Test Questions

Chapter 1
1. Ionizing radiation is a category of particles that deposit energy which is sufficiently concentrated to eject _____ from individual atoms.
A. electrons
B. protons
C. Neutrons
D. radioisotopes

2. Which of the following unit of measurement is used for exposure to ionizing radiation in humans?
A. kilogram
B. sievert (Sv)
C. kVp
D. mAs

3. _____ is the largest contributor to natural background radiation.
A. X-rays
B. CT examinations
C. Nuclear medicine
D. Radon

4. The **first** technology deployed by TSA, is based on the _____ effect of X rays, a type of ionizing radiation.
A. Pair production
B. Electromagnetism
C. Compton scattering
D. Primary x ray

5. The backscattered X rays are of lower energy and intensity than medical X rays and do not penetrate the body as deeply.
A. TRUE
B. FALSE

6. The **second** technology deployed at airports by TSA, uses millimeter-length _____, a type of nonionizing radiation.
A. radioisotopes
B. radio waves
C. scatter radiation
D. cosmic radiation

7. Millimeter wave technology of _____ measures the electromagnetic waves backscattered from the human body or objects.
A. L-3 ProVision
B. Rapiscan Secure 1000
C. Kodak101
D. Fuji500

8. In response to ongoing privacy concerns, TSA piloted a program for manufacturers to develop _____ software for AITs to enable display of anomalies on a generic figure.
A. automatic target recognition (ATR)
B. PACS
C. HIS/RIS
D. DICOM

9. The _____ was asked by Department of Homeland Security (DHS) to evaluate the X-ray backscatter AIT systems.
A. FDA
B. CDC
C. National Research Council (NRC)
D. EPA

10. Which of the following statements were on evaluation tasks for NRC?
A. exposure compliance for ionizing radiation
B. prevention of over exposure to ionizing radiation
C. legal, cultural or privacy implications
D. A and B only

11. X-ray backscatter systems emit _____ radiation.
A. ionizing
B. nonionizing
C. cosmic
D. internal

12. Ionizing radiation is high-frequency electromagnetic radiation that has enough energy to potentially damage the _____ in cells that may lead to cancer.
A. water
B. DNA
C. walls
D. atomic number

13. Which of the following dose-response model of radiation effects is used to measure the risk of cancer?
A. Linear threshold
B. Linear nonthreshold (LNT)
C. Nonlinear threshold
D. Quadratic threshold

14. Which of the following populations are at **higher** risk of developing cancer from being screened with the X-ray backscatter AIT systems?
A. Children and the developing fetus
B. Frequent flyers
C. Airline and airport staff
D. All of the above

15. The standard governing radiation exposure from X-ray backscatter AIT systems—from ANSI/HPS N43.17-2009—sets a maximum whole body dose of _____ per screening.
A. 250 nanosieverts (nSv)
B. 500 sieverts (Sv)
C. 600 nanosieverts (nSv)
D. 780 nanosieverts (nSv)

16. _____ is used to prevent overexposure to radiation due to the malfunction of AIT systems.
A. Dead man's switch
B. Auto stop
C. Safety interlocks
D. none of the above

Chapter 2

17. X-ray backscatter advanced imaging technology (AIT) uses a narrow beam of X-ray photons with energies less than _____ keV.
A. 1
B. 10
C. 11
D. 100

18. Which of the following are basic interactions between x-rays and exposure materials?
A. Compton, Thompson and Rayleigh scattering
B. Photoelectric effect
C. Pair production
D. All of the above

19. Pair production requires a minimum photon energy of _____.
A. 2 keV
B. 1.022 MeV
C. 4 keV
D. 5 keV

20. Which of the following is the dominant interaction for X rays with energies below 30 keV?
A. Compton scattering
B. Photoelectric effect
C. Pair production
D. none of the above

21. _____ increases the probability of x-ray absorption in photoelectric interaction.
A. number of electrons
B. time
C. atomic number of the target atom
D. none of the above

22. _____ is the main interaction for energies above 30 keV.
A. Compton scattering
B. Photoelectric effect
C. Pair production
D. none of the above

23. Practical X-ray sourcesproduce monoenergetic beams.
A. TRUE
B. FALSE

24. The electrons are produced at the negative side of the x-ray tube called _____.
A. anode
B. cathode
C. rotator
D. stator

25. Anode, the positive side of the x-ray tube is typically made of _____.
A. glass
B. rubber
C. fiber
D. tungsten

26. The electrons from cathode side produce which of the following by interacting with heavy nuclei or anode?
A. bremsstrahlung x-rays
B. heat
C. characteristic X rays
D. All of the above

27. Compton scattering depends on the number density of _____ in the material.
A. protons
B. water
C. electrons
D. neutrons

28. Which of the following material have low atomic numbers?
A. skin
B. muscle
C. bones
D. A and B only

29. Bone contains _____ and has a significantly higher rate of photon attenuation.
A. calcium
B. fat
C. air
D. water

Chapter 3

30. Steven W. Smith described the X-ray backscatter advanced imaging technology (AIT) system in _____.
A. 1960
B. 1970
C. 1991
D. 2017

31. The advanced imaging technology (AIT) system collects _____ from a person and creates an image.
A. primary radiation
B. backscattered radiation
C. photoelectric absorption
D. none of the above

32. The _____ of the X-ray backscattered image is defined by the source collimator aperture and distance from the person to the source.
A. spatial resolution
B. histogram
C. size
D. processing time

33. Which of the following manufacturers make AIT systems?
A. Rapiscan Systems
B. American Science and Engineering Inc.
C. Tek84 Engineering Group
D. All of the above

34. Each Rapiscan 1000 unit contains a tungsten anode X-ray tube that operates at a voltage of _____ and 5 mA.
A. 5 kV
B. 50 kV
C. 500 kV
D. 5,000 kV

35. The Rapiscan AIT system can scan in both the upward and the downward direction that produces a
_____ image of the person being screened.
A. one-dimensional
B. two-dimensional
C. three-dimensional
D. four-dimensional

36. AS&E manufactures which of the following X-ray backscatter AIT systems?
A. SmartCheck
B. SmartCheck-HT
C. Rapiscan Secure 1000
D. A and B only

37. AS&E's X-ray tube current for their AIT systems is _____ mA.
A. 12
B. 120
C. 200
D. 250

38. AS&E's AIT systems take about _____ for both anterior and posterior X-ray backscattered images.
A. 6 seconds
B. 60 seconds
C. 6 minutes
D. 60 minutes

39. Which of the following AIT system is **not** equipped with automatic target recognition and is **not** a candidate for deployment at U.S. airports?
A. AS&E SMARTCHECK
B. RAPISCAN SECURE 1000
C. TEK84 AIT84
D. X-ray 5000

Chapter 4

40. Quantification of radiation exposure is complicated because a wide range of ionizing radiation is found in nature and the interactions that those radiation types have with matter are complex.
A. TRUE
B. FALSE

41. Which of the following has developed a self-consistent set of radiation quantities and units to measure ionizing radiation and its effects?
A. FDA
B. Commission on Radiation Units and Measurements (ICRU)
C. National Research Council (NRC)
D. EPA

42. _____ determines of the intensity of photons emitted by an X-ray tube byaccumulating electrical charge collection.
A. collimators
B. filters
C. ionization chambers
D. cathode

43. Which of the following are used to characterize an x-ray spectrum for **most** imaging applications?
A. tube's high voltage and anode material
B. amount of inherent and external filtration
C. angle of the beam relative to the anode surface
D. All of the above

44. _____ refers to the penetration capability of an X-ray beam emerging from a source.
A. beam quality
B. filtration
C. shielding
D. scattered radiation

45. The first _____ reduces the intensity of the incident beam by 50 percent.
A. step wedge filter
B. half-value layer (HVL)
C. collimation
D. AEC

46. _____ is the standard measure of energy transferred to matter by indirectly ionizing radiation (X rays and neutrons).
A. kVp

B. mAs
C. air kerma
D. HVL

47. 1 Gy = _____.
A. 1 J/kg
B. 1 kVp
C. 1 mAs
D. 100 rem

48. _____filled ionization chambers are **generally** preferred for measuring kerma in the range of beam intensities produced by X-ray tubes.
A. water
B. nitrogen liquid
C. gas
D. none of the above

49. The actual amount of ionizing radiation energy deposited in tissue is called _____.
A. half-value layer (HVL)
B. absorbed dose
C. collimation
D. step wedge filter

50. The absorbed dose is symbolized as _____.
A. R
B. AB
C. A
D. D

51. _____ is the sum of doses to specific tissues or organs multiplied by the dimensionless weighting factors WRand WT.
A. Effective dose
B. Absorbed dose
C. Collimation
D. Step wedge filter

52. Effective dose is measured in _____.
A. kVp
B. sievert (Sv)
C. mAs
D. gray (Gy)

53. The International Commission on Radiation Units and Measurements (ICRU) has developed a radiation measurement system using which of the following quantities?
A. stochastic
B. non-stochastic
C. kilogram
D. A and B only

54. The _____ are used to evaluate the average absorbed dose to each of the organs.
A. shielding
B. filters
C. dosimeters
D. collimators

55. What is the radiation weighting factor(WR) for X rays?
A. 1.0
B. 11
C. 100
D. 110

56. Which of the following is used to determine the radiation absorbed dose at specified locations?
A. humans
B. computational phantom
C. animals
D. RT

57. The American National Standards Institute (ANSI) has adopted the concept of a _____ for specifying exposures produced by X-ray AIT systems.
A. reference effective dose (E_{REF})
B. effective dose
C. random absorbed dose
D. REM

58. According to the ANSI/Health Physics Society (ANSI/HPS) standard N43.17-2009, what is the **maximum** E_{REF} dose for general-use of AIT systems per screening?
A. 10 nSv (1,000 nrem)
B. 20 nSv (20,000 nrem)
C. 250 nSv (25,000 nrem)
D. 555 nSv (55,000 nrem)

Chapter 5

59. The _____ standard provides guidelines for both manufacturers and users of the AIT systems including dose recommendations.
A. ANSI/HPS N43.17
B. FDA2000
C. EPA101
D. CDC500

60. Manufacturers of electronic products that emit radiation also need to comply with the _____ Act, Chapter V, Subchapter C.
A. Environmental
B. Federal Food, Drug and Cosmetic
C. Surgeon general
D. none of the above

61. NCRP recommends that a passenger should not receive a dose of more than 250,000 nSv in 1 year from being scanned in a single airport.
A. TRUE
B. FALSE

62. The radiation exposure level needs to comply with which of the following radiation safety principle?
A. CFR
B. NCRP
C. ANSI
D. ALARA

63. NCRP issues a different limit for the embryo or fetus of an occupationally exposed woman and recommends a maximum occupational dose[15] of _____ per month.
A. 500,000 nSv
B. 700,000 nSv
C. 800,000 nSv
D. 900,000 nSv

64. ANSI/HPS N43.17-2009 provides detailed guidance not only for acceptable radiation dose levels for individuals and radiation workers but also for which of the following?
A. radiation producing systems
B. manufacturing, installation and safety performance
C. regular system maintenance
D. All of the above

65. The doses that an X-ray backscatter AIT system is capable of producing are far below the levels required to produce symptoms of _____.
A. hair loss
B. acute radiation syndrome
C. skin cancer
D. none of the above

66. _____ dose is required to produce cardiovascular or neurological damage.
A. 5 nSv
B. 50 nSv
C. 55 nSv
D. 500,000,000 nSv

67. The projections of cancer risks from exposure to radiation are based largely on _____ studies.
A. sociology
B. psychological
C. epidemiological
D. anthropological

68. _____ provide most information on cancer risks from exposure to radiation.
A. atomic bomb survivors in Hiroshima and Nagasaki
B. CDC
C. WHO
D. FDA

69. Currently, the _____ dose-response model for extrapolation to low and very low doses is used as the basis for U.S. radiation protection standards.
A. non-linear threshold
B. linear nonthreshold
C. linear threshold
D. quadratic non-linear

70. There shall be at least one indicator on AIT system, clearly visible from any location from which a scan can be initiated, that indicates when a scan is in progress.
A. TRUE
B. FALSE

71. Power to the AIT system shall be controlled by a _____.
A. key switch
B. automatic button
C. computer lock
D. finger print lock

72. _____ warning label shall be **permanently** affixed on the x-ray system at the location of any controls used to initiate x-ray generation.
A. "BIO HAZARD"
B. "WORK IN PROGRESS"
C. "CAUTION: X-RAYS PRODUCED WHEN ENERGIZED"
D. "STRONG MAGNETIC FIELD"

73. The _____ **must** provide adequate installation procedures so that the installed AIT system complies with its operational specification.
A. TSA
B. manufacturer
C. FDA
D. CDC

74. The institution operating the AIT system must maintain records for at least 5 years including which of the following?
A. documenting operator training
B. maintenance, upgrade and radiation surveys

C. number of scans performed
D. All of the above

Chapter 6

75. Which of the following provided reports on X-ray backscatter advanced imaging technology (AIT) systems?
A. JHU/APL and NIST
B. AAPM and USAPHC
C. FDA
D. All of the above

76. Which of the following issues can result in variations in effective dose to scanned individuals?
A. model of the AIT system evaluated
B. techniques used to measure kerma and half-value layer (HVL)
C. airport and destinations
D. A and B only

77. Which of the following are physical quantities of the AIT system?
A. photon spectrum
B. fluence rate and scan duration
C. location of the subject in the AIT system
D. All of the above

78. What is a thickness of glass window in the X-ray tube used by AIT systems?
A. 1.5 mm
B. 3 mm
C. 4.5 mm
D. 6.5 mm

79. The glass window contributes approximately _____ aluminum equivalent beam filtration in AIT systems.
A. 3 mm
B. 2 mm
C. 1 mm
D. 0.4 mm

80. What is the **maximum**-rated anode current for the x-ray tube in AIT systems?
A. 1 mA
B. 5 mA
C. 15 mA
D. 25 mA

81. The photon spectrum and the fluence rate both change with a change in _____ voltage.
A. anode
B. cathode
C. focusing cup
D. glass window

82. For a tungsten target at 50 kV, a 10 percent increase in anode voltage produces approximately a _____ percent increase in the photon yield.
A. 1
B. 5
C. 10
D. 50

83. The location of the screening passenger in AIT system is controlled by _____ painted on the floor indicating the proper pose.
A. "step here"
B. "footprints"
C. "stand here"

D. "here"

84. Which of the following were used to survey the radiation outside the inspection volume during JHU/APL study9?
A.   Geiger-Mueller (GM detector)
B.   scintillator probes
C.   film-badge
D. A and B only

85. Measurements were made on three AIT systems (1.5 SP systems) at the Rapiscan factory and three AIT systems at _____ during AAPM study.
A. Los Angeles International Airport
B. DFW airport
C. Chicago airport
D. Orlando airport

86. Which of the following **organ** doses were calculated using PCXMC and measured Kerma during AAPM study?
A. skin dose
B. breast dose
C. thyroid dose
D. All of the above

87. According to the phantom AAPM study, the effective dose for standard man by AIT system was _____.
A. 1 nSv
B. 5.9 nSv
C. 11.1 nSv
D. 15.6 nSv

88. The **primary** focus of the USAPHC report was to estimate the effective dose per screening to individuals being scanned and to operators and others in the area of the AIT system using passive dosimeters.
A. TRUE
B. FALSE

89. Which of the following type of dosimeter was used to determine absorbed dose in USAPHC study of AIT system?
A. Thermoluminescent dosimeter (TLD)
B. Optically stimulated luminescence (OSL)
C. Film badge dosimeter
D. none of the above

90. The **minimum** dose reported by the vendor for OSL dosimeters used in USAPHC experiment was _____.
A. 10 nSv
B. 100 nSv
C. 1,100 nSv
D. 10,000 nSv

91. What was the x-ray tube anode potential for Rapiscan Secure 1000 during FDA evaluation?
A. 10 kV
B. 20 kV
C. 50 kV
D. 70 kV

92. All three studies concluded that the X-ray tube is operated at its maximum voltage and that the operator **does not** have access to increase the voltage or current to the X-ray tube.
A. TRUE
B. FALSE

93. The JHU/APL report review of the AIT system manual also notes that an interlock prevents the "beam on" time from exceeding _____, which would not result in overexposure to the person being screened.

A. 1 second
B. 3 seconds
C. 13 seconds
D. 30 seconds

94. An absorbed dose of 1,000 nGy to the skin only or 10 nGy to each of the organs of the body (including the skin) results in the same effective dose of _____.
A. 1nSv
B. 2 nSv
C. 5 nSv
D. 10 nSv

95. After reviewing the reports, the committee agreed that the effective dose per screening to an average passenger is about a factor of _____ **below** the limit of 250 nSV per screening, the dose set by ANSI/HPS N43.17-2009.
A. 10
B. 50
C. 60
D. 70

Chapter 7

96. Which of the following can be measured to evaluate effective dose from an AIT scanner and help to calculate the photon spectrum?
A. HVL
B. depth dose
C. air kerma
D. All of the above

97. The HVL in _____ provides a **common** description for characterizing the spectrum of an X-ray beam.
A. wood
B. rubber
C. aluminum
D. plastic

98. Percent depth dose (PDD) profiles are a relative measurement of dose as a function of depth into _____.
A. blood
B. tissue
C. hair
D. muscles

99. PDD is defined as a function of depth in tissue maintaining a constant _____.
A. source-skin distance (SSD)
B. source to image distance (SID)
C. source to bucky distance
D. collimator to image distance

100. Which of the following are tissue-equivalent materials in phantom to measure PDD?
A. BR12
B. acrylic
C. lead
D. A and B only

101. In order to measure the exposure as a function of tissue depth, the desired thickness of tissue was placed **directly** in front of the _____.
A. scanner
B. collimator
C. filtration
D. ion chamber

102. Measurements for the air kerma were performed with the _____ operated in integrating mode over the course of a normal screening subject scan.
A. densitometer
B. photometer
C. electrometer
D. sensitometer

103. Dose outside the screening area may arise from which of the following sources?
A. TSA staff
B. radiation scattered from scanned subjects
C. X-ray leakage from the X-ray tube housing area
D. B and C only

104. Which of the following procedures are required prior to deployment and after installation of any backscatter system?
A. Passenger testing
B. The factory acceptance test (FAT)
C. The site acceptance test (SAT)
D. B and C only

105. Safety-related information that was requested by Form R-0646 includes which of the following?
A. Test procedure used
B. Background radiation reading
C. Measurement instrument type and Data acquired
D. All of the above

106. In order to ensure that the AIT system is working properly, personnel should run a scan at least _____ a day.
A. once
B. five times
C. seven times
D. nine times

107. The external cables and "Scan in Progress" light inspections should be done _____.
A. weekly
B. monthly
C. every six months
D. annually

108. On a semiannual basis, there should be an inspection of the functionality of which of the following?
A. x-ray power supply
B. the controller and the internal control computer
C. all warning light-bulbs
D. All of the above

109. The ultimate responsibility for the radiation safety of the AIT system, the operators, and the general public rests with the owner.
A. TRUE
B. FALSE

110. The owner of the AIT system is also responsible for ensuring a personnel training program, with refresher training provided at least once every _____.
A. month
B. 6 months
C. 12 months
D. bi annually

111. The pediatric male and female phantoms used in AIT simulated safety check were chosen at a height of _____.
A. 60 cm
B. 105 cm

C. 200 cm
D. 250 cm

112. The pregnant female phantom series provides highly detailed anatomical representation for eleven fetal ages spanning an entire pregnancy.
A. TRUE
B. FALSE

113. The effective dose is determined by applying _____ to all exposed tissues and organs.
A. tissue-weighting factors
B. kVp
C. compression
D. MTF

114. What is the breast absorbed dose in adult female who is in 5th weight percentile per screening?
A. 1 nGy
B. 5 nGy
C. 8 nGy
D. 26 nGy

115. What is the thyroid absorbed dose in pediatric male & female who is in 5th weight percentile per screening?
A. 47 nGy
B. 65 nGy
C. 70 nGy
D. 74 nGy

116. The skin is divided into two **main** regions: the dermis and the epidermis.
A. TRUE
B. FALSE

117. Irradiation of the basal cell in the epidermis layer can lead to _____.
A. leukemia
B. epilation
C. desquamation
D. alopecia

118. Irradiation of the fibroblasts and vascular endothelial cells can lead to _____.
A. leukemia
B. erythema
C. desquamation
D. alopecia

119. Typically, the energy distribution of the x-ray photons incident on the person scanned are derived from which of the following?
A. the operating voltage
B. anode angle
C. measurements of the first HVL in aluminum
D. All of the above

120. According to the key finding in report, no person, regardless of age and weight modeled, would exceed the effective dose limit per screen (i.e., 250 nSv/screen), as defined by the ANSI/HPS N43.17-2009 standard.
A. TRUE
B. FALSE