The left figure below (from Strobl) is intended to demonstrate the existence of good solvent scaling. The right figure (from Doi) shows the behavior of $R_g$ and $R_H$ with temperature.

a) **Explain** the axes on this plot. (You will need a scaling law and a generalized scattering law).

b) **How can** the scaling law used in "a" be obtained from

\[(R/R_0)^5 - (R/R_0)^3 = (9\sqrt{6/16})V_0\sqrt{N/b^3}\]

?  

C) **What is** $V_0$ in the equation in "b"?

- **Explain** the meaning.  
- **Explain** how this term can be expanded to included enthalpic effects (give and equation).

d) **Can the expanded** definition of $V_0$ in "c" explain the Doi figure (right above)?  
- **Explain** your answer.

e) The intrinsic viscosity $[\eta]$ is proportional to $1/\rho$, where $\rho$ is the density of the polymer coil, $N_{coil}/V_{coil}$.

- **Show** that for a theta solvent $[\eta]$ scales with $N^{1/2}$.

- **What** is the scaling for and expanded coil?  
- **Explain** the values of "a" in the Mark-Houwink equation, $[\eta] = K N^a$, where "a" ranges from 0.5 to close to 1.

- Should $[\eta]$ depend on $R_g$ or $R_H$ in the right figure above? Why?
Answers: Quiz 3 Polymer Properties 4/17/01

a) The plot reflects a curve such as described by a generalized OZ plot, \( I(q) = K/(1 + (qR_g)^d/d_0) \), then \( 1/I \) is plotted versus \( q^{\text{df}} \) and a line should result.

b) If \( R/R_0 \) is big then the 5'th power term is much bigger than the 3'rd power term. Also \( R_0 \) scales with \( N^{1/2} \) so,

\[
(R)^5 = (9\sqrt{6}/16)V_0\sqrt{N/b^3} (C N^{6/2}) = C N^{6/2}
\]

and

\[
R = C N^{3/5}
\]

c) \( V_0 \) is the excluded volume. This reflects the volume of a single persistence unit in the original definition (hard core potential). It can be expanded in meaning by including a Boltzmann potential function under a lattice model to \( V_0 (1 - 2\chi) \), where \( c = z\Delta\varepsilon/kT \).

d) The expanded definition of \( V_0 \) doesn't explain the behavior shown in the right graph since the function still predicts only two states, expanded and Gaussian.


For a good solvent coil, \( R_f = C N^{3/5} \) so, \( [\eta] = K N^{0.8} \)

The MH equation doesn't explain blob behavior so can not completely explain the scaling behavior of real polymer coils. Numbers larger than 0.8 for \( a \) are generally associated with rod like behavior.

\( [\eta] \) should depend on \( R_H \) since the coil profile is the important feature and it is a dynamic measurement.