

Exam II  
Administered: Wednesday, October 8, 2003  
28 points

For each problem part:    0 points if not attempted or no work shown,  
                                     1 point for partial credit, if work is shown,  
                                     2 points for correct numerical value of solution

**Problem 1. (10 points)**

We are studying two different methods to determine diffusion coefficients from molecular simulation. In the first method, using the Darken equation, we run 10 simulations and find a sample mean value of the diffusivity to be  $5.0 \times 10^{-8} \text{ m}^2/\text{s}$  with a sample variance of  $0.04 \times 10^{-16} \text{ m}^4/\text{s}^2$ . In the second method, using Linear Irreversible Thermodynamics (LIT), we run 8 simulations and find a sample mean value of the diffusivity to be  $6.2 \times 10^{-8} \text{ m}^2/\text{s}$  with a sample variance of  $25.0 \times 10^{-16} \text{ m}^4/\text{s}^2$ .

Based on this information, answer the following questions.

- (a) What PDF is appropriate for determining a confidence interval on the difference of means?
- (b) Find the lower limit on a 95% confidence interval on the difference of means.
- (c) Find the upper limit on a 95% confidence interval on the difference of means.
- (d) Are we 95% confident that the Darken equation gives diffusivities within  $2.0 \times 10^{-8} \text{ m}^2/\text{s}$  of the LIT method?
- (e) Does this data support the claim that the Darken equation yields statistically the same results as LIT, for the given level of confidence?

**Problem 2. (12 points)**

A particular manufacturer makes tires for both automobiles and motorcycles with the same mean life time of 60,000 miles.

- (a) What PDF would describe the probability that an individual tire is operating after 50,000 miles?
- (b) What is the probability that an individual tire is operating after 50,000 miles?
- (c) What PDF would describe the probability that all the tires on a car are still functioning after 50,000 miles?
- (d) What is the probability that all the tires on a car are still functioning after 50,000 miles?
- (e) What is the probability that all the tires on a motorcycle are still functioning after 50,000 miles?
- (f) Explain why your answer to (d) is greater than (e) or why (e) is greater than (d), as the case may be?

**Problem 3. (6 points)**

We run a warranty company that provides replacement parts for digital cameras. If our research team tells us that on average digital cameras have a lifetime of 4 years with a standard deviation of 2 years, then answer the following questions.

- (a) If we provide a warranty for all cameras lasting less than 1 years, what fraction of the cameras can we expect to replace?
- (b) If we only want to replace 5% of the cameras, how long should our warranty last?
- (c) What PDF did you use to solve (a) & (b)?