Radiation Quantities and Units

1. Which of the following is not a unit of energy:

      A.   Heat unit
      B.   MeV
      C.   Watt
      D.   Joule

2. If the muscle tissue is exposed to 50 roentgens of x-rays, this would produce an approximate dose of:

      A.   50 rad
      B.   50 Gy
      C.   50 sievert
      D.   50 becquerel

3. A gray is equal to:

      A.   10 roentgen
      B.   100 rad
      C.   1000 rad
      D.   1 Ci

4. 1 curie is equal to:

      A.   106 becquerel
      B.   103 becquerel
      C. 3.7×10^{10} becquerel
      D.   37 becquerel

5. Exposure is defined for ionization produced in:

      A.   Water
      B.   Tissue
      C.   Air
      D.   Fat

6. If a charge of 10 coulomb passes through a meter in 2 seconds, the current is:

      A.   20 amps
      B.   5 amps
      C.   10 amps
      D.   8 amps

7. In the following, match the quantity with the corresponding unit:

    A.   Rad
    B.   Ci
    C.   Roentgens
    D.   MeV

    a.   Electron Beam energy
    b.   Exposure
    c.   Absorbed dose
    d.   Radioactivity

8. Which of the following is not a unit of energy:

    A.   Rad
    B.   cGy
    C.   Volt
    D.   Joules

9. One roentgen corresponds to a charge of:

    A. 3.7×10^{10} disintegrations/sec
    B. 2.58×10^{-4} coulomb/kg
    C.   0.03 esu of electrostatic charge
    D.   1 electron volt

10. Which of the following is not an SI unit:

    A.   Kilogram
    B.   Meter
    C.   Ci
    D.   Second

11. Match the following units with the quantity.

    A.   Hz
    B.   Amp
    C.   Angstrom
    D.   coulomb
    E.   kV

    a.   Wavelength
    b.   Frequency
    c.   Charge
    d.   Current
    e.   Tube potential

12. A monitor unit in a linac usually represents an absorbed dose of:

    A.   1 Gy
    B.   0.01 Gy
    C.   100 Gy
    D.   0.1 Gy

13. A picocurie is equal to:

    A.   0.1 Ci
    B.   0.001 Ci
    C. 10^{-6} Ci
    D. 10^{-9} Ci
    E. 10^{-12} Ci

14. Nanocoulomb is equal to:

    A. 10^{-3} coulomb
    B. 10^{-6} coulomb
    C. 10^{-9} coulomb
    D. 10^{-12} coulomb

Structure of Matter

15. Match the charge with the particle:

    A. Electron   a. +1
    B. Positron   b. -1
    C. Proton   c. 0 (neutral)
    D. Neutron
    E. Photon

16. Isobars are nuclides that have the same:

    A. Number of protons
    B. Atomic number
    C. Mass number
    D. Number of neutrons

17. Which of the following nuclear transitions produces only photon radiation:

    A. Isomeric
    B. Electron capture
    C. Isobaric
    D. Isotopic

18. Which of these transitions produces electrons:

    A. Isobaric
    B. Auger
    D. Internal conversion
    E. All of the above

19. What determines the binding energy of an electron:

    A. The physical density of the material
    B. The shell (K, L, etc.) location of the electrons and the atomic
        number of the element
    C. The thickness of the material
    D. The speed of the electron in the orbit

20. Match the following symbols with their corresponding parameters:

    A. Na   a. Plank's constant
    B. A   b. Mass number
    C. Z   c. Atomic number
    D. h   d. Avogadro's number

21. The mass of an electron at rest is:

    A.   1.02 MeV
    B.   0.511 MeV
    C.   9.81 MeV
    D.   5.11 MeV

22. One atomic mass unit is the same as:

    A. 1.66×10^{-27} Kg
    B.   1/12 the mass of a $^{12}C_6$ nucleus
    C.   931 MeV
    D.   All of the above

23. The number of atoms in one gram is equal to:

    A.   The atomic weight divided by the atomic mass
    B.   Avogadro's number divided by atomic weight of the atom
    C.   Avogadro's number divided by the density of the material
    D.   The atomic weight divided by Avogadro's number

24. The binding energy of the nucleus is the:

    A.   Force of repulsion between the electrons of the atoms
    B.   Force of attraction between the protons and electrons of the atom
    C.   Energy needed to keep the nuclear particles together
    D.   Force of attraction between atoms

25. The mass of an electron is:

    A.   The same as that of a proton
    B.   Half of the proton's mass
    C.   The same as that of a neutron
    D.   Much smaller than the mass of a neutron

26. Which of the following does not ionize directly:

    A.   Positron
    B.   Neutron
    C.   Alpha particle
    D.   Electron
    E.   Proton

27. Approximately how heavy is a neutron compared to an electron:

    A.   10   : 1
    B.   100   : 1
    C.   1000 : 1
    D.   2000 : 1

28. The atomic mass number (A) is equal to the:

    A.   Number of neutrons
    B.   Number of electrons and protons
    C.   Number of neutrons, electrons and protons
    D.   Mass of electrons minus their binding energies
    E.   Number of nucleons (protons and neutrons)

29. The energy equivalent of an atomic mass unit is approximately:

    A.   1 keV
    B.   10 keV
    C.   100 MeV
    D.   1000 MeV

30. The binding energy of an electron is:

    A.   Highest for the most external shell
    B.   Highest for the inner most shell
    C.   Highest for a free electron
    D.   Highest for the fastest moving electron

31. Ionization implies:

    A.   An excited state of the atom
    B.   The production of x-rays
    C.   The removal of an electron from the atom
    D.   A neutral state of the atom

32. A deuteron (^{2}H) is the nucleus of an isotope of hydrogen. Which of the following is true:

    A.   It has a mass number of 2
    B.   It has an atomic number of 2
    C.   It has a positive charge of 2
    D.   It has an energy of 2 MeV

33. In order for a photon to ionize an atom, its energy must be:

    A.   Greater than the binding energy of an electron in the atom
    B.   Less than the binding energy of an electron in the atom
    C.   Equal to the binding energy of an electron in the atom
    D.   None of the above

34. An atom is neutral if the number of its electrons is equal to its:

    A.   Number of protons
    B.   Number of nucleons
    C.   Atomic weight
    D.   None of the above

Radioactivity

35. When a radionuclide decays, radiation is emitted from the:

    A.   Outer orbital electrons of the atom
    B.   Innermost shell of the atom
    C.   The nucleus of the atom
    D.   All of the above

36. The half-life of a radionuclide is the time required to reduce:

    A.   The volume of the isotope into half
    B.   The number of radioactive atoms to half of their initial number
    C.   The activity to half of its initial value
    D.   B and C are true
    E.   A, B, C all are true

37. If the activity in a sample of a radionuclide is 100 mCi, how many half-lives would be required for it to decay to less than 2 mCi:

    A.   3
    B.   4
    C.   5
    D.   6

38. Samples of two radionuclides with different half-lives initially contain the same number of radioactive nuclei. The sample with the longer half-life will have:

    A.   A shorter biological half-life
    B.   A longer average life time
    C.   Produce a higher exposure rate
    D.   A higher activity

39. The disintegration constant lambda (λ) is equal to:

    A.   Physical half-life x 1.44
    B.   Biological half-life x .0693
    C.   Physical half-life x 0.693
    D.   0.693/physical half-life

40. The dose delivered to an internal organ is a function of:

    A.   Organ uptake
    B.   Activity administered
    C.   Biological half-life
    D.   Physical half-life
    E.   All of the above

41. Specific activity of a radionuclide refers to:

    A.   Number of disintegrations per second
    B.   Number of grams per Ci
    C.   Activity per unit mass
    D.   Number of atoms per centimeter cube

42. If the specific activity in a sample decreases, its:

    A.   Half-life decreases
    B.   Physical life increases
    C.   Activity per gram of the material decreases
    D.   All of the above

43. The physical half-life of a radionuclide is:

    A.   The same as the average life
    B.   Less than the average life
    C.   Directly proportional to the decay constant
    D.   Reciprocal of biological half-life

44. After 5 half-lives, the fraction of initial activity is reduced to:

    A.   One-fifth
    B.   One-fifth to the power of 2
    C.   Square root of 1/2
    D.   1/2 to the power of 5

X-Ray and Gamma Ray Interactions

45. The amount of attenuation of a photon beam by a material depends upon:

    A. Energy of the photon
    B. Linear attenuation coefficient of the material
    C. Thickness of the material
    D. All of the above

46. Monoenergetic photon beams interacting with tissue are attenuated:

    A. Linearly
    B. Exponentially
    C. Proportional to the density of tissue
    D. None of the above

47. Most often when a photon undergoes scattering:

    A. It gains energy
    B. Its energy remains unchanged
    C. Its energy decreases
    D. None of the above

48. In coherent scattering, the energy of the photon is:

    A. Increased
    B. Decreased
    C. Unchanged
    D. None of the above

49. Which coefficient is used to calculate energy absorbed:

    A. Attenuation
    B. Transfer
    C. Absorption
    D. Scatter

50. The photoelectric process is most significant in the energy range of:

    A. 1 keV to 100 keV
    B. 100 keV to 500 keV
    C. 500 keV to 1 MeV
    D. 1 MeV to 5 MeV

51. When a photon undergoes a Compton process:

    A. A photon of reduced energy is scattered
    B. It is completely absorbed
    C. Characteristic x-rays are produced
    D. Two Compton electrons are produced

52. The annihilation radiation produces:

     A.   2 electrons
     B.   1 electron and 1 positron
     C.   2 photons of energy 0.511 MeV each
     D.   1 photon of 1.02 MeV

53. A half value layer of a photon beam is:

     A.   The thickness required to reduce the beam to half of its initial intensity
     B.   Half of the number of photons in the beam
     C.   The photon beam is blocked into half
     D.   None of the above

54. The linear attenuation coefficient (μ) for monoenergetic photons is equal to:

     A.   HVL x 1.44
     B.   0.693/HVL
     C.   HVL x 0.693
     D.   (HVL) to the power half

55. X-rays and gamma rays in their interaction with tissue:

     A.   Produce high speed electrons
     B.   Deposit energy
     C.   Undergo scattering
     D.   Produce ionization
     E.   All of the above

56. Photons transfer their energy directly to tissue by:

     A.   Scatter
     B.   The production of Cerenkov radiation
     C.   Absorption
     D.   Attenuation
     E.   Production of bremsstrahlung

57. The major type of interaction in megavoltage photon therapy is:

     A.   Photoelectric
     B.   Compton
     C.   Pair production
     D.   Triplet production

58. The photoelectric process of interaction is between the photons and:

     A.   The nucleus of the atom
     B.   The orbital electrons
     C.   Either of the above
     D.   None of the above

59. Pair production refers to:

    A.   Two orbital electrons are ejected from the atom
    B.   One electron and one positron is ejected from the atom
    C.   In the field of the nucleus, the energy of the interacting photon is converted into a positron and an electron
    D.   Any of the above

60. What is the threshold energy for pair production:

    A.   0.511 MeV
    B.   1.02 MeV
    C.   1.533 MeV
    D.   981 MeV

61. The probability that a photon interacts with a material is:

    A.   Dependent on its density
    B.   Proportional to the total attenuation coefficient
    C.   Inversely proportional to the number of protons in the atom
    D.   All of the above

62. Which of the following materials will be most effective in attenuating a high energy photon beam:

    A.   Air
    B.   Water
    C.   Lead
    D.   Copper

63. Pair production becomes significant (i.e., not accounted for in routine calculations) in tissue above:

    A.   5 MeV
    B.   10 MeV
    C.   15 MeV
    D.   20 MeV

64. The mass attenuation for photons in soft tissue:

    A.   Is maximum at 25 MeV
    B.   Increases continuously with energy
    C.   Decreases continuously with energy
    D.   Decreases to about 3 MeV, then increases

Charged Particle Interactions

65. Charged particles interact with body tissues by:

    A.   Photoelectric process
    B.   Triplet production
    C.   Ionization and excitation
    D.   All of the above

66. X-rays are more likely to be produced by interaction between:

    A.   Alpha particles and nuclei
    B.   Protons and nuclei
    C.   Electrons and nuclei
    D.   Neutrons and nuclei

67. The rate of kinetic energy loss per unit path length by a charged particle is called:

    A.   Linear attenuation coefficient
    B.   Stopping power
    C.   Mass energy absorption coefficient
    D.   All of the above

68. The rate of energy loss by a charged particle is:

    A.   Proportional to the particle charge
    B.   Proportional to the square of the particle charge
    C.   Independent of the charge
    D.   None of the above

69. Heavy particles lose most of their energy:

    A.   Immediately as they enter the medium
    B.   In the middle of their range
    C.   Near the end of their range
    D.   Equally throughout their range

70. The Bragg peak is not observed in electrons because of their:

    A.   High speed
    B.   Negative charge
    C.   Small mass
    D.   Short life span

71. Excitation produced by electron beams is of:

    A.   Nucleus of the atom
    B.   Neutrons of the atom
    C.   Orbital electrons of the atom
    D.   Protons of the atom

72. Which of the following particles will penetrate the deepest in tissue:

    A.   20 keV Auger electron
    B.   10 MeV alpha particle
    C.   20 keV proton
    D.   1 MeV positron
    E.   2 MeV beta particle

73. When an electron is ejected from an atom and leaves an ionization track, it is called:

    A.   A characteristic electron
    B.   An Auger electron
    C.   A delta ray
    D.   An electrostatic charge

74. In the production of bremsstrahlung, the electron:

    A.   Ejects a cloud of electrons
    B.   Slows down and loses some of its energy as an x-ray photon
    C.   Produces a heavy particle
    D.   Ejects an electron from the atom