

QUESTION 11

You are the health physicist at a high-energy particle accelerator facility. An open air cylindrical ionization chamber is used in this facility. The chamber is bombarded by a uniform flux density of high-energy (minimum-ionizing) muons incident normal to the long axis of the chamber. The radiation field is constant in time; there is no pulse structure of significance. In this radiation field the current collected from the anode of the ionization chamber has a value of 10^{-12} ampere. Assume that the passage of the muons through the entire length of the chamber represents insignificant degradation of the muon energy and does not significantly alter their direction.

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- Radius of ion chamber = 5 cm
- Length of ion chamber = 20 cm
- The density of air is 1.293 g L^{-1} at one atmosphere absolute pressure and at room temperature.
- The stopping power (dE/dx) of high energy (minimum-ionizing) muons in air is $2.0 \text{ MeV cm}^2 \text{ g}^{-1}$.
- The mass stopping power of the ionization chamber walls is equal to that of the gas.
- The dose equivalent per unit fluence for such muons is $4 \times 10^{-4} \text{ } \mu\text{Sv cm}^2$ per muon.
- For purposes of this problem, the chamber gas and walls are taken to be approximately "tissue-equivalent".
- For a capacitor, the potential difference, V , the charge, Q , and the capacitance, C , are related by, $Q = CV$.

STATE ALL ASSUMPTIONS**POINTS**

- 30** A. Calculate the dose equivalent rate from the measured chamber current, assuming that the anode is 100 percent efficient in collecting this current. **Show all calculations.**
- 25** B. List **five** different conditions that could affect the accuracy of ionization chamber measurements. **Number your responses. Only the first five numbered responses will be graded.**
- 10** C. 1. How are muons created in an accelerator?
2. What is the charge of a muon?
3. How does its mass compare to that of other elementary particles?

- 20** D. List **four** criteria to be considered when determining where an ionization chamber should be located in order to measure the radiation field from a misdirected particle beam that might create a temporary muon radiation field. **Number your responses. Only the first four numbered responses will be graded.**
- 15** E. List **five** hazards (other than from ionizing radiation) associated with high energy accelerator facilities. **Number your responses. Only the first five numbered responses will be graded.**