

2013

ANALYTICAL INSTRUMENTATION

Time Allotted : 3 Hours

Full Marks : 70

The figures in the margin indicate full marks.

*Candidates are required to give their answers in their own words
as far as practicable.*

GROUP – A

(Multiple Choice Type Question)

1. Choose the correct alternatives for any *ten* of the following:
10 x 1 = 10
 - i) The definition of specific gravity (for solid) is the ratio of
 - a) density of solid and density of reference solid
 - b) density of solid and density of reference solid
 - c) density of solid and density of reference solid
 - d) none of these.
 - ii) Which viscometer is used for both of Newtonian and Non-Newtonian fluids?
 - a) Saybolt's viscometer
 - b) Ostwald viscometer
 - c) Cone and plane viscometer
 - d) None of these.
 - iii) Dew point is expressed as
 - a) % (percentage)
 - b) °C
 - c) V_{ppm}
 - d) none of these.

- iv) Globar is source of
- a) microwave
 - b) UV
 - c) IR
 - d) RF.
- v) Density can be measured by using a/ an
- a) hygrometer
 - b) hydrometer
 - c) anemometer
 - d) tachometer.
- vi) A buffer solution is a solution that
- a) retains its pH for a long time
 - b) cannot retain its pH for long
 - c) has no electrolytic property
 - d) acts as an intermediate solution between two solutions of different pH.
- vii) X-ray diffraction grating type monochromator obeys the equation of
- a) Beer's
 - b) Bragg's
 - c) Michelson's
 - d) None of these.
- viii) Typical detector of an ultraviolet gas analyzer is
- a) photomultiplier
 - b) Thermocouple
 - c) Thermistor
 - d) None of these.
- ix) IR spectrometer is based on
- a) Molecular absorption
 - b) Atomic absorption
 - c) Nuclear absorption
 - d) None of these.

- x) The Zirconia fuel cell is used to determine the
 - a) density of a fluid
 - b) oxidation-reduction potential of an electrolyte
 - c) moisture content of a gas
 - d) percentage of oxygen in a gas mixture.
- xi) Katharometer cell is used to measure the
 - a) pH of liquid
 - b) conductivity of liquid
 - c) thermal conductivity of gas
 - d) potential difference.
- xii) Dropping mercury electrode is used in
 - a) polarography
 - b) conductivity test
 - c) pH measurement
 - d) dissolve oxygen analysis.

GROUP – B

(Short Answer Type Questions)

Answer any *three* of the following.

3 x 5 = 15

2. Define the following terms:
Relative humidity, viscosity, Psychrometer, moisture, partial pressure.
3. What is thermal conductivity? Deduce the expression for sensitivity of thermal conductivity gas analyzer.
4. What is polarization? How can it be minimized or eliminated?
5. What do you mean by pH? Explain the working of Calomel reference electrode in the process of pH measurement.

6. Discuss with diagram the principle of operation of FID used in chromatography.

GROUP – C

(Long Answer Type Questions)

Answer any *three* of the following. $3 \times 15 = 45$

7. a) What is Dew point? Draw and explain about a commercial type dew point meter.
- b) Explain rotameter type viscometer with neat sketch. State the Poiseuille's formula What is the main difference between viscosity and consistency?
- c) Explain with neat sketch the Golay detector. $(1+5)+(3+2+1)+3$
8. a) Explain the principle of operation of paramagnetic O_2 analyzer with a neat sketch.
- b) What is the basic principle used in a FT-IR Spectrometer. Explain FT-IR Spectrometer with its block diagram.
- c) Define Curie-Weiss law. In thermomagnetic O_2 analyzer, how old sample of O_2 is replaced by fresh sample of O_2 ? $5+(2+4)+(2+2)$
9. a) List the types of electrode used for pH measurement. Explain construction details of any one of them.
- b) Explain with a schematic diagram the operation of double beam UV Spectrometer.
- c) Explain Inductivity-coupled plasma source. $(1+5)+6+3$
10. a) Explain the atomic processes involved in the generation of an X-ray spectrum.
- b) Draw a schematic diagram of an X-ray tube and explain its principle of operation.

- c) Derive the Bragg condition that is utilized to produce more or less monochromatic X-radiation.
- d) If an accelerating potential of 30 kV is applied in an X-ray tube, what will be the cut off wavelength λ_0 of the generated X-ray spectrum? 6+4+3+2
11. a) Draw a diagram of the gas chromatography set-up and explain the functions of the components.
- b) Explain with a diagram, the principle of operation of flame ionization detector and discuss the types of compounds best suited for this detector.
- c) On a 122 cm long chromatography column, the retention times for the mobile phase, heptanes and octane were 0.9 min, 1.22 min and 1.43 min respectively. The base widths of the bands in the chromatogram were 0.14 min for heptanes and 0.20 min for octane. Find out the relative retention factor (or selectivity) α and the resolution R of the heptanes/octane band. 5+5+5
12. Write short notes on any *three* of the following: 3 x 5
- a) Colorimetry
- b) High Pressure Liquid Chromatography(HPLC)
- c) Katharometer
- d) IR sources
- e) Atomizers.

=====