Partition Coefficient(s)

Most common: \( B(\text{solvent 1} \rightarrow B(\text{solvent 2}) \quad K_{eq} = \frac{[B(2)]}{[B(1)]} \)

e.g., using “sep funnel”

Which of the following are partition coefficients?

<table>
<thead>
<tr>
<th>Name</th>
<th>(Keq)</th>
<th>Partition Coeff.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Henry’s Law constant</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( B(\text{solvent}) \leftrightarrow \text{gas(vacuum)} )</td>
<td>( \frac{P_B}{[B]} ) or ( \frac{P_B}{X_B} )</td>
<td></td>
</tr>
<tr>
<td>Evaporation/Condensing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( A(\text{liquid}) \leftrightarrow \text{gas(vacuum)} )</td>
<td>( \frac{P_A}{X_A} = \text{Vapor Press} )</td>
<td></td>
</tr>
<tr>
<td>Dissolving/Crystallizing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(solubility)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>crystal \leftrightarrow \text{any solvent}</td>
<td>( \text{e.g., } \frac{[B(aq)]}{1} )</td>
<td></td>
</tr>
<tr>
<td>Melting/freezing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>( A(s) \leftrightarrow A(\text{liquid}) )</td>
<td>( X_A/1 )</td>
<td></td>
</tr>
</tbody>
</table>

Answer: All of the above! For example, Henry’s Law constant is actually the PARTITION COEF. of a gas between vacuum and liquid.
Shaking will create an emulsion: like mayonnaise.
Take a different route

\[ \text{Soap(agr)} \xrightarrow{3} \text{Soap(hex)} \]

\[ \text{Soap(Solid)} \]

1. \[ \Delta \mu_i^0 + \Delta \mu_z^0 = \Delta \mu_3^0 \]

\[ = -RT \ln \left( \frac{X_{\text{soap(S)}}}{[\text{Soap(agr)}]} \right)_{eq} - RT \ln \left( \frac{[\text{Soap(hex)}]}{X_{\text{soap(S)}}} \right)_{eq} \]

\[ \Delta \mu_3^0 = -RT \ln \left( \frac{[\text{Soap(hex)}]}{[\text{Soap(agr)}]} \right)_{eq} = K_{\text{partition}} \]

\[ K_{\text{partition}} = \frac{\text{Solubility in hexane}}{\text{Solubility in water}} \]
At equilibrium the activity of a solute or solvent will be the same in **ALL** phases if the same standard state is used in each phase.
**Equilibrium Dialysis, Ligand Binding - Scatchard Plots**

\[ [A]_{out} \text{ is Controlled} \]

\[ [M] \text{ is Known} \]

\[ A_{tot, in} = [A]_{in} + [SA] \quad \text{measured} \]

\[ [A]_{in} = [A]_{out} \quad \text{because} \quad M_{A, out} = M_{A, in} \]

\[ SA \Rightarrow A + S \]

\[ K_d = \frac{[A][S]}{[SA]} = \frac{[A](S_{tot} - [SA])}{[SA]} \]

Where \( S_{tot} = [S] + [SA] \)

**Solve for** \( \frac{[SA]}{S_{tot}} = f = \text{Fraction of } 15 \text{ NOT KNOWN}. \)

\[ K_d[S][A] + [A][SA] = S_{tot}[A] \]

\[ [SA](K_d + [A]) = S_{tot}[A] \]

\[ f(SA) = \frac{[A]}{S_{tot}} = \frac{K_d + [A]}{[SA]} \]

\[ [SA] \Rightarrow S_{tot} \text{ as } f \rightarrow 1 \]

\[ \frac{S_{tot}}{[M]} = \text{sites per Macromol.} \]

\[ N \quad \text{sites per Macromol.} \]

\[ \text{Initial Slope} = \frac{1}{K_d} = K. \]

\[ \text{HARD TO FIND N THIS WAY} \]

\[ \text{(depends on LOW & HIGH } [A] \text{)} \]
A Better Way: The Scatchard Plot

\[ K_d = \frac{[A][S]}{[SA]} = \frac{[A]}{[SA]} \left( \frac{S_{\text{tot}} - [SA]}{[SA]} \right) \]

Rearrange: multiply by \([SA]/[A]\), divide by \(K_d\)

\[ \frac{[SA]}{[A]} = \frac{S_{\text{tot}}}{K_d} - \frac{[SA]}{K_d} \]

Equation for straight line

Intercept = \(\frac{S_{\text{tot}}}{K_d}\)

\[ \text{slope} = -\frac{1}{K_d} \]

Define \(Z = \frac{[SA]}{[M]} = \frac{\text{bound sites}}{\text{macro molecule}}\)

\[ N = \frac{S_{\text{tot}}}{[M]} \]
No theory here. This is just a way to classify the extent of cooperativity.
Efficiency is:

36 moles ATP per 1 mole of glucose
We have roughly the same mass of Na⁺ and K⁺ in our bodies. Most of the ~50 lbs per day of ATP is spent separating them. Most of potassium is inside the cells; sodium outside.

<table>
<thead>
<tr>
<th>Ion</th>
<th>Inside Cell</th>
<th>Blood</th>
<th>Concentration Gradient</th>
<th>( \frac{[\text{concentration}<em>{\text{inside}}]}{[\text{concentration}</em>{\text{outside}}]} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>K⁺</td>
<td>139 mM</td>
<td>4 mM</td>
<td>34:1</td>
<td>[ (\text{pumping ions}) ] wave impulses.</td>
</tr>
<tr>
<td>Na⁺</td>
<td>12 mM</td>
<td>145 mM</td>
<td>12:1</td>
<td>[ (\text{pumping ions}) ] wave impulses.</td>
</tr>
<tr>
<td>Cl⁻</td>
<td>4 mM</td>
<td>116 mM</td>
<td>29:1</td>
<td>[ (\text{pumping ions}) ] wave impulses.</td>
</tr>
<tr>
<td>Mg²⁺</td>
<td>0.8 mM</td>
<td>1.5 mM</td>
<td>0.5:1</td>
<td>[ (\text{pumping ions}) ] wave impulses.</td>
</tr>
<tr>
<td>Ca²⁺</td>
<td>( \approx 0.0005 ) (0.5 µM)</td>
<td>1.8 mM</td>
<td>3:1</td>
<td>[ (\text{pumping ions}) ] wave impulses.</td>
</tr>
</tbody>
</table>

`K^+\text{Na}^+\text{ATPase enzyme.}`

\[
\text{outside} \quad \text{membrane} \quad \text{inside cell}
\]

\[
\text{K}^+ \quad \text{ATP} \rightarrow \text{ADP}
\]
Na-K pump video

http://highered.mheducation.com/sites/0072495855/student_view0/chapter2/animation__how_the_sodium_potassium_pump_works.html