- Show your work.
- This work must be submitted online as a `.pdf` through gradescope.
- If this work is completed with the aid of a numerical program (such as Python, Wolfram Alpha, or MATLAB) all scripts and data must be submitted in addition to the `.pdf`.
- If you work with anyone else, document what you worked on together.

1. (10 points) We have defined the angular neutron density n($\vec{r}$, $\hat{\Omega}$, E, t) in terms of the nuetron energy E and the direction of motion $\hat{\Omega}$, but one could define an angular density that depends instead on the neutron velocity $\vec{v}$, n($\vec{r}$, $\vec{v}$, t). Calculate the relationship between these two dependent variables.

Solution: $n(\vec{r}, \vec{\Omega}, E, t) = \left(\frac{v}{m}\right) n(\vec{r}, \vec{v}, t)$

2. Prove the relations we mentioned in class:
   (a) (5 points) $n(\vec{r}, \vec{\Omega}, E, t) = \left(\frac{1}{mv}\right) n(\vec{r}, v, \vec{\Omega}, t)$
   (b) (5 points) $n(\vec{r}, v, \vec{\Omega}, t) = v^2 n(\vec{r}, \vec{v}, t)$

3. Two thermal neutron beams are injected from opposite directions into a thin sample of ^{235}U. At a given point in the sample, the beam intensities are 10^{12} neutrons/cm^2-s from the left and $2 * 10^{12}$ neutrons/cm^2-s from the right. Compute:

   (a) (10 points) the neutron flux and current density at this point

   (b) (10 points) the fission reaction rate density at this point

4. Suppose that the angular neutron density is given by

$$n(\vec{r}, \hat{\Omega}) = \frac{n_0}{4\pi}(1 - \cos(\theta))$$

where θ is the angle between $\hat{\Omega}$ and the z-axis. If A is the area perpendicular to the z-axis, then what is the number of neutrons passing through the area A per second:

(a) (5 points) er unit solid angle at an angle of 45 degrees with the z-axis,

(b) (5 points) from the negative z to the positive z direction,

(c) (5 points) net

(d) (5 points) total

5. (40 points) A purely absorbing half-plane medium, in which $\sigma = 1$, contains a sourse emitting $1 \left[\frac{n}{cm^3 s}\right]$. Determine the intensity and angular distribution of the flux and the current at the surface. (Bell and Glasstone 1.3)

6. (45 points) Suppose there is a purely absorbing region of finite thickness. It is desired to represent this region as an absorbing region accross which the neutron angular density is discontinuous. Derive the discontinuity which is required in the angular density. (Bell and Glasstone 1.10)