

3.091 OCW Scholar

# **Self-Assessment**

## **Amorphous Materials**

### **Supplemental Exam Problems for Study**

#### **Solutions Key**

**Problem #5**

Composition A: 25% CaO – 75% GeO<sub>2</sub>;      Composition B: 5% CaO – 95% GeO<sub>2</sub>

- (a) Two glass-forming melts, A and B with compositions as specified above, are each cooled from their molten state to room temperature at identical cooling rates. Identify which melt has the higher value of glass transition temperature ( $T_g$ ) and justify your choice by referring to what happens at the molecular level.

A is more heavily modified so less viscous thus more capable of crystallization at a given cooling rate: this means it has a lower  $T_g$ : conclude that B has the higher value of  $T_g$ .

- (b) With reference to what happens at the molecular level, explain how surface-strengthening of a glass of composition A can be achieved by a thermal treatment known as tempering.

- create differential cooling rates between the surface region of the glass and its interior by blowing an air jet over its surfaces.
- molar volume scales with cooling rate so the near surface region has a higher  $V_{\text{molar}}$  than the interior
- the glass has only one dimension so the interior exerts a compressive force on the surfaces
- the stress needed to break the glass is now the sum of the stress needed to break the bonds in the unstressed glass plus the compressive stress in the near surface region

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