SUMMER-15 EXAMINATION

Model Answer

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.

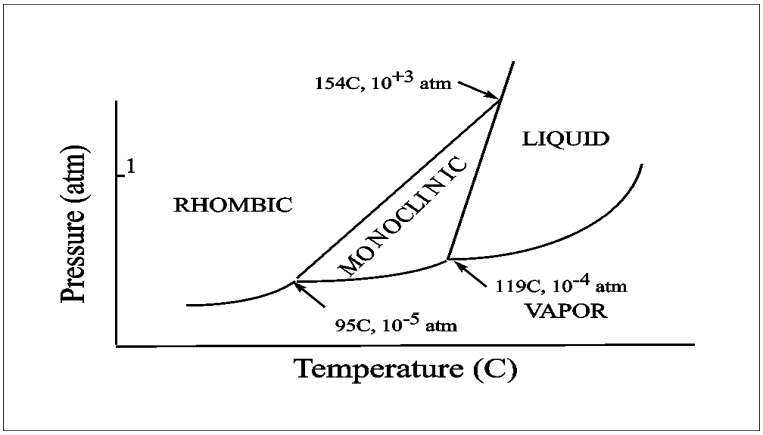
Q No.	Answer	marks	Total marks
1a-i	**The first law of thermodynamics** states that energy neither be created nor destroyed during process, although it may be converted from one form to another. Let Q be the amount of heat absorbed by a system from the surroundings while undergoing a change from state 1 to state2. the absorption of heat by the system results in performance of some work W, by the system and an increase energy, ΔU of the system, therefore, $Q=\Delta U + W$ $\Delta U = Q - W$	1 1	2
1a-ii	**Types of colloidal systems:** • Foam • solid foam • Aerosol • emulsion • solid emulsion(gel) • smoke • sol • solid sol	1/4 mark each	2
1a-iii	**Corrosion** is defined as the gradual deterioration or destruction of a metal by chemical or electrochemical reactions with its environment. **Example**: • Rusting of iron when exposed to atmospheric conditions. • Formation of green film of basic carbonate on the copper when exposed	1 1	2

	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.	1 1	2
1a-v	**Homogeneous systems:** a system consisting of a single phase is called a homogeneous system. **Heterogeneous system:** a system consisting of more than one phase is called heterogeneous system.	1 1	2
1a-vi	Plain carbon steel is a steel in which the main alloying element is carbon in the range of 0.05 to 2% There are three types of carbon steels based on the percentage of carbon. 1) Low carbon steel or mild steel of 0.05% to 0.30% carbon content. 2) Medium carbon steel of 0.3 to 0.5% carbon content. 3) High carbon steel > 0.5% to2% carbon content.	2	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	2
1b-i	**Comparison between hydrophilic & hydrophobic colloids**		4

	hydrophilic	**hydroophobic**			
	They have a definite affinity for the dispersion medium	They have no affinity for dispersion medium		1 mark each for any 4	
	These are organic substances like starch, gum& proteins	These are of inorganic substances like gold, platinum,iron & arsenic.			
	These can be prepared directly by mixing solid material with liquid dispersion medium.	These can be prepared directly by mixing and special methods are used for their preparation.			
	Viscosity is higher than that of the dispersion medium	Viscosity of sols is same as that of the medium.			
	Their particles are not visible even under ultra microscope	These particles are visible under ultra microscope			
	The sols are quite stable	The sols are less stable.			
	These are highly hydrated	These are not much hydrated			
	They are reversible in nature	These are irreversible in nature			
	The particles in sols do not carry charges.	The particles of these sols carry either positive or negative charge.			
	They do not show Tyndall effect	These exhibit Tyndall effect.			
	They will not show any action,when placed in an electric field.	Particles usually migrate towards anode or cathode depending upon their nature of charge.			
1b-ii	The different methods to prevent corrosion:			2	4

	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 marks for any 1	
1b-iii	The composition and uses of **i) cast iron:** composition: 2.7 to 4.5% carbon,1.8 to 3% silicon, traces of P,Mn and balance Fe. Uses: a) used for caustic fusion pots b) used in pumps and valves & water piping,filter presses.,vaccum pumps.blowers,gears,jaw crushers,centrifuges etc. **ii) mild steel:** composition: 0.05 to 0.3% carbon plus small amount of P,Si,S and Mn and balance Fe. Uses: • it is widely used in petroleum and chemical industries for reactors, heat exchangers, dilution vessels, storage tanks.etc • it is used for handling and storing of caustic solution and commercial	1 1 1 1	4

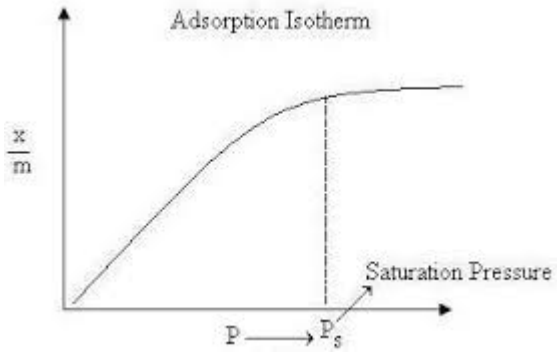
<table>
<tr><td></td><td>grade sulphuric acid.</td><td></td><td></td></tr>
<tr><td>2-a</td><td>Difference between extensive and intensive properties.
<table>
<tr><td>Extensive properties</td><td>Intensive properties</td></tr>
<tr><td>It is depending on the mass of the system</td><td>It is independent of mass /amount of the system</td></tr>
<tr><td>It depends on the amount/quantity of the substance present in the system.
These are additive.</td><td>These are not depending on the size of the system.
These are not additive.</td></tr>
<tr><td>Volume will be different at the stages of the system</td><td>The value of the property is the same at all points.</td></tr>
</table></td><td>4</td><td>4</td></tr>
</table>

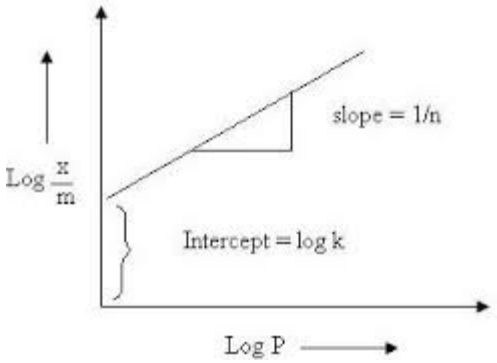
2-b	**Electrochemical(Wet corrosion):** It is the corrosion of the metal that occurs in the presence of liquid medium/aqueous environment, through electrochemical reactions. one part behaves as anode and undergoes oxidation and the other part act as a cathode and undergoes reduction. **Mechanism of wet corrosion:** wet corrosion is a two step process. One is anodic or oxidation reaction and the other is cathodic or reduction process. 1) anodic reaction involves dissolution of metal [$M \rightarrow M^{n+} + ne^-$] the anode are absorbed at the cathode. 2) There are different cathodic reactions in which the electrons are consumed depending upon the nature (acidic / basic / neutral) of the corrosion environment. i) Hydrogen evolution type wet corrosion: it occurs in the acidic environment containing no oxygen or very less oxygen. ii) Oxygen absorption type wet corrosion.: it occurs when the environment is alkaline / basic or neutral, and contains more oxygen, OH^- ions will be given out.	2 2	4
2-c	**Phase diagram for the Sulphur system:**  Sulphur exist in four possible phases. Two solid polymorphic phases.	2 2	4

	Rhomboic sulphur with mp= 114^0C , monoclinic sulphur at mp=120^0C 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.		
2-d	Methods of preparation of colloidal solution: 1**) Dispersion methods**: in this method colloiodal size particles are formed by breaking down large macro-sized particles. Those are: • mechanical dispersion method • electrical dispersion method • peptization **2) Aggregation method:** here colloidal size particles are formed by aggregation of single molecules. Those are: • double decomposition • reduction • Oxidation.	2 2	4
2-e	**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. **Different types of linings are :** 1. Lead lining: it is having high corrosion resistance but it is soft and has poor mechanical property. Because of this it is used for protection of mild	2 2	4

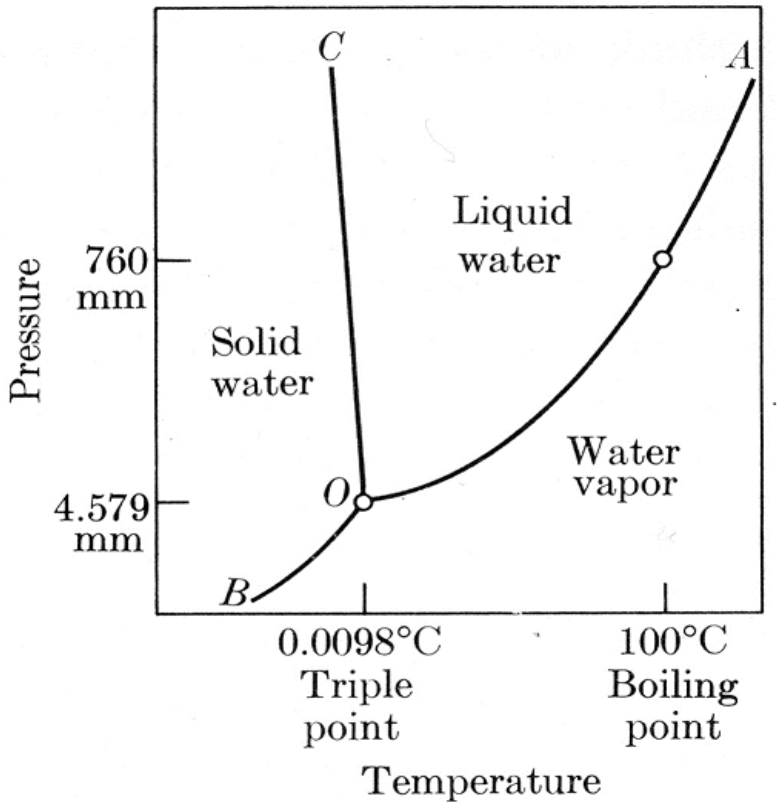
<table>
<tr><td></td><td>steel.
2. Glass lining: glass has excellent resistance to all acids except hydrofluoric. Their general applications are for equipments such as reactors, columns, pipes etc.
3. rubber lining: here lining is generally in the form of sheets or thin films applied by using specific adhesive.
4. plastic lining: the method of plastic lining preparation of the surface plays important part in subsequent adhesion of film to the metal surface.</td><td></td><td></td></tr>
<tr><td>2-f</td><td>Differences between cathodic inhabitors and anodic inhabitors:

<table><tr><th>cathodic inhibitors</th><th>anodic inhibitors</th></tr><tr><td>these controls the cathodic reaction.they shield the cathodic area</td><td>these tend to suppress the anodic reaction or metal dissolution</td></tr><tr><td>ex.amines,thiourea,mercaptants etc</td><td>ex.sodium or potassium chromates,phosphates,silicates etc.</td></tr></table></td><td>4</td><td>4</td></tr>
<tr><td>3-a</td><td>Irreversible process:
A process which goes from the initial to final state in a finite time and cannot be carried in the reverse order is c/a irreversible process.
In an irreversible process, the change is carried out fast with a measurable speed so that the system cannot attain a state of thermodynamic equilibrium when it undergoes the process.
In case of irreversible process , the system is in equilibrium state in the</td><td>3</td><td>4</td></tr>
</table>

	beginning and at the end , but not at stages in between. All processes occurring in nature are irreversible since they take place with finite driving forces between parts of the system or between the system and surrounding. e.g. :-motion with friction	1	
3-b	**Adsorption Isotherm:** a Freundlich adsorption isotherm for adsorption of gases is represented by the equation: $x/m = kP^{(1/n)}$ (1) x = mass of the gas adsorbed at a pressure P m = mass of k and n are constant adsorbent equation (1) represented by graphically as shown in fig. If we plot (x/m) v/s P , get smooth curve as shown in fig. 	4 marks for any one isotherm	4

	 Values of k and n determined by plotting log(x/m) v/s log P Taking log of both sides of equ. (1) Log(x/m) = log k + (1/n) log P Log (x/m) = (1/n) log P + log k ➔ y=mx +c From compare both equ. Slope = 1/n Intercept = log k The plot of log(x/m) v/s logP 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 equ. $x/m = k C^{(1/n)}$ OR Langmuir adsorption isotherm		
3-c	**Plastic as a MOC :** Plastics are use because of their properties. Plastic light in weight. It is excellent resistance to corrosion. It resistant to weather.	4	4

<table>
<tr><td></td><td>It is ease in fabrication.
Easily and cheaply made in complicated shapes.
It has good strength and good wear and impact resistance
e.g. PVC, PP , HDPE etc.</td><td></td><td></td></tr>
<tr><td>3-d</td><td>Diff. Between Reversible and irreversible process:
<table><tr><td>reversible process</td><td>irreversible process</td></tr><tr><td>It is an ideal or imaginary process</td><td>It is an actual or real process</td></tr><tr><td>It take infinite time for its completion</td><td>It take finite time for its completion</td></tr><tr><td>There are no dissipative effects</td><td>There are dissipative effects</td></tr><tr><td>The system passes through the equilibrium states</td><td>The system passes through non equilibrium states</td></tr><tr><td>It is extremely slow process.</td><td>It is a fast process and proceeds with a measurable speed</td></tr><tr><td>An reversible process can be plotted on thermodynamic coordinates</td><td>An irreversible process cannot be plotted on thermodynamic coordinates.</td></tr></table></td><td>1mark each
For any 4</td><td>4</td></tr>
<tr><td>3-e</td><td>Phase diagram of water system</td><td>4</td><td>4</td></tr>
</table>

			
3-f	(i) polyethylene: used for tanks ,industrial container , drums , pipes, valves, packaging films etc. (ii) Teflon: used for gaskets, pumps, seals, agitator shaft etc. (iii) polypropylene :used for pumps, valves, fittings, pipes, ID and FD fans etc. (iv) PVC : used for pumps, valves, fittings, pipes, adsorption tower, scrubber etc	1/2 mark each for any two	4
4-a	(i) C = 1 , P = 3 , F = C – P + 2 F = 1 – 3 + 2 F = 0 System is invariant (ii) C = 1 , P = 2 , F = 1 -2 +2 F = 1	2 2	4

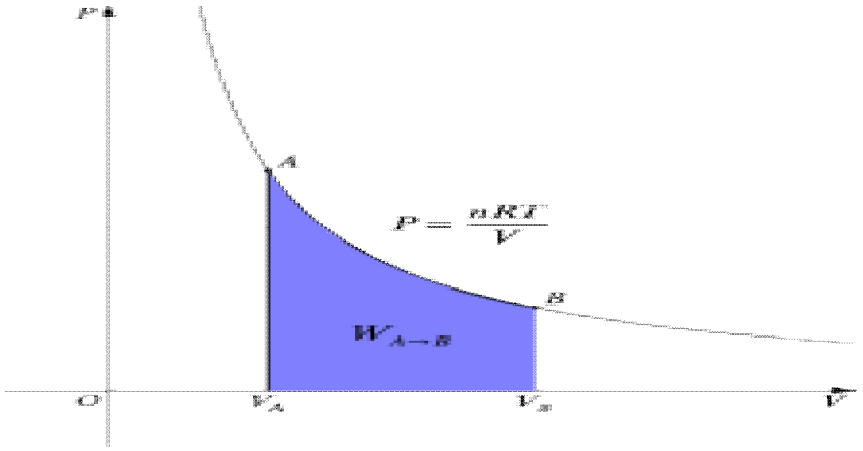
	System is monovarient		
4-b	**Mechanism of dry corrosion :** Types of dry corrosion: (i) corrosion by oxygen (ii) corrosion due to other gases **(i) corrosion by oxygen:** corrosion by oxygen is the the corrosion of a metal due to chemical attack of oxygen in dry environment at low or high temp. .it 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	1 1 2	4
4-c	**For isochoric process work done is zero:** It is a process in which the volume of the system is kept constant.	2	4

<table>
<tr>
<td></td>
<td>For isochoric process , change in volume is zero i.e. dV = 0. (1)
For e.g.
Consider a gas enclosed in a cylinder fitted with a weightless and frictionless piston. Undergoing a reversible expansion process ,this cylinder is in thermal equilibrium with the surroundings so that the temp. Of the gas remains constant, while its expansion. Let P be the pressure of the gas (system). For reversible expansion of the gas , the external pressure (Pext) must be infinitesimally smaller than the pressure of the gas. Therefore the ext. Pressure is (P- dP) where dP is very small quantity.as a ext. Pressure (P- dP) infinitesimal than the gas pressure(pressure of the syst.), the gas will be expand by an nfinitesimal volume dV(the volume of gas changes from V to v + dV) . the work done by the gas when its volume increses by an infinitesimal amount dV is equal to the ext. Pressure times the volume change
Work done by the syst. Is given by
$dW = -[p_{ext}\ dV] = p_{ext}\ dV$
dW = ext. Pressure x change in volume
$=(P - dP)\ dV$
$= p \times 0$
$= 0$
dW =o (for isochoric process)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4.d</td>
<td>Diff. Between physical and chemical adsorption:
<table>
<tr><td>physical adsorption</td><td>chemical adsorption</td></tr>
<tr><td>physical adsorption is a reversible phenomenon</td><td>chemical adsorption is an irreversible phenomenon</td></tr>
<tr><td>It is occurs at low temp.</td><td>It is occurs at all temp.</td></tr>
<tr><td>It is caused by</td><td>It is caused by chemical</td></tr>
</table>
</td>
<td>1 mark each for any 4</td>
<td>4</td>
</tr>
</table>

	intermolecular forces of attraction | interaction The heat evolved inphysical adsorption is small | The heat evolved in chemical adsorptionis large non-specific in nature | Highly specific in nature		
4-e	**Electroplating :** It is widely used in various industries for coating metal objects with a thin layer of a different metal. The layer of metal deposited has some desired property, which the metal of the object lacks. Electroplating is done for following perposes : Give underlying structure protection against corrosion. Prevention of contamination of the material being processed. Minimise the effect of abrasion. Ease of cleaning. Provide high mech. Strength.	4	4
4-f	**MOC for storage of:** (i) liquid ammonia :SS-316, SS-304, POLYPROPYLENE (ii) methanol :MILD STEEL (iii) conc. HNO3 : SS-316 AND SS - 304 (iv) toluene :MILD STEEL	 1 1 1 1	4

5-a	**Langmuir's adsorption isotherm:** **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 – θ). Now, Rate of forward direction depends upon two factors: Number of sited available on the surface of adsorbent, (1 – θ) and Pressure, P. Therefore rate of forward reaction is directly proportional to both mentioned factors. Rate of forward reaction $\propto$ P (1 - θ) Rate of adsorption $\propto$ P (1 - θ) Or, Rate of adsorption = K_aP (1 - θ) 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 $\propto$ θ Or, Rate of desorption = K_d θ At equilibrium, rate of adsorption is equal to rate of desorption. K_a P (1 – θ) = K_d θ We can solve the above equation to write it in terms of θ. K_aP – K_aP θ = K_d θ K_aP = K_aP θ + K_d θ K_aP = (K_d + K_aP) θ $\theta = \frac{K_a P}{K_d + K_a P}$	4	4

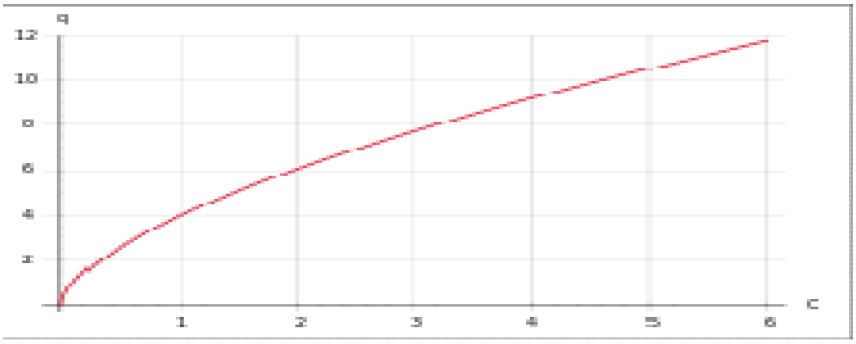
	Divide numerator and denominator on RHS by K_d, we get $\theta = \frac{\frac{K_a}{K_d}P}{\frac{K_d}{K_d} + \frac{K_a}{K_d}P}$ Now put $K = \frac{K_a}{K_d}$ in above equation we get $\theta = \frac{KP}{1+KP}$ Langmuir Adsorption Equation This is known as Langmuir Adsorption Equation.		
5-b	**Oxidation corrosion:** It is the corrosion due to chemical attack of oxygen in a dry environment at low or high temperature. it results in the formation of metal oxide layer on the metal surface. The nature of oxide film formed decides the prevention or continuation of corrosion. The oxide film produced based on its nature can be classified as: Stable oxide film, unstable and volatile film. **stable oxide film**: it acts as barrier between metal and oxygen and thus prevents further corrosion. stable oxide film may be **porous** or **non porous** in nature.in case of porous oxide film permits free access of of oxygen to the metal surface.in the case of non porous film their are no pores or cracks in the oxide film for further corrosion. **unstable oxide film**: the film formed decomposes back to the metal ond oxygen.hence oxidation corrosion is not possible in case of noble metals.	4	4

	volatile oxide film: in this case the film formed vaporizes / volatiles as soon as it is formed and the metal surface is exposed to further corrosion. it leads to continues and excessive corrosion.		
5-c	**Derivation for workdone** 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 **Calculation of work**  The dark area represents "work" for this isothermal changeIn thermodynamics, the work involved when a gas changes from state *A* to state *B* is simply $W_{A\to B} = -\int_{V_A}^{V_B} p\,dV$ For an isothermal, reversible process, this integral equals the area under the relevant pressure-volume isotherm, and is indicated in purple in the figure (at the bottom right-hand of the page) for an ideal gas. Again, $p = nRT / V$ applies and with *T* being constant (as this is an isothermal process), we have:	2 2	4

	$W_{A\to B} = -\int_{V_A}^{V_B} p\,dV = -\int_{V_A}^{V_B} \frac{nRT}{V}dV = -nRT\int_{V_A}^{V_B} \frac{1}{V}dV = -nRT\ln\frac{V_B}{V_A}$ By convention, work is defined as the work the system does on its environment. If, for example, the system expands by a piston moving in the direction of force applied by the internal pressure of a gas, then the work is counted as positive, and as this work is done by using internal energy of the system, the result is that the internal energy decreases. Conversely, if the environment does work on the system so that its internal energy increases, the work is counted as negative.It is also worth noting that, for many systems, if the temperature is held constant, the internal energy of the system also is constant, and so $\Delta U = 0$. From First Law of Thermodynamics, $\Delta U = Q - W$, so it follows that $Q = W$ for this same isothermal process.When no heat flows into or out of the gas because its container is at the same temperature, then there is no work done. Thus, work=0 which means external pressure on any moving surface is zero. This is called free expansion.		
5-d	**Lead lining:** it is having high corrosion resistance but it is soft and has poor mechanical property. Because of this it is used for protection of mild steel. in case of loose lead sheet lining, the lead sheet is applied to surfaces in the thickness from 3mm to 10mm and joints are lead burnt in position. in case of homogeneous lead lining, lead is bonded to the clean surface with the aid of flux and the thickness of lead lining required is further is thereafter deposited in drop by drop by lead burning.and the minimum thickness of 4.5 to maximum 8mm thickness is maintained. it is used in cases where good heat transfer properties are required or operation is to be carried out.	3 1	4

5-e	i) **second law of thermodynamics**: All the statements are equivalent • Heat or in general any type of energy flows from a higher level to a lower level. • When two bodies are at different temperatures, heat flows from a hot body to a relatively cold body. • All natural or spontaneous processes are not thermodynamically reversible. ii) **third law of thermodynamics:** it states that at the absolute zero of temperature, the entropy of pure crystalline substance is zero.	2 Any one statement 2	4
5-f	**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.	½ marks each for any 1 mark each for any 2	4

	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 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.		
6-a	**Factors affecting rate of corrosion:** the factors that affect the rate of corrosion are: • Nature of the metal	½ marks for any 8	4

	• Nature of environment. 1) Nature of metal: a. purity of metal b. surface area of metal c. relative area of cathodic or anodic parts d. position in the galvanic series e. nature of the oxide film f. solubility of the corrosion product g. physical state of the metal h. Volatility of the corrosion product. 2) Nature of the environment: a. temperature of the environment b. pH of the environment c. presence of impurities in the environment d. amount of oxygen present in the environment e. nature of anions and cations present in the environment f. Presence of suspended particles in the environment. g. humidity of environment		
6-b	**Freundlich adsorption isotherm:**  Example of the Freundlich isotherm, showing the amount adsorbed, q (e.g., in	4	4

mol/kg), as a function of equilibrium concentration in the solution, c (e.g., in mol/L). The Freundlich Adsorption Isotherm is mathematically expressed as

$$\frac{x}{m} = Kp^{1/n}$$

It is also written as $\log \frac{x}{m} = \log K + \frac{1}{n} \log p$

Or $\frac{x}{m} - Kc^{1/n}$

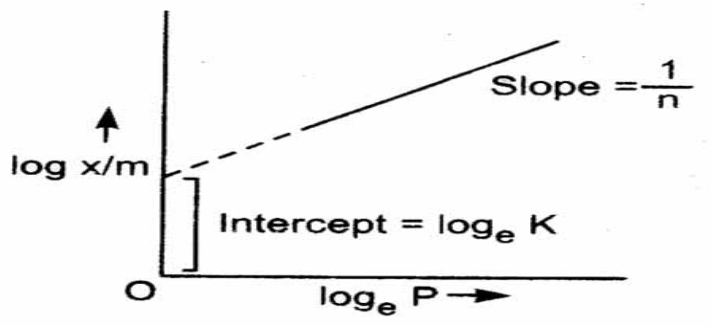
It is also written as $\log \frac{x}{m} = \log K + \frac{1}{n} \log c$

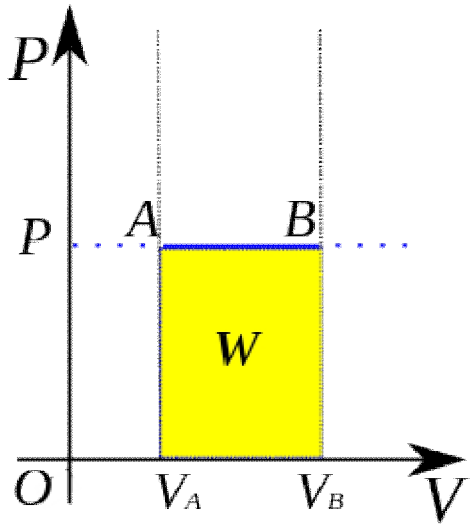
where

x = mass of adsorb ate
m = mass of adsorbent
p = Equilibrium pressure of adsorbate
c = Equilibrium concentration of adsorbate in solution.

K and n are constants for a given adsorbate and adsorbent at a particular temperature.

At high pressure 1/n = 0, hence extent of adsorption becomes independent of pressure.



6-c	**Derivation for workdone for in a reversible isobaric process for ideal gas:** An *isobaric process* is a thermodynamic process in which the pressure stays constant: $\Delta P = 0$. The heat transferred to the system does work, but also changes the internal energy of the system:  The yellow area represents the work done $$Q = \Delta U + W$$ According to the first law of thermodynamics, W is work done *on* the system, U is internal energy, and Q is heat. Pressure-volume work by the closed system is defined as: $$W = \int p\, dV$$ where Δ means change over the whole process, whereas d denotes a differential. Since pressure is constant, this means that	4	4

	$W = p\Delta V.$ Applying the ideal gas law, this becomes $W = nR\Delta T$ assuming that the quantity of gas stays constant, e.g., there is no phase transition during a chemical reaction., the change in internal energy is related to the temperature of the system by $\Delta U = n c_V \Delta T,$ where c_V is specific heat at a constant volume. Substituting the last two equations into the first equation produces: $Q = n c_V \Delta T + nR\Delta T$ $= n(c_V + R)\Delta T$ $= n c_P \Delta T,$ where c_P is specific heat at a constant pressure.		
6-d	The work done by an ideal gas in isothermal reversible expansion is given by $W = nRT\ln(P_1/P_2)$ n = 1 mol R = 8.314 J/(mol K) T = 300K1 P_1 = 4 atm P_2 = 1 atm	1 1	4

	substituting values , we get W = 1 *8.314*300 ln (4/1) = 3458.69 J	1 1	
6-e	**Industrial applications of :** **SS304**: a. Used for process equipments, piping, fittings and flanges in milk processing, wine making,brewing,fruit juice and chemical industry. b. It is used nitration plants. Used for storage tanks, tankers and containers. c. It is used for handling nitric acid , phosphoric acid, citric acid, dyestuffs, crude and refined oils and organic and inorganic chemicals. **SS314 :** a. equipment for furnaces b. radiant tubes c. heat treatment components d. Annealing and carburizing boxes.	1 mark each for any 2 1 mark each for any 2	4
6-f	**i) uniform corrosion:** it is corrosion of a metal either through chemical or electrochemical reaction that proceeds evenly or uniformly over the entire exposed surface or over very large area of the surface. thus, A uniform layer of rust formed on the metal surface and there is a more or less uniform wastage of material. This type of corrosion usually observed on the outer surface of a container exposed at atmosphere. It can be prevented by selecting proper materials, cathodic protection, use of inhibitors and protective coatings.	2	4

	ii) 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 get covered by corrosion product and they grow in the direction of gravity. 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.	2	