Exam I
Administered: Monday, September 16, 2001
20 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)

A railroad tanker containing concentrated sulfuric acid derails near a populated area. The concentration of sulfuric acid in the air as a function of the radial position from the point of the derailment at its worst time is given by the following function, where r is in miles, and c is in ppm

$$c(r) = \begin{cases} 20\exp(-2r) & \text{for } 0 \le r \le 10 \\ 0 & \text{otherwise} \end{cases}$$

The probability distribution of the concentration of sulfuric acid is proportional to the concentration.

$$f(r) = 2\pi c_o c(r) r$$

(a) What is the random variable in this problem, both in terms of physical interpretation and the variable used?
(b) What value of c_o will make this PDF a legitimate function?
(c) What fraction of the sulfuric acid is located within 1 mile of the derailment?
(d) What fraction of the sulfuric acid is located beyond 1 mile of the derailment?
(e) What is the mean sulfuric acid concentration in the ten mile radius?

You may find the following indefinite integrals useful:

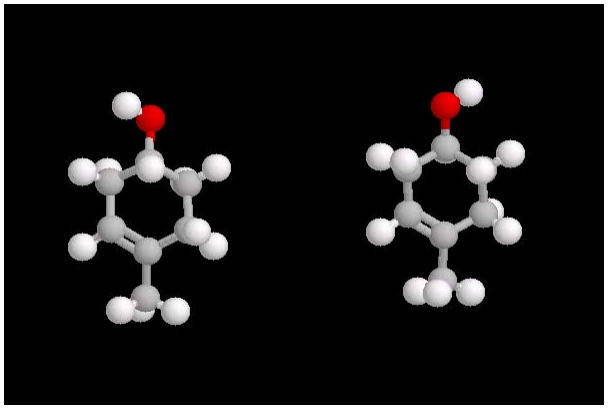
$$\int ar\exp(-br)\,dr = -\frac{a}{b^2}(br+1)\exp(-br)$$

$$\int ar^2\exp(-br)\,dr = -\frac{a}{b^3}\left(b^2r^2+2br+2\right)\exp(-br)$$

$$\int ar^3\exp(-br)\,dr = -\frac{a}{b^4}\left(b^3r^3+3b^2r^2+6br+6\right)\exp(-br)$$

Problem 2. (10 points)

Seudenol, $C_7H_{12}O$, is an aggregation pheromone from the female Douglas fir beetle, *Dendroctonus pseudotsugae*. The natural pheromone is a racemic mixture which is much more biologically active than either single enantiomer. The two enatiomers, (R)-seudenol and (S)-seudenol, are shown in the figure below.



(R)-Seudenol (S)-Seudenol

We are studying two alternative methods, method A and method B to synthesize this mixture. Method A was used to generate 40% of the product. Method A produced 64% (R)-seudenol. Method B produces 76% (R)-seudenol. Answer the following questions. Where appropriate, report to 4 significant figures.

(a) Draw a Venn Diagram of the sample space for the process and classification of the molecules in the product.
(b) What is the probability that a molecule was synthesize using method A and is (R)-seudenol?
(c) What is the probability that a molecule is (R)-seudenol?
(d) What is the probability that a molecule was generated using method B given that it is (R)-seudenol?
(e) What is the probability that a molecule was synthesize using method B and is (S)-seudenol?