

BASIC RADIOLOGICAL PHYSICS COURSE

CLASS GROUP: _____
(Radiation Therapy, Radiation Oncology Resident, Post Doctoral..)

YEAR: _____
(2004, 2005 ...)

Objective:

After completing this Study Guide #18, the students should be able to understand the interaction of heavy particles, electrons, and neutrons with matter. It also covers energy deposition characteristics such as linear energy transfer, attenuation coefficient, differential absorptions, and depth dose curves. Completing this study guide formally completes the basic radiological physics course.

Study Guide #18: Interaction of Radiation with Matter (Part 2 of 2)

Read Sections: "Foundation of Radiological Physics" by C.B. Saw
Sections 11.7 to 11.14

Suggested Reference: Faiz Khan's text – Chapter 5

Assignments: Answer all questions as directed in this handout

Clinical Rotation
Assignment:

Study Guide

- 11.1 In your own words, define the following terms:
- | | |
|------------------------------|------------------------------------|
| (d) elastic collision | |
| (e) inelastic collision | (f) delta ray |
| (g) bremsstrahlung radiation | (h) Cerenkov radiation |
| (i) Bragg peak | (j) specific ionization |
| (k) linear energy transfer | (l) range |
| (m) half-value layer | (n) linear attenuation coefficient |
| (o) tenth-value layer | |
- 11.14 What is the condition required for bremsstrahlung radiation to occur?
- 11.15 List four factors that affect the range of a particle.
- 11.16 Identify the interactions of these particles with matter: (a) alpha particles, (b) beta particles, and (c) neutron particles.

- 11.17 Maximum differential absorption creates a good radiograph. Which interactions are contributory and which are not for the production of a good radiograph?
- 11.18 Describe the attenuation process.
- 11.19 List four parameters that affect the linear attenuation coefficient.
- 11.20 Which interacting processes produce high-speed electrons?
- 11.21 Which type of radiation exhibits finite penetration?

Problems:

- 11.7 An electron in tissue has a specific ionization of 30,000 ion pairs/cm. If W/e is 33.97 eV/ion pair, what is the LET? If the energy of this electron is 3 MeV, what is its range?
- 11.8 Arrange the LET in increasing order for (a) 1 MeV proton, (b) 1 MeV photon, (c) 1 MeV electron, and (d) 1 MeV alpha particle.
- 11.9 A 2 mm thick lead reduces the beam intensity of an 80 kVp x-rays by 50%. What is the minimum thickness that will reduce the intensity by 99%?
- 11.10 The HVL for 60 keV photons is about 0.5 mm of Cu. What thickness of Cu is needed to attenuate the radiation in an experiment to 3.125% of the original value?
- 11.11 The linear attenuation coefficient of a monoenergetic beam through a particular medium is $\mu=0.693 \text{ cm}^{-1}$. What percentage of the beam is transmitted if it traverses through 5 cm of this medium?

Multiple Choice Questions

Select the one correct answer.

- 11.7 In elastic collision of charged particles with matter,
- a) part of its energy is transferred to the atomic electrons.
 - b) part of its energy is transferred to the atomic nuclei.
 - c) no energy is transferred to the atoms.
 - d) part of its energy is given off as radiation.
 - e) none of the above.
- 11.8 Which statement is true about neutron collisions with matter?
- a) They interact similar to billiard ball collision.
 - b) The probability of neutron colliding with electrons is high.
 - c) Fast neutrons can be easily captured to form another radionuclide.
 - d) The maximum energy transfer occurs if the neutron collides with heavier atoms like oxygen atoms.
 - e) none of the above.

- 11.9 The range of a charged particle traversing through a medium depends on
- a) the energy of the charged particle.
 - b) the mass of the charged particle.
 - c) the density of the medium.
 - d) a and b.
 - e) all of the above.
- 11.10 Electrons lose their energies in matter through
1. production of bremsstrahlung radiation.
 2. photoabsorption.
 3. collisions with other electron.
 4. production of δ rays.
- a) 1 and 2
 - b) 1 and 3
 - c) 1, 3, and 4
 - d) 2, 3, and 4
 - e) all of the above

CBS: 3/97

Revised: 6/14/04