



6. Sketch the gamma-ray spectrum that would result from a sample emitting two gamma-rays, one at 1.368 MeV and one at 2.754 MeV. Include the following features, if appropriate: full energy peaks, any escape peaks, backscatter peaks, annihilation peaks, Compton shoulders. Give the energy of each peak.
  
7. Calculate the time required for the  $^{99m}\text{Tc}$  activity in a Mo-Tc isotopic generator to reach 75 % of the activity of the parent  $^{99}\text{Mo}$   
 $^{99}\text{Mo}$  ( $\beta^-$ )  $^{99m}\text{Tc}$   
half life of  $^{99}\text{Mo}$ : 66 h  
half life of  $^{99m}\text{Tc}$ : 6 h
  
8. In radiotracer studies, and in particular if open radioactive sources are being used, a strong preference occurs for gamma-ray emitting radionuclides whereas the use of alpha emitting radionuclides is kept at the minimum
  - a. Why the preference for gamma-ray emitting radionuclides?
  - b. Give two reasons why alpha emitting radionuclides are not popular
  - c. In which cases can't we avoid using alpha emitting radionuclides?
  
9. What thickness of copper would be required to attenuate a 0.661 MeV gamma-ray from a  $^{137}\text{Cs}$  beam from 2.0 Curie to 2.0 microCurie (1 Curie =  $3.7 \cdot 10^{10}$  Bq). The total attenuation coefficient for a 0.661 MeV gamma-ray in copper is 0.0726  $\text{cm}^2/\text{gram}$  and the density of Copper is  $8.92 \text{ g/cm}^3$ . Express the thickness in cm.
  
10. A Ge-detector was claimed to have a relative efficiency of  $> 100\%$ . Can that be true?
  
11. What might be the advantage in nuclear gauging of having a source emitting both low and high energy gamma-rays?
  
12. Can a liquid scintillation detector be used to detect  $\gamma$ -rays. Explain your answer
  
13. A 2.0 ml sample of an aqueous solution containing 0.3 microcurie per ml of tritium is injected into the bloodstream of an animal. After allowing sufficient time for complete circulatory mixing, a 1.0 mL aliquot of blood is removed and found to have an activity of 1480 dpm of tritium. From this, calculate the blood volume of the animal.

14. Imaging modalities used in nuclear medicine.
  - a. Mention three major aspects of SPECT.
  - b. Mention three major aspects of PET.
  - c. What are two major advantages of PET versus SPECT?
  
- ~~15.~~ To what purposes is radiation used in nuclear medicine?
  
  
- ~~16.~~ The iodine that enters the body is stored in the thyroid gland from which it is released to control growth and metabolism. The thyroid can be imaged if iodine-131 is injected into the body. In larger doses  $^{131}\text{I}$  is also used as a means of treating cancer of the thyroid.  $^{131}\text{I}$  has a half-life of 8.70 d and decays by  $e^-$  emission. Emission of a gamma ray accompanies the beta decay.
  - a. Write an equation for the decay. (It is customary to omit gamma rays in nuclear equations that involve production of new nuclei or other particles.)
  - b. Is the beta particle or the gamma ray used in the imaging process?
  - c. How long will it take for 95.0% of a dose of  $^{131}\text{I}$  to decay.

