1. (Attix 4-2) An electron enters a volume V with kinetic energy 4 MeV, and carries 0.5 MeV of that energy out of V when it leaves. While in the volume it produces a Bremsstrahlung x-ray of 1.5 MeV, which escapes from V. What is the contribution of this event to:
   (a) The energy transferred?
   (b) The net energy transferred?
   (c) The energy imparted?

2. (Attix 4-3) A 10-MeV photon enters a volume V and undergoes pair production, thereby disappearing and giving rise to an electron and positron of equal energies. The electron spends half its kinetic energy in collision interactions before escaping from V. The positron spends half of its kinetic energy in collisions in V before being annihilated in flight. The resulting photons escape from V. What is the contribution of this event to:
   (a) The energy transferred?
   (b) The net energy transferred?
   (c) The energy imparted?

3. Kerma can be divided into two parts:

   \[ K = K_{\text{coll}} + K_{\text{rad}} \]

   The expression for \( K_{\text{coll}} \) in terms of energy fluence and the mass energy absorption coefficient was given in class.

   Derive the expression for \( K_{\text{rad}} \) in terms of energy fluence, mass energy absorption coefficient, and \( g \), the fraction of the energy of the secondary charged particles that is lost to Bremsstrahlung.

4. (Attix 4-6) Consider a beam of 3 MeV gamma-rays perpendicularly incident on a Fe foil that is very thin in comparison with the range of the secondary electrons.

   (a) What are the values of \( K \), \( K_{\text{coll}} \), and \( K_{\text{rad}} \) in the foil \((Z=26)\) for a fluence of \(5.6 \times 10^{15} \) photons/m\(^2\) given that for calcium \((Z=20)\) and Cu \((Z=29)\). \((\mu_\text{tr}/\rho) \) is
0.00221 and 0.00211 m$^2$/kg respectively and ($\mu_{en}/\rho$) is 0.00216 and 0.00204 m$^2$/kg respectively?

(b) Approximately what is the absorbed dose in the foil, assuming no charged particles are incident from elsewhere?

(c) What would happen to $K$, $K_{coll}$, $K_{rad}$ and $D$ if a strong magnetic field were applied with lines of force lying in the field?

(d) What is the value of $g$?

5. (Attix 4-7) A broad beam of low-energy x-rays with a fluence rate of $3.7 \times 10^{-4}$ J/cm$^2$ s irradiates a plate of Al perpendicularly, and is completely absorbed.

(a) What is the energy absorbed per cm$^2$ in 5 min?

(b) If the slab is 2 cm thick and has a density of 2.7 g/cm$^3$, what is the average value of $K_{coll}$ throughout the medium?

(c) Assuming no electrons enter or leave the plate, what is the average absorbed dose?

(d) What would be the average absorbed dose if the slab was 4 cm thick?