

Chem 4010

1. The partition coefficient, K , for substance A in a particular chromatographic column is greater than that for substance B. Which compound is more strongly retained in the chromatographic column?
2. The time required for passage of the mobile phase through a particular column is 25 min. What is the value of R for some solute which has a retention time of 261 min? How much times does the solute spend in the mobile phase and in the stationary phase?
3. The value of R for a particular solute on a certain chromatographic column is 0.1. The volume of mobile phase in the column, V_M , is 2.0 mL. What is the value of t_s for the solute when the flow rate of the mobile phase is 10 mL/min?
4. For the system described in problem 3, what is the value of K for the solute if V_s is 0.5 mL?
5. A column 10 cm long is operated with a mobile-phase velocity of 0.01 cm/sec. Component A requires 40 min. for elution. What fraction of the time required for its elution does A spend in the mobile phase? What is the value of R for this compound?
6. In gas chromatography, the velocity of the mobile phase can be measured directly if one injects some solute like methane which is entirely unretained by the stationary phase. On a capillary column 50 m long, the retention time of methane is 71.5 sec and the retention time of *n*-heptadecane is 12.6 min. (A) What is the velocity of the mobile phase? (B) What is the value of R for the *n*-heptadecane zone? (C) What is the velocity of the *n*-heptadecane zone?
7. Write an expression for the retention time (t_R) of some component in terms of the times (t_M and t_S) which that component spends in the mobile and stationary phases.
8. Under fixed conditions in a particular gas-liquid partition chromatographic column, substance A is eluted with $R = 0.5$ and $V_R = 100$ mL. The flow rate of the mobile phase must remain constant, but V_S (the amount of liquid stationary phase) can be changed from its existing value of 1.5 mL. By what factor must V_S be changed in order to double V_R ? Is this factor generally applicable any time V_R is to be doubled, or does it apply only in this particular case?
9. A chromatographic column is tested and found to produce a peak having a Gaussian shape and a width of 40 sec at a retention time of 25 min. How many theoretical plates does the column have under the conditions of the test?
10. Some chromatographic columns can be operated at efficiencies corresponding to 10^5 theoretical plates. Calculate the peak widths obtained from such a column at retention times of 100, 1000, and 10^4 sec. Assume a Gaussian peak-shape.
11. If the length of a column is doubled, by what factor will zone broadening due to

longitudinal diffusion increase? Why?

12. Two gas-liquid chromatographic columns differ only in that one has a greater amount of liquid stationary phase than the other. Will their optimum mobile-phase velocities differ? If so, how and why?
13. A particular gas-liquid chromatographic column two meters in length is tested at three different flow rates using helium as the mobile phase and found to have the following performance characteristics:

<u>Methane</u>	<u><i>n</i>-octadecane</u>	
t_R	t_R	t_w
18.2 sec	2020 sec	223 sec
8.0 sec	888 sec	99 sec
5.0 sec	558 sec	68 sec

- (A) Determine the mobile-phase velocity for each of the runs. (B) Determine the number of theoretical plates and the value of H for each of the runs. (C) By solving simultaneous equations, find the values for the constants in an equation of the form $H = A \div B/v \div Cv$ and graph the result. (D) Through what range of mobile-phase velocities can 90 % of the column efficiency be retained? (E) What is the optimum mobile-phase velocity? (F) A particular separation requires 1100 theoretical plates. What is the fastest mobile-phase velocity at which this can be achieved, and how much time will be saved by running at the maximum flow rate instead of at the optimum?
14. A particular chromatograph used in the analysis of air samples produces sulfur dioxide peaks 25 sec wide with a sample input volume of 1 mL and a mobile-phase flow-rate of 40 mL/min. More sensitivity is required and could be obtained if the sample volume is increased; but the peak width must be held below 1 min. What is the maximum possible sample volume?
15. A particular chromatographic column has an efficiency corresponding to 4200 theoretical plates and has retention times for octadecane and 2-methyl-heptadecane of 15.05 and 14.82 min, respectively. To what degree can these compounds be resolved on this column? How many theoretical plates would be required for unit resolution at those retention times?