3.091 Fall Term 2004

Homework #9

November 2 (to be tested November 9)

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?

2. Account for the fact that Al does not form a stable glass while elemental Se does.

3. Explain why at room temperature glasses are brittle while metals are ductile.

4. Describe two analytical techniques that allow you to distinguish an amorphous solid from a crystalline solid.

5. The addition of CaO to SiO_2 lowers the glass transition temperature. Explain with reference to electronic structure and bonding.

6. (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.

Ch. 14: 45, 46, 47, 48, 62, 95 (2^{nd} ed.); 33, 34, 35, 36, 49, 72 (1^{st} ed.)

7. The decomposition of hydrogen peroxide, H_2O_2 , can be represented by the following reaction:

$$2\ H_2O_2\ (aq) \rightarrow 2\ H_2O\ (l) + O_2\ (g)$$

The table below reports data taken at room temperature (300 K).

Table 1. Decomposition of H_2O_2 (*aq*) at 300 K.

$conc_{H_2O_2}$ (mol/liter)	time (seconds)
2.32	0
2.01	200
1.72	400
1.49	600
0.98	1200
0.62	1800

0.25	3000

(a) Show that the reaction is first order.

(b) Calculate the value of the half-life of this reaction.

(c) Suppose that the initial concentration of H_2O_2 were 3.5 M. How long would it take at 300 K to reduce the concentration of H_2O_2 to 25% of its initial value?

8. 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?