1. Record the first 10 numbers you encounter when you're reading this weekend. It doesn't matter if you're reading for class or for fun–just don't make them up.

Definition. A discrete random variable is said to have a **Poisson distribution** with parameter $\lambda > 0$ if its probability distribution function is

$$p(x; \lambda) = \frac{\lambda^x e^{-\lambda}}{x!} \text{ for } x = 0, 1, 2, \ldots$$

2. Find the moment-generating function of a Poisson random variable and use it to calculate the mean and variance of the distribution.

3. Earthquakes occur pretty much at random and there's never more than one at the same place and time. It turns out that this kind of behavior is nicely modeled using a Poisson distribution. The PNW region has a mean of 9.2 earthquakes of magnitude 4.0 or greater each year (1070 such earthquakes between 1900 and 2016 according to earthquake.usgs.gov, and according to my rough estimate for what the PNW region is). Let N_t be the number of earthquakes in the PNW over t years. Assume that N_t has a Poisson distribution.

a) What parameter λ does N_1 have?

b) What parameter does N_t have?

c) What is the probability that there will be at least one earthquake of magnitude 4.0 or greater in the PNW in the next 60 days?

(Technically, N_t is a family of random variables known as a Poisson process).

Definition. A continuous random variable is said to have a **exponential distribution** with parameter $\theta > 0$ if its probability density function is

$$g(x; \theta) = \begin{cases} \frac{1}{\theta} e^{-\frac{x}{\theta}} & \text{for } x > 0 \\ 0 & \text{elsewhere} \end{cases}$$

We proved the following proposition in class.

Proposition 1. *If X has an exponential distribution with parameter $\theta > 0$, then $M_X(t) = \frac{1}{1-\theta t}$, $E(X) = \theta$, and $V(X) = \theta^2$.*

4. Let T be the time between earthquakes in the PNW, that is the time t at which N_t changes from 0 to 1. We'll think of T as a continuous random variable.

a) Fill in the blank: $T > t$ if and only if $N_t =$ _______

b) Use part a to find the cumulative distribution function for T.

c) Differentiate your cdf to find a probability density function for T.

d) How long do you have to wait between earthquakes on average?

e) How long do you have to wait until the probability of an earthquake occurring exceeds 0.5?

5. Let T_2 be the time to the second earthquake. Find the probability density function of T_2. Hint: use the same steps as the last problem.