Radioisotope and Radiation Applications
EXERCISES
Week 3b

Problem 17:
As the photoelectric effect is highly Z dependent, it is useful to define an effective atomic number $\bar{Z}$ of a compound, (e.g.) as follows:

$$\bar{Z} \;=\; (a_1 Z_1^{2.94} + a_2 Z_2^{2.94} + \ldots + a_n Z_n^{2.94})^{1/2.94}$$

where $a_1, a_2, \ldots a_n$ are the fractional contributions of each element to the total number of electrons in the mixture. Calculate the $\bar{Z}$ of air, with the composition by weight given by: nitrogen 75.5%, oxygen 23.2%, and argon 1.3%, and using that the total number of electrons/g of air is 3.01×10^{23}.

Problem 18:
The percent depth dose P is often tabulated as a function of depth d and field size r and is usually measured at a standard SSD = f of 80 cm. In order to obtain P for a non-standard SSD, as an approximation, the *Mayneord* Factor F can be used:

$$P(d, r, f_2) \;=\; P(d, r, f_1) * F$$

with F given as:

$$F \;=\; \left(\frac{f_2 + d_m}{f_1 + d_m}\right)^2 \cdot \left(\frac{f_1 + d}{f_2 + d}\right)^2$$

The percent depth dose for (a 15×15 field size,) 10 cm depth, and 80 cm SSD is 58.4 (^{60}Co beam). Find the percent depth dose for the same field size and depth for a 100 cm SSD assuming d_m =0.5 cm for ^{60}Co γ-rays.

Problem 19:
A patient is to be treated with an orthovoltage beam having a half-value layer of 3 mm Cu. Supposing that the machine is calibrated in terms of exposure rate in air, find the time required to deliver 200 cGy (rad) at 5 cm depth, given the following data: exposure rate = 100 R/min at 50 cm, field size = 8×8 cm, SSD = 50 cm, percent depth dose = 64.8, backscatter factor = 1.20. Simply use the factor rad/R = 0.95 to translate exposure rate in air to dose rate. (1R=1 Roentgen).

Problem 20:
A patient is to be treated with ^{60}Co radiation. Supposing that the machine is calibrated in air in terms of dose rate free space, find the treatment time to deliver 200 cGy (rad) at a depth of 8 cm, given the following data: dose rate free space = 150 cGy/min at 80 cm for a field size of 10×10 cm, SSD = 80 cm, percent depth dose = 64.1, and backscatter factor = 1.036.

Problem 21:
Determine the time required to deliver 200 cGy (rad) with a ^{60}Co γ-ray beam at the isocenter (a point of intersection of the collimator axis and the gantry axis of rotation), which is placed at a 10 cm depth in a patient. Assume SAD = 80 cm, and that for your field size at the isocenter the dose rate free space at the SAD for this field is 120 cGy/min, and the corresponding TAR = 0.681.