3.091 Fall Term 2004
Homework Quiz #9B
solution outline

(a) A melt of borate glass, g_1, cooled at rate, r_1, has glass transition temperature, T_{g_1}. If a second specimen of molten g_1 is cooled at a new rate, r_2, such that $r_2 < r_1$, how does the glass transition temperature, T_{g_2}, compare to T_{g_1}? Explain with reference to atomic structure.

All other things being equal, i.e., melt composition, the higher the cooling rate, the higher the glass transition temperature. Therefore, $T_{g_2} < T_{g_1}$, since $r_2 < r_1$. At the molecular level, the higher cooling rate allows less time for the liquid to rearrange itself in search of the crystal structure before onset of solidification. This has the effect of quenching in a greater amount of disorder. Hence, the knee in the V versus T curve will lie at a higher temperature for a melt cooled at the higher rate

(b) The fictitious compound, arrhenium fluoride (AhF), reacts with itself to form a dimer with the formula Ah_2F_2. The reaction is second order in AhF. The value of the rate constant is 7.7×10^{-3} M^{-1} s^{-1}. What is the initial rate of reaction in a reactor filled with AhF to a concentration of 3.091 M? Express your answer in M s^{-1}.

$$-\frac{dc}{dt} = kc^2 = 7.7\times10^{-3}\ M^{-1}s^{-1}\ (3.091\,M)^2 = 7.36\,M\,s^{-1}$$