MEPH 569 – SECOND MAJOR EXAM 032

PR 1 A

A certain 3-Ci point source has a specific gamma-ray constant of 1.8 R/h per curie at 1 am. Placing the source behind a shield reduces the exposure rate to 20 mR/h at 60cm. By what factor does the shield reduce the exposure rate ?

a) 15
b) 150
c) 250
d) 750
e) 1500

PR 1 B

Shortly after a tritium inhalation incident, it is found that the initial equivalent dose rate to a worker is 10 mrem/h. The committed equivalent dose based on an effective half life of 10 days, is

a) 0.144 rem
b) 0.240 rem
c) 2.40 rem
d) 3.46 rem
e) 3460 rem

PR 1 C

Match the following quantities and their SI units

a) (Particle) Fluence	m^{-2}
b) Energy fluence	$J\ m^{-1}$
c) (Particle) fluence rate	$m^{-2}\ s^{-1}$
d) Total mass stopping power	$C\ kg^{-1}$
e) Linear energy transfer	s^{-1}
f) Absorbed dose rate	$J\ m^{2}$
g) Kerma	$J\ kg^{-1}\ s^{-1}$
h) Exposure	Js^{-1}
	Jkg^{-1}
	$Jm^{2}kg^{-1}$

PR 2

"Stochastic" and "deterministic" (i.e. nonstochastic) are terms used to describe some qualities in health physics. The expressions are also applied to the biological effects of radiation.

a) What is meant by "stochastic" ?
b) Give an example of a stochastic and a non-stochastic qantity in radiation physics.
c) Give an example of a stochastic and a deterministic (non-stochastic) biological effects of radiation.
d) How are radiation dose and the possible existence of a threshold thought to be related to incidence and severity for these two kinds of effects?

PR 3

In experiments with certain cells, it is found that survival is exponential as a function of dose. That is, the relative number of cells S/S_o that survive an absorbed dose D is given by $S/S_o = \exp(-kD)$, where k is a constant.

a) If only 1% of the cells survive a dose of 38.5 Gy, what is the numerical value of k?
b) What dose is lethal to half the cells?
c) How is k related to the average dose for killing a cell?

PR 4

The classical definition of the roentgen is that amount of X or gamma radiation which will produce 1 esu of charge of either sign in 1 cm^3 of dry air at STP under conditions of charged-particle equilibrium. In the SI system of units, the roentgen is defined as equal to 2.58×10^{-4} C/kg (exactly).

Using each of these two definitions, calculate the absorbed dose in air from an exposure of 1 R. Show your work. No credit for answer alone without showing how it was calculated.

Given:

W_{air} = 34.0 eV/ip = 34.0 J/C
μ_{en}/ρ_{air} = 0.0271 cm^2/g
electronic charge = 4.80×10^{-10} esu
1 MeV = 1.6×10^{-6} ergs = 1.6×10^{-13} J
ρair = 1.293 x 10-3 g/cm^3 @ STP

PR 5

A 2.75-MeV photon produces a 1.10-MeV Compton electron (e_1) at point A in a 20-g target, as shown in the figure below. The electron emits a 0.60-MeV bremsstrahlung photon escapes from the target without interacting, as indicated in the figure. The photon scattered at A is scattered again at D, producing a 1.00-MeV Compton electron (e_2), which loses 0.4 MeV in the target before escaping. Calculate the kerma and the absorbed dose, averaged over the target.

PR 6

A condenser-type pocket chamber with "air-equivalent" walls has a capacitance of 8 x 10^{-12} F and a volume of 3.1 cm^3. it is initially charged at a potential difference of 250 V. after use in a field of gamma rays, the potential difference is 233 V. the temperature is 299K and the pressure is 748 torr.

a) What is the exposure in R?
b) Estimate the air dose.
c) The soft tissue dose.

PR 7

A beam of 330 monoenergetic alpha particles per second enters a parallel-plate ionization chamber containing air, in which they stop. The energy of the particles as they enter is 4.90 MeV. The chamber shows a steady current of 7.2 x 10^{-12} A under saturation conditions. What is the W-value for alpha particles in air (W=average energy needed to produce an ion pair)

PR 8

A worker receives a whole-body equivalent dose of 23 mSv and is also exposed to short-lived radioiodine, which results in a equivalent dose of 130 mSv, restricted to the thyroid. These are the only exposures he receives during the year.

a) What additional whole-body equivalent dose might he have received and still not exceeded ICRP60 recommendations?
b) What additional thyroid equivalent dose might he have received and still not exceeded ICRP60 recommendations?

$$\mathrm{X} = \Gamma\frac{c}{r^2}, H_{T(\tau)} = \int_{t_o}^{t_o+T} H_T dt, PV = nRT$$