

**K.S.R. COLLEGE OF ENGINEERING (Autonomous), TIRUCHENGODE – 637 215**

**DEPARTMENT OF CHEMISTRY**

**FIRST YEAR - I SEMESTER – BATCH 2019-2020**

**(COMMON TO CIVIL, CSE, IT & MECH)**

**18CH051 – ENGINEERING CHEMISTRY – QUESTION BANK**

**UNIT-I : ADVANCED ENGINEERING MATERIALS**

**PART – A: TWO MARK QUESTIONS AND ANSWERS**

- 1. What are abrasives? Give two examples each for natural and artificial abrasives (R) (CO-1)**

Abrasives are hard substances used for grinding, cutting, sharpening, polishing or drilling purpose. They are used in the form of granules or powder. They are characterized by high hardness, high melting point and chemical inertness.

Natural abrasives - Diamond, quartz

Artificial abrasives - Silicon carbide, boron carbide

- 2. Mention the characteristics of abrasives. (R) (CO-1)**

- It should be very hard
- It should possess high refractoriness.
- It should be resistant to mechanical shock
- It should not be affected by the frictional heat.

- 3. Define hardness of an abrasive? What is their unit? (R) (CO-1)**

It is the ability of an abrasive to grind or scratch away other materials. The harder the abrasive quicker will be its abrading action. Hardness of the abrasive is measure on Moh's scale or Vicker's scale.

- 4. Write some applications of abrasives (Or) List out the day today applications of abrasives (R) (CO-1) (APR 2019)**

Abrasives are used for making

- Abrasive paper or cloth which is used to prepare smooth wood, metal and plastic surfaces.
- Grinding wheels to remove the scales from iron surfaces.
- Abrasives powder to clean the metal surface prior to coating.

- 5. What are soft abrasives? (R) (CO-1)**

Abrasives having their hardness 1-4 in Moh's scale are known as soft abrasives.

- 6. How are abrasives used? (U) (CO-1)**

Abrasives are used in three forms

- As loose powder
- As abrasive paper or cloth
- As grinding wheels

- 7. Explain moh's scale for different abrasives. (E) (CO-1) (JUNE 2018)**

Moh's scale is a scale, in which common abrasives are arranged in the order of increasing hardness.

- 8. What are refractories? How are they classified? (R) (CO-1) (JAN 2017) (JUNE 2017) (JAN 2018)**

Refractories are materials that can with stand high temperatures without softening or deformation in shape. They are used for the construction of lining in furnaces, kilns, etc.,

Refractories are classified into 3 types

- i) Acidic refractories : Alumina, fireclay
- ii) Basic refractories : Magnesite, dolomite.
- iii) Neutral refractories: Graphite, Carborundum

9. **Recall the characteristics of a good refractory. (R) (CO-1)**
  - It should be infusible at the operating temperatures.
  - It should be chemically inert towards the corrosive gases, metallic slags and liquid
  - It should resist the abrading action of flue gases, flames, etc.,
  - It should not crack and suffer loss in size at the operating temperatures.
10. **How would you define the term refractoriness? (U) (CO-1)**

Refractoriness is the property of a material by virtue of which it can withstand high temperature without appreciable deformation under working conditions. It is measured as pyrometric cone equivalent (PCE) numbers.
11. **What is RUL? What is it's significance?(R) (CO-1)**

Refractories under load (RUL) is the ability of the refractory to withstand the loads, at high operating temperatures. It indicates the actual capacity of the refractory under service.
12. **What is meant by dimensional stability? (U) CO-1)**

Dimensional stability is the resistance of a refractory to change in volume due to prolonged exposure to high temperatures.
13. **Define Porosity. (R) (CO-1)**

Porosity of a material is the ratio of its pore volume to its bulk volume
14. **What do you mean by thermal spalling? (U) (CO-1)**

Thermal spalling is a property of refractory, by virtue of which it suffers breaking, cracking, peeling off or fracturing at high temperatures.
15. **What are the causes of Thermal Spalling? Mention their remedies. (U) (CO-1)**

**Causes:**

  - Rapid change in temperature in the furnace temperature.
  - Slag penetration into the refractory

**Remedies:**

  - Employ refractories with low coefficient of expansion and good thermal conductivity.
  - Avoiding sudden change in temperature.
  - By improving furnace design to minimize stress and strain.
16. **Define a Lubricant. (R) (CO-1) (JAN 2018)**

A lubricant is a substance capable of reducing the friction between two rubbing surfaces. The process of reducing friction, by introducing a lubricant is called lubrication.
17. **Can you list out the role of a lubricant? (An) (CO-1)**

A lubricant forms a film, that separates the moving parts of two bodies. Following are the functions of a lubricant

  - Reduces wear and tear of machine parts
  - Reduces loss of heat energy
  - Act as a coolant
  - Prevents welding of a machine
  - Act as a corrosion inhibitor
  - Act as a sealant and prevents leakage.
18. **How would you classify lubricants? (R) (CO-1)**

Based on the physical states of lubricants, they are classified as

  - Solid Lubricants Eg. Graphite, Teflon, MoS<sub>2</sub>
  - Semi-Solid Lubricants Eg. Grease, Vaseline
  - Liquid Lubricants Eg.. Tallow Oil, Castor Oil, Silicones
  - Gaseous Lubricants Eg.. CO<sub>2</sub>, Air, Helium

**19. Outline the terms Viscosity and viscosity index. (U) (CO-1)**

Viscosity of a liquid is the property, by virtue of which it offers resistance to its flow. Generally, viscosity of a lubricating oil is determined by using a Redwood, Saybolt or U-tubes (Ostwald or Ubbelohde) visco meters. Its unit is centipoises. Viscosity index of a lubricant is the average decrease in viscosity for 1<sup>0</sup> rising temperature, between 100 and 210<sup>0</sup> F. It is determined by a standard procedure.

If the viscosity of a liquid rapidly falls with the increase in the temperature, the liquid is said to have a low viscosity index. Whereas, if the viscosity does not change much, with the increase in temperature, the oil is said to possess a high viscosity index.

**20. Define the terms flash point and fire point. (R) (CO-1) (JAN 2017) (APR 2019)**

Flash point of a lubricating oil is the lowest temperature, at which it gives enough vapours that flash (ignite) for a moment, when exposed to a tiny flame.

Fire point of a lubricating oil is the lowest temperature, at which it gives enough vapours that ignites (burns) continuously for at least 5 seconds, when exposed to a tiny flame.

**21. List out the significance of flash and fire points? (An) (CO-1)**

A good lubricating oil should have high flash point and high fire point. The values must be greater than the temperature of the operating conditions in order to protect against any fire hazards.

**22. Define the terms cloud point and pour point. What are their significance? (R) (CO-1) (JUNE 2017)**

On cooling, the temperature at which the lubricating oil becomes cloudy or hazy in appearance is called cloud point. On cooling, the temperature at which the lubricating oil ceases to flow or pour is called pour point. Both the cloud and pour points indicate suitability of a lubricating oil in cold conditions. A good lubricant must have low cloud point and pour point.

**23. Define Oiliness of a lubricant. (R) (CO-1)**

Oiliness of a lubricant is the property, virtue of which the oil sticks to the surface of machine parts, under heavy pressure and load.

Oiliness of mineral oils can be improved by adding animal and vegetable oils.

**24. What are nanoparticles? (R) (CO-1)**

According to the widely accepted definitions, nanoparticles are defined as those particles, in which at least one of their dimensions is less than 100nm.

**25. Recall the unique characteristics of nanoparticles? (R) (CO-1)**

- High surface area-to-volume ratio of the particles
- Increased strength, chemical and thermal resistance
- Transparency

**26. What are the two types of carbon nanotubes? (U) (CO-1)**

Carbon nanotubes are classified into two types. They are

- Single wall carbon nanotube (SWNT)
- Multi wall carbon nanotube (MWNT)

**27. Mention few applications of nanotechnology. (R) (CO-1)**

- Carbon black industry
- Electrical and Electronic applications
- Protective coatings
- Packaging industry
- Cosmetic applications
- Medical field

28. **What are the advantages of nanotechnology in fuel cells? (R) (CO-1)**  
Nanotechnology in fuel cells promises the following:
- Cheap bipolar molecules and efficient electrocatalysts,
  - Stable and durable conducting membranes.
29. **Can you recall the application of nanoparticles in catalysis. (R) (CO-1)**  
Nanoparticle catalysts, on application restructure themselves and thereby improves the surface mobility. Nanocatalysts are of two types-natural and synthetic. Enzymes are the natural catalysts that are responsible for overall growth of living organisms. Synthetic catalysts are widely used in a number of industrial applications.
30. **Bring out the role of gold nanoparticles in medicines. (R) (CO-1)**
- Biological electron microscopy
  - Identification of bacteria
  - Curing of cancer
  - HIV drugs.
31. **Classify abrasives based on its source. (U) (CO-1) (DEC 2018)**  
Abrasives are high hardness, high melting point and chemical inertness.  
**Natural abrasives** - Diamond, quartz  
**Artificial abrasives** - Silicon carbide, boron carbide
32. **The surface area/volume ratio is very large for nanoparticles compared to bulk materials. Give reason. (An) (CO-1) (DEC 2018)**  
For the bulk particles the **surface area** of the molecule is **very less** but in the nanoparticles ( $10^{-9}$  m) the **surface area** of the molecule is **more**.

### PART-B- QUESTIONS

1. **What are abrasives? How are they classified? Give its important properties and uses. (U) (CO-1) (JUNE 2017)**
2. **Write a note on artificial abrasives. (R) (CO-1)**
3. **What are refractories? How are they classified? Give examples for each type. (U) (CO-1)**
4. **Give the preparation and application of any one acid refractory. (R) (CO-1)**
5. **Explain the various properties of refractories. (E) (CO-1) (JAN 2017) (JAN 2018) (JUNE 2018)**
6. **Explain the preparation and uses of silicon carbide. (U) (CO-1)**
7. **Explain the preparation and uses of  $\text{MoS}_2$ . (U) (CO-1) (JAN 2017)**
8. **Define refractoriness and explain thermal spalling and porosity of refractories. (R & E) (CO-1)**
9. **What are refractory materials? What are the important characteristics of refractories? (R) (CO-1) (JUNE 2017)**
10. **What are solid lubrications? When are they used? Explain the structure of any one solid lubricant? (R & U) (CO-1) (JUNE 2017) (APR 2019)**
11. **Write detailed account on the graphite.(R) (CO-1)**
12. **Discuss the importance of viscosity, flash point in selecting lubricating oil for a particular use. (U) (CO-1)**
13. **Write notes on flash and fire points of a lubricant. (R) (CO-1) (JAN 2018)**
14. **Write a note on solid lubricants.(R) (CO-1)**
15. **Explain the various properties of lubricants. (E) (CO-1) (JAN 2018) (JUNE 2018) (DEC 2018)**

16. Explain the synthesis of CNT by the following methods (U & E) (CO-1) (JAN 2017) (JUNE 2017) (JAN 2018) (JUNE 2018)  
Chemical vapour deposition method, Laser evaporation & Pyrolysis
17. Discuss the applications of nanomaterials. (C) (CO-1) (JAN 2018)
18. Define refractories. Classify its types. Discuss any four properties of refractories. (R) (CO-1) (DEC 2018)
19. Define CNTs. Explain any three methods to synthesize CNTs and list four applications in medicine and environment. (R) (CO-1) (DEC 2018) (APR 2019)
20. List out the characteristic of refractories (R) (CO-1) (APR 2019)
21. Compare and arrange all type of abrasive in the increasing order of their hardness in mho scale (U) (CO-1) (APR 2019)

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**UNIT-II: ELECTROCHEMISTRY AND CORROSION**  
**PART – A: TWO MARK QUESTIONS AND ANSWERS**

1. What is corrosion? (R) (CO-2) (JAN 2017)  
Any destruction or deterioration of metals or alloys by undergoing chemical and electrochemical reaction with the environment.
2. List the two conditions for wet corrosion to take place. (An) (CO-2)  
(i) When two dissimilar metals are in contact with each other in presence of an aqueous solution or moisture (ii) When a metal is exposed to an electrolyte with varying amount of oxygen.
3. State (a) Pilling-Bedworth ratio (b) Pilling-Bedworth rule (U) (CO-2) (JUNE 2013, JUNE 2014, JAN 2016, JUNE 2016, JAN 2018, JUNE 2018)  
(a) The ratio of volume of oxide film formed to the volume of metal consumed is known as pilling-Bedworth ratio (PB ratio). It gives an idea about whether the oxide film formed on the metal surface is protective or non-protective. (b) Pilling-Bedworth rule: If PB ratio > 1, protective oxide layer, if PB ratio < 1, non-protective oxide layer.
4. Differentiate between dry corrosion and wet corrosion. (An) (CO-2)

S. No.	Dry or chemical corrosion	Wet or Electrochemical corrosion
1.	It occurs in dry state	It occurs in presence of moisture or electrolyte.
2.	It involves direct chemical attack of metals by the gases	It involves setting up of large number of tiny galvanic cells.
3.	It follows adsorption mechanism	It follows the mechanism of electrochemical reactions.
4.	Corrosion product accumulates on the same spot where corrosion occurs.	Corrosion occurs at anode while the product accumulates at cathode.

5. Define galvanic corrosion. (R) (CO-2) (JUNE 2018)  
When two dissimilar metals are electrically connected and exposed to an electrolyte, the metal higher in electrochemical series undergoes corrosion.
6. Iron corrodes faster than aluminium, even though iron placed below aluminium in electrochemical series. Why? (An) (CO-2)  
This is because aluminium forms a non-porous, very thin, tightly adhering protective oxide film ( $\text{Al}_2\text{O}_3$ ) on its surface and this film does not permit further corrosion to occur.

7. **Zinc is more readily corroded when coupled with copper than with lead. Why? (An) (CO-2)**

It is due to galvanic corrosion. The extent of corrosion of a metal in a bimetallic couple depends upon the difference in their position in emf series. Greater the difference faster is the corrosion rate. Since the difference between Zn - Cu is higher than Zn - Pb, zinc gets corrodes vigorously when couple with copper.

8. **Bolt and nut made of same metal is preferred in practice. Why? (R) (CO-2) (JUNE 2015)**

Bolt and nut made of same metal is preferred in practice in order to avoid galvanic type corrosion.

9. **Zinc gives better protection to iron than tin under corrosive environment. Why? (An) (CO-2)**

This is because zinc is anodic to iron where as tin is cathodic to iron. Therefore zinc dissolves in corrosive environment and sacrificially protects iron.

10. **Impure metal corrodes faster than pure metal under identical conditions. Justify. (E) (CO-2)**

Impurities in a metal generally cause heterogeneity (i.e. anodic and cathodic part) and form minute electrochemical cells at the exposed parts, whereby the anodic parts get easily corroded.

11. **Wire mesh corrodes faster at the joints. Why? (Ap) (CO-2)**

The joints of wire mesh are stressed, so these become anodic with respect to unjoined wires. At these anodic parts, oxidation takes place and the metal is corroded fast; while the cathodic parts remain unaffected.

12. **A steel screw in a brass marine hardware corrodes. Justify. (E) (CO-2)**

This is due to galvanic corrosion. Iron (higher in emf series than brass) becomes anodic and is attacked and corroded; while brass (lower in emf series) acts as cathodic and is not attacked at all.

13. **Rusting of iron is quicker in saline water than in ordinary water. Why? (R) (CO-2)**

The presence of sodium chloride in water leads to increased conductivity of liquid (water) in contact with iron surface, there by rusting is speeded up.

14. **Small anodic area results in intense corrosion. Justify. (E) (CO-2)**

Corrosion is more rapid, intense and highly localized, if the anodic area is small, because the current density at a smaller anodic area is very large, and the demand for electrons by the large cathodic area can be met by the smaller anodic area.

15. **What are reversible and irreversible cells? Give examples. (R) (CO-2) (JAN 2014)**

Cells which obey the conditions of thermodynamic reversibility are called reversible cells, example – Daniel cell. Cells which do not obey the conditions of thermodynamic reversibility are called irreversible cells, example – Dry cell, Zinc-Silver cell.

16. **What are vapour phase inhibitors? Give examples. (R) (CO-2)**

Vapour phase inhibitors readily vaporize and form protective layer on the metal surface. They are used to avoid corrosion on the metal surface. They are used to avoid corrosion in closed containers. Examples: Benzotriazole, Phenylthiourea.

17. **Stainless steel is a corrosion resistant alloy. Prove it. (E) (CO-2)**

Stainless steel containing chromium produces an exceptionally coherent oxide film which protects steel from further attack.

18. **Find the factors affecting corrosion? (R) (CO-2)**

Nature of the metal: (i) Position in emf series, (ii) Relative areas of the anode and

cathode, (iii) Purity of the metal, (iv) Over voltage, (v) Nature of surface film and corrosion products.

**Nature of the environment:** (i) Temperature, (ii) Humidity, (iii) Presence of corrosive gases, (iv) pH, (v) Presence of suspended particles.

19. Can we use a Cu vessel to store 1M AgNO<sub>3</sub> solution? ( $E_{\text{Cu}^{2+}/\text{Cu}}^{\circ} = +0.34\text{V}$ ,  $E_{\text{Ag}^{+}/\text{Ag}}^{\circ} = +0.80\text{V}$ ). (An) (CO-2)

Yes, since the reduction potential of Ag<sup>+</sup>/Ag electrode is higher than that of Cu<sup>2+</sup>/Cu electrode.

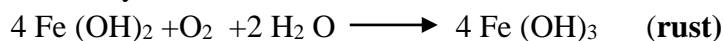
20. Can we use nickel spatula to stir a solution of CuSO<sub>4</sub>? ( $E_{\text{Cu}^{2+}/\text{Cu}}^{\circ} = +0.34\text{V}$ ,  $E_{\text{Ni}^{2+}/\text{Ni}}^{\circ} = +0.025\text{V}$ ). (An) (CO-2)

No, since the reduction potential of Ni<sup>2+</sup>/Ni electrode is less than that of Cu<sup>2+</sup>/Cu electrode. Ni will otherwise displace Cu from CuSO<sub>4</sub> solution.



21. What is rust? (R) (CO-2) (JAN 2013)

Corrosion product of Iron is called rust. If enough oxygen is present, ferrous hydroxide is easily oxidized to ferric hydroxide.



This product, called yellow rust, actually corresponds to Fe<sub>2</sub>O<sub>3</sub> · H<sub>2</sub>O.

22. Name any two cathodic inhibitors. (R) (CO-2) (JAN 2014)

Thiourea, aniline and its derivatives

23. What are corrosion inhibitors? Give any two examples. Or Categorize inhibitors used for corrosion control? Give egs. (R) (CO-2) (JUNE 2015, JAN 2016, JUNE 2016, JUN 2017)

Substances which reduced the corrosion of a metal when it is added to the corrosive environment.

Eg: Anodic inhibitor: Chromates, Phosphates of transition elements with high oxygen content

Cathodic inhibitor: Amines and mercaptanes

24. What are electrochemical cells? (R) (CO-2) (DEC 2014)

Electrochemical cells are the cells in which chemical energy is converted into electrical energy.

25. Recommend any two suggestions to avoid galvanic corrosion. (E) (CO-2) (DEC 2014)

Galvanic corrosion is avoided by using homogenous metals and providing an insulating material between the two metals.

26. Differentiate electrochemical and electrolytic cells with one example each. (An) (CO-2) (DEC2018)

Electrochemical cells are the cells in which **chemical energy** is converted into **electrical energy**. E.g. Galvanic cell

Electrolytic cells are the cells in which **electrical energy** is converted into **chemical energy**. E.g. Molten NaCl

27. An iron pan used for cooking is subjected to corrosion. Identify any four factors which will accelerate corrosion in the above case. (Ap) (CO-2) (DEC 2018).

**Nature of the metal:** (i) Position in emf series, (ii) Relative areas of the anode and cathode, (iii) Purity of the metal, (iv) Over voltage, (v) Nature of surface film and corrosion products.

**Nature of the environment:** (i) Temperature, (ii) Humidity, (iii) Presence of corrosive gases, (iv) pH, (v) Presence of suspended particles.

**28. Define EMF series. (R) (CO-2) (APR 2019)**

Various metals are arranged in the order of increase the standard reduction potential with respect to standard hydrogen electrode. Then the arrangement is called as EMF series.

**29. Classify the types of corrosion inhibitors. (U) (CO-2) (APR 2019)**

1. Anodic inhibitors
2. Cathodic inhibitors
3. Vapour phase inhibitors

**PART-B QUESTIONS**

1. What is electrochemical (EMF) series? Give its applications with suitable examples. (R) (CO-2) (DEC 2014, JUNE 2015, JAN 2016, JAN 2018, JUNE 2018) (DEC 2018)
2. Distinguish between electrolytic and electrochemical cells. (An) (CO-2)
3. Distinguish between reversible cells and irreversible cells. (An) (CO-2). (JUNE 2013, JAN 2018)
4. What are different types of corrosion? Explain the electro chemical theory of wet corrosion with mechanism. (R) (CO-2).
5. Explain the mechanism of electrochemical corrosion with an example (E) (CO-2). (JAN & JUNE 2014, DEC 2014, JUNE 2016, JAN 2017, JUNE 2018) (DEC 2018)
6. Explain the following types of corrosion. (i) Pitting corrosion (ii) Hydrogen embrittlement and (iii) Waterline corrosion. (E) (CO-2). (JUN 2017)
7. How is corrosion prevented by cathodic protection? Explain (E) (CO-2). (JUNE 2014, JAN 2016, JAN 2017, JUN 2017)
8. List out propose the various factors influencing the rate of corrosion. (An) (CO-2) (JAN 2014, JUNE 2015, JAN 2017, JUN 2017, JAN 2018, JUNE 2018) (APR 2019)
9. Illustrate the reactions involved in differential aeration corrosion with reference to the iron materials. Or explain differential aeration corrosion with any two examples (U) (CO-2). (JUNE 2013 & JAN 2013, DEC 2014, JAN 2016, JUN 2017, JUNE 2018).
10. What is meant by corrosion inhibitors? Give examples. (R) (CO-2)
11. Explain chemical corrosion. Also explain the intensity of corrosion varying with the nature of oxide layer formation over the metal. (U) (CO-2)
12. Explain differential aeration corrosion? Explain with an example. (U) (CO-2) (JUNE 2013 & JAN 2014, JAN 2016, JUN 2017).
13. Illustrate the protection of underground pipeline from its corrosion by sacrificial anodic and impressed current cathodic protection. Or Explain sacrificial anode method for corrosion control (U) (CO-2) (JUNE 2015, JAN 2016, JUNE 2016, JAN 2018).
14. Deduce the Nernst equation for the oxidation and reduction potential of an electrode. (U) (CO-2) (JAN 2017, JUN 2017) (DEC 2018) (APR 2019)
15. Compare chemical and electrochemical corrosion (U) (CO-2) (APR 2019)
16. Inspect the type of Galvanic and differential aeration corrossions (An) (CO-2) (APR 2019)

**UNIT-III: CHEMICAL THERMODYNAMICS****PART – A: TWO MARK QUESTIONS AND ANSWERS**

1. State second law of thermodynamics. (R) (CO-3)  
It is impossible to construct a machine which will transfer heat from a low temperature reservoir to high temperature reservoir without using external work.
2. Define entropy. (R) (CO-3)  
It is measure of the loss of capacity of the system to do work. Or it is measure of disorder or randomness of the system.

3. **What is significance of Gibb's Helmholtz equation? (R) (CO-3)**  
 It helps in understanding the force that causes chemical reaction in the forward direction. For example, if  
 $\Delta G$  is negative, the reaction is spontaneous.  
 $\Delta G = 0$ , the reaction is at equilibrium.  
 $\Delta H$  is negative,  $\Delta G$  tend to be negative. Thus exothermic reaction is spontaneous at ordinary temperature.  
 $\Delta S$  is positive,  $\Delta G$  tend to be negative. Thus increase in entropy leads to spontaneous process.
4. **Derive the condition for spontaneity of a process in terms of entropy? (R) (CO-3)**  
 Criteria for spontaneity of in terms of entropy  
 A process is spontaneous, if  $\Delta S$  is positive.  
 A process is non- spontaneous, if  $\Delta S$  is negative.  
 A process is equilibrium, if  $\Delta S$  is zero.
5. **Comment on the statement 'entropy of the universe is always increasing'. (R) (CO-3)**  
 All naturally occurring process in the universe are spontaneous, this leading to increase in entropy. Thus entropy of the universe is always increasing.
6. **What is the effect on entropy of a system when temperature is increased? (R) (CO-3)**  
 As the temperature of the system increase, the molecules become more mobile and random, the entropy of the system increases.
7. **State Clausius statement of second law of thermodynamics. (R) (CO-3)**  
 It states that heat can flow from hot body to cold without any external aid but heat cannot flow from cold body to hot body without any external aid.
8. **What is Gibb's free energy change? (R) (CO-3)**  
 It is a state function related to enthalpy change, entropy change and temperature as  

$$\Delta G = \Delta H - T\Delta S$$
9. **What is significance of decrease in Gibbs free energy? (R) (CO-3)**  
 Decrease in Gibb's free energy is equal to the maximum amount of useful work that a system can perform at constant T and P.
10. **What is condition for the reaction to be at equilibrium? (R) (CO-3)**  
 $\Delta G = 0$ ,  $\Delta S = \text{constant}$ .
11. **Under what condition does the entropy of a system becomes zero? (R) (CO-3)**  
 The substance should be perfectly crystalline and the temperature is absolute zero.
12. **State the second law of thermodynamics. (U) (CO-3) (DEC 2018)**  
 It is impossible to construct a machine which **will transfer heat from a low temperature reservoir to high temperature reservoir without using external work.**  
 (Or)  
 Entropy is a measure of disorder or randomness in a molecule. For spontaneous process there will be increase in entropy for the universe.
13. **Predict the conditions for spontaneity of a chemical reaction. (R) (CO-3) (DEC 2018) (APR 2019).**  
 A process is spontaneous, if  $\Delta S$  is positive and  $\Delta G$  is negative.
14. **Relate the terms involved in Gibbs free energy (U) (CO-3) (APR 2019)**  
 $\Delta G = \Delta H - T\Delta S$  (or)  $G = H - TS$   
 G= Gibbs free energy  
 H= Halmholtz work function  
 T= Temperature  
 S= Entropy

#### PART-B QUESTIONS

1. **Derive Gibb's Helmholtz equation. (R) (CO-3) (APR 2019)**
2. **Derive Van't Hoff's Isotherm for chemical reaction. (R) (CO-3)**
3. **Derive entropy change for a reversible and irreversible system. (R) (CO-3)**
4. **What is van't hoff isochore? Derive an expression for it. (R) (CO-3)**

5. **Derive four Maxwell's relationship. (R) (CO-3) (APR 2019)**
6. **Compare Helmholtz and Gibb's free energy functions and derive Gibbs-Helmholtz thermodynamic equation for calculating changes in the Gibbs energy of a system as a function of temperature. (An) (CO-3) (DEC 2018)**
7. **Derive Clausius-Clapeyron equation to estimate vapor pressure as a function of temperature. (R) (CO-3) (DEC 2018) (APR 2019)**

#### **UNIT-IV: ATOMIC STRUCTURE AND CHEMICAL BONDING**

##### **PART – A: TWO MARK QUESTIONS AND ANSWERS**

1. **What is meant by effective nuclear charge? (R) (CO-4)**  
The effective nuclear charge is the net positive charge experienced by valence electrons. It can be approximated by the following equation  
$$Z_{\text{eff}} = Z - S$$
Where Z is the atomic number and S is the number of shielding electrons.
2. **What is meant by shielding effect? (R) (CO-4)**  
The shielding effect can be defined as a reduction in the effective nuclear charge on the electron cloud, due to difference in the attraction forces on the electron in the atom.
3. **Define Ionization energy. (R) (CO-4)**  
The ionization energy is qualitatively defined as the minimum amount of energy required to remove the most loosely bound electron, the valence electron, of an isolated neutral gaseous atom to form a cation.
4. **What is meant by electron affinity? (R) (CO-4)**  
The electron affinity ( $E_{\text{ea}}$ ) of an atom or molecule is defined as the amount of energy released or spent when an electron is added to a neutral atom or molecule in the gaseous state to form a negative ion.
5. **Define electronegativity. (R) (CO-4)**  
Electronegativity is a chemical property that measures the tendency of an atom to attract electrons towards itself. Electronegativity is affected by the atomic number and the distance between the valence electrons and its nucleus.
6. **Differentiate Ionic bonding and Covalent bonding (An) (CO-4)**

Ionic Bonding	Covalent Bonding
It is formed by the transfer of electrons from one atom to another atom	It is formed by the sharing of valence electron between atom of similar electronegativity
It occurs between a metal and a non metal	It occurs between two non metals
Ionic bonds do not have definite shape	It have definite shape
They exist in solid state at room temperature	They exist as liquid or gaseous state at room temperature
They have high boiling and melting points	They have low boiling and melting points
7. **What is meant by Coordinate bond? (R) (CO-4)**  
A coordinate bond is a covalent bond formed between two atoms in which the shared pair of electron is contributed by only one of the atom. The atom providing the electron pair is called the donor atom. The atom which accepts the electron pair is called the acceptor atom. A coordinate bond is denoted by an arrow towards the acceptor atom.
8. **How is hydrogen bond formed? (U) (CO-4)**  
Hydrogen bond is formed when a charged part of a molecule having polar covalent bond forms an electrostatic (charge, as if positive attracted to negative) interaction with a substance of opposite charge.
9. **Give the postulates of Crystal Field theory. (R) (CO-4)**
  - (i) Central metal atom is surrounded by ligands to form complex.
  - (ii) Types of ligand  
Point charge, point dipole
  - (iii) The bonding between metal cation and ligand arises due to electrostatic interaction. Thus the metal bond between metal and ligand is purely ionic.
  - (iv) The interaction between electron of the metal cation and those of the ligand is entirely

repulsive. These repulsive forces are responsible for the splitting of the d orbital of the metal cation.

(v) The d-orbital which are degenerated in free metal ion have their degeneracy destroyed by the approach of ligand during the formation of complex.

**10. Why does the same covalent bond have different bond energies in different molecules? (R) (CO-4)**

The strength of the covalent bond depends on the amount of electron-density shared by the two atoms involved. This will be influenced by other atoms in the molecule. For example, highly electronegative atoms will tend to attract electron-density away from the bond and so weaken it.

**11. Why is sigma-bond stronger than a pi-bond? (R) (CO-4)**

Orbital's can overlap to a greater extent in a sigma bond, due to their axial orientation, so sigma bond is quite strong. On the other hand, in a pi-bond sideways overlapping of orbital's takes place. The sideways overlapping is not to an appreciable extent, due to the already present sigma bond, which restricts the distance between the involved atoms. Hence, sigma bond is much stronger than a pi-bond.

**12. Arrange LiCl, BeCl<sub>2</sub>, BCl<sub>3</sub>, CCl<sub>4</sub> in order of increasing covalent bond character. Give reason. (Ap) (CO-4)**

$\text{LiCl} < \text{BeCl}_2 < \text{BCl}_3 < \text{CCl}_4$ .

Electronegativity difference in M-Cl bond decreases as we move from  $\text{Li} \rightarrow \text{Be} \rightarrow \text{B} \rightarrow \text{C}$  and, therefore, covalent character varies as indicated.

**13. Find the atom possessing low ionization energy among sodium and potassium with reason. (R) (CO-4) (DEC 2018)**

Due to screening effect.

**14. List two functions of transition metal ions in biological system. (R) (CO-4) (DEC 2018)**

$\text{Fe}^{2+}$  ion is constituent of hemoglobin in blood, Which carries oxygen to different parts of body. Co is an essential component of Vitamin B<sub>12</sub>.

Mn is essential for normal bone structure.

**15. Compare the shapes of S, P, D and F orbitals. (U) (CO-4) (APR 2019)**

S= Spherical symmetrical, maximum 2 electrons

P= Dumb bell, maximum 6 electrons

D= Diffuse, maximum 10 electrons

F= Fundamental lines, maximum 14 electrons

**16. Apply the band theory of solids to a metal and explain its conductivity.(U) (CO-4) (APR 2019)**

Band theory of solids the electrons are jumping from valence band to conduction band the conduction will occurs in solids.

**PART-B QUESTIONS**

**1. What is hydrogen bonding explain an inter and intra molecular hydrogen bonding. (R) (CO-4)**

**2. Derive the energy level diagram for following transition metal complexes ([Fe(CN)<sub>6</sub>]<sup>3-</sup>, [Ni(CN)<sub>4</sub>]<sup>2-</sup> and [CoCl<sub>4</sub>]<sup>2-</sup> only). (U) (CO-4) (DEC 2018) (APR 2019)**

**3. Role of transition metal ions in biological system. (Ap) (CO-4) (APR 2019)**

**4. Explain Band theory of solids. (E) (CO-4)**

**5. Compare ionic, covalent, coordination and hydrogen bonding based on the nature of bonds with examples. (An) (CO-4) (DEC 2018)**

**6. Explain electron affinity and electro negativity of elements in periodic table (U) (CO-4) (APR 2019)**

**UNIT-V: PHOTOCHEMISTRY AND SPECTROSCOPIC TECHNIQUES**

**PART – A: TWO MARK QUESTIONS AND ANSWERS**

**1. Define the terms: (a) Wavelength (b) Frequency (c) Wave number (R) (CO-5)**

(a) Wavelength: The linear distance between successive maxima or minima of a wave. It is usually expressed in

Nm, cm,  $\mu\text{m}$  or  $\text{\AA}$  units.

(b) Frequency: The number of vibrations per second. It is expressed in Hertz (Hz)

(c) Wave number: The reciprocal of wavelength. It is usually expressed in  $\text{cm}^{-1}$

**2. Distinguish between atomic spectra and molecular spectra. (A) (CO-5)**

(i) Atomic spectrum arises from the transition of electrons from one energy level to another due to changes of energy (adsorption or emission) in the atom.

(ii) Atomic spectrum consists of sharp lines which are grouped in series. The frequency of the lines is determined from the differences in energy between the two energy levels of the atom.

(iii) Molecular spectrum involves transition of electrons between rotational and vibrational energy levels in addition to electronic transition.

(iv) Molecular spectrum consists of bands composed of innumerable closely packed lines. The molecular spectra provide most useful information regarding shape and size of the molecules, the bond lengths, strength of bonds, bond dissociation energies and bond angles.

**3. State Beer-Lambert's law. (U) (CO-5)**

The amount of light absorbed is proportional to the concentration of the absorbing substance and the thickness of the absorbing material.

**4. What is a colorimeter? (R) (CO-5)**

It is an instrument used to measure the intensity of a colour present in a solution and to determine the concentration of a particular substance.

**5. Why the spectrophotometers superior to colorimeters? (R) (CO-5)**

(i) Spectrophotometers use a prism or a diffraction grating and they possess the wavelength of 0.5nm or less. Colorimeters use glass filters and they possess a band pass of 10-20 nm.

(ii) Small sample volume is required for spectrophotometers whereas comparatively large volume of sample is required for colorimetric analysis.

(iii) Spectrophotometers maintain greater accuracy than colorimeters.

**6. Write the applications of UV-visible spectrometry. (R) (CO-5)**

(i) UV-visible spectrometry is extensively used in qualitative and quantitative analysis.

(ii) It finds application in chemical kinetics to determine the rate of a reaction.

(iii) Impurities in a compound can be detected by UV-spectroscopy.

(iv) pH and dissociation constant of compounds can also be determined.

**7. Give any two applications of IR spectroscopy. (App) (CO-5)**

(i) IR spectroscopy is widely used for studying hydrogen bonding. The amount of intermolecular hydrogen bonding varies with concentration while intra-molecular hydrogen bonding shows no such effect.

(ii) The progress of a chemical reaction can easily be followed by examining a small portion of spectrum to indicate whether the desired product is formed or not.

**8. What is flame photometry? Name few metals which can be easily detected by this method. (R) (CO-5)**

Flame photometry is based on emission of seven radiations in visible region by a metal atom. This method is used for determining the concentration of alkali and alkaline earth metals such as sodium, potassium and lithium.

**9. What are the wavelength ranges for UV, IR and Visible regions? (R) (CO-5)**

1. The Near Infrared Region (Overtone Region): It ranges from 0.8 to  $2.5\mu$  ( $12500-4000\text{ cm}^{-1}$ ).

2. The Mid Infrared Region (Vibration-Rotation Region): It ranges from  $2.5$  to  $15\mu$  ( $4000-667\text{ cm}^{-1}$ ).

3. The Far Infrared Region (Rotation Region): It ranges from  $15$  to  $200\mu$  ( $667-50\text{ cm}^{-1}$ ).

4. The Near or Quartz Ultra-violet Region: It ranges from  $200$  to  $380\text{ nm}$ .

5. The Visible Region: It ranges from  $380$  to  $780\text{ nm}$ .

**10. What are the sources of UV light in uv visible spectrophotometer? (R) (CO-5)**

1. Hydrogen lamp 2. Deuterium lamp 3. Tungsten filament lamp

**11. Define the terms bathochromic shift and hypsochromic shift. (R) (CO-5)**

Bathochromic shift: (red shift-the shift of absorption to a longer wavelength) is due to

presence of auxochrome. It may be produced by a change in medium (solvent) or by the presence of auxochrome.

Hypsochromic shift (blue shift - the shift of absorption to a shorter wavelength) is due to removal of conjugation. This is also caused by a change in medium.

- 12. What happens to a molecule when it is irradiated with (i) IR light (b) Microwave radiation? (R) (CO-5)**

(i) IR light causes to undergo vibrational and rotational transitions.

(ii) Microwave radiation causes to rotational transition.

- 13. What are chromophores? Give some examples. (R) (CO-5)**

A grouping of atoms in a molecule that is responsible for the absorption of radiation is called a chromophore. Compounds containing the chromophoric groups are called chromogens.

Examples: Some typical chromophores are

---N=O Nitroso    --N=N-- Azo    ---N=N---O Azoxy

- 14. What are auxochromes? Give some examples. (R) (CO-5)**

Auxochromes are groups that do not themselves show any characteristic absorption above 200nm but which, when attached to a given chromophoric system, usually cause a shift in the absorption to longer wavelength and also result in increase in the intensity of the absorption peak. Groups containing non-bonding electrons are responsible for this effect.

Examples

--NH<sub>2</sub> Amino, --Cl Chloro, --SO<sub>3</sub>H Sulphonic acid, --OCH<sub>3</sub> Methoxy

- 15. State Stark-Einstein law for photochemical reaction. (U) (CO-5) (DEC 2018)**

Each molecule is activated by absorption of one quantum of radiation.

- 16. Is it possible to estimate colourless solution using colorimeter? Exemplify your answer. (U) (CO-5) (DEC 2018)**

**No.** with the help of colour solution only the instrument will be operated. Absorbance is taken place only in the colour solution.

- 17. State Groth's law. (U) (CO-4) (APR 2019)**

The only light which is adsorbed can be effective in producing a chemical change.

- 18. Write the selection rule for IR spectra. (R) (CO-5) (APR 2019)**

IR spectra is active when dipole moment must change.

### PART-B QUESTIONS

- 1. Give the applications of fluorescence in medicine. (App) (CO-5)**
- 2. Discuss the principle and instrumentation of colorimetry. (C) (CO-5) (APR 2019)**
- 3. Explain how iron can be estimated by colorimetry. (U) (CO-5)**
- 4. Describe the principle and instrumentation of flame photometry. (Anl) (CO-5) (APR 2019)**
- 5. Estimate the amount of sodium by flame photometry. (E) (CO-5) (APR 2019)**
- 6. Discuss the principle and instrumentation of AAS. (C) (CO-5)**
- 7. How nickel can be estimated by AAS. (R) (CO-5)**
- 8. Derive Beer Lambert's law. List its limitations. (U) (CO-5) (DEC 2018)**
- 9. Differentiate phosphorescence from fluorescence and outline its applications in medicine. (An) (CO-5) (DEC 2018) (APR 2019)**
- 10. Compare with a neat sketch the principle, working and applications of flame photometer with atomic absorption spectrophotometer. (An) (CO-5) (DEC 2018)**

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