國立清華大學 100 學年度碩士班入學考試試題

系所班組別：生醫工程與環境科學系 丙組(醫學物理與工程組)

考試科目（代碼）：放射物理學 (2701)

1. (1) 4%. Describe the relation of these two quantities: the average life (t_a) and the half life (t_h) of a source. Also, describe the relation of t_a and the decay constant (λ). (2) 3%. Cobalt 60 (^{60}Co), having a half-life of 5.26 years, will decay to ^{60}Ni. A 1 mCi source of ^{60}Co is given. Calculate the number of disintegrations within 10 seconds. (3) 3%. A source of Au-198 (t_h= 2.69 days) of initial activity $8x10^7$ Bq is placed in a patient for 3.88 days and then removed. Determine the emitted radiation.
   Note: 1 Ci = $3.7x10^{10}$ Bq; e^{-1} = 0.368; 1 day=$8.64x10^4$ seconds.

2. A detector can record the number of photons that pass through an attenuator: (1) 2%. Describe the linear attenuation coefficient (μ). (2) 3%. Express the relation of μ with N (the number of photons that can be recorded), n (the number of photons that will interact with the attenuator and be removed from the beam), and Δx (the thickness of the attenuator). (3) 3%. An incident beam containing 10^4 photons is incident on a 10 cm slab of material for which μ=0.1 cm^{-1}. Determine the number transmitted.

3. (1) 4%. Describe the kerma and the absorbed dose. (2) 3%. The energy of kerma and absorbed dose are K and D, respectively. The energy of the photon resulting from a collision between the electron and a nucleus (bremsstrahlung) is E_b. Describe the relation of K, D, and E_b. (3) 3%. Will the kerma and absorbed dose take place at the same location? (4) 4%. Suppose a beam of 10.0 MeV photons with fluence of $10^{14}/m^2$ is incident on a small block of carbon. Calculate the kerma. Note: the mass attenuation coefficient (μ/ρ) = 0.00196 m^2/kg; the average energy transferred to electrons of the medium (E_{tr}) = 7.30 MeV; 1 MeV = 1.602 X 10^{-13} J.

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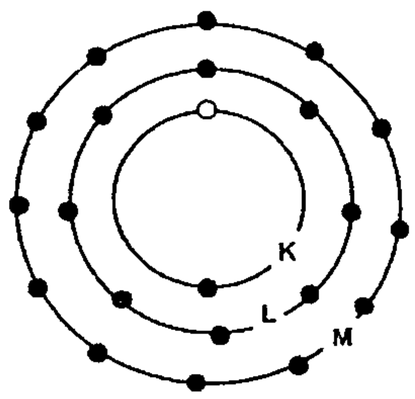
4. As shown in the figure, a hole is in the K shell in the initial state. A KLM Auger electron is ejected. Calculate: (1) 3%.The energy of the characteristic radiation. (2) 3%. The energy of the Auger electron. (3) 4%. Plot the representation of the final state. Note: The binding energy of the electrons in K,L,M shells: E_K, E_L, E_M.



Initial state: hole in K shell

5. (1) 5%. Describe the bremsstrahlung radiation. (2) 3%. Is the energy of the bremsstrahlung radiation with a continuous spectrum or with discrete energy distribution?

6. (10%) In radiation therapy, oftentimes two opposing pairs of beams are used for treatment. If there are three radiation sources available: 200 kV x-ray, Co-60, and 25 MV x-ray, please plot and discuss the dose along axis of these two beams when the separation is 10cm, 20cm, and 30cm.

7. (10%) Let N_s be the sample counts measured in time t_s, N_b be the background counts measured in time t_b. (1) What is the uncorrected sample activity, background activity, and true sample activity? (2) What is the standard deviation of uncorrected activity, background activity, and true activity?

8. (10%) What is the hyperthermia technique in radiation therapy? What is the oxygen effect in radiation therapy?

9. (10%) What are the image qualities in a radiologic film? How to measure them?

10. (10%) When a medium is irradiated by x-ray. What is the quality of the primary beam change with depth? What will be the amount of scattered radiation change with depth? For a given depth, what is the beam quality change with distance away from the axis?