3.091 Fall Term 2004

Homework Quiz #9A

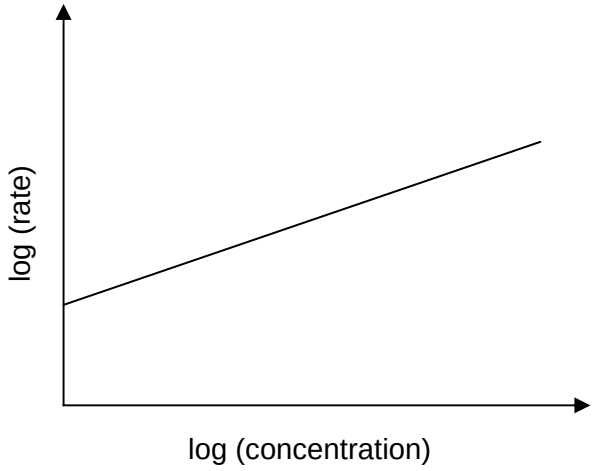
solution outline

(a) A melt of silicate glass, g_1, cooled at rate, r_1, has glass transition temperature, T_{g_1}. A new glass, g_2, is formulated by the addition of CaO to g_1. If a melt of g_2 is cooled at rate, r_1, how does the glass transition temperature, T_{g_2}, compare to T_{g_1}? Explain with reference to atomic structure.

If g_2 is cooled at rate, r_1, the glass transition temperature, T_{g_2}, will lie below T_{g_1}. The addition of CaO to g_1 promotes chain scission of the silicate network. The resulting decrease in viscosity of the g_2 melt allows for greater mobility than would be the case in the g_1 melt at comparable undercooling. Accordingly, if each melt is cooled at the identical rate, it is necessary to cool g_2 to a lower temperature than g_1 before the system has solidified.

So $T_{g_2} < T_{g_1}$.

(b) The fictitious compound, arrhenium fluoride (AhF), decomposes readily at temperatures exceeding 37ºC. The figure below shows how the rate of reaction varies with the concentration of AhF. The rate, r, is in units of M s^{-1} and the concentration of AhF, c, is in units of M (mole L^{-1}). The slope has a value of 1.67 and the intercept has a value of 0.490.



(i) What is the order of reaction? n = 1.67

(ii) Calculate the value of the rate constant. The value of the rate constant is given by the intercept of the plot of log rate versus log concentration. Therefore,

$$k = 10^{0.490} = 3.09\left(\frac{mol}{L}\right)^{-0.67}\frac{1}{s}$$