3.091 Introduction to Solid State Chemistry

Fall Term 2018

Quiz 10

Do yourself a solid.

You want to know how quickly your MIT acceptance balloon will run out of helium gas (He) inside of it. Since you tied the balloon so tightly, you neglect the pinhole at the neck and model the balloon as a closed sphere of latex.

Note: Assume that helium concentration inside the balloon remains constant.

1. The balloon is 0.1 mm thick. The concentration of He gas inside the balloon is 0.04462 M and outside the balloon is 2.32×10^{-7} M. If the diffusivity constant of helium through latex is 7×10^{-9} m^2/s at room temperature, what is the flux of helium gas through the latex balloon (Hint: $1\ L = 0.001\ m^3$)?

2. You're shocked to discover that the helium gas is diffusing through the balloon so quickly! In order to preserve the cherished memories of your MIT undergrad, you decide to slow the diffusion of helium through the balloon.

    a. What concentration of helium gas would you have to have outside the balloon to halve the flux?

b. At what temperature would you have to store the balloon to halve the flux, compared to question 1 $(E_a = 0.09\ eV = 1.44 \bullet 10^{-20}\ J)$?

c. Your beloved balloon is exposed to the Boston winter! It lowers the temperature of the balloon below the glass transition temperature of the latex. How does this affect the diffusion of helium through the balloon?

d. Your friend cross-linked the latex in her balloon before filling it with helium. How would this impact the diffusion of helium through the balloon?

e. Name another way that you could decrease the flux of helium through the balloon.

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