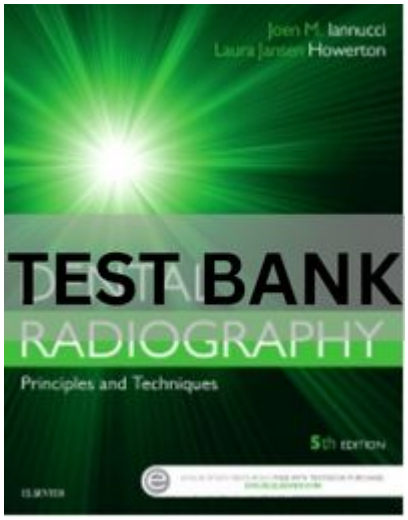
Chapter 01: Radiation History
Iannucci: Dental Radiography, 5th Edition



MULTIPLE CHOICE

1. Radiation is defined as
   a. a form of energy carried by waves or streams of particles.
   b. a beam of energy that has the power to penetrate substances and record image shadows on a receptor.
   c. a high-energy radiation produced by the collision of a beam of electrons with a metal target in an x-ray tube.
   d. a branch of medicine that deals with the use of x-rays.

   ANS: A
   Radiation is a form of energy carried by waves or streams of particles. An x-ray is a beam of energy that has the power to penetrate substances and record image shadows on a receptor. X-radiation is a high-energy radiation produced by the collision of a beam of electrons with a metal target in an x-ray tube. Radiology is a branch of medicine that deals with the use of x-rays.

   DIF: Recall REF: Page 2 OBJ: 1
   TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
   MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

2. A radiograph is defined as
   a. a beam of energy that has the power to penetrate substances and record image shadows on a receptor.
   b. a picture on film produced by the passage of x-rays through an object or body.
   c. the art and science of making radiographs by the exposure of an image receptor to x-rays.
   d. a form of energy carried by waves or a stream of particles.

   ANS: B
   An x-ray is a beam of energy that has the power to penetrate substances and record image shadows on a receptor. A radiograph is a picture on film produced by the passage of x-rays through an object or body. Radiography is the art and science of making dental images by the exposure of a receptor to x-rays. Radiation is a form of energy carried by waves or streams of particles.

DIF: Comprehension REF: Page 2 OBJ: 1
TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

3. Your patient asked you why dental images are important. Which of the following is the correct response?
   a. An oral examination with dental images limits the practitioner to what is seen clinically.
   b. All dental diseases and conditions produce clinical signs and symptoms.
   c. Dental images are not a necessary component of comprehensive patient care.
   d. Many dental diseases are typically discovered only through the use of dental images.

   ANS: D
   An oral examination without dental images limits the practitioner to what is seen clinically. Many dental diseases and conditions produce no clinical signs and symptoms. Dental images are a necessary component of comprehensive patient care. Many dental diseases are typically discovered only through the use of dental images.

   DIF: Application REF: Page 2 OBJ: 2
   TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
   MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.5 General

4. The x-ray was discovered by
   a. Heinrich Geissler
   b. Wilhelm Roentgen
   c. Johann Hittorf
   d. William Crookes

   ANS: B
   Heinrich Geissler built the first vacuum tube in 1838. Wilhelm Roentgen discovered the x-ray on November 8, 1895. Johann Hittorf observed in 1870 that discharges emitted from the negative electrode of a vacuum tube traveled in straight lines, produced heat, and resulted in a greenish fluorescence. William Crookes discovered in the late 1870s that cathode rays were streams of charged particles.

   DIF: Recall REF: Page 2 OBJ: 4
   TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
   MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.5 General

5. Who exposed the first dental radiograph in the United States using a live person?
   a. Otto Walkoff
   b. Wilhelm Roentgen
   c. Edmund Kells
   d. Weston Price

   ANS: C
   Otto Walkoff was a German dentist who made the first dental radiograph. Wilhelm Roentgen was a Bavarian physicist who discovered the x-ray. Edmund Kells exposed the first dental radiograph in the United States using a live person. Price introduced the bisecting technique in 1904.

DIF: Recall REF: Page 4 OBJ: 5
TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.5 General

6. Current fast radiographic film requires ____ % less exposure time than the initial exposure times used in 1920.
   a. 33
   b. 98
   c. 73
   d. 2

   ANS: D
   Current fast radiographic film requires 98% less exposure time than the initial exposure times used in 1920.

   DIF: Comprehension REF: Page 5 OBJ: 6
   TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
   MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.5 General

7. Who modified the paralleling technique with the introduction of the long-cone technique?
   a. C. Edmund Kells
   b. Franklin W. McCormack
   c. F. Gordon Fitzgerald
   d. Howard Riley Raper

   ANS: C
   C. Edmund Kells introduced the paralleling technique in 1896. Franklin W. McCormack reintroduced the paralleling technique in 1920. F. Gordon Fitzgerald modified the paralleling technique with the introduction of the long-cone technique. This is the technique currently used. Howard Riley Raper modified the bisecting technique and introduced the bite-wing technique in 1925.

   DIF: Recall REF: Page 4 OBJ: 7
   TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
   MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.5 General

8. Which of the following is an advantage of digital imaging?
   a. Increased patient radiation exposure
   b. Increased patient comfort
   c. Increased speed for viewing images
   d. Increased chemical usage

   ANS: C
   Patient exposure is reduced with digital imaging. Digital sensors are more sensitive to x-rays than film. Digital sensors are rigid and bulky, causing decreased patient comfort. The image from digital sensors is uploaded directly to the computer and monitor without the need for chemical processing. This allows for immediate interpretation and evaluation. The image from digital sensors is uploaded directly to the computer and monitor without the need for chemical processing.

   DIF: Comprehension REF: Page 6 OBJ: 7
   TOP: CDA, RHS, I.B.2. Demonstrate basic knowledge of digital radiography

MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.5 General

9. Which discovery was the precursor to the discovery of x-rays?
   a. Beta particles
   b. Alpha particles
   c. Cathode rays
   d. Radioactive materials

   ANS: C
   Beta particles are fast moving electrons emitted from the nucleus of radioactive atoms and are not associated with x-rays. Alpha particles are emitted from the nuclei of heavy metals and are not associated with x-rays. Wilhelm Roentgen was experimenting with cathode rays when he discovered x-rays. Radioactive materials are certain unstable atoms or elements that are in the process of spontaneous disintegration or decay.

   DIF: Comprehension REF: Page 3 OBJ: 4
   TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
   MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.5 General

10. Which of the following would you place in the patient's mouth in order to take dental x-rays?
    a. Image
    b. Image receptor
    c. Radiograph
    d. Dental radiograph

    ANS: B
    An image is a picture or likeness of an object. An image receptor is the recording medium (film, phosphor plate, or digital sensor) that is placed in the patient's mouth to record the image produced by the x-rays. A radiograph is an image of two-dimensional representation of a three- dimensional object. A dental radiograph is the dental image produced on a recording medium.

    DIF: Application REF: Page 2 OBJ: 1
    TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
    MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.5 General

Chapter 02: Radiation Physics
Iannucci: Dental Radiography, 5th Edition

MULTIPLE CHOICE

1. The fundamental unit of matter is the
   a. proton.
   b. neutron.
   c. electron.
   d. atom.

   ANS: D
   A proton is a subatomic particle; the fundamental unit of matter is the atom. A neutron is a subatomic particle; the fundamental unit of matter is the atom. An electron is a subatomic particle; the fundamental unit of matter is the atom. The fundamental unit of matter is the atom.

DIF: Recall REF: Page 8 OBJ: 1
TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

2. The nucleus of an atom contains
   a. protons.
   b. neutrons.
   c. protons and neutrons.
   d. electrons.

   ANS: C
   The nucleus of an atom contains neutrons as well as protons. The nucleus of an atom contains protons as well as neutrons. The nucleus of an atom contains protons and neutrons. The nucleus of an atom does not contain electrons; it contains protons and neutrons.

   DIF: Recall REF: Page 8 OBJ: 2
   TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
   MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

3. Which subatomic particle carries a negative electrical charge?
   a. A neutron
   b. A proton
   c. An electron
   d. A nucleon

   ANS: C
   A neutron does not carry an electrical charge. A proton carries a positive electrical charge. An electron carries a negative electrical charge. A nucleon carries a positive (proton) or no (neutron) electrical charge.

   DIF: Comprehension REF: Page 8 OBJ: 2
   TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
   MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

4. Which of the following elements is the simplest atom?
   a. Hydrogen (H #1)
   b. Helium (He #2)
   c. Nitrogen (N #7)
   d. Oxygen (O #8)

   ANS: A
   Atomic numbers are assigned from simplest to most complex. Hydrogen is the simplest atom; with a single proton, it has an atomic number of 1. Helium has an atomic number of 2. Nitrogen has an atomic number of 7. Oxygen has an atomic number of 8.

   DIF: Comprehension REF: Page 8 OBJ: 2
   TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
   MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

5. Which of the following statements is *true* of orbits or shells in the atom?

a. Protons travel around the nucleus in well-defined shells.
b. An atom contains innumerable shells.
c. The energy level within each shell is the same.
d. The orbiting shell closest to the nucleus has the highest energy level.

ANS: D
Electrons travel around the nucleus in well-defined shells. An atom contains a maximum of seven shells. Each of the maximum seven shells within an atom represents a different energy level. The orbiting shell closest to the nucleus has the highest energy level. The K shell is the orbiting shell closest to the nucleus.

DIF: Comprehension REF: Page 8 OBJ: 2
TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

6. The binding energy or binding force of an electron is
   a. determined by the distance between the neutrons and protons within the nucleus.
   b. determined by the distance between the orbiting electrons and the nucleus.
   c. weaker for electrons located in inner shells than in outer shells.
   d. determined by the atomic number.

   ANS: B
   The binding energy or binding force of an electron is determined by the distance between the nucleus and the orbiting electron. The binding energy or binding force of an electron is determined by the distance between the orbiting electron and the nucleus, not the distance between the orbiting electrons. The binding energy or binding force of an electron is stronger for electrons located in inner shells than for outer shells.

   DIF: Recall REF: Page 8 OBJ: 2 TOP: CDA, N/A
   MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

7. Which of the following statements is *true* of ionization?
   a. An atom that gains an electron will have a negative charge.
   b. An atom that loses an electron will have a negative charge.
   c. An atom that loses an electron will have a positive charge.
   d. An atom that gains an electron has a negative charge, and an atom that loses an electron has a positive charge.

   ANS: D
   This answer is not the best answer. An atom that gains an electron has a negative charge; however, an atom that loses an electron has a positive charge. An atom that loses an electron will have a positive charge. An atom that loses an electron has a positive charge; however, an atom that gains an electron has a negative charge. An atom that gains an electron will have a negative charge, and an atom that loses an electron will have a positive charge.

   DIF: Comprehension REF: Page 10 OBJ: 3
   TOP: CDA, N/A
   MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

8. An ion pair results when

a. a proton is removed from an atom.
b. an electron is removed from an atom.
c. a neutron is removed from an atom.
d. two atoms share a pair of electrons.

ANS: B
An ion pair results when an electron is removed from an atom rather than a proton; a neutron.

DIF: Recall REF: Page 10 OBJ: 3
TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

9. (1) *Radiation* is the emission and propagation of energy through space or a substance in the form of waves or particles. (2) *Radioactivity* can be defined as the process by which certain unstable atoms or elements undergo spontaneous disintegration, or decay, in an effort to attain a more balanced nuclear state.
a. Both statements are true.
b. Both statements are false.
c. The first statement is true; the second statement is false.
d. The first statement is false; the second statement is true.

ANS: A
Radiation is the emission and propagation of energy through space or a substance in the form of waves or particles. *Radioactivity* can be defined as the process by which certain unstable atoms or elements undergo spontaneous disintegration, or decay, in an effort to attain a more balanced nuclear state.

DIF: Recall REF: Page 10 OBJ: 4
TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

10. The spontaneous emission of radiation from the disintegration of unstable atomic nuclei is
a. beta particle decay.
b. radiation.
c. radioactivity.
d. alpha particle decay.

ANS: C
Beta particles are fast-moving electrons emitted from the nucleus of radioactive atoms. Radioactivity is the process by which certain unstable atoms or elements undergo spontaneous disintegration, or decay, in an effort to attain a more balanced nuclear state. Radiation is the emission and propagation of energy through space or a substance in the form of waves or particles. Radioactivity is the process by which certain unstable atoms or elements undergo spontaneous disintegration, or decay, in an effort to attain a more balanced nuclear state. Alpha particles are emitted from the nuclei of heavy metals and exist as two protons and neutrons, without electrons. Radioactivity is the process by which certain unstable atoms or elements undergo spontaneous disintegration, or decay, in an effort to attain a more balanced nuclear state.

DIF: Comprehension REF: Page 10 OBJ: 4
TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation

MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

11. Which of the following statements is *true* of ionizing radiation?
    a. It is radiation that is capable of producing ions by removing or adding an electron to an atom.
    b. It is strictly an electromagnetic radiation and does not involve particles that have mass.
    c. It is strictly particulate radiation and cannot travel as waves.
    d. It can only travel at the speed of light.

    ANS: A
    It is radiation that is capable of producing ions by removing or adding an electron to an atom. Ionizing radiation involves both particulate and electromagnetic radiation. There are two groups of ionizing radiation: particulate radiation and electromagnetic radiation. Electromagnetic radiation, a type of ionizing radiation, travels at the speed of light. Particulate radiation travels at varying speeds.

    DIF: Comprehension REF: Page 10 OBJ: 3
    TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
    MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

12. Cathode rays are derived from which of the following types of particulate radiation?
    a. Electrons
    b. Alpha particles
    c. Protons
    d. Neutrons

    ANS: A
    Cathode rays are derived from electrons. Alpha particles are emitted from the nuclei of heavy metals. Protons are accelerated particles with a mass of 1 and a charge of +1. Neutrons are accelerated particles with a mass of 1 and no electrical charge.

    DIF: Recall REF: Page 10 OBJ: 5
    TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
    MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

13. Electromagnetic radiations
    a. are entirely human-made.
    b. include x-rays and visible light.
    c. are a form of particulate radiation.
    d. have mass.

    ANS: B
    Electromagnetic radiations are human-made or occur naturally. Electromagnetic radiations include x-rays and visible light. Electromagnetic radiations are not a form of particulate radiation. Electromagnetic radiations do not have mass.

    DIF: Recall REF: Page 11 OBJ: 6
    TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
    MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics

and radiobiology

14. Which of the following forms of electromagnetic radiation are capable of ionization?
    a. Radio waves
    b. Visible light
    c. Ultraviolet light
    d. X-rays

    ANS: D
    Radio waves are not capable of ionization. Visible light is not capable of ionization. Ultraviolet light is not capable of ionization. Of the forms of electromagnetic radiation listed, only x-rays are capable of ionization.

    DIF: Recall REF: Page 11 OBJ: 6
    TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
    MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

15. Photons are
    a. bundles of energy with mass and weight.
    b. bundles of energy that travel at the speed of sound.
    c. a component of the particle concept of electromagnetic radiation.
    d. a component of the wave concept of electromagnetic radiation.

    ANS: C
    Photons are bundles of energy without mass or weight; that travel at the speed of light. Photons are a component of the particle concept of electromagnetic radiation.

    DIF: Comprehension REF: Page 11 OBJ: 6
    TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
    MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

16. Which of the following statements is *true* of the wave concept of electromagnetic radiation?
    a. *Wavelength* refers to the speed of the wave.
    b. *Velocity* refers to the number of wavelengths that pass a given point in a certain amount of time.
    c. *Frequency* is defined as the distance between the crest of one wave and the crest of the next.
    d. Frequency and wavelength are inversely related.

    ANS: D
    Velocity refers to the speed of the wave. Frequency refers to the number of wavelengths that pass a given point in a certain amount of time. Wavelength is defined as the distance between the crest of one wave and the crest of the next. Frequency and wavelength are inversely related: if the frequency of the wave is high, the wavelength will be short, and if the frequency is low, the wavelength will be long.

    DIF: Recall REF: Page 12 OBJ: 6
    TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
    MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

17. Which of the following forms of electromagnetic radiation has the shortest wavelength?
    a. Radio wave
    b. Television wave
    c. Radar wave
    d. Dental x-ray wave

    ANS: D
    A radio wave has a wavelength as long as 100 meters. A television wave has a wavelength of approximately 1 meter. A radar wave has a wavelength of 1/100 of a meter. The dental x-ray wave has a wavelength of 0.1 nanometer, or 0.00000000001 meter.

    DIF: Comprehension REF: Page 12 OBJ: 6
    TOP: CDA, RHS, III.B.2. Describe the characteristics of x-radiation
    MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

18. Which of the following components of the x-ray machine would have two indicator lights?
    a. X-ray tube
    b. X-ray tubehead
    c. The control panel
    d. The extension arm

    ANS: C
    The x-ray tube is inside the tubehead; it does not have indicator lights. The x-ray tubehead contains the x-ray tube; it does not have indicator lights. The control panel has an indicator light for the on-off switch and an indicator light for the exposure button. The extension arm is used to position the tubehead; it does not have indicator lights.

    DIF: Comprehension REF: Page 12 OBJ: 8
    TOP: CDA, RHS, III.B.3. Demonstrate understanding of x-ray machine factors that influence radiation safety
    MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology

19. Heat is a byproduct of x-ray production. Which component of the x-ray tubehead dissipates the heat created by the production of x-rays?
    a. Metal housing
    b. Insulating oil
    c. Aluminum discs
    d. Lead collimator

    ANS: B
    The metal housing protects the x-ray tube and grounds the high-voltage components. Insulating oil absorbs heat created by the production of x-rays. Aluminum discs filter out nonpenetrating, longer-wavelength x-rays. The lead collimator restricts the size of the x-ray beam.

    DIF: Comprehension REF: Page 13 OBJ: 8
    TOP: CDA, N/A
    MSC: NBDHE, 2.0 Obtaining and Interpreting Radiographs | NBDHE, 2.1 Principles of radiophysics and radiobiology