Quiz 2 Polymer Properties 4/10/01

The mean size of a polymer molecule depends on the molecular weight, N, topology, branch content, and path dimension of the chain. These effects can be summarized in a general fractal scaling law $R_g \approx (N)^{1/df}$ where d_f is the mass fractal dimension and N is the degree of polymerization. For example:

	d_f
Gaussian Chain	2.0
SAW Chain	1.67
Randomly Branched Gaussian	2.5
Randomly Branched SAW	2.0

(SAW is a self-avoiding walk, or good solvent scaling)

a) **-Why** is R_g used in this description and not the RMS end-to-end distance?
-What is C (connectivity dimension) for each case?

b) **-Give** an equation to calculate R_g from the chain index.
-What is the relationship between R_g and the RMS end-to-end distance for a Gaussian chain?

c) **-Show** the difference in a log intensity versus log q plot for these 4 structures if N is the same for all 4.

d) **-Give** two general functions that could be used to determine R_g and d_f respectively from the plots of part c.
-Show the part of the plots where these two equations apply.

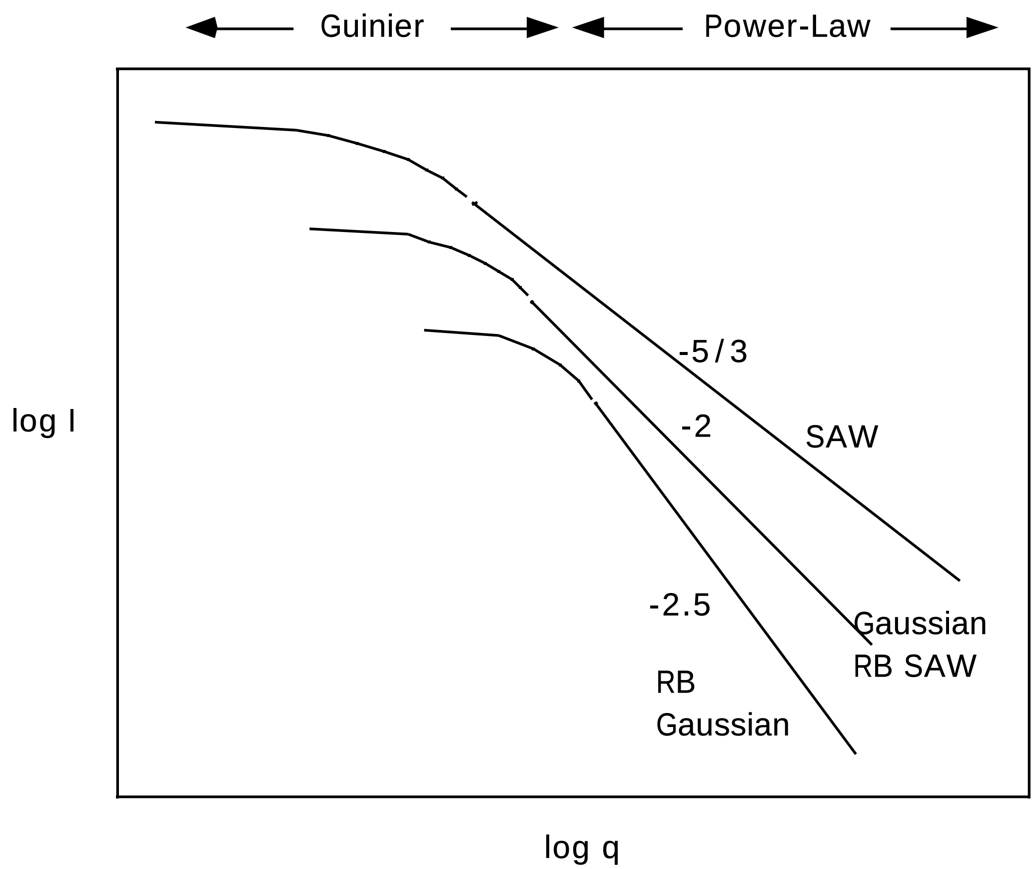
e) A generalized Ornstein-Zernike function is sometimes used to describe both regimes of part d.
-Give the Ornstein-Zernike function for a Gaussian chain and
-explain how it could be generalized in this way.

Answers: Quiz 2 Polymer Properties 4/10/01

a) R_g is used since the end-to-end distance is not well defined for a randomly branched chain. C for the Gaussian chain and the SAW chain is 1.0. For the randomly branched chain it is 1.5 (i.e. bigger than for a linear chain).

b) $R_g^2 = (1/2N^2)\, \Sigma\Sigma \langle (R_n - R_m)^2 \rangle = (1/N)\, \Sigma \langle (R_n - R_G)^2 \rangle$
For a Gaussian Chain $6R_g^2 = R_{eted}^2$

c)



d) R_g from Guinier's Law, $I(q) = G \exp(-q^2 R_g^2/3)$

d_f from power-law equation $I(q) = B\, q^{df}$

e) OZ equation $I(q) = N/(1 + (qR_g)^2/2)$
Generalized OZ equation

$$I(q) = N/(1 + (qR_g)^{df}/d_f)$$

Function is generalized with no analytic justification.