CHEMISTRY (XI)

CHAPTER 2 (EXPERIMENTAL TECHNIQUES IN CHEMISTRY)

Short Questions

1. Define analytical chemistry.

Ans: Analytical chemistry is a branch of chemistry that deals with the complete chemical characterization of a chemical compound.

2. Define qualitative and quantitative analysis.

Ans:

Qualitative Analysis: In qualitative analysis, a chemist is only concerned with the detection or identification of elements present in a compound.

Example: Determination of radicals present in a salt (Salt Analysis)

Quantitative Analysis: In quantitative analysis, a chemist is also concerned with the exact amountof elements present in the compound.

Example: Determination of concentration of a solution.

3. Mention the steps involved in quantitative determination of a sample.

Ans: A complete quantitative determination generally consists of four major steps:

(i) Obtaining a sample for analysis

(ii) Separation of the desired constituent

(iii) Measurement and calculation of results

(iv) Drawing conclusion from the analysis

4. Name the various experimental techniques used for the purification of the substances.

Ans: Purification techniques are as follows:

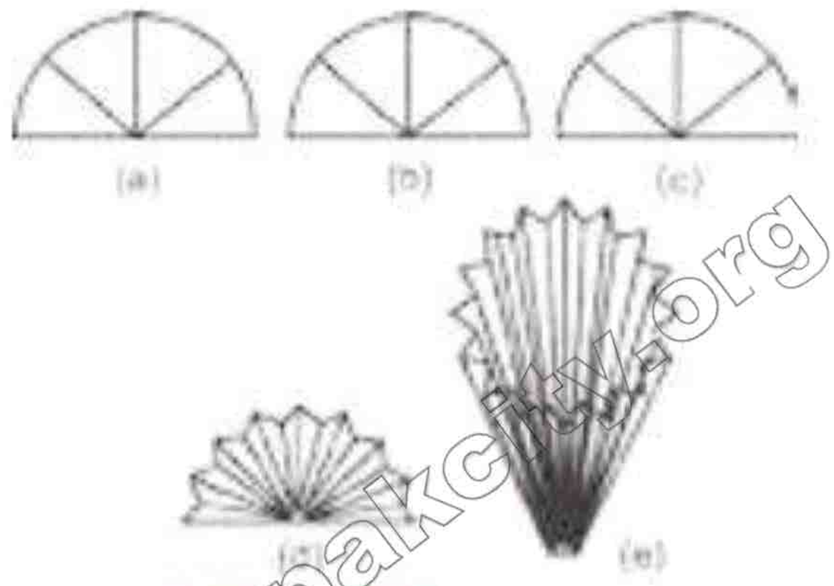
(i) Filtration (ii) Crystallization (iii) Sublimation (iv) Solvent Extraction (v) Chromatography

5. Define filtration. Mention various filter media used.

Ans: The process of filtration is used to separate insoluble particles from liquids. It can be performed with several types of filter media. Nature of the precipitate and other factors dictate which filter medium must be used. The most convenient ways of filtration are either through a filter paper or through a filter crucible.

6. What is the purpose of fluted filter paper? How can it be obtained?

Ans: The rate of filtration through conical funnel can be considerably increased using a fluted filter paper. For preparation of such a paper ordinary filter paper is folded in such a way that a fan like arrangement with alternate elevations and depressions at various folds is obtained.



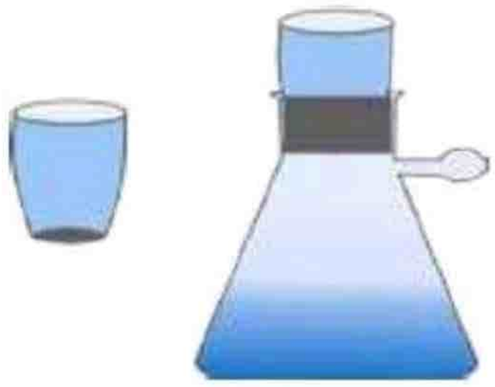
Fluted filter paper

7. How does the rate of filtration increase by using fluted filter paper?

Ans: In fluted filter paper, filter paper is folded in such a way that a fan like arrangement with alternate elevations and depressions at various folds is obtained. In such a way, contact area or surface area of filter paper is increased due to which rate of filtration is also increased.

8. Tell about construction and working of Gooch crucible.

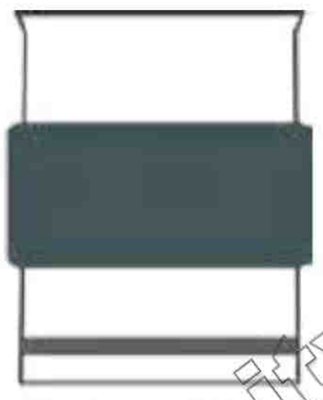
Ans: It is made of porcelain having a perforated bottom which is covered with paper pulp or a filter paper cut to its size. Quick filtration can be done by placing the Gooch crucible in a suction filtering apparatus. It is useful for the filtration of precipitates, which need to be ignited at high temperature. If its perforations are covered with asbestos mat then it may be used to filter solutions that react with paper e.g. concentrated HCl and $KMnO_4$ solutions.



Gooch Crucible with filtering apparatus

9. Describe construction and working of sintered glass crucible.

Ans: Sintered glass crucible is a glass crucible with a porous glass disc sealed into the bottom. It is very convenient to use because no preparation is needed as with the Gooch crucible.

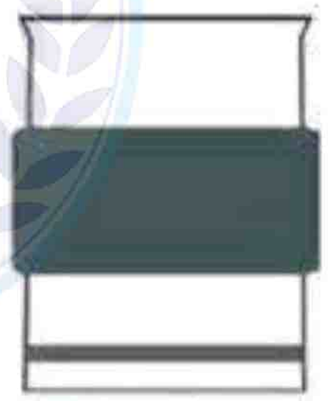


Sintered glass Crucible

10. What is the difference between Gooch crucible and Sintered glass crucible?

Ans: In Gooch crucible, a filter paper or asbestos mat is needed to cover the perforations of crucible. Whereas in Sintered glass crucible, porous glass is sealed with the bottom and it does not require any filter paper or asbestos mat.

Gooch Crucible with filtering apparatus



Sintered glass Crucible

11. Why concentrated $KMnO_4$ and HCl solutions can't be filtered by Gooch crucible?

Ans: $KMnO_4$ and HCl are not filtered by Gooch crucible because both these chemicals can react with filter paper used in Gooch crucible.

12. Define crystallization.

Ans: Crystallization is the removal of a solid from solution by increasing its concentration above the saturation point in such a manner that the excess solid separates out in the form of crystals.

13. Write the names of major steps of crystallization.

Ans: Names of the major steps of crystallization are as follows:

(i) Choice of Solvent
(ii) Preparation of Saturated Solution
(iii) Filtration
(iv) Cooling
(v) Collecting the Crystals
(vi) Drying the Crystals
(vii) Decolourization

14. Why there is a need to crystallize the crude product?

Ans: Crude product prepared in laboratory may contain soluble and insoluble impurities in it. The insoluble impurities of the product are removed by filtration process but the soluble impurities can be removed by crystallization. So, crude product is crystallized to remove impurities.

15. Desiccator is the safest method of drying the crystals. Explain.

Ans: Desiccator is slow but safest method of drying, because in this method, crystals preserve their shape and identity. Whereas, if we use other methods of drying, crystals can be crushed or contaminated. Crystals are placed in a vacuum desiccator for several hours. Drying agents that can be used in desiccator are calcium chloride ($CaCl_2$), silica gel or phosphorous pentoxide (P_2O_5) etc.

16. How crystals are dried by safest and reliable method?

Ans: Safest and reliable method for drying of crystals is using vacuum desiccator. Desiccator is slow but safest method of drying, because in this method, crystals preserve their shape and identity. Whereas, if we use other methods of drying, crystals can be crushed or contaminated. Crystals areplaced in a vacuum desiccator for several hours. Drying agents that can be used in desiccator are calcium chloride ($CaCl_2$), silica gel or phosphorous pentoxide (P_2O_5) etc.

17. Name the commonly used solvents in crystallization.

Ans: The solvents which are mostly used for crystallization are:

Water

Rectified spirit (95% ethanol)

Absolute ethanol

Diethyl ether

Acetone

Chloroform

Carbon tetrachloride

Acetic acid

Petroleum ether

18. How decolourization of undesirable colours from crystals is carried?

Ans: Sometimes during the preparation of a crude substance, the coloring matter or resinous products affect the appearance of product and it may appear colored. Such impurities are conveniently removed by boiling the substance in the solvent with the sufficient quantity of finely powdered animal charcoal and then filtering the hot solution. The colored impurities are adsorbed by animal charcoal and the pure decolorized substance crystallizes out from the filtrate on cooling.

19. What are the characteristics of a good solvent/ideal solvent?

***Ans*:** An ideal solvent should have the following features.

i. It should dissolve a large amount of the substance at its boiling point and only a small amount at the room temperature.

ii. It should not react chemically with the solute.

iii. It should either not dissolve the impurities or the impurities should not crystallize from it along with the solute.

iv. On cooling it should deposit well-formed crystals of the pure compound.

v. It should be inexpensive.

vi. It should be safe to use and should be easily removable.

20. How crystallized substances are dried?

Ans: Crystallized substances can be dried by following processes:

(i) Pressing between several folds of filter paper

(ii) Drying in an Oven

(iii) Placing in vacuum desiccator

21. Define sublimation. Give examples.

Ans: It is a process in which a solid, when heated, vaporizes directly without passing through the liquid phase and these vapours can be condensed to form the solid again. It is frequently used to purify a solid. Examples of such solids are ammonium chloride, iodine, naphthalene, benzoic acid, etc.

22. What type of substances can be purified by sublimation?

Ans: Solid substances can be purified by sublimation. Examples of such solids are ammonium chloride, iodine, naphthalene, benzoic acid etc.

23. Define sublimand and sublimate.

Ans: Sublimand is the impure solid substance to be sublimed.

Sublimate is the pure solid substance which is obtained after sublimation of impure solid substance.

24. How naphthalene can be purified by the process of sublimation?

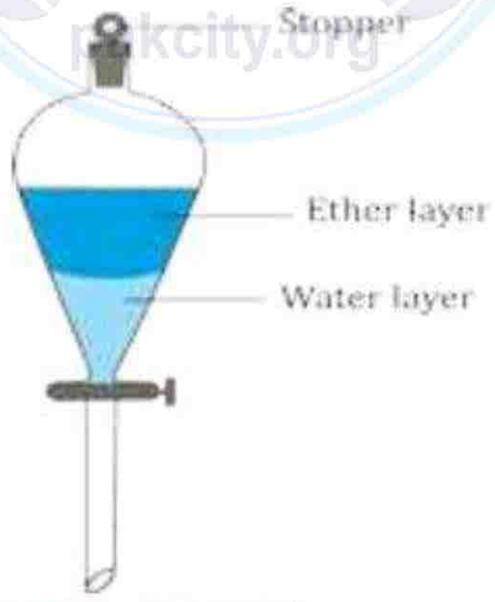
Ans: To carry out the process, the substance is taken in a watch glass covered with an inverted funnel. The substance is then heated slowly over a sand-bath and the funnel is cooled with wet cotton. The pure solid deposits on the inner side of the funnel.

25. What is solvent extraction?

Ans: Solvent extraction is an important technique in chemical analysis. According to this technique, a solute can be separated from a solution by shaking the solution with a solvent in which the solute is more soluble and the added solvent does not mix with the solution. Usually it is done by placing the solution and the second liquid into a separating funnel. The funnel is stoppered andthe two liquids are shaken together.

26. What is ether extraction?

Ans: Ether extraction is used to separate the products of organic synthesis from water. In a typical organic synthesis, the aqueous solution containing the organic product is shaken up with ether in a separating funnel and allowed to separate. The inorganic impurities remain in aqueous phase whereas the organic compound goes to the ether layer. The ether layer is separated and the organic product is obtained by evaporating the ether.



Separating funnel

27. Why repeated extractions are more efficient than single extraction in solvent extraction?

OR

In solvent extraction technique, why repeated extraction using small portions of solvents are more efficient than using a single extraction but larger volume of solvent?

Ans: In solvent extraction technique, repeated extraction using small portions of solvents are more efficient than using a single extraction than larger volume of solvent because organic solvents (such as CCl_4, $CHCl_3$, ether etc.) can absorb approximately half of amount of solute from aqueous solvent. Thus no complete extraction can be done in a single extraction.

28. What is distribution law or partition law?

Ans: Partition law states that a solute distributes itself between two immiscible liquids in a constant ratio of concentrations irrespective of the amount of solute added.

$$\text{Distribution coefficient (KD)} = \frac{\text{Concentration of solute in organic phase}}{\text{Concentration of solute in aqueous phase}}$$

29. Iodine is more soluble in water in the presence of KI. Give reason.

Ans: For the dissolution of I_2 in water a dilute solution of KI should be prepared. The molecule I_2 combines with I^- of KI to generate I_3^- ion. The ion I_3^- is soluble in water. I_2 is not soluble in water.

$$KI + I_2 \rightleftharpoons K^{\oplus} I_3^{\ominus}$$

30. What is stationary phase and mobile phase?

Ans: The stationary phase may be a solid or a liquid supported as a thin film on the surface of an inert solid. The mobile phase flowing over the surface of the stationary phase may be a gas or a liquid.

31. What is distribution coefficient? To which technique is it applicable?

Ans: Distribution coefficient is the ratio of the amounts of solute dissolved in the immiscible liquids at equilibrium.

$$\text{Distribution coefficient (KD)} = \frac{\text{Concentration of solute in organic phase}}{\text{Concentration of solute in aqueous phase}}$$

This is applicable to solvent extraction and is also applied to chromatography

$$K = \frac{\text{Concentration of the component in the moving phase}}{\text{Concentration of the component in the stationary phase}}$$

32. What is the effect of distribution coefficient on distribution of solute?

Ans: The component of a mixture with a small value of K mostly remains in the stationary phase as the moving phase flows over it. The component with a greater value of K remains largely dissolved in the mobile phase and passes over the stationary phase quickly.

33. What is adsorption chromatography and partition chromatography?

Or

What are the types of chromatography?

Ans: **Adsorption Chromatography:** Chromatography in which the stationary phase is a solid, is classified as adsorption chromatography. In this type, a substance leaves the mobile phase to become adsorbed on the surface of the solid phase.

Example: Thin layer chromatography or column chromatography

Partition Chromatography: Chromatography in which the stationary phase is a liquid, is called partition chromatography. In this type, the substances being separated are distributed throughout both the stationary and mobile phases.

Example: Paper chromatography

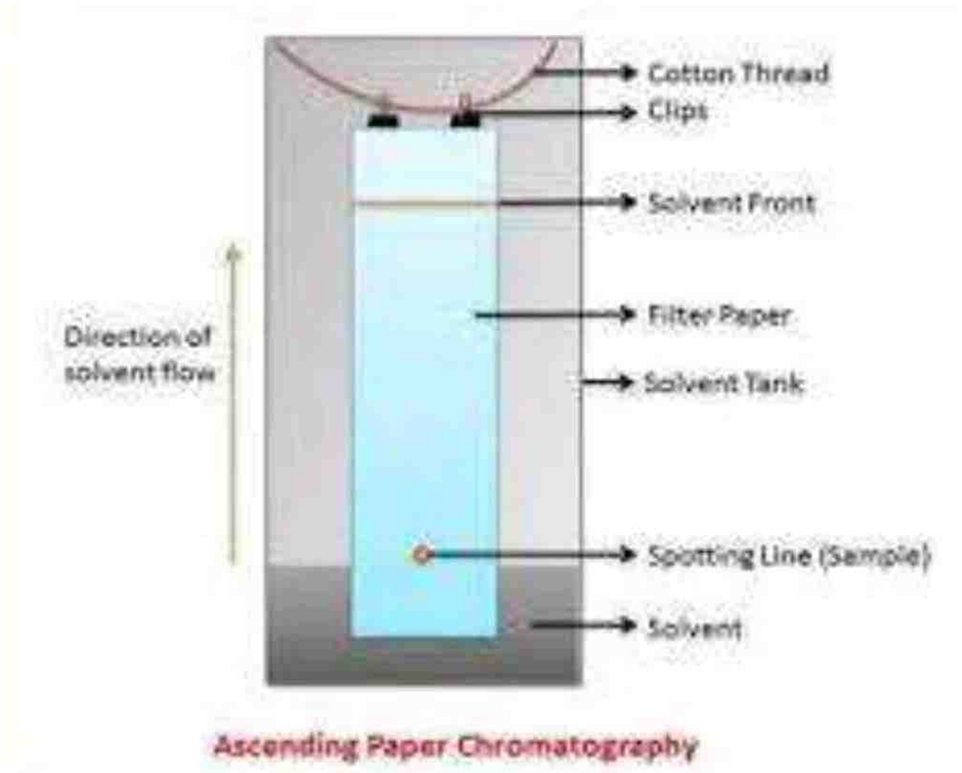
34. What are the types of paper chromatography?

Ans: There are three common ways of carrying out paper chromatography namely:

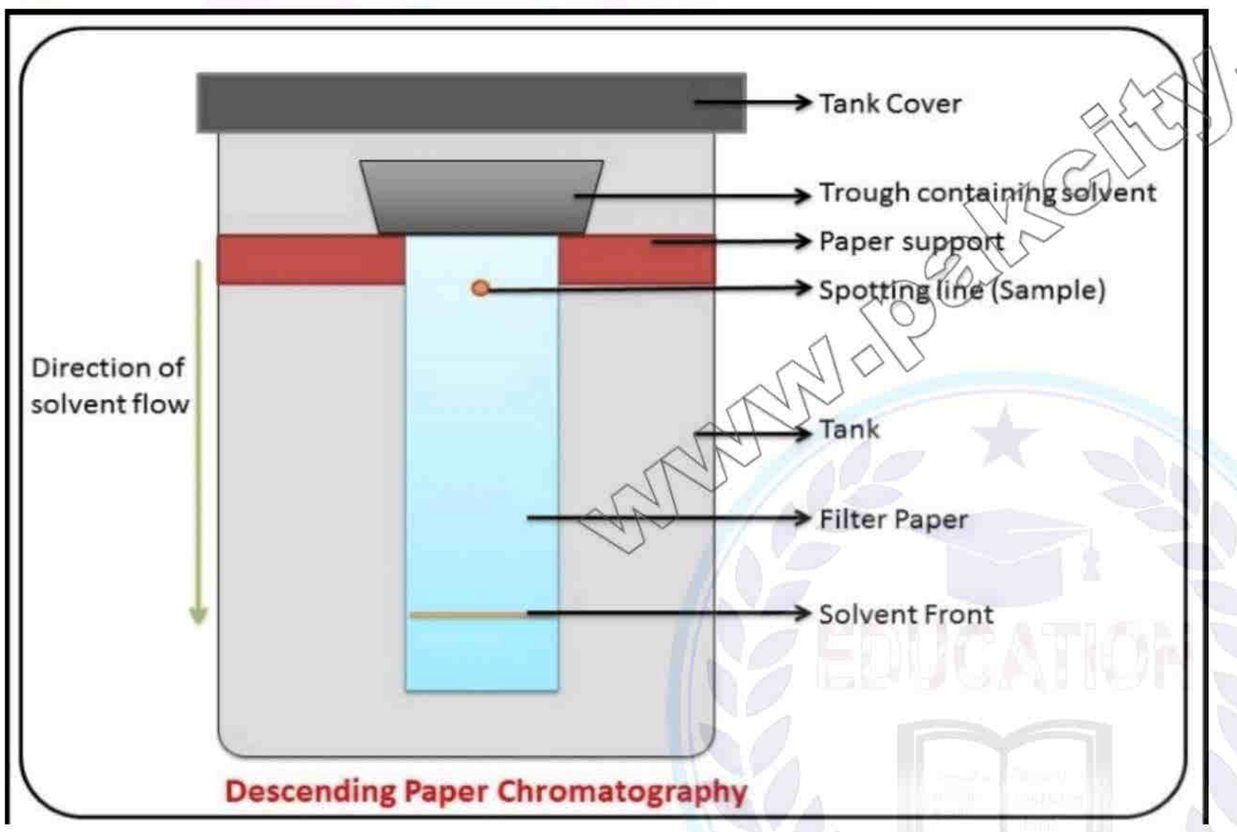
(i) ascending

(ii) descending

(iii) radial/circular



Ascending Paper Chromatography



Descending Paper Chromatography

35. ***What is Rf? Why it has no units?***

Ans: R_f stands for retention factor or retardation factor.

$$Rf = \frac{\text{Distance travelled by a component from the original spot (cm)}}{\text{Distance travelled by solvent from the original spot (cm)}}$$

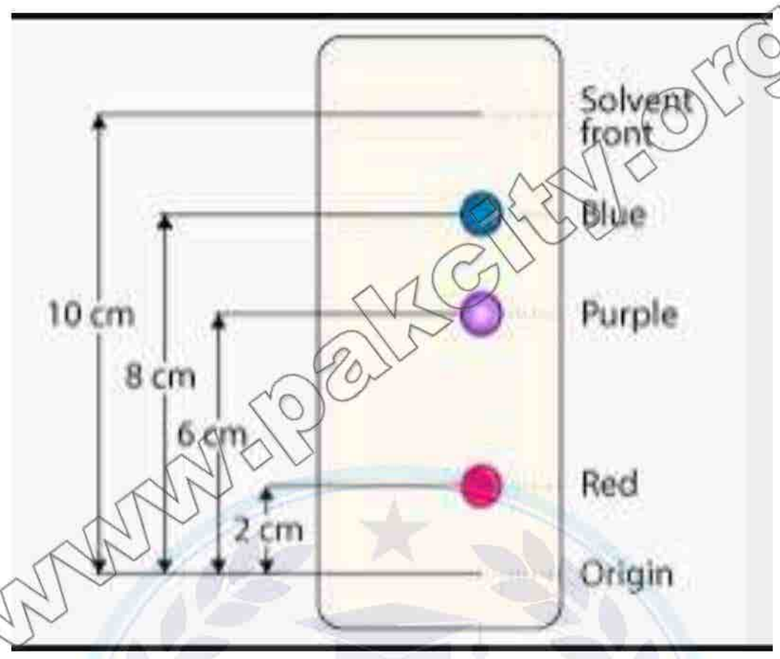
As R_f is the ratio between two similar quantities it has no units.

36. What are the uses of chromatography? OR Give any two uses of chromatography.

Ans: The techniques of chromatography are very useful in organic synthesis for separation, isolation and purification of the products. They are equally important in qualitative and quantitative analyses and for determination of the purity of a substance.

37. What is chromatogram?

Ans: The final filter paper having all the separated components on it is called a chromatogram.



38. A water insoluble organic compound aspirin is prepared by the reaction of salicylic acid with a mixture of acetic acid and acetic anhydride. How will you separate the product from the reaction mixture?

Ans: The product of the reaction mixture is insoluble in water. It can be separated easily by filtration. The reaction mixture is added to the cold water. Aspirin crystallizes out when dissolves in cold water while other products are water soluble. So aspirin can be separated from the reaction mixture by filtration.