal finishing? Mention (any five) technological importance of metal finishing.	[6]	CO2	L1
(b)	What is cathodic protection? Explain sacrificial anode and impressed voltage methods of corossion control.	[6]	CO2	L3
4 (a)	What is electroplating? Explain the electroplating of chromium in detail.	[6]	CO2	L3
(b)	Write the principles and requirement of titrimetric analysis.	[6]	CO5	L2
5 (a)	What is electroless plating? Describe electroless plating of copper with suitable reactions.	[6]	CO2	L2
(b)	Define COD and BOD. In a COD test, 28.3 cm³ and 12.5 cm³ of 0.05 N FAS solutions were consumed for blank & sample titration respectively. The volume of test sample used was 20 cm³. Calculate the COD of the sample solution.	[6]	CO5	L3
6 (a)	Explain the synthesis of nanomaterial by sol gel process. Mention its advantages.	[6]	CO3	L3
(b)	Explain the theory, instrumentation and applications of flame photometry.	[6]	CO5	L4
7 (a)	What are nanomaterials? Explain the synthesis of nanomaterials by precipitation method.	[6]	CO3	L3
7(b)	Define the following units of standard solution. i) Molarity ii) Normality iii) ppm	[6]	CO5	L2

Q1 (a) . Define metallic corrosion? Explain electrochemical theory of corrosion taking rusting of iron as an example. (7 marks)

Answer: Destruction of metal from its surface is known as corrosion. Eg Rusting of iron

Electrochemical theory of corrosion:
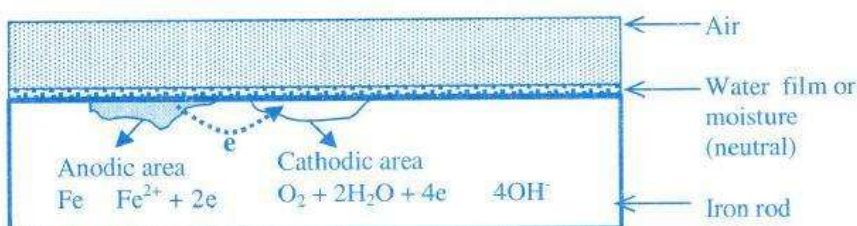
(i) According to electrochemical theory, corrosion of metals takes place due to the formation of minute

galvanic cells over the surface of metal. Thus anodic and cathodic regions are formed on the same metal surface or when two metals are in contact with each other in the presence of a conducting medium.

(ii) At the anodic region oxidation reaction takes place and the metal gets converted into its ions by liberating electrons. Consequently, metal undergoes corrosion at the anodic region.

$$Fe \longrightarrow Fe^{2+} + 2e^-$$

(iii) The electrons flow from the anodic to cathodic area and at the cathodic region, reduction takes place. Since metal cannot be reduced further, metal atoms at the cathodic region are unaffected by the cathodic reaction. Some constitutions of the corrosion medium take part in the cathodic reaction. There are three possible ways in which the reduction can take place.
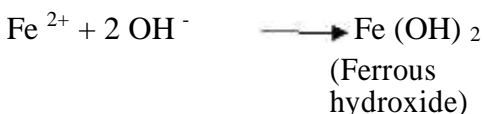
- <u>If the solution is aerated and almost neutral,</u>
  - $O_2 + H_2O + 2e^- \longrightarrow 2OH^-$
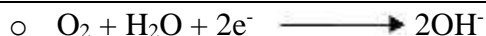
- <u>If the solution is deaerated and almost neutral:</u>

  $$2H_2O + 2e^- \longrightarrow H_2 + 2OH^-$$

- <u>If the solution is deaerated and acidic:</u>
  $$2H^+ + 2e^- \longrightarrow H_2 \uparrow$$

(iv) Corrosion of iron produced Fe^{2+} ions and OH^- ions at the anode and cathode sites respectively. These ions diffuse towards each other and produce insoluble $Fe(OH)_2$.

$$Fe^{2+} + 2OH^- \longrightarrow Fe(OH)_2$$
(Ferrous
hydroxide)

(v) In an oxidizing environment, it is oxidized to ferric oxide and the rust is hydrated ferric oxide.

$$2Fe(OH)_2 + 1/2O_2 + (n-2)H_2O \longrightarrow [Fe_2O_3.nH_2O] \text{ [Rust]}$$

Q1 (b). What is potable water? Explain the determination of hardness of water by EDTA complexometric method.

Answer: Potable water, also known as drinking water, comes from surface and ground sources and is treated to levels that that meet state and federal standards for consumption.

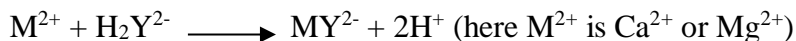Hardness of water is determined by EDTA method, which involves complexometric titration

Principle

EDTA (Ethylene diamminetetra acetic acid) is a hexadentate ligand and forms complexes with Ca^{2+} & Mg^{2+} ions. EDTA commonly represented as H_4Y. It has structure,
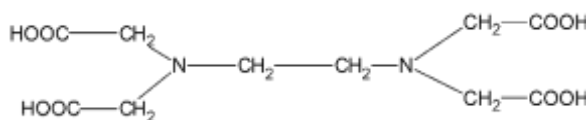
The ionization of EDTA in solution is represented as

$$H_4Y \longrightarrow H_2Y^{2-} + 2H^+$$

The anion forms complexes with metal ions, M^{2+}

$$M^{2+} + H_2Y^{2-} \longrightarrow MY^{2-} + 2H^+ \text{ (here } M^{2+} \text{ is } Ca^{2+} \text{ or } Mg^{2+})$$

The total hardness of water is determined by titrating a known volume of water against standard EDTA solution at pH 10 using Eriochrome black – T (EBT) indicator. The colour of indicator at pH 10 is blue

EBT forms a wine-red complex with M^{2+} ion. On adding EDTA, it forms a complex with free metal ions. At the end point when all the free metal ions are exhausted in the solution, added EDTA dissociates wine red coloured metal – EBT complex, consumes the metal ion and releases blue coloured free indicator. Therefore the colour changes from wine red to blue.

Procedure:

(i) Total hardness

Pipette out 50ml of the sample of water into a clean titration flask, add 1ml of NH_3-NH_4Cl buffer solution and 3-4 drops of EBT indicator. Titrate against 0.01M EDTA till the color changes from wine-red to clear blue. Let the volume of EDTA required be v_1 ml.

(ii) Permanent hardness

Transfer 50ml of the sample of water into a clean 500ml beaker and boil gently for 20-30 minutes. Cool and filter it directly into a 250ml conical flask. Add 1ml of buffer solution followed by 3-4 drops of EBT indicator. Titrate against standard 0.01M EDTA. Let the volume of EDTA required be $v_2$ml.

Calculations:

Total hardness

1000 ml of 1M EDTA = 100g $CaCO_3$ (Molecular mass of $CaCO_3$ = 100g)

$$1\text{ml of 1M EDTA} = \frac{100}{1000} \text{ g of } CaCO_3$$

$$V_1 \text{ ml of 0.01M EDTA} = \frac{v_1 \times 0.01 \times 100}{1000} \text{ g of } CaCO_3$$

$$50 \text{ ml of water sample} = \frac{v_1 \times 0.01 \times 100}{1000} \text{ g of } CaCO_3$$

$$10^6 \text{ (1 million parts) ml of water sample contains} = \frac{v_1 \times 0.01 \times 100 \times 10^6}{1000 \times 50} \text{ g of } CaCO_3$$

$$= 20 \times v_1 \text{ ppm } CaCO_3 \text{ equivalent}$$

Q2 (a). Explain the role of following factors on the rate of corrosion. (i) Ratio of anodic and cathodic areas (ii) nature of corrosion product

Answer: **The ratio of anodic and cathodic areas :** The rate of corrosion largely depends on the relative size of anode and a cathode.
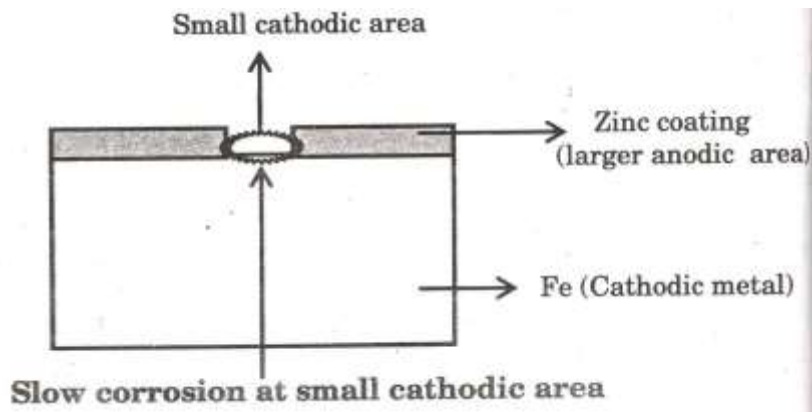
(a) If the metal has a **small anodic and large cathodic area** (i.e; the ratio of anode to cathode is small) then the corrosion is **more intensive and faster in rate.** This is explained as follows

At anode oxidation takes place and electrons areas liberated. At the cathode these electrons consumed when the anode is smaller and cathode region is large, the electrons liberated at the anode, are rapidly consumed, at the cathode region. This process makes the anodic reaction to take place faster, thus increasing the corrosion rate.

Ex: A broken coating of tin on iron surface, tin is cathodic to iron and the small exposed part of iron acts as anodic region and rest of the large tin coated surface acts as cathodic region. Because of small ratio of anodic to cathodic area, the corrosion rate is very high

Rapid corrosion at small anodic area
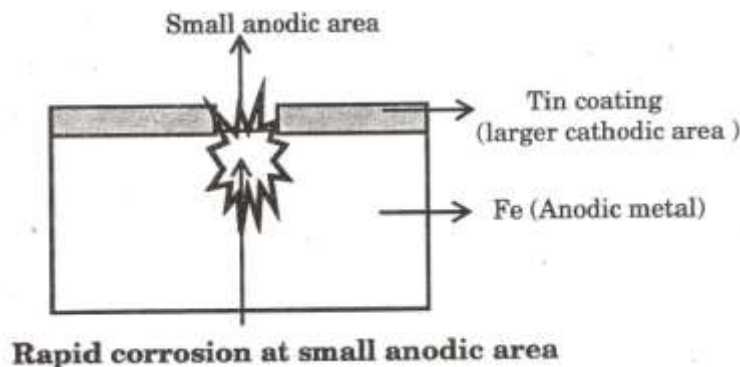
(b) If the **cathode is smaller and anode is larger**, the rate of corrosion will be **less**, because the consumption of electrons will be slower and the corrosion reaction as a whole will be slower.

Small cathodic area

Zinc coating (larger anodic area)

Fe (Cathodic metal)

Slow corrosion at small cathodic area

Eg. The broken coating of Zn over Fe, Zn plating on Fe gives an anodic coating to iron (Zn is above Fe in electrochemical series). Thus even if Zn plating peels off at some point, Fe does not get corroded.

(ii) Nature of the corrosion product

The nature of the corrosion product largely decides the rate of further corrosion. The corrosion product formed on the surface of the metal may or may not act as a protective layer.

(a) **If product is stoichiometric, highly insoluble and non porous** with low ionic and electrical conductivity the rate of corrosion will be **less** because, the product layer acts as protective film and prevent further corrosion. For eg. Al, Ti and Cr develops such a layer on their surface and become passive to further corrosion. Stainless steel (18% Cr, 8% Ni) builds up a thin but a highly protective film of Cr_2O_3 which resist attack in a highly corrosive environment. Metals such as Zr and Mo not only form such protective layer but are also capable of self repairing the oxide films when it is damaged. Hence these metals are extremely resistant to corrosion.

(b) **If the product is non stoichiometric, highly porous, soluble, unstable** the rate of corrosion will be **more** because it can not control further corrosion. In such cases the fresh metal surface is continuously exposed to corrosion environment and corrosion takes place continuously. Eg. Fe and Zn

Q(2b) A thick steel sheet of area 350 cm^2 is exposed to air near the ocean. After a one year period it was found to experience a weight loss of 485 g due to corrosion. If the density of the steel is 7.9g/cm^3, calculate the corrosion penetrating rate in mpy and mm/y (given K= 534 in mpy and 87.6 in mm/y).

Answer:

Corrosion penetrating rate in mpy	Corrosion penetrating rate mm/y
CPR = KW/DAT	CPR = KW/DAT
Weight loss, W= 485000 mg	Weight loss, W= 485000 mg
Density, D = 7.9g/cm^3; Time, T = 1×24×365	Density, D = 7.9g/cm^3; Time, T = 1×24×365
Area A = 350/6.45 in^2	Area A = 350 cm^2
CPR = $\dfrac{534 \times 485000}{7.9 \times (350/6.45) \times 1 \times 24 \times 365}$	CPR = $\dfrac{87.6 \times 485000}{7.9 \times (350) \times 1 \times 24 \times 365}$
CPR = 68.97 mpy	**CPR = 1.754 mm/y**

Q3 (a) What is meant by metal finishing? Mention (any five) technological importance of metal finishing.

Answer: **Definition:** Process of surface modification by way of deposition of another metal or metal alloy or polymer or ceramic or oxide layer to bring about intended better surface characteristics is known as metal finishing.

Technological Importance: Technological significance of metal finishing refers to imparting following different characteristics:

(i) Better corrosion resistance,
(ii) Better hardness, strength, wear / abrasion resistance, etc.
(iii) Better thermal conductance or resistance or reflectance, etc.
(iv) Better optical reflectance,
(v) Better electrical conductance or insulation, etc.
(vi) Building up material or restoration

Q3 (b) What is cathodic protection? Explain sacrificial anode and impressed voltage methods of corossion control.

Answer: **CATHODIC PROTECTION:**

Cathodic protection is a method of protecting a metal or alloy from corrosion by converting it completely into cathodic and no part of it is allowed to act as anode.

There are two methods of cathodic protection.

(i) Sacrificial anodic method.

(ii) Impressed current method.

(i) Sacrificial anodic method:

In this method, the base metal structure is converted into a cathode by connected it to a more active [higher up in galvanic series or less noble] metal. This active metal actually acts as an auxiliary anode. Mostly Zn, Mg, Al are the common auxiliary anodes used in this method. These metals being more active, acts as anode and undergo destruction and protect the metal structure.

Since the anode material sacrifice to protect the metal structure, the method is known as sacrificial anode method. After continuous use exhausted sacrificial anodes are replaced by new ones as and when required.

Ex: 1. A Mg block connected to buried oil storage tank.

2. Mg base areas fixed to the side of ocean going ships.

3. Mg blocks area connected to the buried pipe lines.

Advantages:
(i)The method is simple. (ii) Low installation cost. (iii) Minimum maintenance cost. (iv) Doesn't require power supply.

Disadvantage:
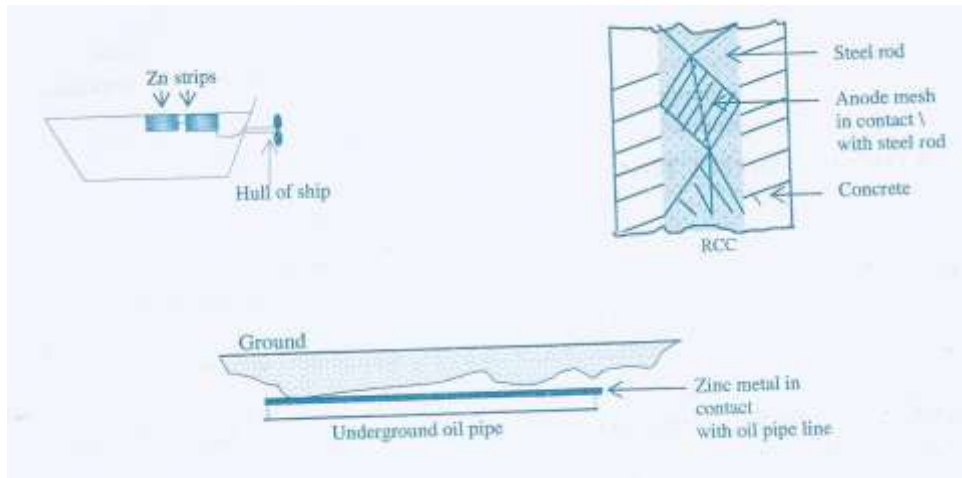(i) Involves recurring expenditure for replacement of consumed anodes.

Fig: Cathodic Protection by sacrificial anode

(II) IMPRESSED VOLTAGE METHOD:

In this method, by applying a direct current larger than the corrosion current, the base metal is made cathodic by connecting it to the cathode of the external source of current and the anode of the source is connected to an inert electrode (lead or graphite). The cathode is the str to be protected and anode is resin bonded graphite rod, high silicon-iron alloy or platinisedTi connected to the positive terminal.

The metal structure being cathode, doesn't undergo corrosion. Anode being inert, remains unaffected [electrons for protection are supplied by a source of direct current].
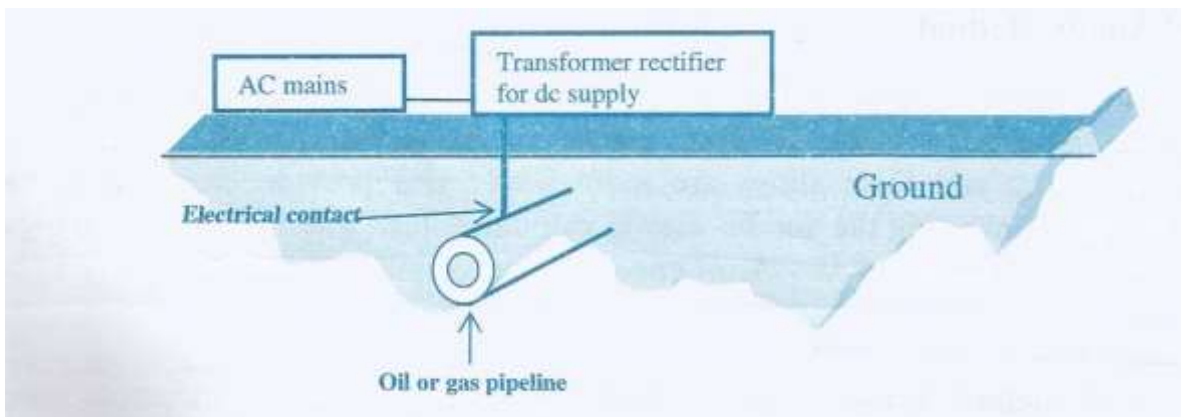

Fig: Protection using an impressed voltage

Advantages:

(i) One installation can protect larger area of metal.

(ii) Low maintenance cost.

Disadvantages:

(i) It is very expensive, because it needs continues current.

(ii) If the impressed current is not uniform on the entire surface of the protected structure, localized corrosion takes place on the protected metal.
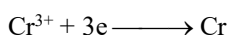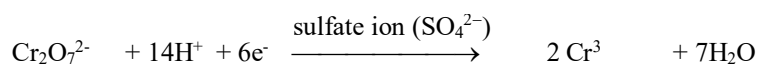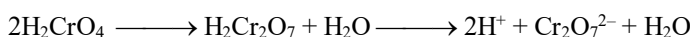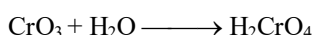
Q4 (a) What is electroplating? Explain the electroplating of chromium in detail.
Answer: The process of deposition of a thin and uniform layer of metal or metal-alloy on to the electrically conducting object surface by electrolysis is known as electroplating.

Chromium is employed for either decorative purposes (as a thinner coat) or engineering purposes (as a thicker hard coat). Mentioned below are coating specifications.
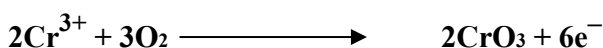
Chromium	Decorative Chromium	Hard Chromium
Bath composition	CrO_3: H_2SO_4 = 100: 1 ratio	CrO_3: H_2SO_4 = 100: 1 ratio
Temperature	45-55 °C	45 -66 °C
pH	2-4	2-4
Current density	100 – 200 mA/cm^2	215 – 430 mA/cm^2
Anode	Insoluble lead- Pb-Sb alloy or Pb-Sn alloy (with lead oxide coating)	Insoluble lead- Pb-Sb alloy or Pb-Sn alloy (with lead oxide coating)
Cathode	Surface cleaned object metal to be plated	Surface cleaned object metal to be plated
Application	Provide durable and good decorative finish on automobiles, surgical instrument etc.	Extensively used in industrial and engineering applications.

☐ There is a complex sequence of reactions which control the concentration of Cr^{3+} in the plating bath. The plating bath contains CrO3 in which Cr is in +6 oxidation state. This is reduced to Cr^{3+} by a series of complex reactions in the presence of $SO4^{--}$ furnished by H2SO4. Cr^{3+} ions are reduced to elemental Cr which gets deposit on the substrate.

$$CrO_3 + H_2O \longrightarrow H_2CrO_4$$

$$2H_2CrO_4 \longrightarrow H_2Cr_2O_7 + H_2O \longrightarrow 2H^+ + Cr_2O_7^{2-} + H_2O$$

$$Cr_2O_7^{2-} + 14H^+ + 6e^- \xrightarrow{\text{sulfate ion } (SO_4^{2-})} 2\ Cr^3 + 7H_2O$$

$$Cr^{3+} + 3e \longrightarrow Cr$$

The amount of Cr^{3+} ions should be restricted in order to obtain good deposits.
Insoluble anodes covered with PbO2 which oxidizes Cr^{3+} to Cr^{6+} and thus control the Cr^{3+} ion concentration.

$$2Cr^{3+} + 3O_2 \longrightarrow 2CrO_3 + 6e^-$$

Applications :

☐ Decorative chromium provides a durable finish on cycles, automobiles, furniture, household fittings, aircraft, surgical and dental instruments.

☐ Hard chromium is mostly used in industries in the making of gauzes, dies, cutting tools, piston rings, cylinder liners, crankshafts of marine and aero engines, bearings, hydraulic rams and in printing industry.

Q4 (b) Write the principles and requirement of titrimetric analysis.

Answer: Principles of titrimetric analysis

1. The solution to be analyzed contains an unknown amount of chemicals.

2. The reagent of unknown concentration reacts with a chemical of an unknown amount in the presence of an indicator (mostly phenolphthalein) to show the end-point. It's the point indicating the completion of the reaction.

3. The volumes are measured by titration which completes the reaction between the solution and reagent.

4. The volume and concentration of reagent which are used in the titration show the amount of reagent and solution.

5. The amount of unknown chemical in the specific volume of solution is determined by the mole fraction of the equation.

When the endpoint of the reaction is reached, the volume of reactant consumed is measured and applied to carry volumetric analysis calculations of the analyte by the following formula,

$Ca = Ct \times (Vt \times M / Va)$

Where,

Ca is the analyte concentration, typically in molarity.

Ct is the titrant concentration, typically in molarity.

Vt is the volume of the titrant which is used, typically in liters.

M is the mole ratio of the analyte and reactant from the balanced equation.

Va is the volume of the analyte, typically in liters.

Many non-acid-base titrations are needed a constant pH throughout the reaction. Therefore, a buffer solution can be added to the titration chamber to maintain the pH value.
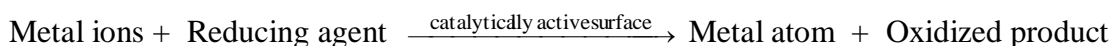
Requirement of titrimetric analysis

1. Reaction between reagent and analyte must be specific. Titrant cannot react with impurities or additions of analyte solution.

2. Reaction must be stoichiometric.

3. Titrant must react rapidly with the analyte so that the time required between additions of reagent is minimised.

4. Titrant must react more or less completely with the analyte so that satisfactory end points are realised.

5. Undergo a selective reaction with the analyte that can be described by simple balanced equation. Equilibrium constant must have high value.

Q5 (a) What is electroless plating? Describe electroless plating of copper with suitable reactions.

Answer: ***Electroless-plating:***

Deposition of metal or alloy over a conducting or non-conducting substrate surface by **chemical reduction of the metal ions by use of reducing reagent** and without the use of electrical energy is called electroless-plating.
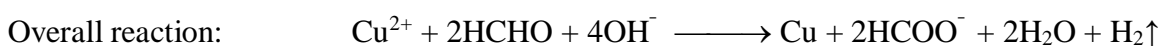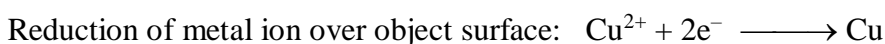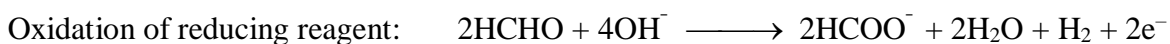
Electroless-plating is generally autocatalytic in nature. Schematically, it can be represented as,

$$\text{Metal ions} + \text{Reducing agent} \xrightarrow{\text{catalytically active surface}} \text{Metal atom} + \text{Oxidized product}$$

Electroless-plating of Copper:

Substrate surface needs to be cleaned by suitable cleansing methods (solvent degreasing, acid pickling, alkali pickling, mechanical polishing, etc.). However, when the object is non-conducting or insulator material such as, plastics, PCBs, glass, etc. it needs to be activated by treatment with acidified $SnCl_2$ and then with acidified $PdCl_2$. Following bath compositions are used for plating.

Reactions:

Oxidation of reducing reagent: $\quad 2HCHO + 4OH^- \longrightarrow 2HCOO^- + 2H_2O + H_2 + 2e^-$

Reduction of metal ion over object surface: $\quad Cu^{2+} + 2e^- \longrightarrow Cu$

Overall reaction: $\quad Cu^{2+} + 2HCHO + 4OH^- \longrightarrow Cu + 2HCOO^- + 2H_2O + H_2\uparrow$

Constituents	Amount	Purpose
$CuSO_4$	12 g/L	Provides metal ions
H-CHO	8 g/L	Reducing reagent
Rochelle salt	14 g/L	Complexing agent
NaOH	15 g/L	Provides alkaline medium
EDTA	20 g/L	Exaltant & complexing agent
pH	11.0	
Temperature	25°C	

Applications:

1. Metalizing PCBs. 2. Producing through-hole connections. 3. For plating on non-conductors.

4. As a base before electroplating.

Q5 (b) Define COD and BOD. In a COD test, 28.3 cm3 and 12.5 cm3 of 0.05 N FAS solutions were consumed for blank & sample titration respectively. The volume of test sample used was 20 cm^3. Calculate the COD of the sample solution.
Answer:
Definition of Biological Oxygen Demand (BOD): Biological oxygen demand, BOD is defined as the amount of oxygen required by microorganisms to oxidize the organic wastes present in one liter of waste water at 20°C over a period of 5 days. It is expressed in mg dm^{-3}.

Chemical Oxygen Demand (COD): COD is defined as the amount of oxygen consumed in the complete chemical oxidation of organic and inorganic wastes present in 1 litre of waste water by using strong oxidizing agent, such as acidified $K_2Cr_2O_7$. It is represented in mg dm^{-3} or ppm

$$\text{COD of sample} = \frac{N_{FAS} \times (b-a) \times 8}{V_s} \text{ g.dm}^{-3}$$

$$= \frac{N_{FAS} \times (b-a) \times 8000}{V_s} \text{ mg.dm}^{-3}$$

$$COD = \frac{0.05 \times (28.3-12.5) \times 8000}{20} = \textbf{316 mg of O}_2\textbf{/litre}$$

Q6 (a) Explain the synthesis of nanomaterial by sol gel process. Mention its advantages.

Answer: The sol-gel method of synthesizing nanomaterial is very popular amongst chemists and is widely employed to prepare oxide materials.

The sol-gel process can be characterized by a series of distinct steps.

Step 1: Formation of different stable solutions of the alkoxide or solvated metal precursor (**the sol**).

Step 2: Gelation resulting from the formation of an oxide- or alcohol- bridged network (thegel) by a polycondensation or polyesterification reaction that results in a dramatic increase in the viscosity of the solution.

MOR + H$_2$O → MOH + ROH (hydrolysis)

MOH+ROM→M-O-M+ROH (condn.)
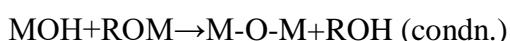
Step 3: Aging of the gel (Syneresis), during which the polycondensation reactions continue until the gel transforms into a solid mass, accompanied by contraction of the gel network and expulsion of solvent from gel pores. The aging process of gels can exceed 7 days and is critical to the

prevention of cracks in gels that have been cast.

Step 4: Drying of the gel, when water and other volatile liquids are removed from the gel network. This process is complicated due to fundamental changes in the structure of the gel. The drying process has itself been broken into four distinct steps: (i) the constant rate period, (ii) the critical point, (iii) the falling rate period, (iv) the second falling rate period. If isolated by thermal evaporation, the resulting monolith is termed a xerogel. If the solvent (such as water) is extracted under supercritical or near supercritical conditions, the product is an aerogel.

Step 5: Dehydration, during which surface- bound M-OH groups are removed, thereby stabilizing the gel against rehydration. This is normally achieved by calcining the monolith at temperatures up to 8000C.

Step 6: Densification and decomposition of the gels at high temperatures (T>8000C). The pores of the gel network are collapsed, and remaining organic species are volatilized. The typical steps that are involved in sol-gel processing are shown in the schematic diagram below.
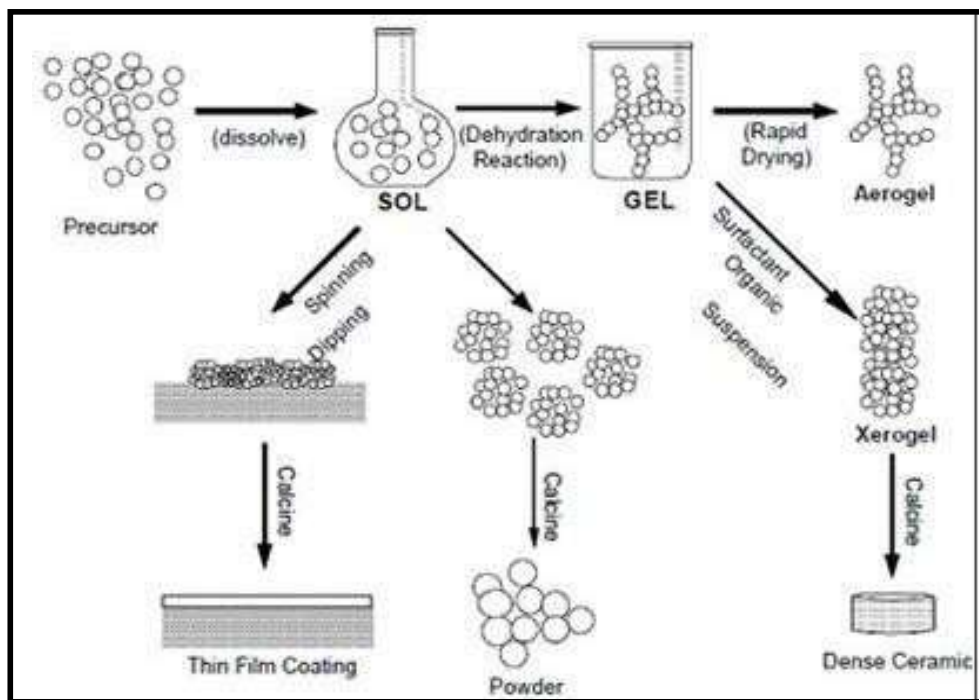
Advantages:
1. Nanomaterials of high purity with good homogeneity can be obtained.
2. Samples can be prepared at lower temperature.
3. Easy to control synthesis parameters to control physical characteristics like shape and size of resulting materials.
4. Simple and inexpensive equipment.
5. Size can be controlled.

6(b) Explain the theory, instrumentation and applications of flame photometry.
Answer: Theory, Instrumentation and applications of Flame Photometry
Theory–Flame photometry is an **atomic emission technique** used **for detection of metals**. Emission of characteristic radiation by an element, and the correlation of the emission intensity with concentration of the element form the basis of flame photometry.

When a solution containing sample is aspirated into the flame, following changes takes place: (i) Firstly, solvent gets evaporated leaving behind salt in the flame. (ii) Then, salt gets evaporated into salt vapours, which further undergo dissociation into its constituent atoms. (iii) These gaseous atoms formed absorb energy from the flame get excited to high energy levels from the ground state. (iv) Being unstable in the excited state, they return back to ground state by emitting characteristic radiation. (v) Intensity of emitted light is proportional to number of atoms in the excited state which in which in turn is proportional to the concentration of solution fed into the flame and is given as

$E = k \, \alpha \, c$
E = detector response
k = constant
α = efficiency of atomic excitation; c = concentration
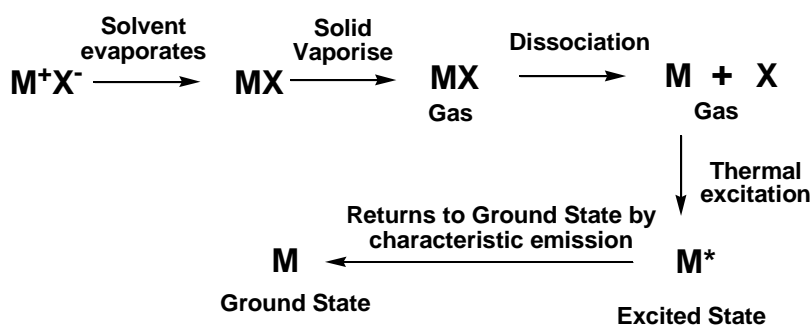
Instrumentation: A simple flame photometer consists of the following basic components:
(a) The burner: Source of flame (Flame serves both as an as an atomizer and excitation source)
(b) Nebuliser and mixing chamber (Nebuliser is used to send homogeneous solution into the flame at a balanced rate)
(c) Simple colour filters: Filters will isolate the wavelength to be measured from that of irrelevant emissions
(d) Photocell-detector: The emitted radiation is converted to an electrical signal with the help of photo detector.
The sample containing the analyte is aspirated into the flame. Radiation from resulting flame is collected by the lens and allowed to pass through an optical filter, which permits only the radiation characteristic of the element under investigation into the detector. The output from detector is read out on a display device.
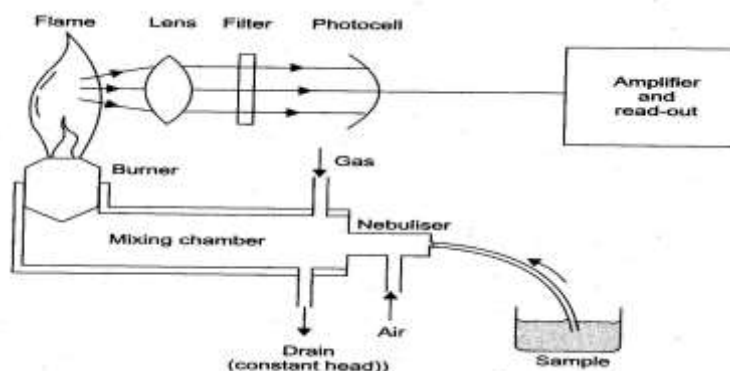
Application: 1) Flame photometer can be applied both for quantitative and qualitative analysis of elements.

2) The presence of various alkali and alkaline earth metals in soil sample can be determined.

3) Flame photometer can be applied for quantitative and qualitative analysis of various alkali and alkaline earth metals. A series of standard solution of analyte is prepared, passed into flame and emission of each solution is measured in flame photometer. Then calibration curve is obtained by plotting emission intensity against concentration of standard solutions. Sample solution is also properly diluted and then its emission is measured. From calibration curve, concentration of sample solution can be determined.
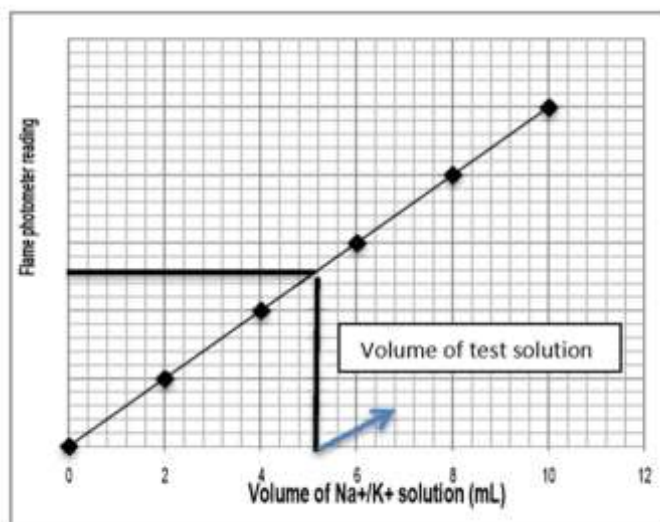
7 (a) What are nanomaterials? Explain the synthesis of nanomaterials by precipitation method.
Answer:
Precipitation Method.

In this method solid nanoparticles are obtained by careful precipitation from their solution. Precipitation method can be used to prepare nanoparticles of metal oxides, metal sulphides and metals.

a) In this method, an inorganic metal salt (such as nitrate, chloride or acetate of metal) is dissolved in water (precursor solution).

b) Metal cations exist in the form of metal hydrate species, for example, $[Al(H_2O)_6]^{3+}$ or $[Fe(H_2O)_6]^{3+}$.

c) These metal hydrates are hydrolyzed by addition of precipitating agent like NaOH or NH$_4$OH, which causes condensation of precursor.

d) The concentration of sol increases and reaches a critical level called supersaturation. At this concentration nucleus formation is initiated. The nucleus further grows into particles, which gets precipitated.

e) The precipitate obtained is filtrated, washed with water, air dried and finally calcined at high temperature to obtain nanoparticles.

Advantages

1. The process is relatively economical.

2. Wide range of single and multicomponent of oxide nanopowders can be synthesized.

3. Nanoparticles of desired Size can be obtained by controlling the rate of supersaturation and nucleation

7(b) Define the following units of standard solution.
i) Molarity ii) Normality iii) ppm

Answer: Molarity: It is one of the most widely used unit of concentration and is denoted by M. It is defined as no. of moles of solute present in 1 liter of solution. Thus,

Molarity = No of moles of solute / Volume of solution (in Liters)

Normality: It is described as the number of gram or mole equivalents of solute present in one litre of a solution.

Normality = No of gram equivalents of solute / Volume of solution (in Liters)

ppm: Parts per million (ppm) is a unit of measurement used when expressing a very dilute concentration level of pollutants in the air, water and other fluids. It also can be expressed as milligrams per liter (mg/L).