Physics 301

Homework due 2 October 2024

1) Stowe problem 4-2.

2) Consider a Gaussian distribution, $P(x) = Ae^{-Bx^2}$. Use the normalization of probability to show that

$$A = \sqrt{\frac{B}{\pi}}.$$

3) Stowe problem 4-5.

4) Stowe problem 4-6.

5) We showed in class that the Gaussian distribution is an approximation to the binomial distribution for the case where N is very large. The following problem is intended to help you derive the Poisson distribution, which is an approximation to the binomial distribution when $n << N$ and $p << 1$. Begin with the binomial distribution: $P_N(n) = \frac{N!}{n!(N-n)!} p^n (1-p)^{N-n}$.

(a) Use the fact that $\ln(1-p) \approx -p$ to show that $(1-p)^{N-n} \approx e^{-Np}$

(b) Show that $\frac{N!}{(N-n)!} \approx N^n$

(c) Apply the results above to the binomial distribution to show that $P_N(n) \approx \frac{\lambda^n e^{-\lambda}}{n!}$ $(n << N$ and $p << 1)$ where $\lambda = Np$ is the mean number of events. The equation in the line above describes the Poisson distribution.