Chapter 01: The History of Ionizing Radiation and Basic Principles of X-Ray Generation
Stabulas-Savage: Frommer's Radiology for the Dental Professional, 10th Edition

MULTIPLE CHOICE

1. The duty rating refers to the number of consecutive seconds a machine can be operated before it overheats, and the duty cycle refers to the portion of every minute that the dental machine can be used without overheating.
   a. Both statements are true.
   b. Both statements are false.
   c. The first statement is true, the second is false.
   d. The first statement is false, the second is true.

   ANS: A
   Both statements are true.

   DIF: Average: Comprehension REF: p. 9 OBJ: #8
   MSC: CDA: Radiation Safety for Patients and Operators: B2
   NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

2. Too many electrons can hit the target causing too much heat production when the milliampere (mA) setting of the x-ray machine is more than:
   a. 5.
   b. 8.
   c. 11.
   d. 15.

   ANS: A
   Heat production at the target is the limiting factor of the milliampere (mA) setting of a dental x-ray machine and an mA of more than 15 more electrons hit the target causing an increase in heat production.

   DIF: Challenging: Application REF: p. 8 OBJ: #8
   MSC: CDA: Radiation Safety for Patients and Operators: B1
   NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

3. Ultrasonic radiation is part of the electromagnetic spectrum, and has no effect on tissue.
   a. Both statements are true.
   b. Both statements are false.
   c. The first statement is true, the second is false.
   d. The first statement is false, the second is true.

   ANS: D
   Ultrasonic radiation is not part of the electromagnetic spectrum, so the first statement is false. It is non-ionizing radiation and therefore has no effect on tissue, so the second statement is true.

   DIF: Average: Comprehension REF: p. 5 OBJ: #4

MSC: CDA: Radiation Safety for Patients and Operators: B2
NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

4. Federal regulations require that all dental x-ray machines have which of the following?
   a. An audible signal in addition to the signal lights in the control panel when an exposure is being made.
   b. A light in the control panel that signals when an exposure is being made.
   c. An audible signal when an exposure is being made.
   d. There are no federal regulations in this area.

   ANS: A
   Federal regulations require that all dental x-ray machines must have an audible signal in addition to the signal lights in the control panel when an exposure is being made.

   DIF: Challenging: Application REF: p. 10 OBJ: #9
   MSC: CDA: Radiation Safety for Patients and Operators: E2
   NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.5 Principles of radiophysics and radiobiology

5. In a stable atom the number of orbiting electrons (–) equals the number of protons (+) in the nucleus. Therefore, the atom is electrically neutral.
   a. Both statements are true.
   b. Both statements are false.
   c. The first statement is true, the second is false.
   d. The first statement is false, the second is true.

   ANS: A
   Both statements are true.

   DIF: Average: Comprehension REF: p. 7 OBJ: #6
   MSC: CDA: Radiation Safety for Patients and Operators: B2
   NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

6. Ionization occurs:
   a. when an atom loses a proton.
   b. when the atom has no charge.
   c. when an atom gains a neutron.
   d. when an atom loses an electron.

   ANS: D
   When an orbiting electron is ejected from its shell in an electrically stable or neutral atom, the process is called ionization.

   DIF: Average: Comprehension REF: p. 7 OBJ: #6
   MSC: CDA: Radiation Safety for Patients and Operators: B2
   NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

7. All of the following are the basic elements of an x-ray tube needed to produce x-rays EXCEPT one. Which one is the EXCEPTION?

a. High voltage
b. The production of heat
c. A target to stop the electrons
d. A source of electrons within the tube.

ANS: B
The three basic elements of an x-ray tube needed to produce x-rays are: high voltage to accelerate electrons across the tube, a source of electrons within the tube, and a target to stop the electrons. Heat production at the target is the limiting factor of the milliampere.

DIF: Average: Comprehension REF: p. 8 OBJ: #9
MSC: CDA: Radiation Safety for Patients and Operators: B1
NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

8. Each of the following are examples of particulate radiation EXCEPT one. Which one is the EXCEPTION?
a. Neutrons
b. Electrons
c. Alpha particles
d. Gamma particles

ANS: C
Particulate radiation consists of atoms or subatomic particles that travel at high speeds to transmit their kinetic energy. Examples of particulate include electron (sometimes called beta particles), protons, neutrons, and alpha particles. Gamma particles are not particulate radiation.

DIF: Average: Comprehension REF: p. 4 OBJ: #3
MSC: CDA: Radiation Safety for Patients and Operators: B4
NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

9. The difference in the electromagnetic spectrum between x-rays and visible light lies in the:
a. energy.
b. wavelength.
c. subatomic particles.
d. weightlessness of the waves.

ANS: B
The individual radiations of the electromagnetic spectrum differ in their wavelengths and frequencies and thus in many of their properties including their ability to penetrate objects. The weightlessness of the waves is what they have in common.

DIF: Average: Comprehension REF: p. 4 OBJ: #4
MSC: CDA: Radiation Safety for Patients and Operators: B2
NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

10. Each of the following are properties of x-rays EXCEPT one. Which one is the EXCEPTION?
a. x-rays are invisible.
b. x-rays travel in wavy lines.

c. x-rays can penetrate structures.
d. x-rays can adversely affect human tissues.

ANS: B
X-rays travel in straight lines not in wavy lines. All the other answers are correct properties of x-rays.

DIF: Easy: Knowledge (Recall) REF: p. 6 OBJ: #5
MSC: CDA: Radiation Safety for Patients and Operators: B2
NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

11. Identify the particles that compose the nucleus of an atom:
a. electrons and photons.
b. electrons and protons.
c. protons and neutrons.
d. neutrons.

ANS: C
The nucleus of an atom is composed of positively charged subatomic particles, called protons, and particles that have no charge, called neutrons. Electrons are negatively charged subatomic particles that orbit around the nucleus.

DIF: Average: Comprehension REF: p. 7 OBJ: #6
MSC: CDA: Radiation Safety for Patients and Operators: B2
NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

12. The target or focal spot in the x-ray tube can be found at the:
a. positively charged anode.
b. negatively charged anode.
c. positively charged cathode.
d. negatively charged cathode.

ANS: A
The target or focal spot of the x-ray is found at the anode side of the tube, and when the circuit is complete, it has a positive (+) charge. The negative side of the x-ray tube is called the cathode.

DIF: Challenging: Application REF: p. 8 OBJ: #7
MSC: CDA: Radiation Safety for Patients and Operators: B2
NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

13. Identify the metal used in the focal spot of the x-ray tube:
a. iron.
b. copper.
c. tungsten.
d. molybdenum.

ANS: C
The x-ray tube is made of tungsten and measures about 0.8×1.8 mm.

DIF: Challenging: Application REF: p. 8 OBJ: #7
MSC: CDA: Radiation Safety for Patients and Operators: B2
NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

14. The total x-ray energy produced by the collision of the electrons with the target inside the x-ray tube is approximately:
    a. less than 1%.
    b. 10%-20%.
    c. 50%.
    d. 99%.

    ANS: A
    Of the total energy produced at the anode by the collision of the electrons with the target, less than 1% is x-ray energy, the remaining 99% is in the form of heat.

    DIF: Challenging: Application REF: p. 8 OBJ: #6
    MSC: CDA: Radiation Safety for Patients and Operators: B2
    NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

15. The distance from the crest of one wave to the crest of another wave is called the frequency. The wavelength of a wave is the number of oscillations per unit of time.
    a. Both statements are true.
    b. Both statements are false.
    c. First statement is true, second is false.
    d. First statement is false, second is true.

    ANS: B
    The distance from the crest of one wave to the crest of another wave is called the wavelength. The frequency of a wave is the number of oscillations per unit of time.

    DIF: Average: Comprehension REF: p. 4 OBJ: #5
    MSC: CDA: Radiation Safety for Patients and Operators: B2
    NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

TRUE/FALSE

1. The amount of heat produced in the x-ray tube is less than the amount of radiation produced.

    ANS: F
    Of the total energy produced at the anode by the collision of the electrons with the target, less than 1% is x-ray energy, the remaining 99% is in the form of heat.

    DIF: Average: Comprehension REF: p. 8 OBJ: #8
    MSC: CDA: Radiation Safety for Patients and Operators: B2
    NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

2. The release of electrons from the hot tungsten filament at the cathode is called the thermionic emission effect.

ANS: T
The hotter the tungsten filament becomes, the more electrons are produced at the cathode. This release of electrons for the hot tungsten filament is called thermionic emission effect.

DIF: Easy: Knowledge (Recall) REF: p. 8 OBJ: #6
MSC: CDA: Radiation Safety for Patients and Operators: B2
NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

3. The tungsten filament in the x-ray tube is found at the cathode.

ANS: T
The main source of electrons in the x-ray tube is the tungsten filament found at the cathode.

DIF: Easy: Knowledge (Recall) REF: p. 8 OBJ: #9
MSC: CDA: Radiation Safety for Patients and Operators: B2
NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

4. Particulate radiations are most commonly emitted from radionuclides.

ANS: T
Radionuclides are radioactive substances that commonly emit particulate radiations.

DIF: Average: Comprehension REF: p. 4 OBJ: #3
MSC: CDA: Radiation Safety for Patients and Operators: B4
NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology

5. Electromagnetic spectrum is a grouping of electrons.

ANS: F
Electromagnetic spectrum is a grouping of energy waves that has in common the weightlessness of the waves and the speed at which they travel (186,000 miles per second, the speed of light).

DIF: Average: Comprehension REF: p. 4 OBJ: #4
MSC: CDA: Radiation Safety for Patients and Operators: B2
NOT: NBDHE: 2.0 Obtaining and Interpreting Radiographs: 2.1 Principles of radiophysics and radiobiology