Chapter 01: Radiation and Its Discovery
Fauber: Radiographic Imaging and Exposure, 5th Edition

MULTIPLE CHOICE

1. When were x-rays discovered?
   a. October 8, 1985
   b. November 8, 1895
   c. January 23, 1896
   d. August 15, 1902

   ANS: B
   X-rays were discovered by Wilhelm Conrad Roentgen on November 8, 1895.

   REF: p.1

2. What type of tube was Roentgen working with in his lab when x-rays were discovered?
   a. Crookes tube
   b. Fluorescent tube
   c. High-vacuum tube
   d. Wurzburg tube

   ANS: A
   Roentgen was working with a low-vacuum tube known as a Crookes tube.

   REF: p.2

3. Which of the following terms could be defined as the instantaneous production of light only during an interaction between a type of energy and some element or compound?
   a. Phosphorescence
   b. Afterglow
   c. Glowing
   d. Fluorescence

   ANS: D
   Fluorescence is the instantaneous emission of light from a material due to the interaction with some type of energy.

   REF: p.2

4. Barium platinocyanide was the:
   a. type of dark paper Roentgen used to darken his laboratory.
   b. material Roentgen used to produce the first radiograph of his wife's hand.
   c. metal used to produce the low-vacuum tube.
   d. fluorescent material that glowed when the tube was energized.

   ANS: D
   A piece of paper coated with barium platinocyanide glowed each time Roentgen energized his tube.

   REF: p.2

5. The first radiograph produced by Roentgen, of his wife's hand, required an exposure time of:
   a. 15 s.
   b. 150 s.
   c. 15 min.
   d. 150 min.

   ANS: C
   It took a 15-min exposure time to produce the first radiograph.

   REF: p.3

6. The letter *x* in *x-ray* is the symbol for:
   a. electricity.
   b. the unknown.
   c. penetrating.
   d. discovery.

   ANS: B
   The letter *x* represents the mathematical symbol of the unknown.

   REF: p.3

7. The first Nobel Prize for physics was received in 1901 by:
   a. Marie Curie.
   b. William Crookes.
   c. Wilhelm Roentgen.
   d. Albert Einstein.

   ANS: C
   Wilhelm Roentgen received the first Nobel Prize for physics in 1901.

   REF: p.4

8. X-rays were at one time called:
   a. Becquerel rays.
   b. Roentgen rays.
   c. Z-rays.
   d. none of the above.

   ANS: B
   X-rays were at one time called Roentgen rays.

   REF: p.4

9. Erythema, an early sign of biologic damage due to x-ray exposure, is:
   a. reddening of the skin.
   b. a malignant tumor.
   c. a chromosomal change.
   d. one of the most serious effects of x-ray exposure.

   ANS: A

Erythema is reddening and burning of the skin, an early and less serious effect of exposure to large doses of x-radiation.

REF: p.5

10. X-rays have which of the following properties?
    a. Electrical
    b. Magnetic
    c. Chemical
    d. A and B
    e. A and C

    ANS: D
    X-rays, a type of electromagnetic radiation, have both electrical and magnetic properties.

    REF: p.5

11. The distance between two successive crests of a sine wave is known as:
    a. an angstrom.
    b. frequency.
    c. the Greek letter *nu*.
    d. wavelength

    ANS: D
    The distance between two successive crests or troughs of a sine wave is the measure of its wavelength.

    REF: p.6

12. X-rays used in radiography have wavelengths that are measured in:
    a. angstroms.
    b. millimeters.
    c. centimeters.
    d. hertz.

    ANS: A
    X-rays in the range used in radiography have wavelengths that are so short that they are measured in angstroms.

    REF: p.6

13. The frequency of a wave is the number of waves passing a given point per given unit of time. Frequency is measured in:
    a. angstroms.
    b. hertz.
    c. inches.
    d. eV.

    ANS: B
    The unit of frequency is hertz. The frequency of x-rays in the radiography range varies from about 3×10^{19} to 3×10^{18} Hz.

REF: p.6

14. Which of the following is a correct description of the relationship between the wavelength and frequency of the x-ray photon?
    a. Wavelength and frequency are directly proportional.
    b. Wavelength and frequency are inversely related by the square root of lambda.
    c. Frequency and wavelength are inversely related.
    d. Wavelength and frequency have no relationship to each other.

    ANS: C
    Wavelength and frequency are inversely related; as one increases, the other decreases.

    REF: p.6

15. A _____ is a small, discrete bundle of energy.
    a. phaser
    b. quark
    c. photon
    d. mesion

    ANS: C
    A photon, or quantum, is a small, discrete bundle of energy.

    REF: p.7

16. The speed of light is:
    a. 3×10^8 meters per second
    b. 3×10^8 miles per second
    c. 186,000 miles per second
    d. A and B
    e. A and C

    ANS: E
    The speed of light can be described as either 3×10^8 meters per second or 186,000 miles per second.

    REF: p.8

17. When first developed, the branch of medicine using x-rays was called:
    a. radiology.
    b. radiography.
    c. roentgenology.
    d. imaging sciences.

    ANS: C
    What we now call *radiology* was first called *roentgenology.*

    REF: p.4

18. The electrical energy applied to an x-ray tube will be transformed to:
    a. heat.
    b. light.

c. x-rays.
d. A and B.
e. A and C.

ANS: E
The electrical energy applied to the x-ray tube will be transformed into heat (primarily) and x-rays.

REF: p.5

19. The Greek symbol lambda (λ) represents the x-ray's:
a. wavelength.
b. speed.
c. frequency.
d. quantity.

ANS: A
Lambda (λ) is the Greek symbol that represents wavelength.

REF: p.6

20. An angstrom (Å) is equal to:
a. 10^{-1} meter
b. 10^{-10} meter
c. 10^{-1} foot
d. 10^{-10} foot

ANS: B
One angstrom is equal to 10^{-10} meter.

REF: p.6

21. X-rays used in radiography have wavelengths ranging from 0.1 to:
a. 0.01 Å.
b. 1 Å.
c. 10 Å.
d. 100 Å.

ANS: B
X-rays used in radiography have wavelengths ranging from 0.1 to 1 Å.

REF: p.6

22. X-rays used in radiography have wavelengths ranging from 3×10^{19} to:
a. 3×10^{8} Hz.
b. 3×10^{-10} Hz.
c. 3×10^{10} Hz.
d. 3×10^{18} Hz.

ANS: D
X-rays used in radiography have wavelengths ranging from 3×10^{19} to 3×10^{18} Hz.

REF: p.6

23. In the formula $c = \lambda v$, c represents:
    a. frequency.
    b. the speed of light.
    c. wavelength.
    d. kinetic energy.

    ANS: B
    In this formula, c represents the speed of light.

    REF: p.6

24. In the formula $c = \lambda v$, v represents:
    a. frequency.
    b. the speed of light.
    c. wavelength.
    d. kinetic energy.

    ANS: A
    In this formula, v represents frequency.

    REF: p.6

25. The energy of an individual x-ray photon is measured in:
    a. frequency.
    b. wavelength.
    c. kilovolts peak (kVp).
    d. electron volts (eV).

    ANS: D
    X-ray photon energy is measured in electron volts (eV).

    REF: p.7

26. An x-ray beam that has photons with many different energies is:
    a. homogenous.
    b. monoenergetic.
    c. heterogeneous.
    d. never found.

    ANS: C
    A heterogeneous x-ray beam consists of photons with many different energies.

    REF: p.8

27. X-rays can:
    a. penetrate the human body.
    b. be absorbed in the human body.
    c. change direction in the human body.
    d. A and B only.
    e. all of the above.

ANS: E
X-rays can penetrate, be absorbed in, or change direction (due to scattering) in the human body.

REF: p.9

28. In conjunction with ALARA, which of the following cardinal principles help to minimize radiation exposure?
I. Time—Increase time exposed to ionizing radiation
II. Time—Decrease time exposed to ionizing radiation
III. Distance—Increase distance from ionizing radiation
IV. Distance—Decrease distance from ionizing radiation
V. Shielding—Maximize use of shielding from ionizing radiation
a. I, III, and V
b. I, IV, and V
c. II, III, and V
d. II, IV, and V

ANS: C
The cardinal principles include decreasing time exposed to ionizing radiation, increasing distance from ionizing radiation, and maximizing use of shielding from ionizing radiation.

REF: p.9

TRUE/FALSE

1. X-rays are invisible.

ANS: T
A characteristic of x-rays is that they are invisible.

REF: p.9

2. X-rays carry a negative charge that causes ionization.

ANS: F
X-rays are electrically neutral.

REF: p.9

3. X-ray photons travel at the speed of light in a vacuum.

ANS: T
In a vacuum, x-rays will travel at the speed of light.

REF: p.9

4. X-ray photons are capable of traveling around corners.

ANS: F
X-rays travel in straight lines, so they are unable to travel around corners.

REF: p.9

5. Chemical changes may occur as a result of exposure to ionizing radiation.

   ANS: T
   Chemical changes, such as in radiographic or photographic film, occur as a result of exposure to ionizing radiation.

   REF: p.9

6. X-rays will change direction in the presence of a strong magnetic field.

   ANS: F
   X-rays do not respond to a magnetic field.

   REF: p.8

7. X-rays produce a slight tingling sensation when they enter the body.

   ANS: F
   X-rays cannot be felt.

   REF: p.8

8. X-rays cannot be focused with a lens.

   ANS: T
   Unlike visible light, it is not possible to focus x-rays with a lens.

   REF: p.9

9. X-rays are able to interact with certain materials and produce light energy.

   ANS: T
   Certain materials will fluoresce, or produce light energy, when stimulated by x-rays.

   REF: p.9

10. It is impossible for x-rays to interact with matter and produce secondary radiation.

    ANS: F
    Secondary radiation is often produced as a result of x-rays interacting with matter.

    REF: p.9

11. X-rays can produce ionization of atoms making up cells, causing damage.

    ANS: T
    A major reason that unnecessary exposure must be avoided is that x-rays can ionize atoms and cause damage.

REF: p.9

12. Since Roentgen's discovery in the late nineteenth century, we have learned an enormous amount about the properties of x-rays.

    ANS: F
    Roentgen's original work on the characteristics of x-rays was so thorough that very little has been learned about their properties since.

    REF: p.12

13. It is the radiographer's responsibility to minimize the radiation dose to the patient, to themselves, and to others in accordance with the **A**s **L**ow **A**s **R**easonably **A**chievable (ALARA) principle.

    ANS: T
    It is the radiographer's responsibility to minimize the radiation dose to the patient, to themselves, and to others in accordance with the **A**s **L**ow **A**s **R**easonably **A**chievable (ALARA) principle.

    REF: p.12

14. Screening for pregnancy is an important task for minimizing unnecessary exposure to a developing fetus.

    ANS: T
    Screening for pregnancy is an important task for minimizing unnecessary exposure to a developing fetus.

    REF: p.12