Applied Chemistry

Time : 2 Hrs.] Prelim Question Paper Solution [Marks : 50

Q.1 Attempt any NINE of the following : **[18]**

Q.1(a) Give various zones of reactions in blast furnace with their temperature range. **[2]**

(A) (i) Zone of reduction (300 - 800°C i.e. dull red heat)
(ii) Zone of heat absorption (800 - 1200°C i. e. bright red heat)
(iii) Zone of fusion (1200 - 1500°C i.e. white heat)

Q.1(b) What are the products of blast furnace? **[2]**

(A) (i) Pig Iron (ii) Slag (iii) Flue Gases

Q.1(c) Define Heat treatment. **[2]**

(A) Heat treatment of steel may be defined as the process of heating steel to a certain high temperature and then cooling it at a controlled rate, in order to develop certain desirable physical properties in it without changing its chemical composition.

Q.1(d) Why gold does not get corroded in air? **[2]**

(A) In case of gold metal the oxide film formed is Unstable oxide film So as soon as the film is formed it decomposes back into original metal & oxygen. Therefore corrosion is not possible here.

$$\underset{\text{Metal}}{2M} + O_2 \rightarrow \underset{\text{Metal Oxide}}{2MO} \rightarrow 2M + O_2$$

Q.1(e) List any two advantages of gaseous fuels over solid fuels. **[2]**

(A) (1) They have higher calorific value as compared to solid fuels.
(2) They are easy to ignite & extinguish.
(3) Their combustion can readily controlled by the use of regulator.
(4) They are ashless & smokeless.
(5) They have high thermal efficiency.
(6) They require only slight excess air for complete combustion.
(7) They can be used in I.C. engines.
(8) They undergo complete combustion without polluting the environment.
(9) They can be easily supplied through pipes.

Q.1(f) Define viscosity index and cloud point. **[2]**

(A) **Viscosity Index:** The rate of change of viscosity of a liquid (Oil) with the change of temperature is known as viscosity index.

Cloud point: Cloud point indicates the temperature at which the oil becomes cloudy in appearance, due to separation of wax.

Q.1(g) Why gold does not get corroded in air? **[2]**

(A) In case of gold metal, the oxide film formed is Unstable oxide film. So as soon as the film is formed it decomposes back into original metal& oxygen. Therefore corrosion is not possible here.

$$2M + O_2 \longrightarrow \underset{\text{Metal oxide}}{2MO} \longrightarrow 2M + O_2 \uparrow$$

Q.1(h) Explain the function of coke in extraction of Iron from it's ore. **[2]**

(A) **Function of coke:**
In the extraction of iron metal from haematite ore coke is used as a reducing agent. It reduces iron oxide to iron metal.

$$Fe_2O_3 + 3C \longrightarrow 2Fe + 3CO \uparrow$$

Q.1(i) State different types of film formed during corrosion and which type of oxide flim is more protective against corrosion? **[2]**

(A) Types of film formed during corrosion: (any two)

(i) Stable film : (a) Porous film (b) Non – Porous film

(ii) Unstable film

(iii) Volatile film

Stable non-porous or Unstable film is more protective against corrosion. (any one)

Q.1(j) Name two ores of Iron with its molecular formulae. **[2]**

(A)

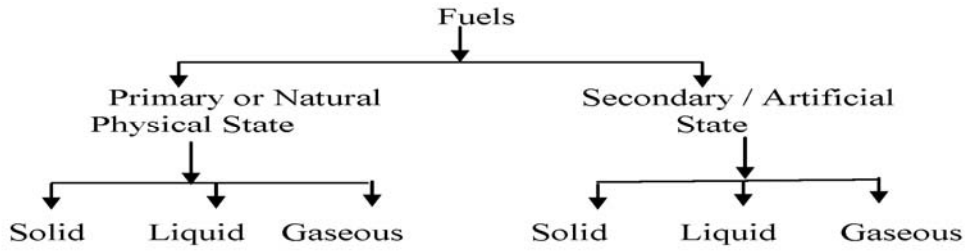
Sr. No.	Name of Ore	Molecular formulae
(i)	Magnetite	(Fe_3O_4)
(ii)	Haematite	(Fe_2O_3)
(iii)	Limonite	($2Fe_2O_3.3H_2O$)
(iv)	Siderite	($FeCO_3$)
(v)	Iron Pyrites	(FeS_2)

Q.1(k) Define fuels. How are they classified? **[2]**

(A) Fuel:

A fuel can be defined as any combustible substance which during combustion gives large amount of heat energy.

Classification of Fuel :



Q.1(l) Give composition of L.P.G. **[2]**

(A) Composition:

The average composition of LPG is

(i) Ethane = 0.20%

(ii) Propane = 57.30%

(iii) Butane = 41.10%

(iv) Pentane = 1.40%

Q.2 Attempt any FOUR of the following : **[16]**

Q.2(a) Write the effect alloying elements carbon and chromium on properties of steel. **[4]**

(A) Effect of alloying element Carbon:

(i) It increases the hardness.

(ii) It increases tensile strength of steel, but reduces its ductility.

Effect of alloying element Chromium:

(i) It increases hardness, toughness and tensile strength.

(ii) It increases wear resistance and resistance to corrosion.

Q.2(b) Differentiate between annealing normalizing. **[4]**

(A)

	Annealing	Normalising
(i)	It is the process of heating the steel at a temperature (760-925°C) and cooling it slowly in the furnace along with the furnace	It is the process of heating the steel at a temperature of 50°C above the critical temperature (725°C) and cooling it freely in air at a rate of 5 °C/Sec.
(ii)	Due to annealing steel becomes more soft, pliable, malleable & ductile.	Due to normalising steel becomes homogenous & more soft. The mechanical properties of steel are more improved than annealing.
(iii)	Time required for annealing is more than normalising	Time required for normalising is less than annealing.
(iv)	Consumption of fuel or electric power is more.	Consumption of fuel or electric power is less.

Q.2(c) List any four characteristics of a good fuel. **[4]**

(A) Characteristics:

(1) A good fuel should have a high calorific value.
(2) A good fuel should have a moderate ignition point.
(3) A good fuel should not liberate any polluting or poisonous product gases.
(4) The velocity of combustion should be moderate.
(5) The combustion should be easily controllable.
(6) It should contain low percentage of non-combustible matter.
(7) It should be cheap, easily available & convenient for transportation.
(8) A good fuel requires smaller space to store.
(9) A good fuel does not contain any volatile matter which causes air pollution.

Q.2(d) State composition properties and applications of C.N.G. **[4]**

(A) Composition:-

CH_4 (methane) = 88.5%
C_2H_6 (ethane) = 5.5%
C_3H_8 (Propane) = 3.7%
C_4H_{10} (butane) = 1.8%
Rest is H_2, CO_2, H_2S etc.

Properties: (Any one)

1. It is cheaper than petrol or diesel.
2. Its ignition temp is high (5400C).
3. It is odourless& non corrosive.
4. It is light weight gas.
5. Its calorific value is high.
6. Being free from lead & sulphur, its use substantially reduces harmful engine emissions.

Applications: (Any one)

1. It is used in traditional petrol I.C. engine cars (petrol / CNG)
2. It is also used in locomotive generators to generate electricity that drives the motors of the train.

Q.2(e) Give chemical reactions taking place in zone of reduction of blast furnace. **[4]**

(A) The reduction of iron oxide is done in the following stages:

$$Fe_2O_3 \longrightarrow Fe_3O_4 \longrightarrow FeO \longrightarrow Fe$$

(i) In between 300 – 500°C, when charge is heated, Fe_2O_3 (Ferric oxide) is reduced to Fe_3O_4 (Ferroso ferric oxide).

$$3Fe_2O_3 + CO \longrightarrow 3Fe_2O_4 + CO_2 \uparrow$$

This Fe_3O_4 is stable upto 650°C in pressure of CO, CO_2 & free coke.

(ii) In between 650 – 700°C, Fe_3O_4 is reduced to FeO

$$Fe_3O_4 + CO \longrightarrow 3FeO + CO_2 \uparrow$$

(iii) At temperature between 700 – 800°C, FeO is reduced to metallic iron.

$$FeO + CO \longrightarrow Fe + CO_2 \uparrow$$

(iv) Simultaneously, the limestone present in the charge is also decomposed to produce lime.

$$CaCO_3 \longrightarrow CaO + CO_2 \uparrow$$

(v) The metal produced is spongy; simultaneously a part of metallic iron reacts with CO to form Fe_2O_3 or Fe_3O_4.

$$2Fe + 3CO \longrightarrow Fe_2O_3 + 3C$$

$$3Fe + 4CO \longrightarrow Fe_3O_4 + 4C$$

(Note : consider any four reactions)

Q.2(f) Explain fluid film lubrication with diagram. [4]

(A) Fluid film lubrication :

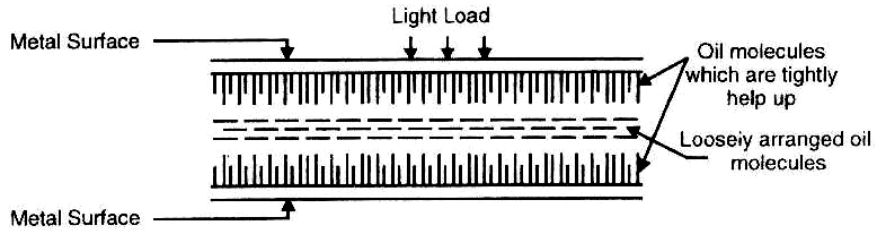
(i) It is carried out by introducing the liquid lubricants in between the moving or sliding surface. The lubricant film covers the irregularities of the sliding or moving surface & forms a thin layer in between them. This thin layer of lubricant avoids metal to metal contact & reduces wear & friction.

(ii) The resistance to movement of moving parts is only due to the internal resistance between the particles of the lubricant moving over each other.

(iii)In fluid film lubrication, the lubricant chosen should have the minimum viscosity under working condition & at the same time it should remain in place & separate the surfaces.

Examples:

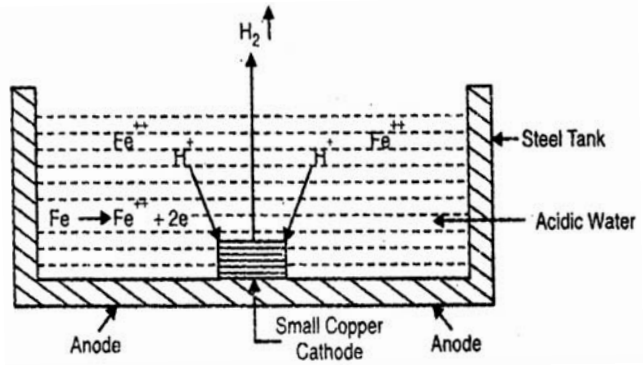
This type of lubrication is provided in case of delicate instrument and light machines like watches, clocks, guns, sewing machines, scientific instrument etc.



Q.3 Attempt any FOUR of the following : [16]

Q.3(a) Explain stepwise mechanism of electrochemical corrosion by evolution of hydrogen gas. [4]

(A)



Steel tank: Anode

Copper strip: Cathode

These types of corrosion occur usually in acidic environments like industrial waste, solutions of non - oxidizing acids.

Consider a steel tank containing acidic industrial waste and small piece of copper scrap in contact with steel. The portion of the steel tank in contact with copper acts as anode & is corroded most with the evolution of hydrogen gas.

Reactions:

At Anode:

$Fe \longrightarrow Fe^{++} + 2e^{-}$ (Oxidation)

These electrons flow through the metal from anode to the cathode that is piece of copper metal where they are accepted by H^+ ions to form H_2 gas

At cathode :

H^+ ions are eliminated as H_2 gas

$2H^+ + 2e^- \longrightarrow H_2 \uparrow$ (Reduction)

Thus, over all reaction is

$Fe + 2H^+ \longrightarrow Fe^{++} + H_2 \uparrow$

Q.3(b) State four functions of lubricant in mechanical industry. [4]

(A) (1) It reduces the surface wear & tear & deformation, so that direct contact between the rubbing surfaces is avoided.
(2) It reduces the loss of heat, so it acts as a coolant.
(3) It reduces expansion of metal by local frictional heat.
(4) It reduces unsmooth relative motion.
(5) It reduces the maintenance & running cost of machine.
(6) It reduces the power loss in I.C. engine.
(7) In I.C. engine, the lubricant acts as a seal between the piston & cylinder wall, hence it prevents the leakage of gases at high pressure.

Q.3(c) Select the lubricants for following mechanical jobs: [4]

(i) Internal combustion engines (ii) Sewing machines
(iii) Rail axel boxes (iv) Cutting tools.

(A) **(i) Internal combustion engines:** Mineral oils containing additives are used.
(ii) Sewing machines: Thin vegetable & animal oils like palm oil, hazel nut oil, neat foot oil, olive oil etc. are used.
(iii) Rail axel boxes: Greases or thick oils or thick blended oils are used.
(iv) Cutting tools: Mineral oil containing additives like fatty oils and oil-emulsions are used.

Q.3(d) Give composition properties and applications of Biogas. [4]

(A) The average composition of biogas is:
CH_4 (methane) = 50 – 60% (Combustible gas)
CO_2 (carbon dioxide) = 30 – 40% (non – combustible gas)
H_2 (hydrogen) = 5 – 10% (Combustible gas)
N_2 (nitrogen) = 2-6% (non – combustible gas)
H_2S (Hydrogen sulphide) = traces (Combustible gas)

Properties:- (any one)
(i) Biogas on burning liberates a larger amount of heat than that obtained by burning animal dung or fire wood directly.
(ii) It burns without producing residue, smoke etc.
(iii) It is cheap, clean in use, has good calorific value & convenient fuel.
(iv) It does not pollute the atmosphere.
(v) It involves no storage problem.
(vi) Biogas production is very economical.
(vii) It provides excellent yield of good manure.

Applications:- (any one)
(i) It is used as an efficient fuel.
(ii) It is used for cooking food.
(iii) It is used as an illuminant in villages.
(iv) To run engines (generators).

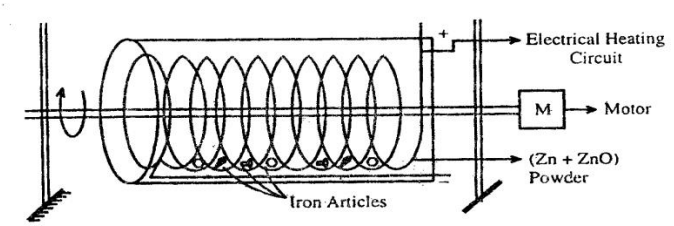
Q.3(e) Distinguish between galvanizing and tinning. **[4]**

(A)

	Galvanizing	Tinning
(i)	A process of covering iron or steel with a thin coat of Zinc to prevent it from rusting.	A process of covering iron or steel with a thin coat of Tin to prevent it from corrosion.
(ii)	In galvanizing, zinc protects the iron as it is more electropositive than iron. It does not allow iron to pass into solution.	Tin protects base metal iron from corrosion, as it is less electropositive than iron and higher corrosion resistance.
(iii)	In galvanizing Zn continues to protect the metal by galvanic cell action, even if coating of Zn is broken.	In tinning, tin protects the iron, till the coating is perfect. Any break in coating causes rapid corrosion.
(iv)	Galvanized containers cannot be used for storing acidic food stuff, since Zn reacts with food acids forming Zn compounds which are highly toxic i.e. poisonous.	Tin coated containers and utensils can be used for storing any food stuff since Tin is non-toxic and protects the metal from corrosion and does not causes food poisoning.

Q.3(f) Name and explain the method used to protect small and uneven articles from corrosion. **[4]**

(A) The method used to protect small and uneven articles from corrosion is sherardizing.



Process:

(i) The iron articles (bolts, screws, nails etc) to be coated are first cleaned and then packed with Zn dust and ZnO powder in a steel drum, which is provided with electrical heating circuit arrangement.

(ii) The drum is slowly rotated for 2-3 hours and its temp is kept between 3500 – 400°C during this process Zn gets diffused slowly into iron forming Fe - Zn alloy at the surface which protects iron surface from corrosion.

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