

1. Define and explain the following terms. (40%)
 - (a) Internal standard
 - (b) Relative standard deviation
 - (c) Systematic vs. random errors
 - (d) Retention time and adjusted retention time
 - (e) Plate number
 - (f) Reverse vs. normal phase chromatography
 - (g) Selected ion monitoring
 - (h) Precursor vs. product ions

2. Describe applications and working principles of the following devices. (25%)
 - (a) Size exclusion chromatography
 - (b) Electron capture detector
 - (c) Time-of-flight mass analyzer
 - (d) Electrospray ionization source
 - (e) Cryogenic pump

3. Explain: (25%)
 - (a) the similarity and difference between fluorescence and phosphorescence.
 - (b) why atomic absorption spectra are line spectra and, on the contrary, molecular absorption spectra are band spectra.
 - (c) the advantages provided by a temperature-controlled oven in gas chromatography.
 - (d) how and why the particle size in a packed HPLC column affects the column efficiency and the pressure required for pumping mobile phase through the column.
 - (e) why vacuum system is necessary in a mass spectrometer.

4. Draw a hypothetical van Deemter plot for a packed liquid chromatographic column. Write down an equation to describe the shape of the plot and explain the meanings of A, B, and C terms in the equation. (10%)