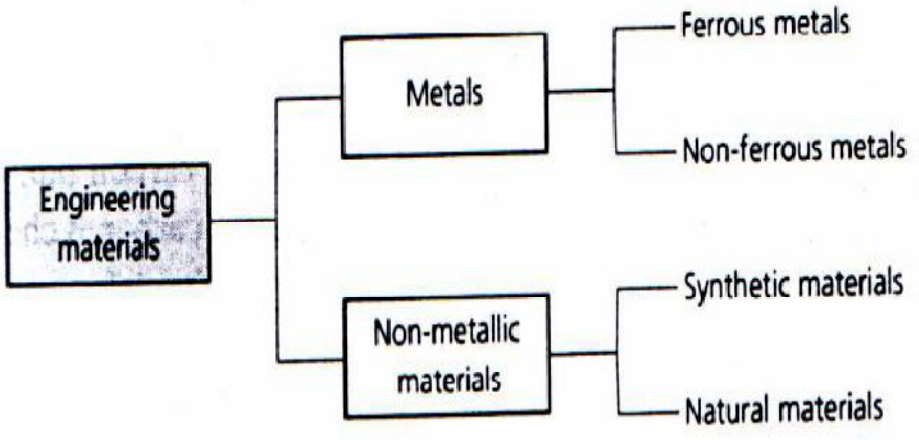
Important Instructions to examiners:

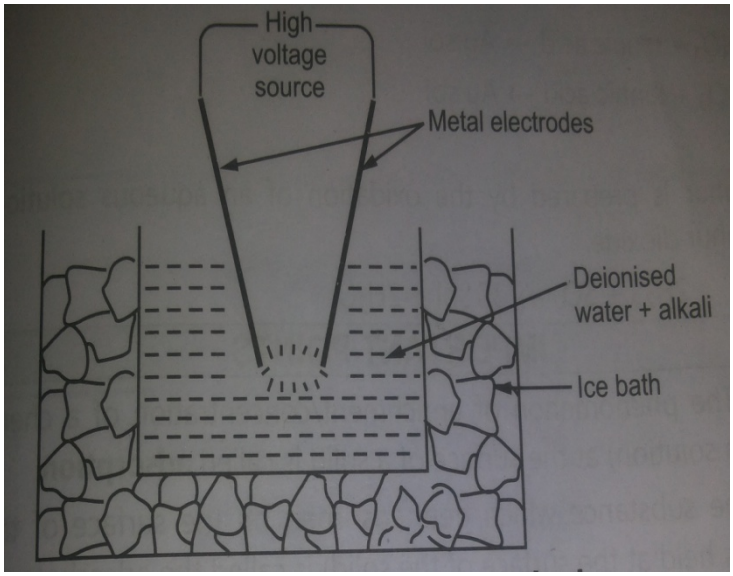
1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills).
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

Q No.	Answer	Marking scheme
1.a	Attempt any six	12
1a-i	**Isothermal process:** An isothermal process is a change of a system, in which the temperature remains constant: $\Delta T = 0$. This typically occurs when a system is in contact with an outside thermal reservoir (heat bath), and the change occurs slowly enough to allow the system to continually adjust to the temperature of the reservoir through heat exchange. **Isobaric process:** An isobaric process is a thermodynamic process in which the pressure stays constant: $\Delta P = 0$.	1 1
1a-ii	**Types of colloidal systems**: • Foam • solid foam • Aerosol • emulsion • solid emulsion(gel) • smoke • sol • solid sol	2
1a-iii	**Corrosion** is defined as the gradual deterioration or destruction of a metal by chemical or electrochemical reactions with its environment.	2

	Example: • Rusting of iron when exposed to atmospheric conditions. • Formation of green film of basic carbonate on the copper when exposed to moist air containing CO_2.	
1a-iv	**The phase rule** states that the number of degrees of freedom in a physical system at equilibrium is equal to the number of components in the system minus the number of phase plus the constant2.mathematically ,it is stated as follows: $F = C - P + 2$ C - number of components, P -number of phases F – number of degrees of freedom.	2
1a-v	**Statements of first law of thermodynamics** 1. Whenever a certain quantity of one kind energy disappears, an exactly equivalent amount of some other kind must appear. 2. It is not possible to construct a perpetual motion machine which can produce work without consuming energy. 3. The total energy of an isolated system always remains constant. 4. The sum of the energy in the universe is constants. 5. In an open system, there is always exchange of energy between the system and the surroundings but its sum is constant at all times.	2(any one statement)
1a-vi	**Classification of Engineering materials :**	2

		
1a-vii	**The types of corrosion are**: a) dry corrosion or chemical corrosion 1) corrosion by oxygen 2) Corrosion by other gases. b) wet corrosion or electrochemical corrosion.	2
1.b	Attempt any two	8
1b-i	**Methods for preparation of colloidal solution (any one method in detail)** A) Dispersion methods i) Mechanical dispersion ii) Electrical dispersion iii) Peptization Electrical dispersion (Bredig's arc method) This methods is used to prepare hydrosols of metals such as silver, gold & platinum. This method uses two electrodes that are made of the metal of which sol is to be prepared. These electrodes are immersed in deionized water containing a trace of alkali contained in a container. Water is cooled by immersing the container in an ice or water bath.	4

An arc is struck between the two electrodes held close together. The large amount of heat generated by the spark across the electrodes vaporizes some of the metal & the vapors condense immediately in water to yield colloidal solution. The small amount of alkali added to the water helps to stabilize the sol. This method is used for preparing silver & gold sols.



Peptization is the process responsible for the formation of stable dispersion of colloidal particles in dispersion medium. In other words it may be defined as a process of converting a precipitate into colloidal sol by shaking it with dispersion medium in the presence of small amount of electrolyte. The electrolyte used in this process is called as peptizing agent.

This is particularly important in colloid chemistry or for precipitation reactions in an aqueous solution. When colloidal particles bear a same sign electric charge, they mutually repel each other and cannot aggregate together. Freshly precipitated aluminum or iron hydroxide is extremely difficult to filter because the very fine

	colloidal particles directly pass through a paper filter. To facilitate the filtration, the colloidal suspension must be first flocculated by adding a concentrated solution of salt to the system. Multivalent cations are more efficient flocculants than monovalent cations: $AlCl_3$ > $CaCl_2$ > NaCl. The electrical charges present at the surface of the particles are so "*neutralised*" and disappear. More correctly speaking, the electrical double layer existing at the surface of the particles is compressed by the added electrolyte and collapses at high ionic strength. The electrical repulsion no longer hinders the aggregation of particles and they can then coalesce to form a flocculent precipitate that is easy to filter. If the precipitate is washed with an excessive volume of deionizer water, the electrical double layer present at the surface of the particles expands again and the electrical repulsion reappears: the precipitate peptizes and the particles pass again through the filter. Mechanical dispersion using colloidal mill The solid along with the liquid is fed into a colloidal mill. The colloidal mill consists of two steel plates nearly touching each other and rotating in opposite directions with high speed. The solid particles are ground down to colloidal size and then dispersed in the liquid. Colloidal graphite and printing inks are made by this method.	

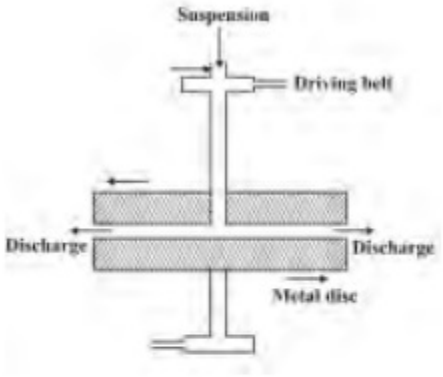


Fig. Colloid mill

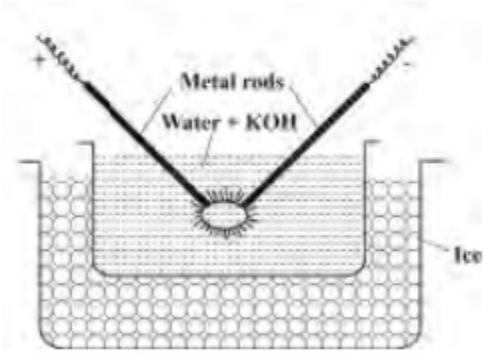


Fig. Electro-dispersion

1b-ii	1)**Intergranular corrosion** (IGC), also known as intergranular attack (IGA), is a form of corrosion where the boundaries of crystallites of the material are more susceptible to corrosion than their insides. (*Cf.* transgranular corrosion.) This situation can happen in otherwise corrosion-resistant alloys, when the grain boundaries are depleted, known as *grain boundary depletion*, of the corrosion-inhibiting elements such as chromium by some mechanism. In nickel alloys and	2

	austenitic stainless steels, where chromium is added for corrosion resistance, the mechanism involved is precipitation of chromium carbide at the grain boundaries, resulting in the formation of chromium-depleted zones adjacent to the grain boundaries (this process is called sensitization). Around 12% chromium is minimally required to ensure passivation, a mechanism by which an ultra thin invisible film, known as passive film, forms on the surface of stainless steels. This passive film protects the metal from corrosive environments. The self-healing property of the passive film make the steel stainless. Selective leaching often involves grain boundary depletion mechanisms. 2**) Erosion corrosion** is a degradation of material surface due to mechanical action, often by impinging liquid, abrasion by a slurry, particles suspended in fast flowing liquid or gas, bubbles or droplets, cavitations, etc. The mechanism can be described as follows: • mechanical erosion of the material, or protective (or passive) oxide layer on its surface, • enhanced corrosion of the material, if the corrosion rate of the material depends on the thickness of the oxide layer.	2

1b-iii	**Lining** :a layer of different material covering the inside surface of something. **Importance of Lining** In order to attain certain desired features, the base metal may be lined with another metal, rubber, glass & plastic. Lining mild steel pipe with a material able to withstand chemical attack permits its used to carry corrosive fluids. Lining give the underlying structure protection against chemical attack. It prevents contamination of metal. Due to lining effect of abrasion can be reduced. It also provides high mechanical strength to the metal. Importance of lining: a. to protect against corrosion b. to prevent the contamination of the materials being processed. c. minimize the effect of a abrasion. d. ease of cleaning. e. provide high mechanical strength.	1 3
2	Attempt any four	16
2-a	**Expression for Work done in Isothermal Expansion of IDEAL gas** Consider a gas enclosed in a cylinder fitted with a weightless & frictionless piston, undergoing a reversible expansion process. The cylinder is in thermal equilibrium with the surroundings so that the temperature of the gas remains constants while its expansion. The total work done by the gas in the expansion process as the piston moves from position 1to position 2 during which volume is changing from V_1 to V_2(and its pressure is reduced from P_1 to P_2) is given by $W = W_{1-2} = \int_1^2 PdV = \int_{v1}^{v2} PdV$	4

The work done in reversible isotherm expansion of a gas is given by

$$W = \int_{v1}^{v2} P\,dV \quad (1)$$

The ideal gas equation is

$PV = nRT$

$P = nRT/V$ (2)

Substituting for P from eq (2) eq (1 becomes)

$$W = \int_{V1}^{V2} (nRT/V)\,dV = nRT \int_{v1}^{v2} dV/V$$

Integrating gives

$W = nRT\ln V_2/V_1$ (3)

We have $P_1 V_1 = nRT_1$ and $P_2 V_2 = nRT_2$

But $T_1=T_2$---------- For Isothermal Process

$P_1V_1 = P_2 V_2$

$V_2/ V_1 = P_1/P_2$

With this, equation (3) becomes

$W = nRT\ln P_1/P_2$

$W = nRT\ln V_2/V_1 = nRT\ln P_1/P_2$

Since for an isothermal process , $\triangle U = 0$ and $\triangle T = 0$,

Hence $\triangle H = 0$

We have $\triangle U = Q - W$

For an Isothermal Process $\triangle U = 0$.Therefore, the first law becomes $0 = Q-W$

$Q = W$

	Thus, In an isothermal process ,Heat absorbed by a system gets completely converted into work or the work is done at the expense of heat absorbed and the temperature remains constant. Work done in isothermal reversible expansion of an ideal gas is given by $W = nRT\ln V_2/V_1 = nRT\ln P_1/P_2$	
2-b	**The galvanic series :** The galvanic series (or electropotential series) determines the nobility of metals and semi-metals. When two metals are submerged in an electrolyte, while electrically connected, the less noble (base) will experience galvanic corrosion. The rate of corrosion is determined by the electrolyte and the difference in nobility. The difference can be measured as a difference in voltage potential. Galvanic reaction is the principle upon which batteries are based. GALVANIC SERIES of Dissimilar Metals. Largest, corrosive part, positive. 1. Magnesium 2. Ninc 3. Cadmlum 4. Aluminum 5. Steel 6. Iron 7. Stainless-Steel 8. Solder 9. Lead 10. Tin 11. Nickel	2 2

	12. Brass 13. Copper 14. Bronze 15. Silver Solder 16. Silver 17. Titanium 18. Graphite 19. Gold 20. Platinum Smallest, protected part, negative.	
2-c	**Derivation of phase rule** Lets assume that we have a heterogeneous system in equilibrium consisting of C components distributed in P phases . The composition of each phase containing C component is determined by specifying C -1 mole fraction since the some of mole fraction of components present in any phase is equal to 1.If we specify mole fractions of components ,say 2,3,4 …..,then mole fraction of component 1 is obtained as X_1 = 1-(X_1+X_2+X_3+….).Thus as regarding composition, each phase possess C-1 variables. Since there are P phases, it follows that the whole system possesses P(C-1) composition variables. State of the system will depend upon temperature and pressure, these 02 variables are also to be specified .Thus our system of C components and P phases possesses P(C-1) + 2 intensive variables. In order to define the state of system completely ,it is necessary to have as many equations as there are variables .Since the number of equations is equal to the number of variables ,the number of unknown variables that must be arbitrarily fixed or specified to define the system completely or the number of degree of	2 2

	freedom (F) or variance of the system will be F = Number of variables – Number of Equations $=\{P(C-1)+2\} - C(p-1)$ $= PC - P + 2 - PC + C$ $F = C-P+2$	
2-d	**The applications of adsorption are:** a. in production of high vacuum: b. in gas masks c. in heterogeneous catalysts d. in removing colouring matter from solutions e. in chromatography f. in dehumidification g. in water purification. a) In production of high vacuum: in order to remove traces of air from a partially evacuated container. it is connected to a small bulb filled with activated charcoal or silica gel and cooled with a liquid air. The activated charcoal adsorbs the traces of air resulting in the production of very high vacuum in the container. b) In gas masks: gas masks are personal protective devices containing activated charcoal. The activated charcoal removes poisonous, toxic gases from air by adsorption and thus purifies the air for breathing. c) In heterogeneous catalysis : solid catalyzed gas phase reactions proceed through the adsorption of gaseous reactants on the surface of a solid catalyst. d) In removing colouring matter from solutions: animal charcoal removes colours	1 marks each for any 4

	of solutions by adsorbing colour causing impurities. Animal charcoal is used as a decolouriser in the manufacture of cane sugar. e) In dehumidification: silica gel removes moisture present in the air by adsorption .hence, silica gel is used for dehumidification of air in the storage facility of delicate electronic instruments. f) In chromatographic analysis: with the help of chromatographic techniques, it is possible to separate and analyze mixture containing small quantities of organic substances. The component of a mixture has different adsorption tendencies. g) in water purification and softening of water: in water purification by using charcoal bed, the bed acts not only as filter but also as a good adsorbent, which adsorbs impurities which has an objectionable taste and odour.water treatment using ion exchange resins is also considered as an adsorption operation.	
2-e	**Ductility**: ductility is a solid material's ability to deform under tensile stress; this is often characterized by the material's ability to be stretched into a wire **Plasticity** : plasticity is the propensity of a material to undergo permanent deformation under load. **Hardness**: Hardness is a measure of how resistant solid matter is to various kinds of permanent shape change when a compressive force is applied. Some materials (e.g. metals) are harder than others (e.g. plastics). Macroscopic hardness is generally characterized by strong intermolecular bonds, but the behavior of solid materials under force is complex; therefore, there are different measurements of hardness: *scratch hardness*, *indentation hardness*, and *rebound hardness*. **Strength**: In materials science, the strength of a material is its ability to withstand an applied load without failure or plastic deformation. The field of strength of materials deals with forces and deformations that result from their	1 1 1 1

	acting on a material. A load applied to a mechanical member will induce internal forces within the member called stresses.	
2-f	**Mechanism of dry corrosion :** Types of dry corrosion: (i) corrosion by oxygen (ii) corrosion due to other gases (i) corrosion by oxygen: corrosion by oxygen is the the corrosion of a metal due to chemical attack of oxygen in dry environment at low or high temp. .it results in the formation of metal oxide layer on the metal surface according to the following reaction : $2M + n\ O2 \rightarrow 2MOn$ Initially a thin layer of oxide film is formed and it gradually grows with time. The nature of metal oxide film/layer formed decides the prevention or continuation of corrosion. The oxide film produced based on its nature can be classified as: (i)stable oxide film : it acts as a barrier between metal and oxygen and thus prevents further corrosion. it may be porous or non-porous in nature (ii) unstable oxide film : when the oxide film is umstable , it decomposes back to the metal and oxygen. Hence oxidation corrosion is not possible in case of nobel metals such as Ag , Au as they are protected by this manner. (ii)volatile oxide film : when oxide film formed is volatile, it volatalises as soon as it is formed and metal surface is exposed to further corrosion. Hence it leads to continuous and excessive corrosion. OR Corrosion by other gases	4

3	Attempt any four	16
3-a	**Langmuir Adsorption Equation** Langmuir proposed that dynamic equilibrium exists between adsorbed gaseous molecules and the free gaseous molecules. Using the equilibrium equation, equilibrium constant can be calculated. $A(g) + B(S) \underset{K_d}{\overset{K_a}{\rightleftharpoons}} AB$ Where K_a represents equilibrium constant for forward reaction and K_d represents equilibrium constant for backward direction. According to Kinetic theory, Rate of forward reaction = K_a [A] [B] Rate of backward reaction = K_d [AB] At equilibrium, Rate of forward reaction is equal to Rate of backward reaction $K_a [A] [B] = K_d [AB]$ Or, $\frac{K_a}{K_d} = \frac{[AB]}{[A][B]}$ $K = \frac{K_a}{K_d} = \frac{[AB]}{[A][B]}$ The above equation represents the equilibrium constant for distribution of adsorbate between the surface and the gas phase. ***Derivation*** Langmuir Equation which depicts a relationship between the number of active sites of the surface undergoing adsorption (i.e. extent of adsorption) and pressure. To derive Langmuir Equation and new parameter ' θ ' is introduced. Let θ the	1 1

number of sites of the surface which are covered with gaseous molecules. Therefore, the fraction of surface which are unoccupied by gaseous molecules will be $(1 - \theta)$.

Now, Rate of forward direction depends upon two factors: Number of sited available on the surface of adsorbent, $(1 - \theta)$ and Pressure, P. Therefore rate of forward reaction is directly proportional to both mentioned factors.

Rate of forward reaction $\propto P(1 - \theta)$

Rate of adsorption $\propto P(1 - \theta)$

Or, Rate of adsorption $= K_a P(1 - \theta)$

Similarly, Rate of backward reaction or Rate of Desorption depends upon number of sites occupied by the gaseous molecules on the surface of adsorbent.

Rate of desorption $\propto \theta$

Or, Rate of desorption $= K_d \theta$

At equilibrium, rate of adsorption is equal to rate of desorption.

$K_a P(1 - \theta) = K_d \theta$

We can solve the above equation to write it in terms of θ.

$K_aP - K_aP\theta = K_d\theta$

$K_aP = K_aP\theta + K_d\theta$

$K_aP = (K_d + K_aP)\theta$

$$\theta = \frac{K_aP}{K_d + K_aP}$$

Divide numerator and denominator on RHS by K_d, we get

1

	$\theta = \frac{\frac{K_a}{K_d} P}{\frac{K_d}{K_d} + \frac{K_a}{K_d} P}$ Now put $K = \frac{K_a}{K_d}$ in above equation we get $\theta = \frac{KP}{1+KP}$ Langmuir Adsorption Equation This is known as Langmuir Adsorption Equation.	1
3-b	**i)Rubber Lining:** Rubber Lining is an application method used to protect multiple types of systems by lining corrosion and abrasion-resistant rubber upon the surface or inside of pipes and tanks. Lining is done by hand by our experienced staff for a durable finished product, so having application accuracy by qualified liners and crews are a must. The equipments to be lined, working conditions and environment are different for each customer. Therefore, selecting the most suitable material is a crucial procedure that we provide to cater to their specification **Applicatiion:** Steeland non ferrous industry Organic chemical industry Fertilizer industry Pollution control equipment	1

ii)Glass Lining:

Glass resistance is excellent resistance to all acids .it is subjected to alkali attack. Glass is also damage by thermal shock. Methods foe glass lining are: 1

Wet spray process: The metal surface of a vessel on which glass lining is to be done is cleaned. A suspension called slip consisting of enamel powder and emulsifying agent I sprayed like a paint on metal surface, then the coat is drayed and then the vessel is transfer to a furnace and fired at temp that result in fusion of partials.

Hot dust method:

It is generally applicable to cast iron components' he process is similar to wet spray only after coating dry powder cover coat enamels is dusted.

Application:

Reactor

Acid storage tank

Pipeline

Column

iii)Lead Lining: 1

Lead lining is the process of applying lead to sheet metal, plastics or castings. Vulcan GMS uses a variety of contact cements and epoxies based on the application.

Lead can be saw cut, router cut or die cut to produce the lead blank needed for the application. We can use other processes like spinning or forming to generate the needed profiles.

Vulcan can apply the sheets or shapes with pressure if needed to ensure a solid bond or expansion. We can also use a variety of techniques to ensure that there are no joints (overlap joints, stop joints, lead burned joints or corner extrusions) which

	could cause radiation leaks. We also can lead line nearly any application for products such as X-Ray tube housing, X-Ray tunnels, X-Ray tanks and collimators, which are all typically used in the medical X-ray and security markets. **iv)Plastic Lining** Lined tanks are widely used in the finishing industry—especially for corrosives. The lining protects the tank from corrosion and the tank contents from contamination, and the substrate provides structural integrity. In electroplating, the lining also provides electrical insulation.	1
3-c	**Second Law of Thermodynamics Statement:** The Second Law of Thermodynamics states that the state of entropy of the entire universe, as an isolated system, will always increase over time The entropy change of the surroundings and the entropy change of the system itself. Given the entropy change of the universe is equivalent to the sums of the changes in entropy of the system and surroundings: $\Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr} = q_{sys}T + q_{surr}T$ In an isothermal reversible expansion, the heat q absorbed by the system from the surroundings is $q_{rev} = nRT \ln V_2 V_1$ Since the heat absorbed by the system is the amount lost by the surroundings, $q_{sys} = -q_{surr}$.Therefore, for a truly reversible process, the entropy change is $\Delta S_{univ} = nRT \ln V_2 V_1 T + -nRT \ln V_2 V_1 T = 0$ If the process is irreversible however, the entropy change is $\Delta S_{univ} = nRT \ln V_2 V_1 T > 0$ If we put the two equations for ΔS_{univ}together for both types of processes, we are	2 2

	left with the second law of thermodynamics, $\Delta S_{univ} = \Delta S_{sys} + \Delta S_{surr} \geq 0$ where ΔS_{univ} equals zero for a truly reversible process and is greater than zero for an irreversible process. In reality, however, truly reversible processes never happen (or will take an infinitely long time to happen), so it is safe to say all thermodynamic processes we encounter everyday are irreversible in the direction they occur. The second law of thermodynamics can also be stated that "all **spontaneous** processes produce an **increase** in the entropy of the universe".	
3-d	**Enthalpy** is a defined thermodynamic potential, designated by the letter "H", that consists of the internal energy of the system (U) plus the product of pressure (P) and volume (V) of the system $H = U + PV$ Since enthalpy, H, consists of internal energy, U, plus the product of pressure (P) and the volume (V) of the system, which are all functions of the state of the thermodynamic system, enthalpy is a state function. The enthalpy of a homogeneous system is defined as $H = U + pV$ where H is the enthalpy of the system U is the internal energy of the system p is the pressure of the system V is the volume of the system.	2 1

The enthalpy is an extensive property. This means that, for homogeneous systems, the enthalpy is proportional to the size of the system. It is convenient to introduce the specific enthalpy h =H/m where m is the mass of the system, or the molar enthalpy H_m = H/n, where n is the number of moles (h and H_m are intensive properties). For inhomogeneous systems the enthalpy is the sum of the enthalpies of the composing subsystems

$$H = \Sigma_k H_k$$

where the label k refers to the various subsystems. In case of continuously varying p, T, and/or composition the summation becomes an integral:

$$H = \int \rho h \mathrm{d}V,$$

whereρ is the density.

The enthalpy H(S,p) of homogeneous systems can be derived as a characteristic function of the entropy S and the pressure p as follows: we start from the first law of thermodynamics for closed systems for an infinitesimal process

$$\mathrm{d}U = \delta Q - \delta W.$$

1

Here, δQ is a small amount of heat added to the system and δW a small amount of work performed by the system. In a homogeneous system only reversible processes can take place so the second law of thermodynamics gives δQ = TdSwith T the absolute temperature of the system. Furthermore, if only pV work is done, δW = pdV. As a result

$$dU = TdS - pdV.$$

Adding d(pV) to both sides of this expression gives

$$dU + d(pV) = TdS - pdV + d(pV)$$

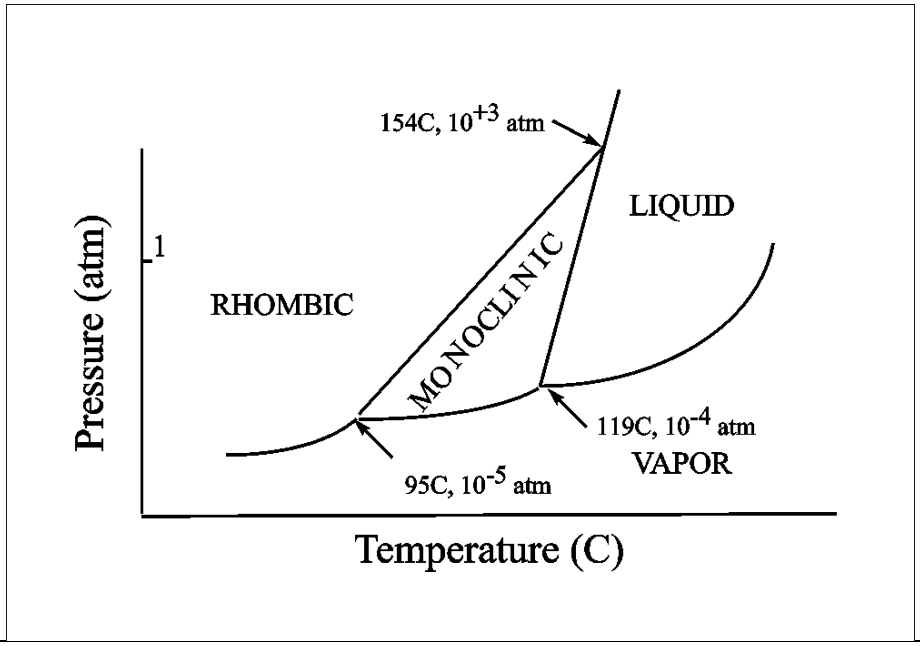
or

$$d(U + pV) = TdS + Vdp.$$

So

$$dH(S,p) = TdS + Vdp.$$

3-e **Phase Diagram for sulphur System:** 4



3-f **i)carbon Steel:** 1

Composition :

Element	Content
Carbon, C	0.25 - 0.290 %
Copper, Cu	0.20 %
Iron, Fe	98.0 %
Manganese, Mn	1.03 %

Uses:

Used for simple structural applications such as cold formed fasteners and bolts

1

ii)SS304:

Composition :

Element	Content
Carbon	0.03
Manganese	2.00
Silicone	1.00

Uses:

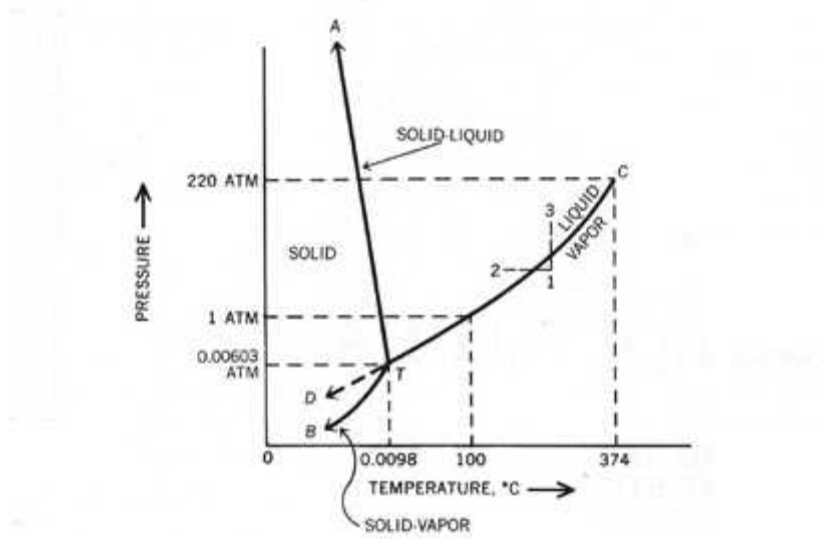
304 stainless steel is used for a variety of household and industrial applications such as screws,[4] machinery parts, car headers, and food-handling equipment. 304 stainless steel is also used in the architectural field for exterior accents such as water and fire features.

1

iii)Aluminium Alloy:

Composition :

	The typical alloying element are copper, magnesium, manganese, silicon, tin and zinc Uses: in making Aircraft **iv)Mild Steel:** Composition : Element — Content Carbon, C — 0.25 - 0.290 % Copper, Cu — 0.20 % Iron, Fe — 98.0 % Manganese, Mn — 1.03 % Uses:General purpose engineering material	1
4	**Attempt any four**	16
4-a	Phase diagram for water system:	4

		
4-b	**i) PVC:** 1) It is also used for bottles, other non-food packaging, and cards (such as bank or membership cards). 2) it is also used in plumbing, electrical cable insulation, imitation leather, signage, inflatable products, and many applications where it replaces rubber. **ii) Teflon:** 1) non stick coatings. 2) gaseous exchange membranes. 3) used as grafts in Bio medical application. used in manfacture of Stopcocks,glass fibres,transformers,plumbing thread tape,etc...used in manfacture of computer mice foot,solid fuel rocket propellents,cells used in spectrometer,containers,magnetic stirrers etc...it is also used for making non stick cookwares **Polypropylene:**	2 1 1

Its used for pumps,valves,fittings & pipes,also used for tanks,ID and FD fans, reaction vessels,filter press, scrubbers, filtercloth, crates, and trays.

4-c

Zeroth law of thermodynamics:

If two systems are in thermal equilibrium independently with a third system, they must be in thermal equilibrium with each other. This law helps define the notion of temperature.

4

4 d

1 mark each for any 4

S.No.	PROPERTY	LYOPHILIC COLLOIDS	LYOPHOBIC COLLOIDS
1.	**Mode of preparation.**	Forms easily by mere shaking or warming the dispersed phase with dispersion medium E.g. Gelatine in water.	Forms only by special methods. **Example:** AS_2S_3 in water.
2.	**Size of particle**	The particles are true molecules and are just bigger in size (Molecular colloids).	The particles are aggregates thousands of molecules (Associa colloids).
3.	**Nature**	Reversible and once precipitated can readily pass into colloidal state by direct contact with dispersion medium because particles are solvent loving.	Irreversible and once precipita can not easily pass into collo state because particles are solv hating.
4.	**Visibility**	The particles are not easily detected even under ultra microscope.	The particles are easily dete under ultra microscope.
5.	**Charge**	The charge of particles depends upon P_H of medium and it	The particles carry positive negative charge.

			may be positive, negative or neutral.		
	6.	**Stability**	These are stable and are self – stabilized.	These are unstable and hence require traces of electrolyte for stabilisation.	
	7.	**Action of electrolytes**	Co-agulation can be brought about by the addition of large amount of electrolyte.	Co-agulation can be brought about by small amount of electrolyte.	
	8.	**Viscosity**	It is much higher than that of dispersion medium.	It is about same as that of dispersion medium.	
	9.	**Surface**	It is lower than dispersion medium	It is about same as that of dispersion medium.	
	10.	**Tyndall effect**	Less distinct	More distinct.	
	11.	**Electrophoresis**	The particles may or may not show electrophoresis.	The particles show electrophoresis.	
	12.	**Hydration**	The particles are heavily hydrated due to love for solvent.	The particles are not appreciably hydrated due to hate for solvent.	
	13.	**Conc. Of dispersed phase**	Higher concentrations of dispersed phase are possible.	Only low concentrations of dispersed phase are possible.	
	14.	**Colligative property**	They have relatively high osmotic pressure, depression in freezing point and high lowering in vapour pressure.	They have high osmotic pressure, less depression in freezing point, less elevation in boiling point and less lowering of vapour pressure.	

4-e

i)Uniform Corrosion: 2

Uniform or general corrosion is the most classical form of corrosion, but is not always the most important in terms of cost or safety.

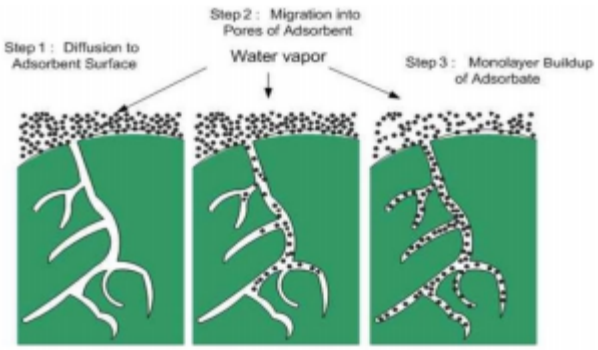
It is characterized by the existence of several individual electrochemical processes that occur uniformly over the whole of the surface considered.

The consequences of uniform corrosion are a decrease in metal thickness per unit

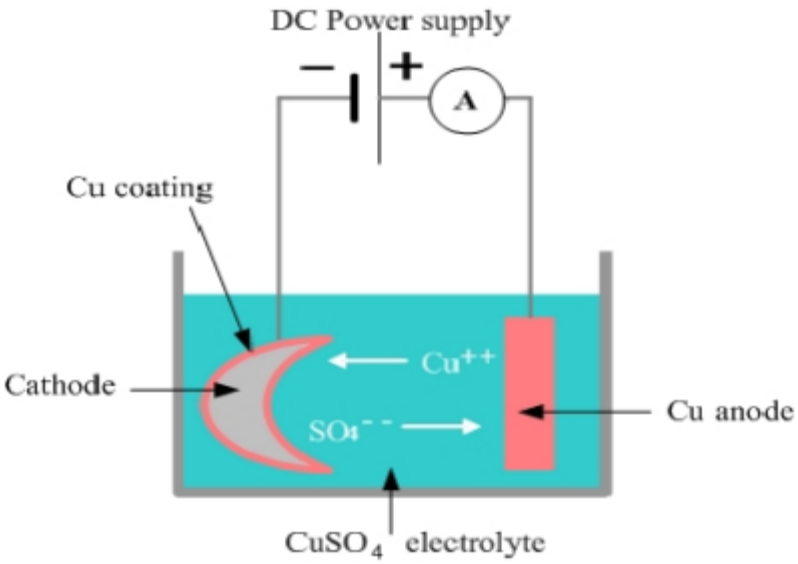
	time (or a weight loss per unit area per unit time) if the corrosion products are soluble, or a more or less uniform deposit of these products if they are insoluble. Uniform corrosion can be limited or prevented by an appropriate choice of material, including the use of metallic or organic coatings, modification of the medium (pH, temperature, concentrations of dissolved oxygen and electroactive impurities, addition of inhibitors, etc.), cathodic protection. **ii)Pitting Corrosion:** Pitting results when a small hole, or cavity, forms in the metal, usually as a result of de-passivation of a small area. This area becomes anodic, while part of the remaining metal becomes cathodic, producing a localized galvanic reaction. The deterioration of this small area penetrates the metal and can lead to failure. This form of corrosion isoften difficult to detect due to the fact that it is usually relatively small and may be covered and hidden by corrosion-produced compounds **iii)Selective Corrosion**: This process, also called "dealloying" or "selective leaching", involves the selective dissolution of one of the elements in a single phase alloy or one of the phases in a multiphase alloy The most well known example is the dezincification of brass (e.g. 70Cu - 30Zn). In this case, the brass takes on a red coppery tinge as the zinc is removed. It also becomes porous and very brittle, without modification to the overall dimensions of the part. This problem can be overcome by choosing an alloy that is less prone, such as a copper-rich cupro-nickel. Brasses with lower zinc contents or containing elements such as tin (1%) and/or small quantities of arsenic, antimony, or phosphorus have much greater resistance.	1 1

<table>
<tr><td></td><td>Numerous other alloys are susceptible to selective corrosion in certain conditions. For example, denickelization can occur in Cu-Ni alloys, and dealuminization in aluminium bronzes, while the graphitization phenomenon in grey cast irons is due to slow dissolution of the ferrite matrix.</td><td></td></tr>
<tr><td>4-f</td><td>i)Hydrocloric Acid: fiberglass-reinforced plastic (FRP) tank
ii)Sulphuric Acid: Store in a metallic or coated fiberboard drum using a strong polyethylene inner package
iii)Nitric Acid: Aluminium and its alloy
iv)Caustic Soda: Stainless steel</td><td>1
1
1
1</td></tr>
<tr><td>5</td><td>Answer any 4</td><td>16</td></tr>
<tr><td>5-a</td><td>Differentiate between physical and chemical adsorption
<table>
<tr><th>PHYSICAL ADSORPTION</th><th>CHEMISORPTIONS</th></tr>
<tr><td>The forces operating in these are weak vander Waal’s forces.</td><td>The forces operating in these cases are similar to those of a chemical bond.</td></tr>
<tr><td>The heat of adsorption are low i.e. about 20 – 40 kJ mol-1</td><td>The heat of adsorption are high i.e. about 40 400 kJ mol-1</td></tr>
<tr><td>No compound formation takes place in these cases.</td><td>Surface compounds are formed.</td></tr>
<tr><td>The process is reversible i.e. desorption of the gas occurs by increasing the temperature or decreasing the pressure.</td><td>The process is irreversible. Efforts to free the adsorbed gas give some definite compound.</td></tr>
<tr><td>It does not require any activation energy.</td><td>It requires any activation energy</td></tr>
<tr><td>This type of adsorption decreases with increase of temperature.</td><td>This type of adsorption first increases with increase of temperature. The effect is called activated adsorption.</td></tr>
<tr><td>It is not specific in nature i.e. all gases are adsorbed on all solids to some extent.</td><td>It is specific in nature and occurs only when there is some possibility of compound formation between the gas being adsorbed and the solid adsorbent.</td></tr>
<tr><td>The amount of the gas adsorbed is related to the ease of liquefaction of the</td><td>There is no such correlation exists.</td></tr>
</table></td><td>1 mark each for any 4</td></tr>
</table>

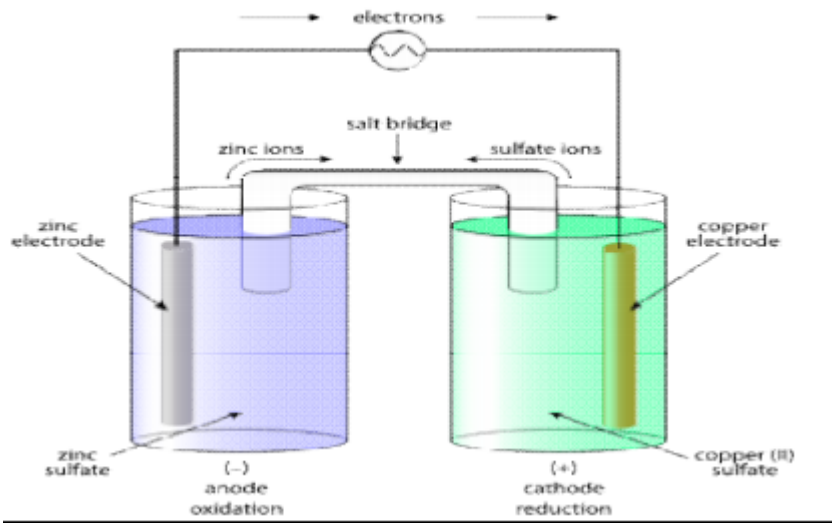
	gas.	
	It forms multimolecular layer.	It forms unimolecular layer.
5-b	**Explain corrosion prevention and control methods** The different methods to prevent corrosion: 1) Use of high purity metal. 2) Use of alloy addition. 1) **Use of high purity metal**: The impurities present in a metal cause heterogeneity and form tiny electrochemical cells with rest of the metal. due to this, metal surface undergoes corrosion at the region where the impurities are present .the corrosion resistance of any metal can be improved by increasing the purity of the metal. 2) **Use of alloy addition**: Corrosion resistance as well as strength of metals can be improved by alloying .ex. stainless steel containing chromium produce a coherent oxide film which protects the steel from further attack.	2 2
5-c	**Define system, surroundings, boundary. Differentiate open and closed system** **System**: The specified portion of the universe containing a definite quantity/amount of a specific substance or group of substances under thermodynamic study is called a system. **Surrounding:** The part of the universe other than the system which is separated from the system by a boundary is called the surroundings. Everything external to the system is called surroundings. **Boundary:** A boundary is a closed surface surrounding a system through which energy and mass may enter or leave the system. **Open system**: In which exchange of energy or matter takes place across the boundary with its surroundings **Closed system**: In which exchange of energy but not matter takes place across the boundary with its surroundings	1 1 1 1
5-d	**Give the four properties of polyethylene** 1. It is rigid, waxy, white translucent, cheap material.	1 mark each for

	2. Its softening point is 125-135°C. 3. Resistant to strong acids, alkalis and salts at room temperature. 4. It is good electrical insulator 5. Mechanical properties are poor above 50°C 6. Resistant to sunlight and weather	any 4
5-e	**Explain Homogeneous and Heterogeneous system** **Homogeneous systems**: a system consisting of a single phase is called a homogeneous system. eg: as one phase, for e.g (NaCl + H2O) though this are present Na+ and Cl- ions still it is a one phase system. Completely miscible liquids constitute a one phase system (H2O+C2H5OH). **Heterogeneous system:** a system consisting of more than one phase is called heterogeneous system. Ex:A mixture of diamond and graphite will constitute a two phase system as they have different crystal structure.	2 2
5-f	**Explain mechanism of adsorption** Adsorption: Adsorption is the adhesion of atoms, ions, or molecules from a gas, liquid, or dissolved solid to a surface. This process creates a film of the adsorbate on the surface of the adsorbent.  Mechanism of Adsorption: It is mainly divided into three steps as follows Step 1 : Molecule diffusion	4

	process into the thin layer of fluid(Called as fluid film) which is attached on the adsorbent. Step 2 : According to developing of diffusion, the surface diffusion process which attached the vapour or gas along the pores. It is called as mixed diffusion because there exist two diffusion of pore diffusion and surface diffusion. Step 3 : Adsorption process in the pore adsorption sites	
6	Answer any 4	
6-a	**Explain electroplating with neat sketch.** Electroplating: Electroplating is another method through which iron or steel can be protected and prevented from rusting and corroding. Here, the metal to be protected is coated by a thin layer of another metal having non-rusting properties by reducing it. Normally, the metals involved form the electrodes, which are processed inside an electrolyte by passing electric current (DC) across the electrodes, through the electrolyte. In this process the electrode which is connected to the negative of the supply gradually gets covered with the metal of the electrode connected to the positive of the electric supply which slowly disintegrates or reduces and becomes attached over the other electrode. The electrode connected to the negative is the one which is being electroplated for the required protection	2

		2
6-b	**Explain effect of pH value on corrosion** Acidic media (pH<7) are generally more corrosive than alkaline and neutral media. However amphoteric metals like Al, Zn, Pb can dissolve in alkaline solutions as complexions. Many materials are resistant to alkalis although they are readily attacked by acids. In such cases, their corrosively can be reduced by increasing the pH of the solution. The rate of corrosion of Fe metal is slow in oxygen free water until pH < 5 and Zn suffers minimum corrosion at pH=11. Thus the pH of media is a very important factor in considering the rate of corrosion.	4
6-c	**Explain equilibrium and non-equilibrium state.** **Equilibrium state:** In thermodynamics, equilibrium state or *state of equilibrium* is a conjunction term describing the state of a system that is in equilibrium, meaning that neither it nor its surroundings are evolving with time. The process of changing a system from one equilibrium state to another generally centers on the meaning or effect of the entropy change ΔS for the process.	2

	Non-Equilibrium state: A non-equilibrium state refers to the state of existence of a given system or body in which the variation of the thermodynamic potential quantifying the system is not equal to zero. A system or body in a non-equilibrium state means that unbalanced potentials (or driving forces) exist within the system	2
6-d	**What is caustic embrittlement?** Caustic Embrittlement: Caustic embrittlement is a phenomenon that occurs in boilers where caustic substances accumulate in boiler materials. It also can be described as the cracking of riveted mild steel boiler plates. This occurs at temperatures of 200°-250°C as a result of local deposition of concentrated hydroxide. Caustic embrittlement focuses on the stressed parts of the boiler, including cracks, bends, rivets and joints. Residual sodium carbonate, which is used for the softening process, undergoes hydrolysis, forming sodium hydroxide at high pressures and temperatures. Caustic embrittlement is also known as stress corrosion cracking. There are many causes of caustic embrittlement, including the combined action of the following three components: • A susceptible material • A given chemical species • Tensile stress Sodium hydroxide (caustic soda) prevents scaling when added to the boiler water. The presence of alkali in the crevices, found around the rivet heads and other hot spots, combined with fabrication stress around rivet holes, causes cracks in the steel boiler shells and tube plates. The alkaline water enters the minute holes and cracks by capillarity action on the interior of the boiler. The water then diffuses out of the cracks, leaving behind hydroxide salts that accumulate when more water evaporates. The hydroxide then attacks the surrounding material of the boiler and dissolves iron as sodium ferrite. This corrosion at high pH levels produces hydrogen, which attacks the crystal structure of iron, making it hard and brittle. This is highly dangerous because the tube can	4

	then fail at the boiler's normal operating temperature. Caustic embrittlement can be prevented through several methods, including: • Controlling the temperature and potential • Controlling the stress levels and hardness • Use of materials that do not crack when used in given environments • Avoiding alkali where necessary • Replacing sodium carbonates with sodium sulphates as softening reagents • Adding lignin, tannin or sodium sulphate that blocks hairline cracks as well as preventing infiltration of sodium hydroxide into the areas	
6-e	**Draw neat labeled sketch of galvanic cell.** 	4
6-f	**Define pressure, volume, work and give their expression.** **Pressure**: Pressure is an expression of force exerted on a surface per unit area P=F/A **Volume**: the amount of space that a substance or object occupies, or that is enclosed within a container at specified temperature and pressure.	4

	V=nRT/P **Work**: refers to an activity involving a force and movement in the direction of the force. W=F.S	