Chemistry 255
Spring 2011
Problem Set #8
Answer Key

1. Aqueous (blood) = phase 1 $\qquad K_a = 3.058\times10^{-10}$

$K = \dfrac{[S_2]}{[S_1]} = \dfrac{\text{heart}}{\text{blood}} = \dfrac{1}{2.65} = 0.37736 \qquad [H^+] = 3.98\times10^{-8}$

$D = \dfrac{K \bullet K_a}{[H^+] + K_a} = \dfrac{(0.37736)(3.058\times10^{-10})}{3.98\times10^{-8} + 3.058\times10^{-10}} = 2.877\times10^{-3} = \dfrac{\text{conc. in heart}}{\text{conc. in blood}}$

Desired concentration in heart : 1.25×10^{-8}

$2.877\times10^{-3} = \dfrac{1.25\times10^{-8}}{x(\text{blood})} \qquad x = 4.344\times10^{-6}\text{M}$

$(4.344\times10^{-6}\text{M})(4.00\text{L}) = 1.738\times10^{-5}\text{ moles}\times\dfrac{472.6\text{ g}}{\text{mole}} = 8.212\times10^{-3}\text{g} = 8.21\text{mg}$

2. C18 column

initial mobile phase 100% water = polar

Mobile phase becoming increasingly nonpolar. $\therefore$ reversed phase separation

Order of elution :

1. ethanol : the most polar compound and thus it elutes first
2. ibuprofen : has intermediate polarity
3. cholesterol : least polar due to large hydrocarbon region and thus elutes last.

3. a) $R_s = \dfrac{\Delta t_r}{w_{avg}} = \dfrac{6.023 - 4.638}{\left(\dfrac{0.274 + 0.356}{2}\right)} = 4.3968$

$N = \dfrac{16t_r^{\,2}}{w_2} = \dfrac{16(6.023)^2}{(0.356)^2} = 4.58\text{x}10^3$

$R_s = \dfrac{\sqrt{N}}{4}\left(\dfrac{\alpha - 1}{\alpha}\right)\left(\dfrac{k_2'}{1 + k_{avg}'}\right) = \sqrt{N}K \qquad \therefore R_s \propto \sqrt{N}$

$\dfrac{4.3968}{6.00} = \dfrac{\sqrt{4.58\text{x}10^3}K}{\sqrt{x}K} \qquad x = 8529 = 8.53\times10^3$

b) $H = \dfrac{L}{N}$ $\qquad$ 1st Column : $H = \dfrac{20.0\text{ cm}}{4.58\text{x}10^3} = 4.367\times10^{-3}$

2nd Column : $4.367\times10^{-3} = \dfrac{x}{8.53\times10^3} \qquad x = 37.249\text{ cm} = 37.2\text{ cm}$

4. a) $\frac{\text{large mass}}{\text{small mass}} = \left(\frac{\text{large column radius}}{\text{small column radius}}\right)^2 \Rightarrow \frac{12.0\,\text{g}}{1.15\text{x}10^{-3}\,\text{g}} = \frac{\text{x}^2}{(0.200\,\text{cm})^2}$

x = 20.430 cm radius

diameter = 40.9 cm

keep length the same $\therefore$ length = 20.0 cm

b) $\frac{\text{flow}_2}{\text{flow}_1} = \frac{\text{mass}_2}{\text{mass}_1}$

$$\frac{\text{x}}{0.50\,\text{ml/min}} = \frac{12.0\,\text{gm}}{1.15\text{x}10^{-3}\,\text{g}} = 5217.39\,\text{mL}/\text{min} = 5.2\text{x}10^3\,\frac{\text{mL}}{\text{min}} = 5.2\,\frac{\text{L}}{\text{min}}$$

5. a) relative retention

$$\text{k}' = \frac{\text{t}_\text{r} - \text{t}_\text{m}}{\text{t}_\text{m}} \qquad \text{k}'_\text{a} = \frac{7.42 - 0.74}{0.74} = 9.027 \qquad \text{k}'_\text{b} = \frac{11.15 - 0.74}{0.74} = 14.0676$$

$$\alpha = \frac{\text{k}'_\text{b}}{\text{k}'_\text{a}} = \frac{14.0676}{9.027} = 1.56$$

b) Capacity factor for Peak A : (determined above) $9.027 \approx 9.0$

c) Resolution $= \frac{\Delta\text{t}_\text{r}}{\text{w}_\text{avg}} = \frac{11.15 - 7.42}{0.5(1.03 + 1.77)} = \frac{3.73}{1.40} = 2.66$

d) # plates for peak B : $\text{N} = \frac{16(11.15)^2}{(1.77)^2} = 6.35 \times 10^2$

6. a) heptane,1-pentanol, 2-hexanone, octane, nonane, decane

b) heptane, octane, 1-pentanol, 2-hexanone, nonane, decane

c) heptane, octane, nonane, decane, 2-hexanone, 1-pentanol