2 Radiation Physics

CHAPTER LESSON PLANS & OBJECTIVES

Lesson 2.1: Atoms, Ionization, and Radiation

1. Define the key terms associated with radiation physics.
2. Identify the structure of the atom.
3. Describe the process of ionization.
4. Discuss the difference between radiation and radioactivity.
5. List the two types of ionizing radiation and give examples of each.
6. List the characteristics of electromagnetic radiation.

Lesson 2.2: Dental X-Rays

7. List the properties of x-radiation.
8. Identify the component parts of the x-ray machine.
9. Label the parts of the dental x-ray tubehead and the dental x-ray tube.
10. Describe in detail how dental x-rays are produced.
11. List and describe the possible interactions of x-rays with matter.

CHAPTER TEACHING FOCUS

- Students will have the opportunity to learn how x-rays are produced.
- Students will have the opportunity to learn about the fundamental concepts of atomic and molecular structure, defining and characterizing x-radiation and the x-ray machine, and describing in detail how x-rays are produced.
- Students will have the opportunity to discuss the interaction of x-radiation with matter.

CHAPTER PRETEST

Have the students answer these questions prior to covering this chapter to understand where they stand in relation to the content.

1) What type of electrical charge does the proton carry?
   a) No charge
   b) Positive charge
   c) Negative charge
   d) Positive and negative charge

2) What is an atom that gains or loses an electron and becomes electrically unbalanced?
   a) Molecule
   b) Proton
   c) Neutron
   d) Ion

3) What is the emission and propagation of energy through space or a substance in the form of waves or particles?
   a) Radiation
   b) Ionization
   c) Radioactivity
   d) Electron volts

4) What 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) Radiation
   b) Ionization
   c) Radioactivity
   d) Kilo electron volts

5) What can be defined as radiation that is capable of producing ions by removing or adding an electron to an atom?
   a) Radiation
   b) Radioactivity
   c) Ion pair
   d) Ionizing radiation

6) What portion of the dental x-ray machine contains the on-off switch and an indicator light, an exposure button, and control devices?
   a) Extension arm
   b) Cathode
   c) Control panel
   d) Tubehead

7) What portion of the x-ray tube is responsible for supplying electrons that are necessary to generate x-rays?
   a) Anode
   b) Leaded-glass window
   c) Cathode
   d) Copper stem

8) What is the measurement of the number of electrons moving through a conductor?
   a) Amperage
   b) Kilovoltage
   c) Kinetic energy
   d) Thermionic emission

9) What is the measurement of electrical force that causes electrons to move from a negative pole to a positive one?
   a) Amperage
   b) Voltage
   c) Kinetic energy
   d) Thermionic emission

10) Which term refers to the penetrating x-ray beam that is produced at the target of the anode and that exits the tubehead?
   a) Scatter radiation
   b) Primary beam
   c) Secondary beam
   d) Characteristic radiation

CHAPTER PRETEST ANSWERS

1) b
Protons carry positive electrical changes.
p. 8

2) d
An atom that gains or loses an electron and becomes electrically unbalanced is known as an *ion*.
p. 10

3) a
Radiation is the emission and propagation of energy through space or a substance in the form of waves or particles.
p. 10

4) c
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.
p. 10

5) d
Ionizing radiation can be defined as radiation that is capable of producing ions by removing or adding an electron to an atom.
p. 10

6) c
The control panel of the dental x-ray machine contains an on-off switch and indicator light, an exposure button and indicator light, and control devices (time, kilovoltage, and milliamperage selectors) to regulate the x-ray beam.
p. 12

7) c
The purpose of the cathode is to supply the electrons necessary to generate x-rays.
p. 14

8) a
Amperage is the measurement of the number of electrons moving through a conductor.
p. 15

9) b
Voltage is the measurement of electrical force that causes electrons to move from a negative pole to a positive one.
p. 15

10) b
Primary radiation refers to the penetrating x-ray beam that is produced at the target of the anode and that exits the tubehead. This x-ray beam is often referred to as the *primary beam*, or *useful beam*.
p. 14

Classroom Preparation
Lesson 2.1: Atoms, Ionization, and Radiation

INSTRUCTOR PREPARATION

Textbook Objectives Covered

1. Define the key terms associated with radiation physics.
2. Identify the structure of the atom.
3. Describe the process of ionization.
4. Discuss the difference between radiation and radioactivity.
5. List the two types of ionizing radiation and give examples of each.
6. List the characteristics of electromagnetic radiation.

National Standards Covered

CODA Standards for Dental Hygiene Programs

- Standard 2: Educational Program:
  - Curriculum content: Dental sciences content must include tooth morphology, head, neck and oral anatomy, oral embryology and histology, oral pathology, radiography, periodontology, pain management, and dental materials (2-8.c)

Lesson Preparation Checklist

- Prepare lecture from TEACH lecture slides available on Evolve.
- Assemble materials and supplies needed for each lesson as indicated below.
- Bring index cards so students can create key term flash cards.

Materials and Supplies

- computer
- index cards
- projector

Classroom Preparation
Lesson 2.1: Atoms, Ionization, and Radiation

STUDENT PREPARATION (4 hrs)	
1	**READ – Textbook (pp. 8-19)** **ANSWER – Workbook Module 1: Radiation Basics** • Basic Terminology Crossword Puzzle, questions 1-12 (p. 9)
2	**READ – Textbook (pp. 8-10)** **ANSWER – Textbook** • Quiz Questions: Multiple Choice, questions 1-3 (p. 20)
3	**READ – Textbook (p. 10)** **ANSWER – Textbook** • Quiz Question: Multiple Choice, question 4 (p. 20) **PREPARE** • Students should search the Internet for examples of ionization that occur in everyday living. They will discuss these examples in class.
4	**READ – Textbook (p. 10)** **ANSWER – Textbook** • Quiz Questions: Multiple Choice, question 5 (p. 20)
5	**READ – Textbook (pp. 10-11)** **ANSWER – Textbook** • Quiz Questions: Multiple Choice, question 6 (p. 20)

6	**READ – Textbook (pp. 11-12)**
	
	ANSWER – Textbook
	• Quiz Questions:
	  • Multiple Choice, questions 7, 8 (p. 20)
	  • Identification, questions 45-48 (p. 23)
	
	PREPARE
	• Have the students do research about items around their homes that are considered part of the electromagnetic energy spectrum. Students will share their findings in class.

50-Minute Lesson Plan
Lesson 2.1: Atoms, Ionization, and Radiation

LECTURE OUTLINE (20 min)	
1 & 2	**ATOMS: SLIDES 3-11 (pp. 8-19)** • Define terms related to radiation physics. • Describe the structure of atoms.
3	**IONIZATION: SLIDES 12-14 (p. 10)** • Explain how ionization occurs.
4	**RADIATION/RADIOACTIVITY: SLIDE 15 (p. 10)** • Discuss radiation and radioactivity, explaining how the two concepts differ.
5	**IONIZING RADIATION: SLIDES 16-19 (pp. 10-11)** • Describe the two classifications of ionizing radiation.
6	**ELECTROMAGNETIC RADIATION: SLIDES 20-23 (pp. 11-12)** • Discuss electromagnetic radiation.

LEARNING ACTIVITIES (choose one or more to equal 30 min)	
1	**CREATE (20 min)** • Have each student create index cards for all key terms. These should have a key term on one side and the definition and sentence using the key term correctly on the other. Pronounce a key term for the class and have the students share their cards for that term with each other so they can compare their sentences. Repeat the drill until all key terms have been thoroughly reviewed. • *Appropriate Settings:* Traditional classroom, flipped classroom
2	**DEMONSTRATE (10 min)** • On the board, draw an illustration that resembles a miniature solar system. Draw the planets revolving around the sun. Explain to the class how this resembles electrons traveling around the nucleus in well-defined paths known as *orbits* or *shells*. Be sure to draw seven orbits and label them K, L, M, N, O, P, and Q. Explain why K has the strongest binding energy and why Q has the weakest binding energy. • *Appropriate Settings:* Traditional classroom, flipped classroom
3	**DISCUSS (10 min)** • Students should discuss examples of ionization they researched as homework. Allow all students to share some examples. • *Appropriate Settings:* Traditional classroom, flipped classroom
4	**REVIEW (10 min)** • Ask the students to compare and contrast the differences between radiation and radioactivity. Have the students give examples of each. On the board draw a two-column chart to record the student's findings. • *Appropriate Settings:* Traditional classroom, flipped classroom
5	**DISCUSS (10 min)** • Have a class discussion regarding the four types of particulate radiation and their mass. • *Appropriate Settings: Traditional classroom, flipped classroom*
6	**DISCUSS (20 min)** • Have the students share findings about electromagnetic energy they researched as homework. • *Appropriate Settings:* Traditional classroom, flipped classroom **POST & COMMENT (10 min)** • Post the Critical Thinking Question for this lesson on the Evolve discussion board. Students should post their answers and conduct an online discussion in comments. Each student should offer critical feedback to at least two other students. • *Appropriate Setting*: Online

CRITICAL THINKING QUESTION

A 35-year-old man who smokes comes to your office for a new patient examination. The patient reports not having been to the dentist since he was about 10 years old. He claims to brush his teeth one time per day but does not floss his teeth because they bleed when he flosses. He complains that a few of his teeth have recently become increasingly sensitive. After a comprehensive examination, the dentist orders a full mouth series of radiographs in order to properly diagnose and treat the patient. While you are preparing the necessary films and holders, the patient asks you why you have to take so many radiographs. What are some of the reasons you can give him?

Discussion Guidelines: Because this patient has not been to the dentist in years, a baseline series of radiographs is important for many reasons. Radiographs are crucial for accurate diagnosis: without them a dentist cannot offer suitable treatment because caries, or decay, between the teeth or under existing restorations is not generally detectable by a clinical examination. This patient has even reported tooth sensitivity, which may be related to active decay. The series of radiographs will also help in the diagnosis of periodontal disease, of which this particular patient shows signs, as his gums bleed, indicating gingivitis. Chronic uncontrolled gingivitis can lead to periodontitis. He is a smoker furthermore, and smokers are at a greater risk of developing periodontitis. Dental radiographs are also useful in oral pathology of screening the jawbones and as a baseline for future comparisons. Asymptomatic lesions may be detected in very early stages when treatment and prognosis are more favorable.

Classroom Preparation
Lesson 2.2: Dental X-Rays

INSTRUCTOR PREPARATION

Textbook Objectives Covered

7. List the properties of x-radiation.
8. Identify the component parts of the x-ray machine.
9. Label the parts of the dental x-ray tubehead and the dental x-ray tube.
10. Describe in detail how dental x-rays are produced.
11. List and describe the possible interactions of x-rays with matter.

National Standards Covered

ABHES DAI (Dental Assisting I – Basic)

- Section A: Curriculum, Competencies, Externship and/or Internal Clinical Experience:
  - Dental Sciences: Radiography of the Oral Cavity. Courses in radiography are designed to integrate theoretical and practical application of exposing and processing intra- and extra-oral radiographs. Graduates demonstrate knowledge of radiation safety measures and competency in producing radiographs in the laboratory on mannequins before they are allowed to take radiographs at clinical sites. Supervision and evaluation by faculty is essential for safety and proper instruction. (17.c)

ABHES DAII (Dental Assisting II – Advanced)

- Section A: Curriculum, Competencies, Externship and/or Internal Clinical Experience:
  - Dental Sciences: Radiography of the Oral Cavity. Courses in radiography are designed to integrate theoretical and practical application of exposing and processing intra- and extra-oral radiographs. Graduates demonstrate knowledge of radiation safety measures and competency in producing radiographs in the laboratory on mannequins before they are allowed to take radiographs at clinical sites. Supervision and evaluation by faculty is essential for safety and proper instruction. (19.c)

Lesson Preparation Checklist

- Prepare lecture from TEACH lecture slides available on Evolve.
- Assemble materials and supplies needed for each lesson as indicated below.
- Bring in a blank dental x-ray tubehead to use for a class cativity.
- Bring in copies of Figures 2-2 to 2-12 (pp. 9-13) to use for a class activity.
- Create two sets of index cards. For each set, write the steps involved in x-ray production, one step to a card.

Materials and Supplies

- computer
- index cards
- projector

Classroom Preparation
Lesson 2.2: Dental X-Rays

STUDENT PREPARATION (6 hrs)	
7	**READ – Textbook (p. 12)** **ANSWER – Textbook** • Quiz Questions: Multiple Choice questions 9, 10 (p. 20) **ANSWER – Workbook Module 1: Radiation Basics** • Multiple Choice: Property of X-Rays, questions 1-13 (p. 13)
8	**READ – Textbook (pp. 12-14)** **ANSWER – Workbook Module 1: Radiation Basics** • Identification and Labeling: Dental X-Ray Machine, questions 1-3 (p. 10)

9	**READ – Textbook (pp. 14-16)**
	
	ANSWER – Textbook
	• Quiz Questions:
	  • Identification, questions 11-28 (p. 20)
	  • Multiple Choice, questions 29, 30 (p. 20)
	
	ANSWER – Workbook Module 1: Radiation Basics
	• Identification and Labeling: Dental X-Ray Tubehead, questions 1, 2 (p. 10)
	• Identification and Labeling: Dental X-Ray Tube, questions 1-10 (p. 11)
	• Identification and Labeling: Dental X-Ray Tubehead, questions 1-11 (p. 11)

10	**READ – Textbook (pp. 16-17)**
	
	ANSWER – Textbook
	• Quiz Questions:
	  • Multiple Choice, questions 31-38 (p. 21)
	  • Identification, questions 39-40 (p. 21)
	
	ANSWER – Workbook Module 1: Radiation Basics
	• Short Answer: Production of Dental X-Rays, questions 1, 2 (p. 12)

11	**READ – Textbook (pp. 17-20)** **ANSWER – Textbook** • Quiz Questions: Multiple Choice questions 41-44 (pp. 22-23) **APPLY – Workbook Module 1: Radiation Basics** • Critical Thinking Questions 7, 8 (p. 30)
All	**REVIEW – Evolve Student Resources** • Additional Case Scenarios • Case Studies • Review Questions – Self-Study Examination

50-Minute Lesson Plan
Lesson 2.2: Dental X-Rays

LECTURE OUTLINE (30 min)	
7	**X-RADIATION: SLIDE 25 (p. 12)** • Define *radiation* and how x-rays are created.
8	**X-RAY MACHINE: SLIDES 26-28 (pp. 12-14)** • Describe the control panel and extension arm of an x-ray machine.
9	**X-RAY PARTS: SLIDES 29-35 (pp. 14-16)** • Describe the tubehead and x-ray tube of an x-ray machine. • Explain the differences between anodes and cathodes.
10	**DENTAL X-RAYS: SLIDES 36-53 (pp. 16-17)** • Explain the many steps involved in x-ray production. • Discuss the types of x-rays that can be made using the machine.
11	**INTERACTIONS: SLIDES 54-58 (pp. 17-20)** • Describe the different interactions that can occur and provide examples of each type.

LEARNING ACTIVITIES (choose one or more to equal 20 min)	
7	**DISCUSS (10 min)** • Lead a class discussion regarding the properties of x-rays. Discuss why it is important for the dental radiographer to be familiar with the properties of x-rays. • *Appropriate Settings:* Traditional classroom, flipped classroom
8	**REVIEW (15 min)** • Use an overhead projector and place a blank diagram of a dental x-ray tubehead on the board. Have the students take turns in labeling the diagram. When each student labels his or her part, make sure he or she can state what its function is. • *Appropriate Settings:* Traditional classroom, flipped classroom

9	**DISCUSS (10 min)**
	• Divide the class into small groups, and distribute to each group a copy of Figures 2-2 to 2-12 (pp. 9-13) with the labels removed. Have the students work together to assign the correct names to the parts and discuss their functions. Then, have each group share their findings with the class.
	  • *Appropriate Settings:* Traditional classroom, flipped classroom
	POST & COMMENT (10 min)
	• Post the Critical Thinking Question for this lesson on the Evolve discussion board. Students should post their answers and conduct an online discussion in comments. Each student should offer critical feedback to at least two other students.
	  • *Appropriate Setting:* Online

10	**REVIEW (10 min)** • Divide the class in half, and provide each group with a set of cards. Have each group attempt to place the cards in order of occurrence. Have the groups present their results to the class for further discussion. • *Appropriate Settings:* Traditional classroom, flipped classroom
11	**ANALYZE (15 min)** • Have the students get into groups of two. Assign each group a type of x-radiation to describe. Be sure the students include primary radiation, secondary radiation, scatter radiation, Compton scatter, and coherent scatter. Have the students share their findings with the class. Give a five question pop quiz over what the students have just learned. • *Appropriate Settings:* Traditional classroom, flipped classroom

CRITICAL THINKING QUESTION

Your office has just reopened after a week off for equipment repairs, the installation of some new dental chairs, and a thorough spring cleaning. You have been asked to retake a radiograph that you just took on a patient because the dentist states that, although you captured the correct tooth, it is nondiagnostic quality: the film is blurry and far too light. What are some of the variables that you can check in order to ensure that the second exposure is of diagnostic quality?

Discussion Guidelines: Because the office has just undergone renovations and numerous workers who may not be familiar with the radiology equipment have been in the office, it may be necessary to check over the various components. First, check that the developing machine has been maintained properly. Old chemicals of the wrong temperature will change the quality of the developed image. Next, ensure that the film you used is from a package with a valid expiration date and that the film has been stored at the proper temperature. Check that the settings on the control panel have not been altered. Many units hold a constant kilovoltage and milliamperage, yet allow the operator to adjust the exposure time. If your unit does allow for changes in the kVp or mA, check that these readings are desirable. Otherwise, focus your attention on ensuring that a proper exposure time is in place. Evaluate whether the exposure time may have to be increased from the previously selected setting, especially if your patient is a larger adult and/or is having a radiograph exposed in an area with more dense bone. You may also wish to check that the tubehead is not vibrating when lined up for exposure. Always remind the patient to remain as still as possible while exposing the radiograph. Just before leaving the room, check that the patient is not straining to hold the film holder in place because this may also cause enough motion to distort the image. Extra cotton rolls or a more comfortable placement of the holder may be required for acceptable, motionless exposure.

Assessments
Chapter 2: Radiation Physics

ASSESSMENTS BY OBJECTIVE	
1	**Evolve Instructor Resources** • Test Bank: Multiple Choice, question 1 **Workbook Module 1: Radiation Basics** • Basic Terminology Crossword Puzzle, questions 1-12 (p. 9)
2	**Evolve Instructor Resources** • Test Bank: Multiple Choice, questions 2-6
3	**Evolve Instructor Resources** • Test Bank: Multiple Choice, questions 7, 8, 11
4	**Evolve Instructor Resources** • Test Bank: Multiple Choice, questions 9, 10
5	**Evolve Instructor Resources** • Test Bank: Multiple Choice, question 12
6	**Evolve Instructor Resources** • Test Bank: Multiple Choice, questions 13-17
7	**Evolve Instructor Resources** • Test Bank: Multiple Choice, question 36 **Workbook Module 1: Radiation Basics** • Multiple Choice: Property of X-Rays, questions 1-13 (p. 13)
8	**Evolve Instructor Resources** • Test Bank: Multiple Choice, questions 18-21, 23, 24 **Workbook Module 1: Radiation Basics** • Identification and Labeling: Dental X-Ray Machine, questions 1-3 (p. 10)
9	**Workbook Module 1: Radiation Basics** • Identification and Labeling: Dental X-Ray Tubehead, questions 1, 2 (p. 10) • Identification and Labeling: Dental X-Ray Tube, questions 1-10 (p. 11) • Identification and Labeling: Dental X-Ray Tubehead, questions 1-11 (p. 11)
10	**Evolve Instructor Resources** • Test Bank: Multiple Choice, questions 22, 25-28, 32-35 **Workbook Module 1: Radiation Basics** • Short Answer: Production of Dental X-Rays, questions 1, 2 (p. 12)
11	**Evolve Instructor Resources** • Test Bank: Multiple Choice, questions 29-31, 33 **Workbook Module 1: Radiation Basics** • Critical Thinking Questions 7, 8 (p. 30)