

QUESTION 10

You are the RSO for a large state university. A cyclotron is used to produce large activities of various radioactive gases with short half lives (^{11}C , ^{13}N , ^{15}O and ^{18}F). These radioactive gases are transported via a carrier gas through tubing above the laboratory ceiling into a laboratory hood. Radiochemical processing occurs in a shielded reaction vessel in the hood. An accident occurred when a ceiling tile dislodged and knocked loose the gas line, allowing ^{15}O to be released at a constant rate into the laboratory room air.

GIVEN:

Assume instant and complete mixing of ^{15}O with room air.

Room ventilation occurs only through hood exhaust, and volume exhaust rate is $30\text{ m}^3\text{ min}^{-1}$

Room size is $6\text{ m} \times 6\text{ m} \times 3\text{ m}$

^{15}O release rate = $2.6 \times 10^9\text{ atoms s}^{-1}$

^{15}O half life = 122 s

STATE ALL ASSUMPTIONS**POINTS**

- 30** A. 1. Will room ventilation or radioactive decay be the dominant removal mechanism?
Justify your answer
2. What is the room activity concentration of ^{15}O (in Bq/m^3) after 4 minutes of release? **Show all work.**
- 20** B. Flow was terminated after 6 minutes and the technician left the room. The technician is concerned because she has calculated an air concentration of ^{15}O that greatly exceeded the DAC (4000 Bq m^{-3} for submersion) at the time she exited the room. Give **two** reasons why exceeding this DAC does not necessarily mean that a dose limit has been exceeded. **Number your responses. Only the first two will be graded.**
- 30** C. 1. What types of decay modes do the following radionuclides undergo, and what types of characteristic radiation do they emit: ^{11}C , ^{13}N , ^{15}O and ^{18}F ?
2. List **two** health physics concerns with the way the transfer tubing is used and situated to transport the gas from the shielded reaction vessel in the hood. **Justify your answers. Number your responses. Only the first two will be graded.**

- 20** D. You are considering monitoring the laboratory hood exhaust stack. Monitoring needs to be able to detect releases of these radionuclides (^{11}C , ^{13}N , ^{15}O and ^{18}F) and yet be relatively insensitive to common activities of most other radioactive materials used in university research (^3H , ^{14}C , ^{32}P , and ^{125}I). Evaluate the following instrument and sampling combinations for applicability to this situation. **Discuss your answer.**
1. NaI detectors used in coincidence counting of flow-through sampler.
 2. G-M tube counting of buildup on particulate filter sample.
 3. Solid state silicon detector counting of buildup in charcoal cartridge sample.
 4. Energy compensated G-M count flow-through sampler.
 5. Wide range ionization chamber monitoring of flow-through sampler.