The likelihood of a Compton interaction occurring is most related to which of the following?

A. Atomic number  
B. Electron density  
C. K-shell binding energy  
D. Physical density

Compton interactions involve free electrons, so the probability of such interactions occurring is proportional to electron density.

Which of the following statements is true?

A. The change in energy of the photon is a function only of the angle of scatter.  
B. The change in wavelength of the photon is a function of both incident photon energy and angle of scatter.  
C. The change in wavelength of the photon is a function only of the angle of scatter.  
D. The energy imparted to the scattered electron is a function only of the angle of scatter.

The change in wavelength of the scattered photon is only a function of the scatter angle as given by the equation:

$$\Delta \lambda = \frac{hc}{m_e c^2} (1 - \cos \theta)$$

Which of the following statements regarding the energy of the incident photon in Compton scatter is true (to a good approximation)?

A. The energy is divided between kinetic energy of the scattered photon and kinetic energy of the ejected electron.  
B. The energy is divided between overcoming the binding energy of the orbital electron, kinetic energy of the scattered photon, and kinetic energy of the ejected electron.  
C. The energy is divided between recoil energy of the nucleus, kinetic energy of the scattered photon, and kinetic energy of the ejected electron.  
D. The energy is divided between recoil energy of the nucleus, overcoming the binding energy of the orbital electron, and kinetic energy of the ejected electron.

Recall, that the collision is assumed to be between a free electron and an incident photon so there is no atomic recoil to consider and, likewise, no binding energy to consider.
For patient alignment before radiation treatment, a ‘portal’ image may be taken to align the bony anatomy to a reference kV image. The portal image is made by using therapy beam to deliver a relatively small amount of radiation to the patient, generating an image the same way as a typical diagnostic x-ray. What is the greatest cause of contrast loss in the MV portal image above?

A. Compton interactions decrease the number of photons reaching the image detector
B. Compton interactions increase the number of scattered photons reaching the image detector
C. MV X-rays are more penetrating than kV
D. Photoelectric effect has a greater Z dependence than Compton interaction

The loss in contrast between bone and tissue is due to the difference in Z-dependence between photoelectric and Compton scatter. The additional scattered photons reaching the detector further degrades image quality but is not cause of the loss of contrast.

Which of the following is NOT an assumption used to derive the Compton equations?

A. Binding energy of the atomic electron is negligible
B. Compton electron can produce Bremsstrahlung
C. Energy is conserved
D. Momentum is conserved

While B is true and can happen after a Compton interaction, it is not an assumption that is factored into the Compton equations.

For the same incident photon energy and scattering angle, if the atomic binding energies of outer shell electrons were not neglected in deriving the Compton equations, how would that change the resulting energies of the scattered photon and Compton electron?

A. Both would increase
B. Both would decrease
C. Scattered photon energy increases while electron energy decreases
D. Scattered photon energy decreases while electron energy increase

For a given interaction, the binding energy would be subtracted from the incident photon energy, resulting in less energy to impart to both the scattered photon and electron.
For a Compton interaction, which of the following scattered photon angles would result in the delivery of the most dose?

A. 0 degrees
B. 45 degrees
C. 90 degrees
D. 180 degrees

For a Compton interaction, which of the following scattered photon angles would result in the delivery of the most dose?

D. 180 degrees

Of the two products of the Compton interaction (scattered photon and Compton electron), only the electron is directly ionizing and able to deposit dose immediately after the interaction, and a backscattered photon results in a maximum energy transfer to the electron.

A Cobalt-60 radiation therapy treatment unit emits gamma rays of average energy 1.25 MeV. How do the Compton interactions in a patient treated with Co-60 compare to those in a patient treated with a 10 MV linac?

A. The scattered electron receives more of the incident photon energy
B. The scattered photon receives less of the incident photon energy
C. The probability of backscattered photons is greater
D. The probability of forward scattered photons is the same

A Cobalt-60 radiation therapy treatment unit emits gamma rays of average energy 1.25 MeV. How do the Compton interactions in a patient treated with Co-60 compare to those in a patient treated with a 10 MV linac?

C. The probability of backscattered photons is greater

Assume Co-60 is $\alpha \sim 2$ and 10 MV linac is $\alpha \sim 20$, forward scattered electrons would have 4/5 and 40/41 the energy of the incident photon, so the electron receives LESS of the incident energy (eliminates A). Likewise, the scattered photon will receive MORE of the energy for the Co-60 forward scatters (eliminates B). Then, we look at the differential scattering cross sections and see that which the Klein-Nishina corrections taken into account, there is a greater probability of photon backscattering at 1 MeV than 10 MeV.