



**RUTGERS**  
UNIVERSITY

Department of Materials Science and Engineering

**Glass Engineering -- 150:312**

**Hourly #1**

**Spring Term 2007**  
**Time Limit: 20 minutes**

**Prof. Lehman**  
**Thursday March 1, 2007**

**Name** \_\_\_\_\_

**RUID** \_\_\_\_\_

*The exam contains 8 questions. Answer them all. Confine your answer to the same page as the question. You may use the back of the sheet as necessary for computations.*

1. Give a comprehensive definition of glass. Include in your answer practical considerations as well as elements of the ASTM definition and the National Research Council.

2. The structural basis of silicate glasses is the  $\text{SiO}_4^{4-}$  tetrahedron. Diagram three  $\text{SiO}_4^{4-}$  tetrahedra linked together by bridging oxygen. What is the O-Si-O bond angle, on average? What is the Si-O-Si bond angle, on average? Are these angles constants or do they vary throughout the structure?

3. What are Zachariasen's rules regarding glass formation in oxides? How successful have these rules been in predicting glass formation in oxides?

- Using two-dimensional representation, diagram (a.) pure  $\text{SiO}_2$  glass and (b.) sodium silicate glass. What is the stoichiometric relationship (reactants and products) for the reaction of  $\equiv\text{Si-O-Si}\equiv$  units and  $\text{Na}_2\text{O}$ ?

- What is batch segregation? Why does it occur? How can it be prevented?



8. [A] Glass is dripping from the platinum tips of an overheated fiberglass textile bushing. Each tip drips glass at the rate of  $0.11 \text{ cm}^3/\text{s}$  and the tip radius is  $0.2 \text{ cm}$  and the length is  $7 \text{ mm}$ . If the glass depth above the tip is  $25 \text{ cm}$  and the glass has density of  $2.5 \text{ g/cm}^3$ , what is the viscosity of this glass?

[B] A separate laboratory measurement of the same glass at the same temperature by the sinking platinum sphere method gave the following results:

Sphere radius =  $2 \text{ mm}$

Terminal settling velocity =  $0.33 \text{ cm/s}$

What viscosity value is calculated by this method? Is this result consistent or different than that obtained from the dripping rate calculations?

# Helpful Mathematic Relationships and Constants

Density of platinum = 21.4 g/cm<sup>3</sup>

$$Q = \frac{\pi PR^4}{8L\eta}$$

$$\eta = \frac{2gr^2(\rho_s - \rho_{glass})}{9v}$$