BASIC RADIOLOGICAL PHYSICS COURSE

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

YEAR: _____
(2004, 2005 …)

Objective:

After completing this Study Guide #3, the students should be able to (1) use electronic calculator, (2) manipulate exponential functions, (3) understand scientific notation, and (4) manipulate log functions. This section is a preparatory exercise in dealing with exponential functions.

Study Guide #3:	Mathematics Review (Part 1 of 1)
Read Sections:	Foundation of Radiological Physics (C B Saw) Chapter 2 – Mathematics I **Sections 2.5 to 2.12**
Suggested Reference:	
Assignments:	Answer all questions as directed in this handout
Clinical Rotation Assignment:	What kind of linear accelerators operate in your facility? What is the MU rate used on each of the linear accelerators?

Study Guide

2.14 Understand the keystroke sequences in your electronic calculators and show to yourself that

(a) $\sqrt{2} = 1.414\ldots$
(b) $10^2 = 100$
(c) $8^{1/3} = 2$
(d) $5^3 = 125$
(e) $\ln 2 = 0.693$
(f) $\log 2 = 0.3010$

These values should be used to check whether your calculator is functioning properly or the keystroke sequences are correct.

Problems

2.8 Due to the inverse square effect, the exposure rate at 5 cm is reduced to $\frac{1}{25}$ of its value at 1 cm. If the exposure rate at 1 cm is 8¼ R/hr, what is the exposure rate at 5 cm from the source? Express the result in common fraction.

2.9 What percentage of the activity remains after 5 half-lives in a radioactive decay? One half-life refers to the time when the activity is reduced to one half its original amount.

2.10 The cobalt-60 source decays to about 0.989 of its original amount in a month. What is the decay factor in 6 months?

2.11 Find the decimal equivalent of (a) 10^{-4} and (b) 3^4.

2.12 Reduce the expression: $125^{-1/3}$ x $(5^2)^3$.

2.13 Using equation (2.8), compute the source activity after 5 days if the initial activity is 25 mCi. Assume λ = 0.0485 per day.

2.14 The cell survival curve is given as $N=N_0 \exp(-D/D_o)$, where N is the number of surviving cells, D_0 is the mean lethal dose, and N_0 is the initial number of surviving cells before irradiation. If the initial tumor colony contains 10^6 cells, compute the number of surviving cells after 60 Gy of radiation using a mean lethal dose (D_0) of 2 Gy.

2.15 The equation, $X = X_0 e^{-\mu t}$ describes the attenuation of a radiation beam through a shielding barrier, where X_0 is the initial exposure before the shield, X is the exposure beyond the shield, and t is the thickness of the shield. Compute the exposure beyond a 2.5 cm thick lead shield if μ=0.126 per mm Pb and the exposure before the shield is 20 mrem.

2.16 Compute the percentage of transmitted radiation beam after it passes through 5 half-value-layer (HVL) thickness of lead. One HVL is the thickness of materials that would reduce the transmitted beam intensity by one-half of its original amount.

2.17 Solve the equation: x^6=110.

2.18 In film dosimetry, the optical density (OD) is defined as the log of the ratio of light intensity incident onto the film to the light intensity transmitted through the film as $\mathrm{OD} = \log_{10}\left(\frac{\text{incident intensity}}{\text{transmitted intensity}}\right)$. What is the relative transmission factor (transmitted intensity / incident intensity) if the optical density is 1.5?

2.19 The general equation for computing the radiation barrier thickness is given as $B = \frac{1}{10^{TVL}}$, where B is the fraction of transmitted intensity and TVL is the amount of material thickness that would reduce the transmitted radiation intensity to one-tenth of its original intensity. How many TVLs are needed to reduce the transmitted intensity to 1.5×10^{-5} of the original intensity?

2.20 How long does it take for 20 mCi of technetium-99m to decay to 10 mCi? The decay factor λ is 0.115 per hour.

2.21 Compute the values of (a) $\log_2(20)$ and (b) $\log_2(5)$.

Multiple Choice Questions
Choose one correct answer.

2.4 The natural logarithm of the expression exp ($-\lambda t$) is
a) $-\lambda t$
b) $-\lambda$
c) ln ($-\lambda t$)
d) ln ($-\lambda$)
e) exp (λt)

2.5 The circumference of a circle divided by its diameter gives the value of pi (π). Which of the following is NOT its equivalent expression?
a) 3 1/7
b) 3.14
c) 31.4 %
d) 314 %
e) 22/7

2.6 Which of the following is the scientific notation for the value 342.15?
a) 0.34215×10^3
b) 3.4215×10^2
c) 34.215×10^1
d) 342.15×10^0
e) 3421.5

2.7 A radionuclide has a half-life of 2.7 days. What is the activity after 2 days if its initial activity is 20 mCi?
a) 11.97 mCi
b) 14.81 mCi
c) 20.00 mCi
d) 27.00 mCi
e) 33.42 mCi

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