Session #22: Homework Problems

Problem #1

(a) In the context of amorphous inorganic compounds, name two network formers, two network modifiers, and one intermediate.

(b) Sketch the variation of molar volume with temperature for pure silica. Show glass formation at two different cooling rates. As well, show crystallization. On each cooling curve, label the melting point or the glass transition temperature.

(c) What are two key factors that determine whether a material will solidify as a glass or a crystal?

Problem #2

(a) Draw the network structure of a borate glass.

(b) Explain how the addition of Na_2O to B_2O_3 decreases viscosity of the glass melt.

(c) To raise the glass transition temperature of the borate glass, do you increase or decrease the cooling rate? Explain.

(d) Describe one surface treatment method by which you can strengthen a borate glass.

(e) Explain why borate glass is transparent to visible light.

Problem #3

The decay rate of ^{14}C in living tissue is 15.3 disintegrations per minute per gram of carbon. Experimentally, the decay rate can be measured to ± 0.1 disintegrations per minute per gram of carbon. The half-life of ^{14}C is 5730 years.

(a) What is the maximum age of a sample that can be dated, and what is the uncertainty associated with this measurement?

(b) What is the minimum age of a sample that can be dated, and what is the uncertainty associated with this measurement?

Problem #4

What is the activation energy of a process which is observed to increase by a factor of three when the temperature is increased from room temperature (20°C) to 40°C?

Problem #5

A first order chemical reaction is found to have an activation energy (E_A) of 250 kJ/mole and a pre-exponential (A) of 1.7×10^{14} s^{-1}.

(a) Determine the rate constant at T = 750°C.

(b) What fraction of the reaction will be completed at 600°C in a period of 10 minutes?

(c) At what temperature will the reaction be three times as fast as at 750°C?

Problem #6

Whiskey, suspected to be of the “moonshine” variety, is analyzed for its age by determining its amount of naturally occurring tritium (T) which is a radioactive hydrogen isotope (H^3) with a half-life of 12.5 years. In this “shine” the activity is found to be 6% of that encountered in fresh bourbon. What is the age of the whiskey in question?

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