MEPH 569 – FIRST MAJOR 032

PR – 1

A. The wavelength (λ) of an electron as a function of its mass (m), kinetic energy (E) and planck's constant (h) is

a) $h/E^{1/2}$
b) $h/(mE)^{1/2}$
c) $h/(2mE)^{1/2}$
d) $(h/2mE)^{1/2}$
e) $(2h/mE)^{1/2}$

B. Which of the following materials is commonly found in photoneutron sources?

a) Beryllium
b) Carbon
c) Aluminum
d) Cobalt
e) Polonium

C. Of the following kinds of radiation emitted from I-126, which is the single least significant potential contributor to external dose?

a) Annihilation photons
b) Bremsstrahlung
c) Internal-conversion electrons
d) Auger electrons
e) Antineutrinos

D. A radionuclide has a disintegration constant of 1.0/min. What fraction of atoms has decayed after 2.0 min?

a) 0.135
b) 0.25
c) 0.50
d) 0.75
e) 0.865

E. You have lead and polyethylene shielding materials available. In shielding a pure 2.5-MeV beta emitter, how would you arrange the available materials to minimize worker exposure? List the materials as a function of distance from the radiation source, and determine the optimum shielding configuration.

a) Lead only
b) Polyethylene only
c) Lead followed by polyethylene
d) Polyethylene followed by lead
e) Lead, polyethylene, and lead

F. Which of the following sequences represents the dominant photon interaction mechanism in tissue as the photon energy increases from 10 keV to 100 Mev?

a) Photoelectric effect, Compton scattering, and pair production, respectively
b) Compton scattering, photoelectric effect, and pair production, respectively
c) Pair production, Compton scattering and photoelectric effect, respectively
d) Pair production, photoelectric effect, and Compton scattering, respectively
e) Photoelectric effect, pair production, and Compton scattering, respectively

G. Draw a figure showing the linear attenuation coefficient of photons as a function of energy in water for each of the three interaction mechanisms.

<u>PR – 2</u>

Calculate the slowing-down rate of an 800-keV electron in water and estimate the stopping time.

PR – 3

Considering the following five statements the following 5 statements or expressions (a) – (e). and match each to a different one of the six entries, 1-6, from the list that follows. Explain your match in a, b and c, and define the un-match term.

a) All 1-Mev protons do not lose the same amount of energy in traveling the first micron in water.
b) All 5-MeV alpha particles do not travel exactly the same distance in coming to rest.
c) A parallel beam of deuterons begins to diverge slightly as when it enters a target
d) Mass stopping power of a material
e) Restricted stopping power

1. Range straggling
2. Independent of density
3. Multiple coulomb scattering
4. Energy straggling
5. Delta rays
6. Cannot exceed LET_∞

PR – 4

1-MeV photons are normally incident on a 1-cm lead slab. The mass attenuation coefficient of lead (density = 11.35 g/cm^3) is 0.0708 cm^2/g and the atomic weight is 207.2.

a) Calculate the linear attenuation coefficient
b) What fraction of 1-MeV photons interact in a 1-cm lead slab?
c) What thickness of lead is required for half the incident photons to interact?
d) Calculate the mean free path

PR – 5

You are using ^{50}Cr activation foils to determine the thermal neutron fluence rate of a research reactor. A 0.1-g foil was in the reactor for 50 hours. The initial gamma count rate on the foil was 10^5 counts per minute when removed from the reactor. Other pertinent data are:

^{50}Cr(n,γ)^{51}Cr 320 keV photons (9 %)
315 keV electrons

σ_{th}(^{50}Cr) = 16 barns/atom

Detector efficiency, ε = 10 %, for 320 – keV photons
$T_{1/2}(^{51}Cr)$ = 28 days
μ (water) = 9×10^{-2} cm^{-1}

a) What is the thermal neutron fluence rate of the reactor? (Assuming no change in power during irradiation)
b) What is the irradiation time required for the foil to reach 80 % of its equilibrium radioactivity.
c) The foil is to be stored under-water. How deep must the water be to reduce the radiation level to 5% of its unshielded value? (Neglect build-up).