

BASIC RADIOLOGICAL PHYSICS COURSE

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

YEAR: _____
(2004, 2005 ...)

Objective:

After completing this Study Guide #14, the students should be able to understand decay modes of radioactive nuclides. This includes the (a) types of decay, (b) energy-level diagram, (c) alpha decay and (d) negatron decay. Certain important radionuclides are being chosen to demonstrate these decay modes.

Study Guide #14: Nuclear Transformation (Part 1 of 2)

Read Sections: Foundation of Radiological Physics (CBSaw)
Sections 9.1 to 9.4

Suggested Reference: Faiz Khan's text – Section 1-2, 1-3, 1-6, and 1-7

Assignments: Answer all questions as directed in this handout

Clinical Rotation
Assignment:

Study Guide

- 9.1 In your own words, define the following terms:
(a) nuclear transformation (b) Q-value
(c) isobaric transition (d) isomeric transition
- 9.2 State the conservation laws of energy, mass number, and charge that govern nuclear transformation.
- 9.3 Write the equation for alpha decay. Identify the mass number and the charges of the parent nuclide, the daughter nuclide, and the emitted particle consistent with the conservational laws. Give an example of an alpha decay transformation.
- 9.4 Write the equation for beta decay. Identify the mass number and the charges of the parent nuclide, the daughter nuclide, and the emitted particle consistent with the conservational laws. Give an example of a negatron decay transformation.
- 9.5 Write the equation for gamma decay. Identify the mass number and the charges of the parent nuclide, the daughter nuclide, and the emitted particle consistent with the conservational laws. Give an example of a gamma decay transformation.

- 9.6 Compare the mass and charge between neutrinos, anti-neutrinos, alpha ray, beta ray, negatron, positron, electron, and a gamma ray.
- 9.7 List the three types of beta decays. Identify the conversion process from neutron to proton and vice versa with the respective emission of neutrinos or antineutrinos. Under what conditions is each type of decay possible?
- 9.14 What are the decay products of the following radioactive nuclides?
(a) radium-226 (b) cesium-137
(c) cobalt-60 (d) molybdenum-99

Problems

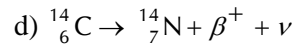
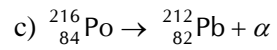
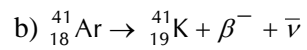
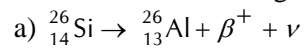
- 9.1 Show that the Q-value for the decay, $^{226}\text{Ra} \rightarrow ^{222}\text{Rn} + \alpha$ is 4.87 MeV and the kinetic energy of the alpha particle is 4.78 MeV.
- 9.2 Show that the maximum kinetic energy of the negatron particle in the $^{32}\text{P} \rightarrow ^{32}\text{S} + \beta^-$ transformation is 1.71 MeV, as depicted in Figure 9.5.
- 9.3 How many gamma rays are emitted per negatron particle emission in the ^{32}P decay?
- 9.4 Compute the Q-value for the positron decay of ^{22}Na in Figure 9.8.

Multiple Choice Questions

Select the one correct answer.

- 9.1 Isobaric transition refers to
a) nuclear transformation involving no change in mass number.
b) nuclear transformation involving no change in charge.
c) nuclear transformation involving no change in nuclear energy state.
d) nuclear transformation involving no change in energy.
e) none of the above.
- 9.2 The alpha decay equation is given as $^A_Z\text{M} \rightarrow ^X_Y\text{M} + ^4_2\text{He}$, where
a) $X=A-4$ and $Y=Z-2$.
b) $X=A+4$ and $Y=Z-2$.
c) $X=-4$ and $Y=-2$.
d) $X=Z-4$ and $Y=A-2$.
e) none of the above.
- 9.3 Which statement is NOT true about beta decay?
a) Transitions are always towards neighboring isobaric nucleus.
b) Beta plus decay involves the emission of a positron.
c) Beta minus decay involves the emission of a negatron.
d) Positron decay competes with electron capture.
e) none of the above.

9.4 Which of the following decays is NOT possible?



e) none of the above

9.5 Which statement is NOT true about positron?

a) Positron is short lived.

b) Positron has the same spin as an electron.

c) When combined with electron, two photons are emitted in opposite directions.

d) Positron has the same charge as an electron.

e) none of the above.

CBS: 3/97

Revised: 6/14/04