



SUMMER-16 EXAMINATION
Model Answer

Subject code : (17423)

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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.



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Q No.	Answer	marks	Total marks
1.a	Attempt any six		12
1a-i	Extensive property An extensive property is a property that changes when the size of the sample changes. Examples are mass, volume, length, and total charge Intensive property An intensive property doesn't change when you take away some of the sample. Examples are temperature, color, hardness, melting point, boiling point, pressure, molecular weight, and density. Because intensive properties are sometimes characteristic of a particular material, they can be helpful as clues in identifying unknown substances.	1 1	2
1a-ii	Oxidation Corrosion Oxidation corrosion is the corrosion of a metal due to chemical attack in a dry environment at low or high temperature. It results in the formation of metal oxide layer on the metal surface according to the following reaction: $2M + nO_2 \longrightarrow 2MO_n$ <p>(metal) (metal oxide)</p> Initially a thin layer of oxide film is formed & it gradually grows with time. The nature of metal oxide film/layer formed decides the prevention or continuation of corrosion.	2	2
1a-iii	Adsorbate -The substance that gets adsorbed is called the Adsorbate. It can be a gas or vapor or a solute in a solution. for e.g. ammonia, hydrogen b) Adsorbent -The substance on whose surface adsorption takes place is called the adsorbent. For e.g. charcoal	1 1	2



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1a-iv	Colloids: They are particles of the size ranges from 10 \AA^0 to 2000 \AA^0 Characteristics of colloids(any 2) 1. The size of particles ranges from 10 \AA^0 to 2000 \AA^0 2. Particles do not diffuse through parchment membrane. 3. Particles pass through filter paper. 4. Particles scatter light. 5. Particles are invisible even under a powerful microscope but a scattering effect can be observed under ultra microscope	1 Each carry $\frac{1}{2}$ marks)	2
1a-v	a) Phase: A phase is defined a part of system which is chemically and physically uniform through out. This is intensive property such as d, T, P (not depend upon quantity). ii)Component(C): It is defined as the minimum no. of chemical species necessary to described the composition of each and every phase of the system in equilibrium	1 1	2
1a-vi	Composition of duralumin: 4% Cu +small amount of Mg ,Mn+ balance Al	2	2
1a-vii	Passivity of metal: it is the resistance to corrosion by the metal due to the formation of a thin ,protective oxide film on the surface of the metal. This film will prevent the metal from further corrosion in the environment.	2	2
1.b	Attempt any two		8
1b-i	Pitting corrosion : it is highly localized corrosion of a metal which forms pits in the metal surface. It is confined to small areas and occurs at microscopic defects (impurities, rough spots and scratches) on the metal surface. The pits may not be easily visible as they	2	4



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	<p>get covered by corrosion product and they grow in the direction of gravity.</p> <p>Pitting corrosion results due to inhomogenities in metal, which creates potential difference with rest of the metal, breaking of a protective coating due to mechanical wear and high velocity of a flowing fluid. It occurs easily on a polished area than on the base metal surface.</p> <p>Galvanic corrosion :</p> <p>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.</p>	2	
1b-ii	<p>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).</p> <p>Heterogeneous system: a system consisting of more than one phase is called heterogeneous system.</p> <p>Ex:A mixture of diamond and graphite will constitute a two phase system as they have different crystal structure.</p>	2	4



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1b-iii	<p>Electrochemical(Wet corrosion):</p> <p>It is the corrosion of the metal that occurs in the presence of liquid medium/aqueous environment, through electrochemical reactions. one part behaves as anode and undergoes oxidation and the other part act as a cathode and undergoes reduction.</p> <p>Mechanism of wet corrosion: wet corrosion is a two step process. One is anodic or oxidation reaction and the other is cathodic or reduction process.</p> <p>anodic reaction involves dissolution of metal [$M \rightarrow M^{n+} + ne^-$] the anode are absorbed at the cathode.</p> <p>There are different cathodic reactions in which the electrons are consumed depending upon the nature (acidic / basic / neutral) of the corrosion environment.</p> <p>Hydrogen evolution type wet corrosion: it occurs in the acidic environment containing no oxygen or very less oxygen.</p>	4	4
2	Attempt any four		16
2-a	<p>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 constant 2. mathematically ,it is stated as follows:</p> $F = C - P + 2$ <p>C - number of components, P -number of phases F – number of degrees of freedom</p> <p>Derivation of phase rule</p> <p>Lets assume that we have a heterogeneous system in equilibrium consisting of C components distributed in P phases .</p> <p>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</p>	2	4



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	<p>mole fraction of component 1 is obtained as</p> $X_1 = 1 - (X_2 + X_3 + \dots)$ <p>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.</p> <p>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.</p> <p>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 freedom (F) or variance of the system will be</p> $F = \text{Number of variables} - \text{Number of Equations}$ $= [P(C-1) + 2] - C(p-1)$ $= PC - P + 2 - PC + C$ $\mathbf{F = C - P + 2}$		
2-b	<p>Rubber lining: here lining is generally in the form of sheets or thin films applied by using specific adhesive.</p> <p>Rubber is applied in the form of latex, highly vulcanized rubber or fully vulcanized soft or hard rubber. The surface to be lined is suitably prepared and treated and adhesives or bonding agents are applied to the cleaned surface, sheets are then applied and vulcanization is carried out using steam or hot air. The most effective and most commonly employed method of protecting corrodible surfaces with soft or hard rubber is to apply it over bonding cement prior to vulcanization.</p> <p>After being rubber lined, usually the equipment is allowed to remain as it is for a period of one or two days before being vulcanized. Any air trapped between rubber and metal will be diffused. Process of vulcanization changes rubber from plastic to</p>	4	4



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	an elastic state. Also improves resistance to abrasion ,tearing etc.		
2-c	Uses of SS-316: (any 4) <ol style="list-style-type: none">1. It is used for making furnace parts2. It is used for making Heat exchanger tubing and coil3. It is used for making reactors ,digesters, tank4. It is used for making Distillation column5. It is used for making pharmaceutical equipment's6. It is used for making pulp paper and textile processing equipment	1 mark each	4
2-d	Expression for Work done in Reversible Isothermal Expansion of 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 1 to 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	4	4



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$$W = W_{1-2} = \int_1^2 PdV = \int_{v_1}^{v_2} PdV$$

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

$$W = P \int_{v_1}^{v_2} PdV \quad (1)$$

The ideal gas equation is

$$PV = nRT$$

$$P = nRT/V \quad (2)$$

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

$$W = \int_{V_1}^{V_2} (nRT/V)dV = nRT \int_{v_1}^{v_2} dV/V$$

Integrating gives

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

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

But $T_1 = T_2$ For Isothermal Process

$$P_1 V_1 = P_2 V_2$$

$$V_2 / V_1 = P_1 / P_2$$

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 , $\Delta U = 0$ and $\Delta T = 0$,

Hence $\Delta H = 0$



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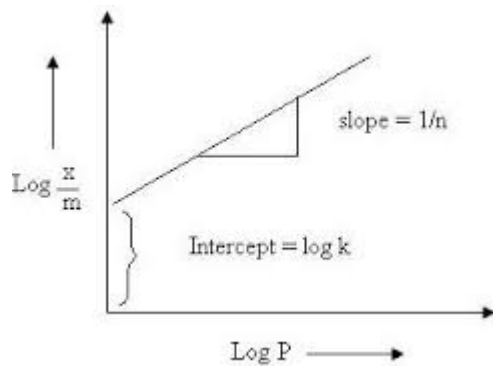
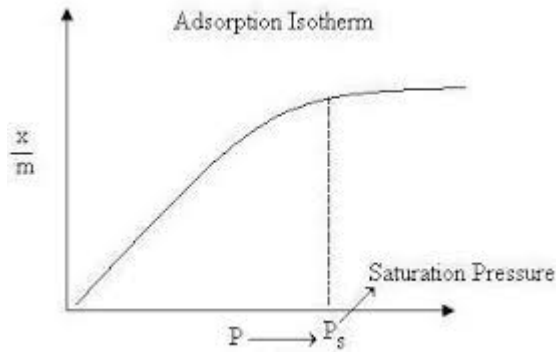
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	<p>We have $\Delta U = Q - W$ For an Isothermal Process $\Delta U = 0$. Therefore, the first law becomes $0 = Q - W$ $Q = W$</p> <p>Thus, In an isothermal process, Heat absorbed by a system gets completely converted into work or the work is done at the expense of heat absorbed and the temperature remains constant.</p> <p>Work done in isothermal reversible expansion of an ideal gas is given by</p> $W = nRT \ln V_2 / V_1 = nRT \ln P_1 / P_2$		
2-e	<p>Freundlich adsorption isotherm:</p> <p>A Freundlich adsorption isotherm for adsorption of gases is represented by the equation:</p> $x/m = kP^{(1/n)} \quad (1)$ <p>x = mass of the gas adsorbed at a pressure P m = mass of k and n are constant adsorbent</p> <p>equation (1) represented by graphically as shown in fig. If we plot (x/m) v/s P, get smooth curve as shown in fig.</p>	4	4



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Values of k and n determined by plotting $\log(x/m)$ v/s $\log P$

Taking log of both sides of equ. (1)

$$\text{Log}(x/m) = \log k + (1/n) \log P$$

$$\text{Log}(x/m) = (1/n) \log P + \log k \rightarrow y=mx + c$$

From compare both equ.

$$\text{Slope} = 1/n$$

$$\text{Intercept} = \log k$$

The plot of $\log(x/m)$ v/s $\log P$ is a straight line upto moderate P and is slightly curved at high P . the Freundlich adsorption isotherm holds good upto moderate P of gases.

Freundlich adsorption isotherm in case of adsorption of solute from a solution is given by

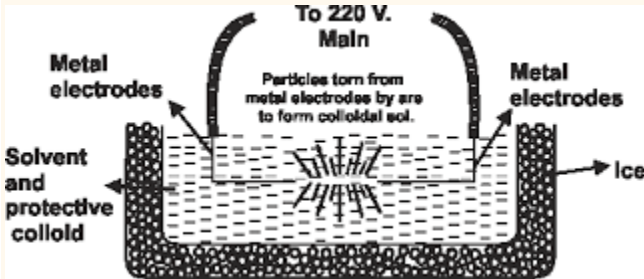


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	<p>equ. $x/m = k C^{(1/n)}$</p>		
2-f	<p>Galvanic cell :</p> <p>A galvanic cell consists of two half-cells, such that the electrode of one half-cell is composed of metal A, and the electrode of the other half-cell is composed of metal B; the redox reactions for the two separate half-cells. The solutions are connected by a salt bridge or a porous plate in order to conduct the ions (both the metal-A cations from one solution, and the anions from the other solution), which balances the charges of the solutions and thereby allows the reaction between metal A and metal B to continue without opposition. Copper readily oxidizes zinc; for the the anode is zinc and the cathode is copper, and the anions in the solutions are sulfates of the respective metals. When an electrically conducting device connects the electrodes, the electrochemical reaction is:. The zinc electrode is dissolved and copper is deposited on the copper electrode. Galvanic cells are typically used as a source of electrical power. By their nature, they produce direct current.</p>	4	4
3	Attempt any four		16
3-a		1 mark	4



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	Reversible Process	Irreversible Process	each	
	1. It takes place in infinite number of infinitesimally small steps and it would take finite time to occur.	1. It takes place infinite time.	for any 4	
	2. It is imaginary as it assumes the presence of frictionless and weight less piston.	2. It is real and can be performed actually.		
	3. It is in equilibrium state at all stage of the operation.	3. It is in equilibrium state only at the initial and final stage of the operation.		
	4. All changes are reversed when the process is carried out in reversible direction.	4. After this type of process has occurred all changes do not return to the initial stage by themselves.		
	5. It is extremely slow.	5. It proceeds at measureable speed.		
	6. Work done by a reversible process is greater than the corresponding irreversible process.	6. Work done by a irreversible process is smaller than the corresponding reversible process.		
3-b	Bredig's Arc Method: 		4	4



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	<p>This process involves dispersion as well as aggregation. Colloidal solutions of metals such as gold, silver, platinum etc. can be prepared by this method. In this method electric arc is struck between electrodes of metal immersed in the dispersion medium. The intense heat produced vapourises some of metal, which then condenses to form particles of colloidal size.</p>		
3-c	<p><i>Caustic Embrittlement</i></p> <p>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.</p> <p>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.</p> <p>Caustic embrittlement is also known as stress corrosion cracking.</p> <p>There are many causes of caustic embrittlement, including the combined action of the following three components:</p> <ul style="list-style-type: none">• A susceptible material• A given chemical species• Tensile stress <p>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</p>	4	4



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	<p>boiler shells and tube plates.</p> <p>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.</p> <p>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 then fail at the boiler's normal operating temperature.</p> <p>Caustic embrittlement can be prevented through several methods, including:</p> <ul style="list-style-type: none">• 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		
3-d	<p>Purpose of lining</p> <p>i) chemical resistance, ii) low permeability, iii) physical durability and iv) economical installation.</p>	1 mark each	4
3-e	<p>Derivations of the Langmuir Adsorption Equation</p> <p>Langmuir proposed that dynamic equilibrium exists between adsorbed gaseous molecules and the free gaseous molecules. Using the equilibrium equation,</p>	4	4

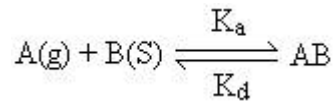


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equilibrium constant can be calculated.



Where K_a represents equilibrium constant for forward reaction and K_d represents equilibrium constant for backward direction.

According to Kinetic theory,

$$\text{Rate of forward reaction} = K_a [A] [B]$$

$$\text{Rate of backward reaction} = K_d [AB]$$

At equilibrium, Rate of forward reaction is equal to Rate of backward reaction

$$K_a [A] [B] = K_d [AB]$$

$$\text{Or, } \frac{K_a}{K_d} = \frac{[AB]}{[A][B]}$$

$$K = \frac{K_a}{K_d} = \frac{[AB]}{[A][B]}$$

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 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 sites available on the surface of adsorbent, $(1 - \theta)$ and Pressure, P. Therefore rate of forward



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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 .

$$K_a P - K_a P \theta = K_d \theta$$

$$K_a P = K_a P \theta + K_d \theta$$

$$K_a P = (K_d + K_a P) \theta$$

$$\theta = \frac{K_a P}{K_d + K_a P}$$

Divide numerator and denominator on RHS by K_d , we get

$$\theta = \frac{\frac{K_a P}{K_d}}{\frac{K_d}{K_d} + \frac{K_a P}{K_d}}$$

Now put

$$K = \frac{K_a}{K_d}$$



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	<p>in above equation we get</p> $\theta = \frac{KP}{1+KP}$ <p>Langmuir Adsorption Equation</p> <p>This is known as Langmuir Adsorption Equation.</p>											
3-f	<p>Material of construction for storage of</p> <p>i)HCl Acid : fiberglass-reinforced plastic (FRP) tank</p> <p>ii)CH₃COOH :Copper , Glass carboys</p> <p>iii)Castic lye :steel or stainless</p> <p>iv)conc H₂SO₄ : carbon steel, refractory-lined</p>	1 mark each	4									
4	Attempt any four		16									
4-a	<p>Differentiate between lyophilic and lyophobic sols</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 25%;">Definition</td> <td style="width: 25%;">Lyophilic colloids are liquid loving colloids (Lyo means solvent and philic means loving).</td> <td style="width: 25%;">Lyophobic colloids are liquid hating colloids (Lyo means solvent and phobic means hating).</td> </tr> <tr> <td>Nature of Substance</td> <td>These sols are usually formed by the organic substances like starch, gum, proteins etc.</td> <td>These sols are usually formed by the inorganic materials like metals, their sulphides etc.</td> </tr> <tr> <td>Viscosity</td> <td>The lyophilic colloids are highly viscous in nature and have higher viscosity than</td> <td>The Lyophobic colloids have almost same viscosity as that of medium</td> </tr> </table>	Definition	Lyophilic colloids are liquid loving colloids (Lyo means solvent and philic means loving).	Lyophobic colloids are liquid hating colloids (Lyo means solvent and phobic means hating).	Nature of Substance	These sols are usually formed by the organic substances like starch, gum, proteins etc.	These sols are usually formed by the inorganic materials like metals, their sulphides etc.	Viscosity	The lyophilic colloids are highly viscous in nature and have higher viscosity than	The Lyophobic colloids have almost same viscosity as that of medium	1 mark each	4
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		that of the medium.			
	Stability	Lyophilic sols are relatively stable as strong forces of interaction exist between colloidal particles and liquid.	Lyophobic sols are less stable as weak forces of interaction exist between colloidal particles and liquid		
4-b	<ul style="list-style-type: none"> • 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. • First law of thermodynamics: When energy passes, as work, as heat, or with matter, into or out from a system, its energy changes in accord with the law of conservation of energy. Equivalently, perpetual motion machines of the first kind are impossible. • Second law of thermodynamics: In a natural thermodynamic process, the sum of the entropies of the interacting thermodynamic systems increases. Equivalently, perpetual motion machines of the second kind are impossible. • Third law of thermodynamics: The entropy of a system approaches a constant value as the temperature approaches absolute zero. With the exception of non-crystalline solids (glasses) 			1	4
				1	
				1	
				1	



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	the entropy of a system at absolute zero is typically close to zero, and is equal to the logarithm of the multiplicity of the quantum ground states		
4-c	<p>Electroplating</p> <p>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.</p> <p>Normally, the metals involved form the electrodes, which are processed inside an electrolyte by passing electric current (DC) across the electrodes, through the electrolyte.</p> <p>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.</p> <p>The electrode connected to the negative is the one which is being electroplated for the required protections.</p>	4	4
4.d	<p>% Composition of SS304:</p> <p>C:0.08 Si:0.75 Mn:2 Cr:18 Ni:8 P:0.045 S:0.030</p> <p>Properties:</p> <ul style="list-style-type: none"> High ductility, 	2	4
		2	



	<ul style="list-style-type: none"> • excellent drawing, • forming, and • spinning <i>properties</i>. 								
4-e	<p>i) Enthalpy:</p> <p>A thermodynamic quantity equivalent to the total heat content of a system. It is equal to the internal energy of the system plus the product of pressure and volume.</p> <p>ii) Entropy:</p> <p>In thermodynamics, <i>entropy</i> (usual symbol S) is a measure of the number of specific realizations or microstates that may realize a thermodynamic system in a <i>defined</i> state specified by macroscopic variables. Most understand <i>entropy</i> as a measure of molecular disorder within a macroscopic system.</p> <p>iii) Internal Energy</p> <p>In thermodynamics, the <i>internal energy</i> of a system is the <i>energy</i> contained within the system, excluding the kinetic <i>energy</i> of motion of the system as a whole and the potential <i>energy</i> of the system as a whole due to external force fields.</p> <p>iv) Chemical potential</p> <p>In thermodynamics, <i>chemical potential</i>, also known as partial molar free energy, is a form of <i>potential</i> energy that can be absorbed or released during a <i>chemical</i> reaction.</p>	1 1 1 1	4						
4-f	<p>Differentiate between physical and chemical adsorption</p> <table border="1" style="width: 100%;"> <thead> <tr> <th style="text-align: left;">PHYSICAL ADSORPTION</th> <th style="text-align: left;">CHEMISORPTIONS</th> </tr> </thead> <tbody> <tr> <td>The forces operating in these are weak vander Waal's forces.</td> <td>The forces operating in these cases 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. 400 kJ mol⁻¹</td> </tr> </tbody> </table>	PHYSICAL ADSORPTION	CHEMISORPTIONS	The forces operating in these are weak vander Waal's forces.	The forces operating in these cases those of a chemical bond.	The heat of adsorption are low i.e. about 20 – 40 kJ mol ⁻¹	The heat of adsorption are high i.e. 400 kJ mol ⁻¹	1/2 mark each	4
PHYSICAL ADSORPTION	CHEMISORPTIONS								
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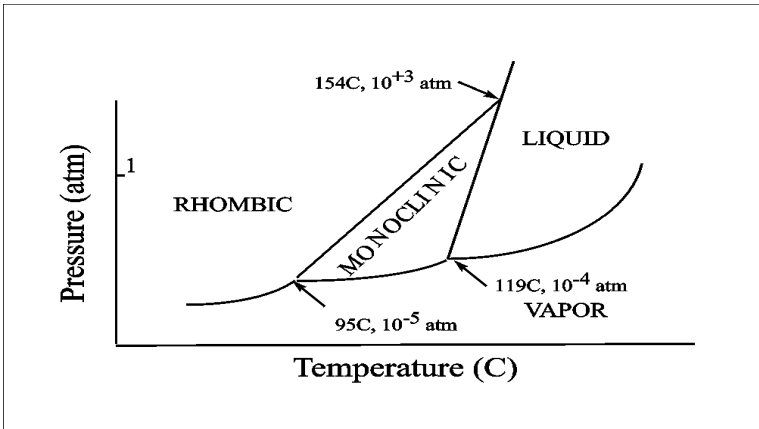


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	No compound formation takes place in these cases.	Surface compounds are formed.		
	The process is reversible i.e. desorption of the gas occurs by increasing the temperature or decreasing the pressure.	The process is irreversible. Efforts to free the adsorbed gas give some definite compound.		
	It does not require any activation energy.	It requires any activation energy.		
	This type of adsorption decreases with increase of temperature.	This type of adsorption first increases with increase of temperature. The effect is called activated adsorption.		
	It is not specific in nature i.e. all gases are adsorbed on all solids to some extent.	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.		
	The amount of the gas adsorbed is related to the ease of liquefaction of the gas.	There is no such correlation exists.		
	It forms multimolecular layer.	It forms unimolecular layer.		
5	Attempt any four			16
5-a	<p>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.</p> <p>ii) Isobaric process: An isobaric process is a thermodynamic process in which the pressure stays constant: $\Delta P = 0$.</p> <p>iii) Adiabatic process: An adiabatic process is a process that occurs without the</p>		1	4
			1	



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	<p>transfer of heat or matter between a system and its surroundings. Adiabatic processes are primarily and exactly defined for a system contained by walls that are completely thermally insulating and impermeable to matter; such walls are said to be adiabatic.</p> <p>iv) Isochoric process:</p> <p>An isochoric process, also called a constant-volume process, an isovolumetric process, or an isometric process, is a thermodynamic process during which the volume of the closed system undergoing such a process remains constant.</p> <p>An isochoric thermodynamic process is characterized by constant volume, i.e., $\Delta V=0$.</p>	1	
5-b	<p>Phase diagram for the Sulphur system:</p>  <p>Sulphur exist in four possible phases. Two solid polymorphic phases. Rhombic sulphur with mp= 114⁰C , monoclinic sulphur at mp=120⁰C sulphur liquid . allthese phases have the same chemical species .and represented by one chemical entity S (sulphur) .thus the system sulphur is a four phase, one component system.</p>	4	4
5-c	<p>Features of electrochemical series: (any 4)</p> <p>1. Metals having higher negative electrode potential show more corrosion.</p>	1 mark each	4



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	<ol style="list-style-type: none">2. Metals having higher positive potential show less or no corrosion.3. Metals at top of the series called anodic (active), where as the metals at bottom of the series are called cathodic or noble.4. When two metals coupled ,then the metal with less potential becomes anode with respect to the other and gets corroded.5. Higher corrosion rate is observed with metals that are farther apart from each other in the series, when used in couple.6. The metal with less electrode potential displaces the metal having more electrode potential.		
5-d	<p>Properties of Teflon{any four}</p> <ol style="list-style-type: none">1. Plastic light in weight.2. It is excellent resistance to corrosion.3. It resistant to weather.4. It is ease in fabrication.5. Easily and cheaply made in complicated shapes.6. It has good strength and good wear and impact resistance	1 mark each	4
5-e	<p>The applications of adsorption are (any 4)</p> <p>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.</p> <p>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.</p> <p>c) In heterogeneous catalysis : solid catalyzed gas phase reactions proceed through the adsorption of gaseous</p>	1 mark each	4



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	<p>reactants on the surface of a solid catalyst.</p> <p>d) In removing colouring matter from solutions: animal charcoal removes colours of solutions by adsorbing colour causing impurities. Animal charcoal is used as a decolouriser in the manufacture of cane sugar.</p> <p>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.</p> <p>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.</p> <p>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</p>										
5-f	<p>Differences between wet and dry corrosion: (any 4)</p> <table border="1"><thead><tr><th>Dry corrosion</th><th>Wet corrosion</th></tr></thead><tbody><tr><td>1)It occurs in dry condition.</td><td>1)It occurs in wet condition.</td></tr><tr><td>2)If the corrosion takes place due to direct chemical attack (in the absence of moisture), corrosion is known as dry corrosion.</td><td>2)If the corrosion takes place due to electrochemical attack in presence of moisture or a conducting medium ,corrosion is known as wet corrosion</td></tr><tr><td>3)Explained by absorption mechanism</td><td>3)Explained by electrochemical mechanism</td></tr></tbody></table>	Dry corrosion	Wet corrosion	1)It occurs in dry condition.	1)It occurs in wet condition.	2)If the corrosion takes place due to direct chemical attack (in the absence of moisture), corrosion is known as dry corrosion.	2)If the corrosion takes place due to electrochemical attack in presence of moisture or a conducting medium ,corrosion is known as wet corrosion	3)Explained by absorption mechanism	3)Explained by electrochemical mechanism	1 mark each	4
Dry corrosion	Wet corrosion										
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	<p>4)It occurs on both heterogeneous and homogeneous surfaces.</p> <p>5)Corrosion is uniform.</p> <p>6)It is a slow process.</p> <p>7)Corrosion products accumulate at the place where corrosion occurs.</p>	<p>4)It occurs only on heterogeneous metal surfaces.</p> <p>5)Corrosion is not uniform.</p> <p>6)It is a fast process.</p> <p>7)Corrosion take place at anode but products accumulate near the cathode.</p>			
6	Attempt any four				16
6-a	<p style="text-align: center;">Material of construction</p> <pre> graph TD A[Material of construction] --> B[Metals] A --> C[non meta] B --> D[Ferrous metals] B --> E[Non ferrous metals] D --> D1[Cast iron] D --> D2[Grey cast iron] D --> D3[Plain carbon steels: Mild steel] D --> D4[High carbon steel] D --> D5[Medium carbon steel] D --> D6[Low alloy steel] D --> D7[Stainless steel] E --> E1[Al & its alloys] E --> E2[Cu & its alloys] E --> E3[Ni & its alloys] E --> E4[Pb & its alloys] E --> E5[Cr & its alloys] C --> C1[plastics] C --> C2[rubber] C --> C3[glass] C --> C4[ceramics] </pre>		4		4
6-b	<p>Inhibitors are organic or inorganic chemicals which are added in small amounts to a corrosion medium in order to reduce the corrosive effect of the medium. Usually they form and maintain a protective film on the metal surface and thus act as a barrier for further corrosion. Anodic inhibitors such as sodium or potassium chromates, phosphates and the silicates tend to suppress the anodic reaction or metal</p>		4		4



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	<p>dissolution. Cathodic inhibitors control the cathodic reaction (they shield the cathodic areas) many organic components such as amines,thiourea and mercaptants work as cathodic inhibitors. The cathodic and anodic inhibitors working together are more effective than acting separately.</p>		
<p>6-c</p>	<p>Adiabatic expansion of gas: In an adiabatic expansion of gas, no heat is allowed to enter or leave the system hence $Q=0$ The first law of thermodynamics: $\Delta U = Q - W$ BUT $Q=0$ $\Delta U = 0 - W$ $-\Delta U = W$</p> <p>Therefore in an adiabatic expansion gas, work is done on the gas which increases its internal energy and consequently the temperature of the gas increases.</p> <p>For an Ideal gas: The molar heat capacity at constant volume is given by $C_v = dU/dT$</p> <p>$dU = C_v dT$ for a finite change the above equation becomes $\Delta U = C_v \Delta T$</p> <p>For enthalpy: We have $\Delta H = \Delta U + \Delta PV$ $\Delta PV = R \Delta T$ for one mole of gas $\Delta H = \Delta U + R \Delta T$</p> <p>But $\Delta U = C_v \Delta T$ So, $\Delta H = C_v \Delta T + R \Delta T$ $\Delta H = (C_v + R) \Delta T$</p> <p>For an ideal gas: $C_p - C_v = R$ So, $C_v + R = C_p$ Where C_p is molar heat capacity at constant temperature Then $\Delta H = C_p \Delta T$.</p> <p>Workdone: W</p>	<p>4</p>	<p>4</p>



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	<p>Since $Q=0$ $\Delta U=0-W$ $W=-\Delta U$ $W=-C_v \Delta T.$</p>		
6-d	<p>degree of freedom for NH₃ and water: $p=2, c=2$ $F=C-P+2$ $F=2-2+2$ $F=2$</p> <p>ii) NaCl & WATER : $P=2, C=2$ $F=C-P+2$ $F=2-2+2$ $F=2$</p>	2	4
6-e	<p>for isothermal reversible reaction: $W=nRT \ln V_2/V_1$ $n=1 \text{ mol}$ $R=8.314 \text{ J/molK}$ $T=300 \text{ K}$ $V_1=V_1$ $V_2=10V_1$</p> <p>SO $W=8.314 \times 300 \ln 10$ $W=5743.1077 \text{ J}$ Since the process, $Q=W$ So, $Q=5743.1077 \text{ J}$</p>	1 1	4
		1	



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6-f	<p>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:</p> <p>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.</p> <p>Hot dust method:</p> <p>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.</p>	4	4
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