**Quiz 9**
**Polymer Properties**
**March 8, 2017**

1) Through modification of the Arrhenius equation $\eta = \eta_0 \exp\left(\frac{-E_a}{kT}\right)$ using the Vogel temperature, $T_V$ and the idea that $E_a$ is a free energy rather than an enthalpy, $E_a = \Delta H - T\Delta S$, show that it is possible to obtain the WLF expression, $\eta = \eta_0 \exp\left(\frac{-C_1(T-T_0)}{C_2+(T-T_0)}\right)$. Do this by finding expressions for $\Delta H$, $\Delta S$ and $T_v$ in terms of $C_1$, $C_2$ and $T_0$.
2) Explain what the Vogel temperature is and, using a cartoon of circles in flow, explain to what $\Delta H$ and $\Delta S$ correspond.
3) The hydrodynamic radius corresponds to something like a harmonic mean while the radius of gyration corresponds to a second order moment, a type of arithmetic mean. Explain why this might be the case. Where is the harmonic mean usually used? Which size is larger for an expanded coil, $R_H$ or $R_g$? What about for a sphere?
4) Starting with the power series expression for intrinsic viscosity,
$\eta = \eta_0\left(1 + c[\eta] + k_1c^2[\eta]^2 + k_2c^3[\eta]^3 + \cdots + k_{n-1}c^n[\eta]^n\right)$
Explain the origin of the Kraemer equation,
$\frac{\ln(\eta_r)}{c} = [\eta] + k_1'[\eta]^2 c$