Question 1: Compton scattering of photons (30 points)

Please derive the Compton scattering formula given below (assuming that the electron is at rest when the collision happens, and $m$ is the rest mass of the electron).

\[ h\nu' = \frac{h\nu}{1 + \frac{h\nu}{mc^2}(1 - \cos \theta)} \]
Question 2: Attenuation coefficient for X-ray and gamma rays in matter (20 points)

What is energy transfer coefficient? and what is energy absorption coefficient for X-ray and gamma-rays?

Please explain and write down the equations for these attenuation coefficients and explain the meaning of each individual terms in the equations.
Question 3: Elastic Scattering of Neutrons (40 points)

(a) Please derive the maximum energy that a neutron of mass $M$ and kinetic energy $E_n$ could transfer to a target nucleus of mass $m$ through a single elastic collision.

(b) If a 2.6 MeV neutron has an elastic collision with hydrogen, what is the probability that it loses between 0.63 to 0.75 MeV?

(c) What is the average energy loss by a 2.6 MeV neutron through a single collision with a carbon nucleus?

Hint: The energy loss by neutrons through elastic scattering follows a uniform distribution. To make use of this distribution, you will need to find the lower and upper limits of the distribution first.