RADIATION SAFETY EXAM

Indiana University - Bloomington

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Please read each question carefully and circle the letter for the best answer. Each question is worth two points except as noted. Return completed exam to the Radiation Safety Office, Jordan Hall 071.

1. ^{3}H, ^{14}C, and ^{32}P are all:

   a. stable isotopes
   b. unstable isotopes that undergo radioactive decay
   c. radionuclides
   d. b and c

2. Any material which contains measurable amounts of one or more radionuclides is:

   a. a radioactive material
   b. a fissionable fuel
   c. a hazardous waste
   d. a critical mass

3. How much "activity" will remain four weeks after a 1.0 millicurie shipment of ^{32}P (half-life of 14 days) is received?

   a. 1.0 millicurie
   b. 0.5 millicurie
   c. 0.250 millicurie
   d. 0.125 millicurie

4. Given a vial containing 1.0 microcurie of ^{3}H (12 year half-life) and a second vial containing an equal "activity" of ^{35}S (90 day half-life), which of the following is true?

   a. the number of nuclei decaying per second in each vial will be nearly the same
   b. the ^{3}H vial will have far more radionuclei present than will the ^{35}S vial
   c. the time required for 90% of the radionuclei to decay will be shorter for the ^{35}S
   d. all of the above

5. The commonly used radionuclides; ^{3}H, ^{14}C, ^{35}S, ^{45}Ca, and ^{32}P emit:

   a. alpha particles
   b. beta particles
   c. gamma rays
   d. a and c

6. Alpha and beta particles together with gamma and X-rays are referred to as ionizing radiations because they:

   a. originate in the ionosphere
   b. interact only with ions
   c. remove electrons from the atoms with which they interact
   d. none of the above

7. At the level of the human organism, long-term exposure to low levels of ionizing radiation may result in:

   a. destruction of the bone marrow
   b. increased risks of certain cancers
   c. hair loss
   d. nausea

8. What is the underlying cellular effect believed to be responsible for delayed effects of radiation exposure, such as cancer?

   a. transformation of the cell's DNA following unrepaired or misrepaired damage
   b. cell death
   c. alteration of oxidative phosphorylation in the cell's mitochondria
   d. inhibition of cell membrane function

9. The lifetime risk of fatal cancer for an individual who receives a dose equivalent of one rem is estimated to:

   a. decrease from 20% to 15%
   b. increase from 20% to 50%
   c. increase from 20% to 20.05%
   d. increase from 10% to 20%

10. Current radiation exposure limits were set at levels designed to:

    a. prevent all acute (prompt) effects of radiation exposure
    b. prevent all chronic (delayed) effects of radiation exposure
    c. limit the risk of chronic (delayed) effects (such as cancer) to very low levels
    d. a and c

11. The total effective dose equivalent which a radiation worker may receive annually is:

a. 5 rem
b. 15 rem
c. 500 mrem
d. 450 rem

12. The dose equivalent limit for radiation exposure to the hands is:

a. 10 times the limit for the whole body
b. 100 times the limit for the whole body
c. less than that for the whole body
d. none of the above

13. The Annual Limit on Intake (ALI) is that activity of a radionuclide which if ingested or inhaled will yield a:

a. committed effective dose equivalent of 5 rem
b. committed dose equivalent of 50 rem to any organ
c. either a or b, depending on which is more restrictive
d. none of the above

14. If an individual were to accidentally ingest 1.0 millicurie of ^{14}C (0.5 of the ALI), the committed effective dose equivalent received would be:

a. 2.5 rem
b. 5 rem
c. 10 rem
d. 50 rem

15. Adherence to the ALARA philosophy:

a. is required by law
b. means that individuals cannot be exposed up to their dose limits
c. implies that all reasonable precautions for minimizing radiation exposures must be observed
d. all of the above

16. The total dose that an individual will receive from an uptake of radioactive material will depend in part upon:

a. the physical half-life of each radionuclide involved
b. the biological half-life of each radionuclide involved
c. both a and b
d. none of the above

17. The dose that will result from an uptake of radioactive material:

a. can be reduced through the use of shielding
b. cannot be easily altered
c. is generally less than for an external exposure
d. can be reduced by inducing vomiting

18. The accidental uptake of radioactive material may result from:

a. eating, drinking, or smoking in radionuclide work areas
b. handling radioactive material without gloves
c. failing to exercise proper contamination control measures
d. all of the above

19. External radiation exposure to the hands from a vial of ^{32}P may be reduced by all of the following except:

a. wearing a ring dosimeter
b. decreasing the time spent handling the vial
c. increasing the distance between the hands and vial
d. placing the vial in a lucite container or rack

20. Which of the following radionuclides pose an internal hazard following an uptake?

a. ^{3}H and ^{14}C
b. ^{32}P and ^{125}I
c. ^{45}Ca and ^{35}S
d. all of the above

21. For which of the following radionuclides would the use of a 1.0 centimeter thick lucite or plexiglass shield be appropriate?

a. ^{125}I
b. ^{32}P
c. ^{35}S
d. ^{14}C

22. Contamination consisting of ^{3}H and ^{35}S can be detected best through the use of:

a. a thin-crystal NaI detector
b. a thin-window GM detector
c. surface wipes analyzed in a liquid scintillation counter
d. an ion chamber

23. Contamination consisting of ^{32}P can be detected through the use of:

a. pancake GM detector
b. an end-window GM detector
c. surface wipes analyzed in a liquid scintillation counter
d. all of the above

24. Contamination monitoring should be conducted:

a. only by the highly trained Radiation Safety staff
b. by the researcher during and after each procedure involving radionuclides
c. on a quarterly basis only
d. twice each year

25. An individual who works, in any one experiment, with ^{32}P in quantities of 1.0 millicurie or more must:

a. wear a ring dosimeter
b. work behind a lucite shield
c. have a monthly urinalysis
d. a and b

26. The purpose of a dosimeter is to:

a. reduce the radiation exposure of the wearer
b. provide an indication of the radiation dose received from external irradiation
c. provide an indication of the radiation dose received from internal irradiation
d. b and c

27. For which of the following incidents must the authorized user immediately notify the Radiation Safety Officer?

a. loss of radioactive material
b. radioactive contamination of personnel
c. major radioactive material spill
d. all of the above

28. In an accident involving radioactive material in which there has been a personal injury, the primary concern is to:

a. attend to the injured person after decontaminating the immediate area
b. isolate the injured person until help can arrive
c. attend to the injured person first and assess potential contamination later
d. call the Homeland Security hotline immediately

29. In order to ensure that radioactive material is secured against unauthorized access, the authorized user must:

a. lock the laboratory doors whenever the laboratory is unattended
b. confront any strangers who are observed in the laboratory
c. search each person before they exit the laboratory
d. a and b

30. Most uses of radioactive material at Indiana University are regulated by the:

a. Indiana Department of Health
b. U.S. Atomic Energy Commission
c. U.S. Nuclear Regulatory Commission
d. Indiana Department of Natural Resources

31. All uses of radioactive material at Indiana University must be reviewed and approved by the:

a. Chancellor
b. Radiation Safety Officer
c. Vice President for Research
d. Department Chair

32. An application for individual use of radioactive material at Indiana University must describe all of the following except the:

a. applicant's marital status
b. applicant's training and experience
c. types and quantities of radioactive material to be used
d. the identity of the Principal Investigator of the project

33. The individual approved by the Radiation Safety Officer as the Principal Investigator in the use of radioactive material is responsible for ensuring that:

a. activities involving radioactive material are conducted as approved
b. laboratory personnel are adequately trained and supervised
c. the Radiation Safety Officer is notified of proposed changes in the use of radioactive material
d. all of the above

34. An individual who is not an approved Principal Investigator may work with radioactive material provided he or she:

a. has completed all radiation safety training requirements
b. has been approved by the Radiation Safety Officer and Principal Investigator of the project
c. has been previously approved at another institution
d. a and b

35. When placing an order for radioactive material, the authorized user must instruct the vendor to ship the material to the:

a. laboratory of the Principal Investigator
b. Purchasing Department
c. Radiation Safety Office/Jordan Hall
d. either a or c

36. Upon notification by radiation safety staff that a package of radioactive material has arrived, the authorized user must:

a. pick up the shipment at the Radiation Safety Office (JH071)
b. return the package to the laboratory and complete check-in procedures
c. place the radioactive material in secure storage until used
d. all of the above

37. Which of the following requires segregation as a specific radioactive waste category?

a. sharps
b. radioactive source vials and lead containers
c. non-aqueous solvents
d. all of the above

38. Before radioactive waste can be removed from the lab, the authorized user must do all of the following except:

a. seal all bags and containers
b. determine the total weight of the waste
c. estimate the maximum activity of each radionuclide present in the waste
d. complete and affix a radioactive waste tag to each separate item of waste

39. Radioactive material users are required to maintain records of:

a. contamination surveys performed
b. radioactive material use and disposal
c. both a and b
d. none of the above

40. Periodic radiation safety audits conducted by Radiation Safety staff include all of the following except:

a. a contamination survey
b. a review of inventory and survey records
c. a review of safety procedures
d. a search for missing plutonium

41. At the end of an experimental procedure, you have accidentally dropped a glass jug containing 2 liters of aqueous waste with approximately 500 microcuries of ^{32}P. The jug shattered upon impact with the floor. Briefly describe the <u>immediate</u> steps you would take to respond to this incident. (5 points)

(1) Contain, (2) notify people in lab,
(3) Check for contam. tha (e.g. shoes),
(4) report spill, (5) clean up spill

42. Describe the steps you would take to decontaminate surfaces affected by the previously described spill. (5 points)

1) survey / wipe test
2) mark cont. area
3) "suit up"
4) scrub area from edge to center
5) ~~dispose~~ test for decontamination effectiveness
6) Dispose of cleaning materials

43. Following decontamination of the previously described spill, several wipe samples of approximately 100 cm^2 each are taken of the affected floor area. Upon analysis in a liquid scintillation counter, the highest reading obtained for any sample is 230 cpm. If the counter is nearly 100 percent efficient for ^{32}P and has a background of 50 cpm, can the floor be considered satisfactorily decontaminated? (4 points) **Hint:** Contamination limits in dpm are listed in Table 3, page 21 of *The Radiation Safety Manual.*

Yes, decontaminated because

230 - 50 = 180 = contamination

200 = threshold.

threshold > contamination

44. If the previous spill involves ^{3}H rather than ^{32}P (LSC efficiency of 50 percent), can the floor be considered satisfactorily decontaminated? Show your work! (6 points).

$E = \frac{CPM}{DPM}$ // 50% efficiency = $\frac{1 cpm}{2 dpm}$

230 cpm $\frac{2 DPM}{CPM}$ = 460 dpm

72 fold above limit

threshold

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Contaminated!

Ludlow model 5

Room 438 Scanlation Center