

DEPARTMENT OF INSTRUMENTATION AND CONTROL ENGINEERING
ICH584-ANALYTICAL INSTRUMENTATION
QUESTION BANK
UNIT I – SPECTROPHOTOMETRY
Part A

I. Choose the correct answer

1. Spectral methods of analysis are based on the interaction between:

- A) Heat and matter
- B) Electromagnetic radiation and matter
- C) Sound and matter
- D) Pressure and matter

Answer: B

2. Beer–Lambert law relates absorbance with:

- A) Pressure and temperature
- B) Concentration and path length
- C) Density and viscosity
- D) Time and volume

Answer: B

3. The wavelength range of UV and visible regions are respectively:

- A) 200–400 nm and 400–700 nm
- B) 400–700 nm and 200–400 nm
- C) 10–100 nm and 700–1000 nm
- D) 700–1000 nm and 400–700 nm

Answer: A

4. The visible light source used in a UV-Visible spectrophotometer is:

- A) Deuterium lamp
- B) Hydrogen lamp
- C) Tungsten lamp
- D) Xenon lamp

Answer: C

5. Which optical component is commonly used to disperse radiation into its component wavelengths?

- A) Prism or diffraction grating
- B) Sample cell
- C) Beam splitter
- D) Photocell

Answer: A

6. The instrument used to hold the sample solution in a UV-Visible spectrophotometer is called:

- A) Burner
- B) Cuvette
- C) Atomizer
- D) Nebulizer

Answer: B

7. Which detector is commonly used in UV-Visible spectroscopy?

- A) Thermocouple
- B) Photomultiplier tube
- C) Flame detector
- D) Geiger counter

Answer: B

8. IR spectroscopy is mainly based on:

- A) Electronic transition
- B) Molecular vibration
- C) Nuclear transition
- D) Ionization

Answer: B

9. Which is an IR radiation source?

- A) Tungsten lamp
- B) Deuterium lamp
- C) Nernst glower
- D) Hollow cathode lamp

Answer: C

10. FTIR stands for:

- A) Fast Transform Infrared Radiation
- B) Fourier Transform Infrared
- C) Full Transmission Infrared
- D) Frequency Transform IR

Answer: B

11. The fingerprint region of an IR spectrum is particularly useful for:

- A) Identifying compounds
- B) Measuring pressure

- C) Measuring flame temperature
- D) Determining dissolved oxygen

Answer: A

12. The output produced by the interferometer is called:

- A) Spectrum
- B) Interferogram
- C) Chromatogram
- D) Oscillogram

Answer: B

13. The radiation source used in Atomic Absorption Spectrophotometer is:

- A) Tungsten lamp
- B) Hollow cathode lamp
- C) Nernst glower
- D) Xenon lamp

Answer: B

14. In Atomic absorption spectrophotometer, the sample is converted into free atoms in the:

- A) Detector
- B) Atomizer
- C) Nebulizer
- D) Monochromator

Answer: B

15. The principle of Atomic Absorption Spectroscopy is based on:

- A) Emission of light
- B) Absorption of light by free atoms
- C) Reflection of light
- D) Fluorescence

Answer: B

16. Flame emission photometry measures:

- A) Absorbed light
- B) Reflected light
- C) Emitted light
- D) Scattered light

Answer: C

17. Which component converts sample solution into a fine mist?

- A) Detector
- B) Burner
- C) Nebulizer
- D) Filter

Answer: C

18. The equation of Beer–Lambert law is

- A) $A = \epsilon / cl$
- B) $A = \epsilon cl$
- C) $A = c / \epsilon l$
- D) $A = \epsilon + c + l$

Answer: B

19. The heart of an FTIR spectrophotometer is the

- A) Detector
- B) Monochromator
- C) Michelson interferometer
- D) Sample cell

Answer: C

20. The pyroelectric detector works based on changes in:

- A) Pressure
- B) Electrical polarization due to temperature change
- C) Magnetic field
- D) Current flow through a filament

Answer: B

21. Which of the following is a detector used in IR spectroscopy?

- A) Photodiode
- B) Thermocouple
- C) PMT
- D) Hollow cathode lamp

Answer: B

Analytical MCQs

22. A pharmaceutical company wants to identify the functional groups present in a new drug. Which analytical technique is most suitable?

- A) Flame photometry
- B) FTIR spectroscopy
- C) Atomic Absorption Spectrophotometry

D) UV-Visible spectroscopy

Answer: B

23. During UV analysis, a student accidentally uses a glass cuvette instead of a quartz cuvette. What is the most likely result?

A) Better transmission of UV radiation

B) Incorrect absorbance because glass absorbs UV radiation

C) Increased fluorescence of the sample

D) No change in the experimental result

Answer: B

24. A chemist wants to determine the concentration of a coloured solution using the Beer–Lambert law. Which instrument should be used?

A) UV-Visible spectrophotometer

B) Flame photometer

C) FTIR spectrophotometer

D) Atomic Absorption Spectrophotometer

Answer: A

25. A water sample contains sodium and potassium ions. Which instrument is most suitable for their routine analysis?

A) FTIR spectrophotometer

B) Flame photometer

C) IR spectrophotometer

D) High-Performance Liquid Chromatography (HPLC)

Answer: B

26. During FTIR analysis, the beam splitter becomes damaged. Which process will be directly affected?

A) Atomization of the sample

B) Formation of the interferogram

C) Nebulization of the sample

D) Emission of radiation by the source

Answer: B

27. A scientist requires rapid acquisition of the complete IR spectrum with high sensitivity. Which instrument is most appropriate?

A) Conventional IR spectrophotometer

B) FTIR spectrophotometer

C) Flame photometer

D) UV-Visible spectrophotometer

Answer: B

28. In an Atomic Absorption Spectrophotometry experiment, the nebulizer becomes blocked. What will be the immediate effect?

- A) The sample cannot be converted into a fine aerosol for atomization.
- B) The detector stops functioning.
- C) The hollow cathode lamp stops emitting radiation.
- D) The monochromator stops selecting wavelengths.

Answer: A

29. A sample shows strong absorption at 280 nm. This absorption is mainly due to:

- A) Molecular vibration
- B) Electronic transition
- C) Nuclear transition
- D) Magnetic resonance

Answer: B

30. A laboratory needs to determine the concentration of iron in drinking water. Which instrument is most suitable?

- A) UV Spectrophotometer
- B) FTIR
- C) Atomic Absorption Spectrophotometer
- D) Paper chromatography

Answer: C

PART-B

II. Descriptive type questions

1. Explain the construction and working of a double-beam UV-Visible spectrophotometer with a neat block diagram.
2. Explain the construction and working of an FTIR spectrophotometer with a neat diagram.
3. Explain the construction and working of Atomic Absorption Spectrophotometry and mention its applications.
4. Explain the construction and working of a flame emission photometer. Mention its applications.

5. Analytical type question

A) Assertion and Reason (2 Marks)

Assertion (A): UV-Visible spectroscopy can be used to determine the concentration of a coloured solution.

Reason (R): According to Beer-Lambert law, absorbance is directly proportional to the concentration of the solution.

- A) Both A and R are true, and R is the correct explanation of A.
- B) Both A and R are true, but R is not the correct explanation of A.
- C) A is true, but R is false.
- D) A is false, but R is true.

B) Identify the Instrument (2 Marks)

A pharmaceutical laboratory wants to identify the functional groups present in a newly prepared organic compound. The instrument measures absorption due to molecular vibrations. Identify the instrument.

C) Select the Correct Statements (2 Marks)

- 1. UV-Visible spectroscopy involves electronic transitions.
- 2. Quartz cuvettes are used for UV measurements.
- 3. FTIR uses an interferometer to obtain the IR spectrum.
- 4. AAS measures the emission of light from excited atoms.

D) Match the Following – (2Marks)

Column A

- 1. Beer-Lambert law
- 2. FTIR
- 3. UV spectroscopy
- 4. IR spectroscopy
- 5. AAS

Column B

- a. Michelson interferometer
- b. Concentration and absorbance
- c. Molecular vibrations
- d. Electronic transitions
- e. Hollow cathode lamp

E) Identify the Instrument (2 Marks)

A laboratory needs to determine the concentration of metal ions such as sodium, calcium or iron in a sample. Which spectroscopic technique is commonly used to identify and determine the concentration of metals present in a sample?

UNIT II – CHROMATOGRAPHY

Part A

I. Choose the correct answer

1. Chromatography was introduced by:

- A) Robert Bunsen
- B) Mikhail Tswett
- C) Louis Pasteur
- D) Michael Faraday

Answer: B

2. Chromatography is mainly used for:

- A) Heating compounds
- B) Separating components of a mixture
- C) Measuring pressure
- D) Measuring viscosity

Answer: B

3. The word 'Chromatography' means:

- A) Colour separation
- B) Colour writing
- C) Light absorption
- D) Colour detection

Answer: B

4. The stationary phase in chromatography:

- A) Always moves
- B) Remains fixed
- C) Is always a gas
- D) Is always a liquid

Answer: B

5. The mobile phase in gas chromatography is:

- A) Solid
- B) Liquid
- C) Gas
- D) Gel

Answer: C

6. Separation in chromatography occurs because of differences in:

- A) Colour
- B) Affinity towards stationary and mobile phases
- C) Density only
- D) Melting point

Answer: B

7. Which chromatography is based on adsorption?

- A) Paper chromatography
- B) Column chromatography
- C) Gas-liquid chromatography

D) Partition chromatography

Answer: B

8. Which adsorbent is commonly used as the stationary phase in column chromatography?

A) Cotton

B) Silica gel

C) Charcoal

D) Glass wool

Answer: B

9. The flow of solvent in column chromatography is controlled by the:

A) Detector

B) Stopcock

C) Recorder

D) Pump

Answer: B

10. Paper chromatography is based on the principle of:

A) Adsorption

B) Partition

C) Ion exchange

D) Size exclusion

Answer: B

11. In paper chromatography, the solvent moves upward by:

A) Diffusion

B) Gravity

C) Capillary action

D) Centrifugal force

Answer: C

12. TLC stands for:

A) Thin Layer Chromatography

B) Thermal Layer Chromatography

C) Total Liquid Chromatography

D) Thin Liquid Column

Answer: A

13. The stationary phase used in TLC is usually:

- A) Water
 - B) Silica gel
 - C) Nitrogen
 - D) Helium
- Answer: B

14. The separated spots in TLC are commonly visualized using:

- A) UV light
 - B) Laser beam
 - C) X-rays
 - D) Sunlight only
- Answer: A

15. The heart of a gas chromatograph is the:

- A) Detector
 - B) Chromatographic column
 - C) Recorder
 - D) Carrier gas cylinder
- Answer: B

16. Which gas is commonly used as the carrier gas in GC?

- A) Oxygen
 - B) Nitrogen
 - C) Carbon dioxide
 - D) Chlorine
- Answer: B

17. The graphical output of chromatography is called:

- A) Spectrogram
 - B) Chromatogram
 - C) Interferogram
 - D) Thermogram
- Answer: B

18. HPLC stands for:

- A) High Pressure Liquid Chromatography
 - B) High Performance Liquid Chromatography
 - C) High Precision Liquid Chromatography
 - D) High Power Liquid Chromatography
- Answer: B

19. The mobile phase in HPLC is pumped through the column using:

- A) Vacuum pump
- B) High-pressure pump
- C) Air compressor
- D) Syringe only

Answer: B

20. Liquid Chromatography (LC) is mainly used for the analysis of:

- A) Highly volatile compounds
- B) Non-volatile and thermally unstable compounds
- C) Permanent gases only
- D) Noble gases only

Answer: B

21. Retention time is the time taken for a component to:

- A) Enter the detector
- B) Reach the detector after injection
- C) Dissolve in the solvent
- D) Leave the injection port

Answer: B

Analytical MCQs

21. A chemist wants to separate chlorophyll and xanthophyll from a plant extract. Which technique should be used?

- A) UV spectroscopy
- B) Column chromatography
- C) Flame photometry
- D) FTIR spectroscopy

Answer: B

22. In a planar chromatography experiment, a component travels 4 cm from the origin while the solvent front travels 8 cm. What is the retention factor (R_f) of the component?

- A) 0.25
- B) 0.50
- C) 2
- D) 4

Answer: B

23. In TLC, silica gel is accidentally not coated on the plate. What will be the immediate effect?

- A) The sample will vaporize
- B) Separation will not occur properly
- C) The detector will fail
- D) The solvent will evaporate immediately

Answer: B

24. During column chromatography, the stopcock is fully closed after adding the solvent. What will happen?

- A) The solvent flows faster
- B) The mobile phase cannot pass through the column
- C) The detector stops working
- D) The sample becomes more concentrated

Answer: B

25. A sample contains volatile organic compounds. Which chromatographic technique is most suitable for analysis?

- A) Paper chromatography
- B) Gas chromatography
- C) Thin Layer Chromatography
- D) HPLC

Answer: B

26. During gas chromatography, helium supply is interrupted. What will be the immediate effect?

- A) The detector becomes more sensitive
- B) The sample cannot be carried through the column
- C) Peak area increases
- D) Retention time becomes zero

Answer: B

27. A pharmaceutical company wants to analyze a heat-sensitive drug. Which technique is the best choice?

- A) Gas chromatography
- B) HPLC
- C) Flame photometry
- D) IR spectroscopy

Answer: B

28. During HPLC analysis, the high-pressure pump stops working. Which process is directly affected?

- A) Detection of peaks
- B) Flow of the mobile phase through the column
- C) Sample injection
- D) Signal recording

Answer: B

29. A chromatogram shows two peaks with different retention times. This indicates that:

- A) The sample contains two different components
- B) The detector has failed
- C) The mobile phase is contaminated
- D) The sample is completely pure

Answer: A

30. A mixture containing ethanol and water is injected into a gas chromatograph. Ethanol appears as the first peak because it has a lower boiling point than water. What is the reason for this?

- A) Ethanol has a longer retention time.
- B) Ethanol moves faster through the column due to its higher volatility.
- C) Ethanol reacts with the detector.
- D) Water is used as the stationary phase.

Answer: B

PART-B

II.Descriptive type questions

1. What is chromatography? with a neat diagram explain the construction and working of Column Chromatography.
2. Explain Paper Chromatography with neat diagram.
3. Explain the principle, construction and working of a Gas Chromatography with a neat diagram.
4. Explain the working of a High-Pressure Liquid Chromatography system with a neat diagram.

Analytical type question

5.(i) Assertion and Reason Type Question (2 Marks)

Assertion (A): Gas Chromatography (GC) is suitable for separating volatile and thermally stable compounds.

Reason (R): In Gas Chromatography, the mobile phase is an inert carrier gas that transports the sample through the column.

Options:

- (A) Both A and R are true, and R is the correct explanation of A
- (B) Both A and R are true, but R is not the correct explanation of A
- (C) A is true, but R is false.
- (D) A is false, but R is true.

(ii) Identify the Technique (2 Marks)

A laboratory needs to separate and identify the different coloured pigments present in black ink. The sample is placed on a stationary phase, and a solvent moves upward by capillary action, separating the pigments into distinct coloured bands. Identify the chromatographic technique.

(iii) Select the Correct Statements (2 Marks)

- a) In chromatography, the mobile phase carries the sample through the stationary phase.
- b) The stationary phase always moves along with the sample during separation.
- c) Components with greater affinity for the stationary phase move more slowly and separate later.
- d) Gas Chromatography is suitable for separating volatile compounds.
- e) Liquid Chromatography uses a liquid as the mobile phase.

(VI) Identify the device. (2 Marks)

A device is used to introduce a very small volume of liquid sample into the carrier gas stream through a self-sealing rubber septum in Gas Chromatography.

(V) Arrange the steps in correct order related to the working of Thin Layer Chromatography (2 Marks)

- A) The separated components appear as distinct spots on the paper.
- B) The sample mixture is spotted near the bottom of the chromatography paper.
- C) The TLC plate is placed in a solvent with the sample spot above the solvent level.
- D) The solvent rises through the paper by capillary action, carrying the sample components.
- E). The chromatogram is removed, dried, and the separated spots are observed.

UNIT-III – INDUSTRIAL GAS ANALYSER

PART-A

I. Choose the correct answer

- 1. The primary purpose of industrial gas analysers is to
 - A) Increase fuel consumption
 - B) Monitor and measure gas concentration
 - C) Reduce pipe diameter

D) Increase process pressure

Answer: B

2. A oxygen analyser works based on the

- A) Infrared absorption
- B) Paramagnetic property
- C) Thermal conductivity
- D) Ionization

Answer: B

3. In a paramagnetic oxygen analyser, the dumbbell is filled with

- A) Oxygen
- B) Nitrogen
- C) Hydrogen
- D) Carbon dioxide

Answer: B

4. Which analyser works on the chemiluminescence principle?

- A) Oxygen analyser
- B) NO_x analyser
- C) IR analyser
- D) Thermal conductivity analyser

Answer: B

5. In a NO_x analyser, nitric oxide reacts with _____ to produce light.

- A) Nitrogen
- B) Oxygen
- C) Ozone
- D) Carbon monoxide

Answer: C

6. The emitted light in a chemiluminescence analyser is detected by a

- A) Thermocouple
- B) Photomultiplier tube
- C) LVDT
- D) Strain gauge

Answer: B

7. The H₂S analyser commonly operates on the

- A) UV fluorescence principle
- B) Magnetic principle
- C) Thermal conductivity principle
- D) Piezoelectric principle

Answer: A

8. The UV lamp in an H₂S analyser is used to

- A) Generate ozone
- B) Excite SO₂ molecules
- C) Heat the sample
- D) Measure pressure

Answer: B

9. Which analyser works on the Non-Dispersive Infrared (NDIR) absorption principle?

- A) Thermal conductivity analyser
- B) Infrared gas analyser
- C) Paramagnetic analyser
- D) Flame ionization detector

Answer: B

10. Which gas is commonly measured using an infrared gas analyser?

- A) Oxygen
- B) Nitrogen
- C) Carbon monoxide
- D) Helium

Answer: C

11. The thermal conductivity analyser uses a

- A) Wheatstone bridge
- B) Maxwell bridge
- C) Schering bridge
- D) Wien bridge

Answer: A

12. The sensing elements of a thermal conductivity analyser are called

- A) Bellows
- B) Katharometer elements
- C) Bourdon tubes
- D) Diaphragms

Answer: B

13. The Flame Ionization Detector (FID) is mainly used for measuring

- A) Oxygen
- B) Hydrocarbons
- C) Nitrogen
- D) Sulphur dioxide

Answer: B

14. The flame used in an FID is

- A) Oxygen–acetylene
- B) Hydrogen–air
- C) LPG–air
- D) Nitrogen–air

Answer: B

15. Carbon monoxide absorbs radiation in the:

- A) Ultraviolet region
- B) Visible region
- C) Infrared region
- D) X-ray region

Answer: C

16. Which of the following is a major harmful effect of sulphur dioxide (SO₂) in the atmosphere?

- A) Formation of acid rain
- B) Increase in dissolved oxygen in water
- C) Reduction of atmospheric humidity
- D) Increase in photosynthesis

Answer: A

17. Dust monitors help industries to:

- A) Increase production speed
- B) Comply with environmental pollution standards
- C) Reduce water consumption
- D) Measure humidity

Answer: B

18. Smoke measurement is based on the

- A) Magnetic principle
- B) Mie scattering principle
- C) Thermal conductivity principle
- D) UV fluorescence principle

Answer: B

19. The principle of the Flame Ionization Detector is based on:

- A) Absorption of light
- B) Ionization of organic compounds in a hydrogen flame
- C) Thermal conductivity
- D) Magnetic susceptibility

Answer: B

20. Dust particles smaller than _____ are considered highly dangerous because they penetrate deep into the lungs.

- A) 50 µm
- B) 20 µm
- C) 5 µm
- D) 100 µm

Answer: C

21. Which instrument is used to monitor smoke density in diesel engine exhaust?

- A) Opacity meter
- B) Paramagnetic analyser
- C) Chemiluminescence analyser
- D) Thermal conductivity analyser

Answer: A

Analytical MCQ

22. A paramagnetic oxygen analyser is installed in a boiler. The sample gas contains moisture and dust, resulting in unstable readings. Which is the most likely reason?

- A) Oxygen has become diamagnetic
- B) Moisture and dust interfere with the measurement.
- C) Magnetic field strength has increase
- D) Nitrogen concentration has increase

Answer: B

23. A chemiluminescence analyser measures total NO_x as 120 ppm and as 85 p

- A) 35 ppm
- B) 120 ppm
- C) 85 ppm
- D) 205 ppm

Answer: A

24. A gas sample contains oxygen, nitrogen and carbon dioxide. Which gas mainly causes the output signal in a paramagnetic analyser?

- A) Nitrogen
- B) Carbon dioxide
- C) Oxygen
- D) All gases equally

Answer: C

25. A boiler is operating with insufficient air supply, causing incomplete combustion of fuel. The flue gas analyser shows an increased concentration of which pollutant?

- A) SO₂
- B) CO₂
- C) CO
- D) O₂

Answer: C

26. A Flame Ionization Detector (FID) produces almost no output when analysing carbon dioxide. What is the reason?

- A) CO₂ does not absorb UV light.
- B) CO₂ does not produce ions in a hydrogen-air flame.
- C) CO₂ is paramagnetic
- D) CO₂ has high thermal conductivity.

Answer: B

27. During H_2S measurement, the UV lamp stops working. Which part of the analyser will be directly affected?

- A) Sample pump
- B) Fluorescence chamber
- C) Display unit
- D) Particulate filter

Answer: B

28. A thermal conductivity analyser gives zero output when both reference gas and sample gas are identical. This is because

- A) the Wheatstone bridge remains balanced.
- B) all filaments are switched off.
- C) oxygen absorbs heat completely.
- D) the detector becomes saturate

Answer: A

29. An optical dust monitor shows a higher output when dust concentration increases. Which property of dust causes this change?

- A) Magnetic attraction
- B) Light scattering
- C) Electrical conductivity
- D) Infrared absorption

Answer: B

30. In an optical smoke detector, an increase in smoke concentration causes:

- A) combustion efficiency has improved.
- B) smoke particles are blocking more light.
- C) oxygen concentration has increase.
- D) the exhaust gas has become cleaner.

Answer: B

Part-B

II. Descriptive Type Question

1. Explain the Paramagnetic Oxygen Analyser with a neat diagram.
2. Explain the Thermal conductivity analyser with a neat diagram.
3. Explain the causes of air pollution due to hydrocarbons and describe the estimation of hydrocarbons.
4. Explain the construction and working of an Optical Dust Monitor with neat diagrams.

5 Analytical type question

A) Assertion and Reason (2 Marks)

Assertion (A): A Flame Ionization Detector is widely used for measuring hydrocarbons in exhaust gases.

Reason (R): Organic compounds produce ions when burned in a hydrogen-air flame, generating an ion current proportional to their concentration.

- a) Both A and R are true, and R is the correct explanation of A
- b) Both A and R are true, but R is not the correct explanation of A
- c) A is true, but R is false.
- d) A is false, but R is true.

B) Identify the Device (2 Marks)

A gas analyser uses a sample cell, reference cell, infrared source, optical filter and detector. It measures gas concentration based on infrared absorption. Identify the instrument.

C) Select the Correct Statements (2 Marks)

- 1. Oxygen is a paramagnetic gas.
- 2. NO reacts with ozone in a chemiluminescence analyser.
- 3. Flame Ionization Detector is used for oxygen measurement.
- 4. Optical dust monitors operate based on light scattering.

D) Arrange the Steps (2 Marks)

Arrange the following steps involved in NO_x measurement using a Chemiluminescence Analyser.

- 1. Light is detected by the photomultiplier tube.
- 2. Sample gas enters the reaction chamber.
- 3. Nitric oxide reacts with ozone.
- 4. Electrical output proportional to NO concentration is obtained

E) Match the Following (2 marks)

Column A	Column B
A. Paramagnetic oxygen analyser	1. Photomultiplier tube
B. NO _x analyser	2. Nitrogen-filled dumbbell
C. H ₂ S analyser	3. Four matched filaments
D. TCD	4. UV fluorescence chamber

UNIT IV – pH Meters and Dissolved Component Analysers

PART – A

I. Choose the correct answer

(30 × 1 = 30)

- 1. The pH of a solution indicates its
 - A) Electrical conductivity
 - B) Acidity or alkalinity
 - C) Temperature

D) Pressure

Answer: B

2. A pH meter measures the concentration of

A) Sodium ions

B) Chloride ions

C) Hydrogen ions

D) Calcium ions

Answer: C

3. Which electrode is directly sensitive to hydrogen ions?

A) Glass electrode

B) Reference electrode

C) Calomel electrode

D) Platinum electrode

Answer: A

4. The pH value of a neutral solution is

A) 0

B) 14

C) 1

D) 7

Answer: D

5. The reference electrode commonly contains

A) Mercury and calomel

B) Copper sulphate

C) Zinc chloride

D) Sodium hydroxide

Answer: A

6. The main function of a reference electrode is to provide

A) High current

B) High resistance

C) Constant potential

D) Variable voltage

Answer: C

7. Which type of membrane is commonly used in an ion-selective electrode for measuring fluoride ions (F^-)?

A) Glass membrane

B) Crystalline membrane

C) Ion-exchange resin membrane

D) Metal membrane

Answer: B

8. Which membrane is used in an ammonia electrode?

- A) Cellulose membrane
- B) Glass membrane
- C) Nylon membrane
- D) Gas-permeable membrane

Answer: D

9. Which reagent is added to the sample solution to convert ammonium ions (NH_4^+) into ammonia gas (NH_3) in an ammonia gas-sensing electrode?

- A) Hydrochloric acid (HCl)
- B) Sodium chloride (NaCl)
- C) Sodium hydroxide (NaOH)
- D) Sulphuric acid (H_2SO_4)

Answer: C

10. A biosensor converts a biological reaction into

- A) Heat energy
- B) Electrical signal
- C) Mechanical energy
- D) Sound energy

Answer: B

11. Which enzyme is used in a glucose biosensor?

- A) Glucose oxidase
- B) Catalase
- C) Urease
- D) Lipase

Answer: A

12. A dissolved oxygen analyser measures oxygen dissolved in

- A) Air
- B) Steam
- C) Soil
- D) Water

Answer: D

13. The cathode in a dissolved oxygen analyser is usually made of

- A) Silver
- B) Gold
- C) Iron
- D) Aluminium

Answer: A

14. A thermal power plant monitors sodium ion concentration in boiler water. Why is sodium analysis important?

- A) Sodium increases the water temperature.
- B) Sodium improves turbine efficiency.

- C) Excess sodium can cause corrosion and deposits.
- D) Sodium removes impurities from water.

Answer: C

15. In sodium analyser, the ion-selective electrode contains a

- A) Sensitive glass membrane
- B) Rubber membrane
- C) Plastic membrane
- D) Cellulose membrane

Answer: A

16. A silica analyser works on the

- A) Chemiluminescence principle
- B) Paramagnetic principle
- C) Thermal conductivity principle
- D) Colorimetric principle

Answer: D

17. In a silica analyser, dissolved silica reacts with ammonium molybdate to form a

- A) White precipitate
- B) Yellow complex
- C) Green complex
- D) Red complex

Answer: B

18. A water quality analyser is used to measure

- A) Only pH
- B) Only conductivity
- C) Multiple water quality parameters
- D) Only dissolved oxygen

Answer: C

19. Which sensor measures suspended particles in water?

- A) Turbidity sensor
- B) pH sensor
- C) Conductivity sensor
- D) Dissolved oxygen sensor

Answer: A

20. Dissolved oxygen concentration is commonly expressed in

- A) Pascal
- B) Ohms
- C) Volt
- D) mg/L

Answer: D

21. A glucose biosensor is widely used in

- A) Textile industries
- B) Healthcare and hospitals
- C) Cement industries
- D) Mining industries

Answer: B

Analytical MCQs

22. A pharmaceutical company needs to continuously monitor the acidity of a chemical solution during production. Which instrument is most suitable for this application?

- A) Conductivity meter
- B) Turbidity meter
- C) pH meter
- D) Hygrometer

Answer: C

23. Why is dissolved oxygen measured in a power plant?

- A) To increase the temperature of boiler water
- B) To increase the pressure of steam
- C) To prevent corrosion of boiler and feedwater equipment
- D) To increase the dissolved oxygen level

Answer: C

24. Before measuring the pH of a sample, a technician calibrates the pH meter using standard buffer solutions. The main purpose of calibration is to

- A) Increase the sample temperature.
- B) Improve the accuracy of measurement.
- C) Remove dissolved oxygen.
- D) Neutralize the sample.

Answer: B

25. Which type of biosensor measures the heat generated during an enzyme-catalyzed reaction?

- A) Optical biosensor
- B) Piezoelectric biosensor
- C) Calorimetric biosensor
- D) Amperometric biosensor

Answer: C

26. What is the main function of an enzyme in a biosensor?

- A) To convert the biochemical reaction into an electrical signal
- B) To specifically recognize the analyte and catalyze its biochemical reaction
- C) To amplify the electrical signal produced by the sensor
- D) To measure the physical change produced by the biochemical reaction

Answer: B

27. During silica analysis, ammonium molybdate is added to the water sample to
- A) Remove dissolved oxygen.
 - B) Increase the pH.
 - C) Produce a coloured complex with silica.
 - D) Reduce the sodium concentration.

Answer: C

28. A multiparameter water quality analyser is capable of measuring
- A) Pressure, flow and level
 - B) Voltage, current and resistance
 - C) Speed, torque and vibration
 - D) pH, dissolved oxygen and conductivity

Answer: D

29. A pH meter gives incorrect readings even after replacing the battery. The most likely reason is
- A) Damaged glass electrode.
 - B) Low water level in the sample.
 - C) High dissolved oxygen concentration.
 - D) Excessive room lighting.

Answer: A

30. In an ammonia electrode, ammonia is detected after which process?
- A) Ammonia gas diffuses through a gas-permeable membrane and changes the internal electrolyte pH.
 - B) Ammonium ions diffuse through the gas-permeable membrane and directly change the internal pH.
 - C) Ammonia gas reacts with the glass membrane to produce an electrical potential.
 - D) Ammonium ions pass through the glass electrode and generate the measurement signal.

Answer: A

PART-B

II. Descriptive type question

1. Explain the construction and working of a glass electrode. State its limitations.
2. Explain the construction and working of selective ion electrode
3. Explain the construction, working, Dissolved Oxygen (DO) analyser using the galvanic cell method with a neat diagram.
4. What is Biosensor? Explain glucose biosensor with neat diagram and its application.

5. Analytical type question

A) Assertion and Reason (2 Marks)

Assertion (A): A glass electrode is commonly used to measure the pH of a solution.

Reason (R): The glass membrane develops a potential difference that depends on the hydrogen ion concentration of the solution.

- a) Both A and R are true, and R is the correct explanation of A.
- b) Both A and R are true, but R is not the correct explanation of A.
- c) A is true, but R is false.
- d) A is false, but R is true.

B) Identify the Analyser (2 Marks)

During water quality testing, the engineer observes that fish in a pond are dying due to a very low concentration of oxygen in water. An instrument is required to continuously monitor this parameter. Which analyser should be selected?

C) Match the Following (2 Marks)

Column A

- 1. Glass Electrode
- 2. Reference Electrode
- 3. Biosensor
- 4. ISFET

Column B

- A. Converts biological reaction into an electrical signal
- B. Constant potential
- C. Measures hydrogen ion concentration
- D. Semiconductor-based pH sensor

D) Arrange the Steps (2 Marks)

Arrange the following steps involved in the measurement of dissolved oxygen using the galvanic cell method.

- 1. Electrical current is generated.
- 2. Dissolved oxygen diffuses through the Teflon membrane.
- 3. Oxygen is reduced at the silver cathode.
- 4. The current is displayed as dissolved oxygen concentration.

E) Identify the Analyser (2 Marks)

A water treatment plant measures pH, conductivity, dissolved oxygen, temperature and turbidity using a single analyser to ensure safe drinking water. Identify the analyser.

UNIT-5 -Nuclear Magnetic Resonance and Microscopic Technique

PART – A

I. Choose the best answer ($21 \times 1 = 21$)

1. NMR spectroscopy is mainly used to determine the

- A) Surface structure of materials
- B) Molecular structure of compounds
- C) Particle size of solids
- D) Oxygen concentration

Answer: B

2. In an NMR spectrometer, the sample is placed inside a

- A) Resonant cavity
- B) Strong magnetic field
- C) Vacuum chamber
- D) Ion source

Answer: B

3. The frequency at which a nucleus precesses is called the:

- A) Radio frequency
- B) Larmor frequency
- C) Resonance frequency
- D) Natural frequency

Answer: B

4. Fourier Transform (FT) in an NMR spectrometer is used to

- A) Ionize the sample
- B) Produce the NMR spectrum
- C) Generate RF pulses
- D) Detect electrons

Answer: B

5. Electron Spin Resonance spectroscopy is used to study substances containing

- A) Paired electrons
- B) Unpaired electrons
- C) Protons only
- D) Neutrons only

Answer: B

6. Which component produces microwave radiation in an ESR spectrometer?

- A) Magnet
- B) Klystron
- C) Detector
- D) Resonant cavity

Answer: B

7. Which of the following is an important NMR nucleus?

- A) ^1H
- B) ^{12}C
- C) ^{16}O
- D) ^{23}Na

Answer: A

8. SEM produces images by detecting

- A) X-rays
- B) Secondary electrons
- C) Radio waves
- D) Infrared rays

Answer: B

9. The electron beam in SEM scans the specimen in a

- A) Circular pattern
- B) Raster pattern
- C) Spiral pattern
- D) Random pattern

Answer: B

10. TEM is mainly used to study the

- A) Surface structure
- B) Internal structure
- C) Gas composition
- D) Magnetic properties

Answer: B

11. In a TEM, the electron beam passes through a

- A) Thick specimen
- B) Thin specimen
- C) Liquid sample
- D) Gas sample

Answer: B

12. Which microscope provides information about the internal structure of a specimen?

- A) SEM
- B) TEM
- C) Optical Microscope
- D) Stereo Microscope

Answer: B

13. Mass spectrometry identifies compounds based on their

- A) Colour
- B) Mass-to-charge ratio (m/z)

- C) Density
- D) Viscosity

Answer: B

14. The function of the sample inlet system in a mass spectrometer is to

- A) Detect ions
- B) Introduce the sample
- C) Separate ions
- D) Amplify signals

Answer: B

15. Which ionization method uses high-energy electrons to produce positive ions?

- A) Chemical Ionization
- B) Electron Ionization
- C) Electrospray Ionization
- D) MALDI

Answer: B

16. Which ionization technique is commonly used for liquid samples?

- A) Electron Ionization
- B) Electrospray Ionization
- C) Chemical Ionization
- D) Spark Ionization

Answer: B

17. MALDI ionization uses a

- A) Laser source
- B) Flame
- C) Magnetic field
- D) UV detector

Answer: A

18. In a quadrupole mass analyzer, ions are separated according to their

- A) Size
- B) Mass-to-charge ratio
- C) Colour
- D) Shape

Answer: B

19. Which mass spectrometry technique is suitable for volatile organic compounds?

- A) LC-MS
- B) GC-MS
- C) ICP-MS
- D) MALDI-MS

Answer: B

20. In ICP-MS, the sample is ionized using

- A) Hydrogen flame
- B) Argon plasma
- C) Laser beam
- D) Microwave cavity

Answer: B

21. The detector in ICP-MS converts ions into

- A) Heat energy
- B) Electrical signals
- C) Light energy
- D) Mechanical energy

Answer: B

Analytical MCQs

22. A pharmaceutical company wants to identify the molecular structure of a newly synthesized organic compound without destroying the sample. Which instrument is most suitable?

- A) SEM
- B) TEM
- C) NMR Spectrometer
- D) ESR Spectrometer

Answer: C

23. A researcher wants to detect free radicals produced during a chemical reaction. Which instrument should be selected?

- A) NMR Spectrometer
- B) ESR Spectrometer
- C) SEM
- D) TEM

Answer: B

24. An engineer wants to examine the surface cracks of a fractured metal component. Which instrument is most suitable?

- A) TEM
- B) SEM
- C) NMR Spectrometer
- D) ICP-MS

Answer: B

25. A microbiologist needs to observe the internal structure of bacteria at very high magnification. Which instrument should be used?

- A) SEM
- B) TEM

- C) ESR Spectrometer
- D) NMR Spectrometer

Answer: B

26. A chemist wants to analyze a volatile organic compound separated by gas chromatography. Which analytical technique should be selected?

- A) LC-MS
- B) GC-MS
- C) MALDI-MS
- D) ICP-MS

Answer: B

27. A laboratory is analyzing a heat-sensitive pharmaceutical compound that cannot be vaporized easily. Which mass spectrometry technique is most suitable?

- A) GC-MS
- B) LC-MS
- C) ESR Spectroscopy
- D) SEM

Answer: B

28. A biomedical researcher needs to identify the molecular mass of proteins with minimum fragmentation. Which ionization method is most suitable?

- A) Electron Ionization (EI)
- B) Chemical Ionization (CI)
- C) Matrix-Assisted Laser Desorption Ionization (MALDI)
- D) Spark Ionization

Answer: C

29. An environmental laboratory needs to determine the concentration of trace elements in a water sample with high sensitivity. Which instrument should be selected?

- A) NMR Spectrometer
- B) ICP-MS
- C) SEM
- D) ESR Spectrometer

Answer: B

30. A laboratory requires a mass analyzer that is compact, provides fast analysis, and separates ions according to their mass-to-charge ratio (m/z). Which mass analyzer is most suitable?

- A) Magnetic Sector Analyzer
- B) Quadrupole Mass Analyzer
- C) Ion Trap Analyzer
- D) Time-of-Flight (TOF) Analyzer

Answer: B

PART-B

II. Descriptive type questions

1. Explain the construction and working of an NMR spectrometer with a neat block diagram.
2. Explain the construction and working of an Electron Spin Resonance (ESR) spectrometer with a neat block diagram.
3. Explain the construction and working of a Scanning Electron Microscope with a neat diagram and its applications.
4. Explain the construction and working of Mass Spectrometer using Magnetic Sector Analyser.

5. Analytical type question.

A) Assertion and Reason (2 Marks)

Assertion (A): TEM is used to study the internal structure of a specimen.

Reason (R): In TEM, a beam of electrons passes through a very thin specimen to produce a highly magnified image.

- a) Both A and R are true, and R is the correct explanation of A.
- b) Both A and R are true, but R is not the correct explanation of A.
- c) A is true, but R is false.
- d) A is false, but R is true.

B) Identify the Instrument (2 Marks)

A pharmaceutical laboratory wants to determine the molecular structure of an unknown organic compound without destroying the sample. Which instrument is most suitable?

C) Select the Correct Statements (2 Marks)

1. SEM is used to study the surface structure of materials.
2. TEM produces images of the internal structure of a specimen.
3. ESR spectroscopy detects substances containing unpaired electrons.
4. NMR spectroscopy uses microwave radiation to excite nuclei.

D) Match the following

Column 1

1. NMR
2. ESR
3. SEM
4. Sample Preparation

Column 2

- a. Microwave absorption by unpaired electrons
- b. Radiofrequency interaction with nuclear spins
- c. Demands high vacuum and conductive coating
- d. Focused electron beam for surface topography

E) Identify the technique

A biomedical laboratory needs to determine the molecular mass of proteins with minimum fragmentation. Which ionization technique is most suitable?

