

Essentials of Dental Radiography, 10e (Thomson/Johnson)
Chapter 2 Characteristics and Measurement of Radiation

2.1 Multiple Choice Questions

1) Each of the following is a form of energy *except* one. Which one is the *exception*?

- A) Heat
- B) Water
- C) Light
- D) X-radiation

Answer: B

Explanation: A) Water is a form of matter. Heat, light, electricity, and x-radiation are forms of energy.

B) Water is a form of matter. Heat, light, electricity, and x-radiation are forms of energy.

C) Water is a form of matter. Heat, light, electricity, and x-radiation are forms of energy.

D) Water is a form of matter. Heat, light, electricity, and x-radiation are forms of energy.

2) What is the maximum number of electron shells (energy levels) an atom can have?

- A) 1
- B) 3
- C) 5
- D) 7

Answer: D

Explanation: A) The innermost shell is the K shell, followed by the L shell, and so on, up to a maximum of seven shells.

B) The innermost shell is the K shell, followed by the L shell, and so on, up to a maximum of seven shells.

C) The innermost shell is the K shell, followed by the L shell, and so on, up to a maximum of seven shells.

D) The innermost shell is the K shell, followed by the L shell, and so on, up to a maximum of seven shells.

3) Each of the following is a form of ionizing radiation *except* one. Which one is the *exception*?

- A) Cosmic rays
- B) X-rays
- C) Radio waves
- D) Gamma rays

Answer: C

Explanation: A) Only radiation that produces ions is termed ionizing radiation.

B) Only radiation that produces ions is termed ionizing radiation.

C) Only radiation that produces ions is termed ionizing radiation.

D) Only radiation that produces ions is termed ionizing radiation.

4) Each of the following statements about electromagnetic radiations is true *except* one. Which one is the *exception*?

- A) They have a negative electrical charge.
- B) They have no mass.
- C) They pass through space as particles and in a wavelike motion.
- D) They have no weight.

Answer: A

Explanation: A) Electromagnetic radiations have no electrical charge.

- B) Electromagnetic radiations have no electrical charge.
- C) Electromagnetic radiations have no electrical charge.
- D) Electromagnetic radiations have no electrical charge.

5) Which of the following statements about x-rays is *not* true?

- A) They travel at the speed of light.
- B) They are invisible.
- C) They have no mass.
- D) They cannot affect biological tissue.

Answer: D

Explanation: A) X-rays can affect biological tissue.

- B) X-rays can affect biological tissue.
- C) X-rays can affect biological tissue.
- D) X-rays can affect biological tissue.

6) Which one of these is *not* a *Système Internationale* (SI) unit of measurement?

- A) Sievert
- B) Roentgen
- C) Coulombs per kilogram
- D) Gray

Answer: B

Explanation: A) Roentgen is a traditional unit of measurement.

- B) Roentgen is a traditional unit of measurement.
- C) Roentgen is a traditional unit of measurement.
- D) Roentgen is a traditional unit of measurement.

7) The *Système Internationale* unit for measuring absorbed dose is the

- A) gray.
- B) sievert.
- C) rad.
- D) rem.

Answer: A

Explanation: A) While the rad is the unit for measuring absorbed dose in traditional units, the gray is the unit used by the SI system.

B) While the rad is the unit for measuring absorbed dose in traditional units, the gray is the unit used by the SI system.

C) While the rad is the unit for measuring absorbed dose in traditional units, the gray is the unit used by the SI system.

D) While the rad is the unit for measuring absorbed dose in traditional units, the gray is the unit used by the SI system.

8) The greatest exposure to ionizing radiation to the population comes from

- A) CT scans.
- B) radon and thoron.
- C) dental x-rays.
- D) nuclear medicine.

Answer: B

Explanation: A) Radon and thoron are types of background radiation that account for the highest (37 percent) amount of radiation received by the U.S. population.

B) Radon and thoron are types of background radiation that account for the highest (37 percent) amount of radiation received by the U.S. population.

C) Radon and thoron are types of background radiation that account for the highest (37 percent) amount of radiation received by the U.S. population.

D) Radon and thoron are types of background radiation that account for the highest (37 percent) amount of radiation received by the U.S. population.

9) The speed of a wave is its

- A) wavelength.
- B) velocity.
- C) frequency.
- D) photon.

Answer: B

Explanation: A) Velocity is a measure of the speed of travel.

B) Velocity is a measure of the speed of travel.

C) Velocity is a measure of the speed of travel.

D) Velocity is a measure of the speed of travel.

10) The majority of x-rays produced by dental x-ray machines are formed by

- A) characteristic radiation.
- B) radionuclide decay.
- C) bremsstrahlung radiation.
- D) coherent scattering.

Answer: C

Explanation: A) The majority of x-rays produced by dental x-ray machines are formed by general/bremsstrahlung radiation, which is produced when electrons are accelerated across the tube head and abruptly stop against the tungsten target.

B) The majority of x-rays produced by dental x-ray machines are formed by general/bremsstrahlung radiation, which is produced when electrons are accelerated across the tube head and abruptly stop against the tungsten target.

C) The majority of x-rays produced by dental x-ray machines are formed by general/bremsstrahlung radiation, which is produced when electrons are accelerated across the tube head and abruptly stop against the tungsten target.

D) The majority of x-rays produced by dental x-ray machines are formed by general/bremsstrahlung radiation, which is produced when electrons are accelerated across the tube head and abruptly stop against the tungsten target.

11) Radiation is best described as a

- A) substance that occupies space.
- B) resistor of heat.
- C) type of electricity.
- D) movement of energy.

Answer: D

Explanation: A) Radiation is defined as the emission and movement of energy through space in the form of electromagnetic radiation (x-rays and gamma rays) or particulate radiation (alpha and beta particles).

B) Radiation is defined as the emission and movement of energy through space in the form of electromagnetic radiation (x-rays and gamma rays) or particulate radiation (alpha and beta particles).

C) Radiation is defined as the emission and movement of energy through space in the form of electromagnetic radiation (x-rays and gamma rays) or particulate radiation (alpha and beta particles).

D) Radiation is defined as the emission and movement of energy through space in the form of electromagnetic radiation (x-rays and gamma rays) or particulate radiation (alpha and beta particles).

- 12) The smallest particle of a substance that still retains the properties of that substance is a(n)
- A) atom.
 - B) electron.
 - C) neutron.
 - D) molecule.

Answer: D

Explanation: A) A molecule is the smallest particle of a substance that retains the properties of that substance.

- B) A molecule is the smallest particle of a substance that retains the properties of that substance.
- C) A molecule is the smallest particle of a substance that retains the properties of that substance.
- D) A molecule is the smallest particle of a substance that retains the properties of that substance.

- 13) The emission and movement of electromagnetic or particulate energy through space is known as

- A) ionization.
- B) radiation.
- C) radioactivity.
- D) the formation of ion pairs.

Answer: B

Explanation: A) Radiation is defined as the emission and movement of energy through space in the form of electromagnetic radiation (x-rays and gamma rays) or particulate radiation (alpha and beta particles).

B) Radiation is defined as the emission and movement of energy through space in the form of electromagnetic radiation (x-rays and gamma rays) or particulate radiation (alpha and beta particles).

C) Radiation is defined as the emission and movement of energy through space in the form of electromagnetic radiation (x-rays and gamma rays) or particulate radiation (alpha and beta particles).

D) Radiation is defined as the emission and movement of energy through space in the form of electromagnetic radiation (x-rays and gamma rays) or particulate radiation (alpha and beta particles).

- 14) The measure of the number of waves that pass a given point per unit of time is known as the

- A) angstrom unit.
- B) wavelength.
- C) frequency.
- D) velocity.

Answer: C

Explanation: A) Frequency is a measure of the number of waves that pass a given point per unit of time.

B) Frequency is a measure of the number of waves that pass a given point per unit of time.

C) Frequency is a measure of the number of waves that pass a given point per unit of time.

D) Frequency is a measure of the number of waves that pass a given point per unit of time.

15) When x-rays pass through matter, which interaction results in x-rays being scattered in all directions 60 percent of the time?

- A) Coherent effect
- B) Photoelectric effect
- C) Compton effect

Answer: C

Explanation: A) The Compton effect causes x-rays to be scattered in all directions.

B) The Compton effect causes x-rays to be scattered in all directions.

C) The Compton effect causes x-rays to be scattered in all directions.

16) The amount of energy deposited in the teeth or soft tissue by any type of radiation is called the

- A) exposure amount.
- B) absorbed dose.
- C) dose equivalent.
- D) background radiation.

Answer: B

Explanation: A) Absorbed dose is the traditional unit of measure referring to the amount of energy deposited in tissues by any type of radiation.

B) Absorbed dose is the traditional unit of measure referring to the amount of energy deposited in tissues by any type of radiation.

C) Absorbed dose is the traditional unit of measure referring to the amount of energy deposited in tissues by any type of radiation.

D) Absorbed dose is the traditional unit of measure referring to the amount of energy deposited in tissues by any type of radiation.

17) The unit used to measure the dose equivalent of radiation is the

- A) gray (Gy).
- B) sievert (Sv).
- C) coulomb per kilogram (C/kg).
- D) roentgen (R).

Answer: B

Explanation: A) Sievert is the *Système Internationale* unit for measuring dose equivalent.

B) Sievert is the *Système Internationale* unit for measuring dose equivalent.

C) Sievert is the *Système Internationale* unit for measuring dose equivalent.

D) Sievert is the *Système Internationale* unit for measuring dose equivalent.

18) The sievert and rem are units of measurement for

- A) the radiation exposure in the air.
- B) the amount of energy absorbed by tissues.
- C) the comparison of biological effects.
- D) all of the above.

Answer: C

Explanation: A) The sievert is the *Système Internationale* unit and the rem is the traditional unit of measurement for the comparison of biological effects.

B) The sievert is the *Système Internationale* unit and the rem is the traditional unit of measurement for the comparison of biological effects.

C) The sievert is the *Système Internationale* unit and the rem is the traditional unit of measurement for the comparison of biological effects.

D) The sievert is the *Système Internationale* unit and the rem is the traditional unit of measurement for the comparison of biological effects.

19) A weighting (qualifying) factor is used to determine which of the following?

- A) Coulombs per kilogram
- B) Sievert
- C) Roentgen
- D) Gray

Answer: B

Explanation: A) "Dose equivalent" is defined as the product of the absorbed dose multiplied by a biological-effect qualifying or weighting factor. The *Système Internationale* unit for measuring the dose equivalent is the sievert (Sv).

B) "Dose equivalent" is defined as the product of the absorbed dose multiplied by a biological-effect qualifying or weighting factor. The *Système Internationale* unit for measuring the dose equivalent is the sievert (Sv).

C) "Dose equivalent" is defined as the product of the absorbed dose multiplied by a biological-effect qualifying or weighting factor. The *Système Internationale* unit for measuring the dose equivalent is the sievert (Sv).

D) "Dose equivalent" is defined as the product of the absorbed dose multiplied by a biological-effect qualifying or weighting factor. The *Système Internationale* unit for measuring the dose equivalent is the sievert (Sv).

20) The wavelength determines the energy and penetrating power of the radiation. The longer the wavelength, the higher the energy of the radiation.

A) The first statement is true. The second statement is false.

B) The first statement is false. The second statement is true.

C) Both statements are true.

D) Both statements are false.

Answer: A

Explanation: A) Wavelength is the distance between two similar points on two successive waves. The shorter the wavelength, the more penetrating the radiation.

B) Wavelength is the distance between two similar points on two successive waves. The shorter the wavelength, the more penetrating the radiation.

C) Wavelength is the distance between two similar points on two successive waves. The shorter the wavelength, the more penetrating the radiation.

D) Wavelength is the distance between two similar points on two successive waves. The shorter the wavelength, the more penetrating the radiation.

2.2 True/False Questions

1) Matter is defined as the ability to do work and overcome resistance.

Answer: FALSE

Explanation: Energy is the ability to do work and overcome resistance. Energy is produced whenever the state of matter is altered.

2) An atom is the smallest part of an element that still retains properties of that element.

Answer: TRUE

Explanation: If an atom is split, the resulting particles do not retain the full properties of the element.

3) Electrons have a positive charge.

Answer: FALSE

Explanation: Electrons have a negative charge and are constantly orbiting the nucleus. Protons are the component of an atom that have a positive charge.

4) The innermost electron shell in an atom is the K shell.

Answer: TRUE

Explanation: There may be as many as seven shells in an atom. The innermost level is the K shell, followed by the L shell, and so on.

5) Dental x-rays do not involve the use of radioactivity.

Answer: TRUE

Explanation: Dental x-rays involve the use of electromagnetic radiation and not unstable radioactive isotopes.

6) X-rays travel at the speed of sound.

Answer: FALSE

Explanation: X-rays travel at the speed of light (186,000 miles per second).

7) Wavelength and frequency are directly related.

Answer: FALSE

Explanation: Wavelength and frequency are inversely related. When the wavelength is long, the frequency is low. When the wavelength is short, the frequency is high.

8) X-rays make the materials they pass through radioactive.

Answer: FALSE

Explanation: Dental x-rays have no effect on the atoms they interact with, so the irradiated materials are not made radioactive.

9) The photoelectric effect is an all-or-nothing energy loss.

Answer: TRUE

Explanation: When an x-ray imparts all of its energy to an orbital electron of an atom, the x-ray vanishes.

10) The Compton effect causes x-rays to be scattered in all directions.

Answer: TRUE

Explanation: Part of the energy of a dental x-ray is transferred to an orbital electron and a new, weaker x-ray is formed that scatters in a different direction, possibly even a direction opposite to the original x-ray.

11) The number of electrons in the nucleus of an element determines its atomic number.

Answer: FALSE

Explanation: The number of protons in the nucleus of an element determines its atomic number.

12) Background radiation includes cosmic rays from outer space, naturally occurring radiation from the earth, and radiation from radioactive materials.

Answer: TRUE

Explanation: Background radiation is defined as ionizing radiation that is always present in our environment and includes cosmic rays from outer space, naturally occurring radiation from the earth, and radiation from radioactive materials.

13) Kinetic energy is the internal energy within the atom that holds its components together.

Answer: FALSE

Explanation: Binding energy is the internal energy within the atom that holds its components together.

14) The total number of protons in the nucleus of an atom determines the atomic number.

Answer: TRUE

Explanation: The number of protons in the nucleus of an element determines its atomic number.

15) Energy that travels in a different direction than that of the original x-ray is collectively called "secondary radiation."

Answer: TRUE

Explanation: Secondary radiation is radiation that travels in a direction opposite that of the original x-ray.

16) The majority of x-rays produced by dental x-ray machines are formed by general (bremsstrahlung) radiation.

Answer: TRUE

Explanation: The majority of x-rays produced by dental x-ray machines are formed by general/bremsstrahlung radiation.

17) The electromagnetic spectrum arranges energy types by decay rates.

Answer: FALSE

Explanation: The electromagnetic spectrum arranges energy types by wavelengths.

18) X-rays of high energy and extremely short wavelengths are classified as hard radiation.

Answer: TRUE

Explanation: Hard radiation refers to x-radiation with extremely short wavelengths indicative of high energy.

19) Ionizing radiation is energy that is capable of producing ions.

Answer: TRUE

Explanation: Any radiation that produces ions is called "ionizing radiation."

20) Electromagnetic radiation is propelled through space as both particles and waves.

Answer: TRUE

Explanation: Electromagnetic radiations display two seemingly contradictory properties believed to move through space as both particles and waves.

2.3 Short Answer Questions

1) What is defined as anything that occupies space and has mass?

Answer: Matter. The world consists of matter and energy. Matter makes up anything we can see, touch, and recognize.

2) What are the positively charged particles in the nucleus of an atom called?

Answer: Protons. Positively charged protons and neutral neutrons make up the nucleus of atoms.

3) What is the term for atoms that have gained or lost electrons and electrical neutrality?

Answer: Ions. The number of protons (positive charges) in an atom normally equals the number of electrons (negative charges). When an electron is removed from a neutral atom, it loses electrical neutrality and becomes an ion.

4) What is the name of the process in which unstable elements undergo spontaneous decay in order to become stable?

Answer: Radioactivity. Unstable, radioactive isotopes try to regain nuclear stability through the release of energy.

5) What is the term for bundles of energy that travel through space at the speed of light?

Answer: Photons. The particle (or quantum) theory assumes that electromagnetic radiations are particles or quanta. These particles are called "photons."

6) What is the speed of a wave called?

Answer: Velocity. "Velocity" is the term for the speed of a wave of electromagnetic energy.

7) When radiation has great penetrating power, what is it called?

Answer: Hard radiation. Useful wavelengths in diagnostic dental radiography range from 0.1 to 0.5 Angstrom and are called "hard radiation" because they have sufficient penetrating power to expose dental radiographs.

8) Should you wait 30 seconds after making an exposure before entering the room?

Answer: No. X-rays travel at the speed of light and cease to exist after releasing the exposure button.

9) People living on the Colorado plateau receive a higher dose of what type of radiation than people living in Philadelphia?

Answer: Background. Those living on the Colorado plateau receive additional background radiation due to the increased cosmic radiation at the higher altitude and enhanced terrestrial radiation from higher concentrations of radionuclides such as uranium in the soil.

10) One gray equals how many rads?

Answer: 100. The gray is the unit in the SI system that is replacing the rad unit in the traditional system—both measure absorbed dose.