King Saud University
Department of Chemistry

Chemical Separation & Chromatographic Methods

Q_1) Define [5 marks]
(a) Chromatography
(b) Stationary phase
(c) Gradient elution
(d) Reversed phase chromatography
(e) Preconcentration

Q_2) Fill blanks [10 marks]
(a) Extraction is a family of separation methods based on ……
(b) A chromatogram is useful for both …… and quantitative analysis. The …… of the peak may serve to identify the components of the sample; while the heights or …… under the peaks provide a quantitative measurement of each component
(c) To achieve a separation there must be at least one significant difference between the …… or …… properties of the analyte and interferent
(d) The time it takes after sample injection for the analyte peak to reach the detector is called ……
(e) We need separation methods for …… or ……
(f) Separation technique based on mass (an example) ……
(g) Based on the purpose of chromatography experiment, chromatographic methods can be categorized to …… and ……
(h) Masking is a pseudo-separation method based on ……
(i) Sublimation is a separation technique based on ……
(j) In chromatography, mobile phase could be ……., liquid or a supercritical fluid, while stationary phase could be liquid or ……
(k) In liquid-solid or adsorption chromatography the stationary phase is ……., while in gas-liquid chromatography the mobile phase is ……
(l) Separation technique based on change in physical state (an example) ……
(m) HPLC is an abbreviation for ……

Q_3) Circle the one correct answer from the choices listed [6 marks]
The simplest property that can be exploited in a separation is
(a) mass
(b) size
(c) charge
(d) partitioning

A student runs a sample of n-propanol through a gas chromatogram at 95°C. The n-propanol produces a peak after 4.2 minutes. The student then injects a mixture of unknown organic substances into the same column at the same temperature. There are peaks after 3.1, 4.2 and 7.4 minutes. From this information, it can be concluded that

(a) the mixture has three components, one of which must be n-propanol
(b) the mixture has at least three components, one of which must be n-propanol
(c) the mixture has three components, but n-propanol is not one of them
(d) the mixture has at least three components, one of which might be n-propanol

Of the following compounds, which would you expect to elute ***first*** from a gas chromatography column?
(a) methanol
(b) ethanol
(c) n-propanol
(d) n-butanol

Of the following compounds, which would you expect to elute ***last*** from a reverse-phase liquid chromatography column?
(a) methanol
(b) ethanol
(c) n-propanol
(d) n-butanol

In normal phase chromatography, there is a
(a) the mobile phase is polar and the stationary phase is nonpolar
(b) the mobile phase is nonpolar and the stationary phase is polar
(c) both the mobile and the stationary phase are non-polar
(d) both the mobile and the stationary phase are polar

Liquid chromatography methods include
(a) liquid/liquid (partition) chromatography
(b) liquid/solid (adsorption) chromatography
(c) ion exchange and size exclusion chromatography
(d) all of the above

Q_4) Describe chromatographic technique (briefly), and give an example and sketch if possible [3 marks]

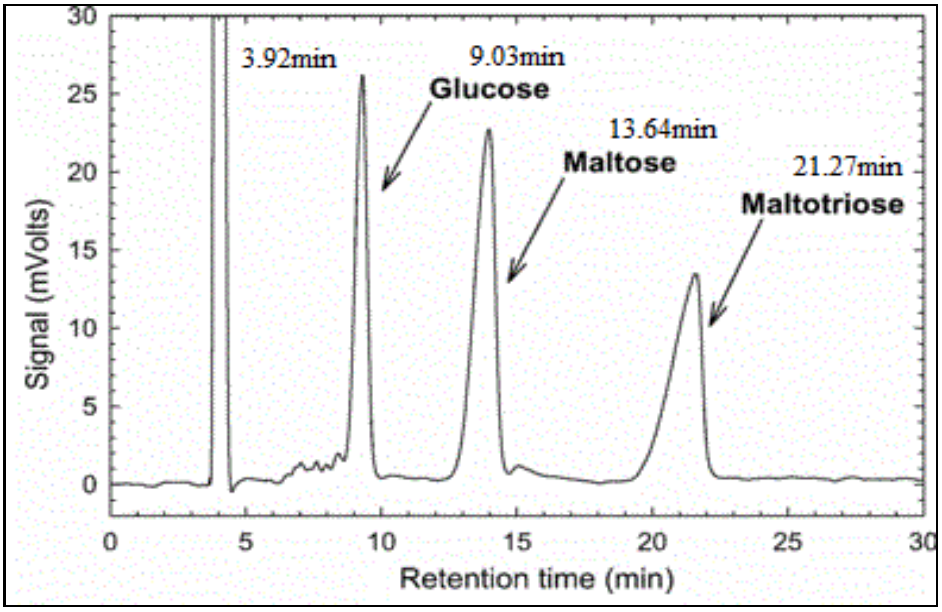
Q_5) Describe the five major **GC** components and their functions, a diagram can be useful [5 marks]

Q_6) Modern chromatographic methods have many applications; list three of them [3 marks]

Q_7) List five variables affect method efficiency in chromatography [5 marks]

Q_8) What are the main differences between
(a) HPLC and GC [2 marks]
(b) Separation and purification [2 marks]

Q_9) A chromatograph of a two component mixture is shown below. The LC column is 250 mm long. The flow rate was 0.50 mL/min. Using the chromatograph to calculate the following, knowing that width of the peaks at half ($w_{1/2}$) for Glucose, Maltose and Maltotriose are 0.33, 0.67 and 1.32min, respectively



Calculate

(a) The time of **Glucose** spends on the stationary phase [1 marks]
(b) The retention factor for **Maltotriose** [1 marks]
(c) The resolution between **Maltose** and **Maltotriose** [1 mark]
(d) The selectivity factor for **Maltose** and **Maltotriose** [1 mark]
(e) An average number of plates for the three components [3 mark]
(f) An average plate height for the column [1 mark]
(g) The standard deviation for **Maltose** [1 mark]

Related equations:

$$k' = \frac{t_R - t_M}{t_M}$$

$$\alpha = \frac{t_{R2} - t_M}{t_{R1} - t_M}$$

$$R_s = 2\,\frac{t_{R2} - t_{R1}}{w_1 + w_2} = 1.18\,\frac{t_{R2} - t_{R1}}{w_{(1/2)1} + w_{(1/2)2}}$$

$$H = \frac{L}{N}$$

$$N = \left(\frac{t_R}{\sigma}\right)^2 = 16\left(\frac{t_R}{w}\right)^2 = 5.54\left(\frac{t_R}{w_{(1/2)}}\right)^2$$

Good Luck !!
Course instructor
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