

Fauber: Radiographic Imaging and Exposure, 4th Edition

Chapter 02: The X-ray Beam

Test Bank

MULTIPLE CHOICE

1. The _____ is the portion of the x-ray tube that contains the filament.
 - a. Cathode
 - b. Anode
 - c. Rotor
 - d. Rotating disk

ANS: A

The filament, the source of electrons during x-ray production, is located in the cathode.

REF: 13 OBJ: 3

2. The filament is made of:
 - a. Tungsten
 - b. Rhenium
 - c. Molybdenum
 - d. Lead

ANS: A

The cathode filament is made of tungsten.

REF: 13 OBJ: 3

3. The focusing cup:
 - a. Surrounds the anode
 - b. Has a positive charge
 - c. Has a negative charge
 - d. Focuses the x-ray beam

ANS: C

The focusing cup, surrounding the filament on three sides, has a negative charge, keeping the negatively charged electrons focused.

REF: 14 OBJ: 3

4. _____ is the phenomenon that occurs around the filament during thermionic emission and prevents the further escape of electrons from the filament.
 - a. Saturation current
 - b. Space charge effect
 - c. mA rectification
 - d. Line focus principle

ANS: B

The space charge effect limits the number of electrons in the space charge by preventing additional electrons from being boiled off the filament.

REF: 21 OBJ: 5

5. The positive side of the x-ray tube is the:
- Anode
 - Cathode
 - Window
 - Stream of electrons

ANS: A

The anode is the positive side of the x-ray tube, and the cathode is the negative.

REF: 14 OBJ: 3

6. The maximum speed the rotating anode will typically achieve is _____ rpm.
- 3200
 - 5000
 - 10,000
 - 20,000

ANS: C

Rotating anodes rotate at a set speed ranging from 3000 to 10,000 revolutions per minute (rpm).

REF: 14 OBJ: 3

7. What is the base material of the anode disc?
- Molybdenum
 - Tungsten
 - Rhenium
 - Beryllium

ANS: A

The base of the rotating anode disc is made of molybdenum, along with a graphite layer.

REF: 14 OBJ: 3

8. What is the name of the exact area on the anode that is struck by the electron stream?
- Focal spot
 - Focal point
 - Focal range
 - Any of the above

ANS: A

The focal spot is the exact area on the focal track of the anode target where electrons strike.

REF: 16 OBJ: 3

9. What is the name of the device in a rotating anode x-ray tube that turns the rotor?
- Stator
 - Rotor

- c. Focusing cup
- d. Rheostat

ANS: A

Located outside the envelope of the x-ray tube, the stator is an electric motor that turns the rotor.

REF: 15 OBJ: 4

10. Effective compensation for the anode heel effect would involve positioning:
- a. the thinnest portion of the part under the anode
 - b. The thickest portion of the part under the anode
 - c. The thinnest portion of the part under the cathode
 - d. B and C

ANS: A

The thinnest portion of a part should be placed under the anode, because the more intense x-rays are emitted toward the cathode end of the tube, where the thickest part should be placed.

REF: 32-33 OBJ: 8

11. What is an acceptable level of leakage from the tube housing?
- a. 100 mR per hour, measured 6 feet away
 - b. 10 mR per hour, measured 1 foot away
 - c. 1000 R per hour, measured at a distance of 4 meters
 - d. 100 mR per hour, measured at a distance of 1 meter

ANS: D

The maximum amount of leakage radiation from an x-ray tube is 100 mR per hour when measured at a distance of 1 meter.

REF: 17 OBJ: 3

12. Which of the following could be defined as the production of an x-ray photon by the electrostatic attraction between the incident electron and the nucleus of the tungsten atom?
- a. Photoelectric interaction
 - b. Bremsstrahlung interaction
 - c. Characteristic interaction
 - d. Pair production interaction

ANS: B

Production of an x-ray photon as a result of a slowing down of the incoming electron due to the electrostatic force of the nucleus is due to a bremsstrahlung interaction.

REF: 18 OBJ: 5

13. Which of the following could be defined as the production of an x-ray photon by a collision between the incident electron and a K-shell electron of the tungsten atom?
- a. Photoelectric interaction
 - b. Bremsstrahlung interaction
 - c. Characteristic interaction
 - d. Pair production interaction

ANS: C

Characteristic interactions involve the incident electron colliding with a K-shell electron and ejecting it from orbit. X-rays are produced as a result.

REF: 19-20 OBJ: 5

14. _____ is the boiling off of electrons from the filament when current is applied.
- Saturation emission
 - Thermionic emission
 - Filament transport
 - Proton emission

ANS: B

Thermionic emission is the emission of electrons (ion) as a result of heat (therm). The heating of the filament is due to the application of current.

REF: 21 OBJ: 5

15. The actual flow of electrons from cathode to anode within the x-ray tube is known as:
- Tube current
 - Filament current
 - Anode current
 - A and C

ANS: A

The tube current is the flow of electrons from cathode to anode within the tube.

REF: 23 OBJ: 5

16. mA is a measure of _____ that flows from cathode to anode.
- Filament current
 - Tube current
 - Space charge
 - Thermionic emission

ANS: B

mA, or milliamper, is the unit of measure for the amount of current flowing from cathode to anode within the x-ray tube.

REF: 23 OBJ: 6

17. Increasing the kVp will do which of the following?
- Decrease the tube current
 - Increase the speed of the electrons
 - Increase the penetrability of the beam
 - B and C

ANS: D

Increasing the kilovoltage (kVp) increases the speed of the electrons traveling between cathode and anode and results in an x-ray beam with greater penetrability.

REF: 24-25 OBJ: 6

18. The amount the voltage varies during an x-ray exposure is known as:
- kVp
 - Voltage ripple
 - mA
 - Tube current

ANS: B

The amount of variation of the voltage during an x-ray exposure is voltage ripple; it can vary from 100% to less than 1%, depending on the type of generator being used.

REF: 26 OBJ: 6

19. What focal spot size is measured directly under the anode target?
- Actual focal spot
 - Target focal spot
 - Filament focal spot
 - Effective focal spot

ANS: D

Based on the line focus principle, the effective focal spot size refers to the measurement of the focal spot from a point directly below the target.

REF: 30 OBJ: 7

20. Filtration of the x-ray beam results in:
- Increased beam quantity
 - Increased beam quality
 - Lower average energy photons
 - B and C

ANS: B

Beam filtration results in removing lower energy x-ray photons, resulting in an x-ray beam with fewer photons but with a higher average energy.

REF: 33 OBJ: 9

21. Which of the following is not classified as inherent filtration?
- The oil in the transformer
 - The collimator mirror
 - The tube envelope
 - The oil surrounding the tube

ANS: A

The oil in the transformer is not in the path of the x-ray beam, so it has no role in filtering the beam.

REF: 33 OBJ: 9

22. The amount of filtration required to reduce the exposure of the beam to half of its original intensity is defined as:
- Wedge filtration
 - HVL
 - mAs compensator

d. mA linearity

ANS: B

HVL, or half value layer, is the amount of filtration needed to reduce the intensity of the x-ray beam to half of its original.

REF: 35 OBJ: 9

23. Which of the following types of filtration produce a more uniform exposure to the image receptor?
- a. Compensating
 - b. Half-value
 - c. Inherent
 - d. Spatial

ANS: A

Compensating filters are added filters that alter the beam intensity so images of non-uniform anatomic structures have more uniform brightness/density.

REF: 35 OBJ: 9

24. In order to produce x-rays, electrons must be:
- a. Suddenly decelerated
 - b. Accelerated
 - c. Liberated from the cathode filament
 - d. All of the above

ANS: D

Electrons must be liberated from the cathode filament (thermionic emission), accelerated, and then decelerated very suddenly in order to produce x-rays.

REF: 13 OBJ: 5

25. The device that nearly surrounds the filament is the:
- a. Rotor
 - b. Focusing cup
 - c. Stator
 - d. Anode

ANS: B

The focusing cup surrounds the filament with the exception of the side open to the anode.

REF: 14 OBJ: 3

26. A dual-focus tube has two:
- a. Cathode filaments
 - b. Anodes
 - c. Tubes
 - d. None of the above

ANS: A

A dual-focus x-ray tube has two cathode filaments: a large and a small one.

REF: 13 OBJ: 3

27. The rotating target track is primarily made of:
- a. Rhenium
 - b. Nickel
 - c. Tungsten
 - d. Copper

ANS: C

The target track of a rotating anode is made up primarily of tungsten.

REF: 14 OBJ: 3

28. The target angle of rotating targets typically ranges from:
- a. 1 to 5°
 - b. 5 to 20°
 - c. 30 to 50°
 - d. 50 to 70°

ANS: B

Rotating anode target angles usually range from 5 to 20°.

REF: 14 OBJ: 3

29. Tungsten has a _____ atomic number and a _____ melting point.
- a. Low; low
 - b. Low; high
 - c. High; low
 - d. High; high

ANS: D

Tungsten has a high atomic number and a high melting point.

REF: 15 OBJ: 3

30. The part of the x-ray tube that is connected to the target and causes it to turn is the:
- a. Filament
 - b. Rotor
 - c. Stator
 - d. Base

ANS: B

The rotor is physically connected to the target and causes it to turn.

REF: 15 OBJ: 3

31. The advantage to having a focal track is that:
- a. The focal spot will be smaller.
 - b. The focal spot will be larger.
 - c. Lower exposure factors can be used.
 - d. Higher exposure factors can be used.

ANS: D

When the stream of electrons constantly has a new area of the target to hit, the result is that higher exposure factors can be used.

REF: 16 OBJ: 5

32. _____ envelopes are more commonly used in today's x-ray tubes.
- a. Glass
 - b. Paper
 - c. Metal
 - d. Lead

ANS: C

Metal envelopes are more commonly found in today's x-ray tube, replacing glass envelopes.

REF: 16 OBJ: 3

33. As compared to glass, which of the following is an advantage to having a metal envelope x-ray tube?
- a. Decrease in off-focus radiation
 - b. Increase in off-focus radiation
 - c. Increased deposits of tungsten on the inside surface of the envelope
 - d. A and C

ANS: A

The metal x-ray tube envelope results in less off-focus radiation being produced.

REF: 17 OBJ: 3

34. Inside the x-ray tube envelope you will find:
- a. Oil
 - b. Air
 - c. a and b
 - d. None of the above

ANS: D

The x-ray tube envelope has been evacuated, leaving a vacuum present.

REF: 17 OBJ: 3

35. The speed the electrons inside the x-ray tube travel is:
- a. The speed of light
 - b. Approximately one half the speed of light
 - c. Dependent on the mAs set
 - d. Dependent on the exposure time set.

ANS: B

The electrons in the tube current travel at approximately one half the speed of light.

REF: 17 OBJ: 5

36. Diagnostic x-ray exposures range from:
- a. 15 to 40 kVp
 - b. 20 to 65 kVp

- c. 30 to 150 kVp
- d. 60 to 225 kVp

ANS: C

The kVp in the diagnostic x-ray range varies from approximately 30 to 150.

REF: 19 OBJ: 6

37. With a standard x-ray tube, _____% of the x-ray beam produced with 65 kVp is the result of bremsstrahlung interactions.
- a. 0
 - b. 15
 - c. 85
 - d. 100

ANS: D

With a standard x-ray tube, 100% of the x-ray beam produced with 65 kVp is the result of bremsstrahlung interactions. The electrons must have at least 69.5 keV to produce characteristic radiation.

REF: 19 OBJ: 5

38. With a standard x-ray tube, _____% of the x-ray beam produced with 90 kVp is the result of bremsstrahlung interactions.
- a. 0
 - b. 15
 - c. 85
 - d. 100

ANS: C

With a standard x-ray tube, 85% of the x-ray beam produced with 90 kVp is the result of bremsstrahlung interactions.

REF: 19 OBJ: 5

39. With a standard x-ray tube, _____% of the x-ray beam produced with 65 kVp is the result of characteristic interactions.
- a. 0
 - b. 15
 - c. 85
 - d. 100

ANS: A

With a standard x-ray tube, 0% of the x-ray beam produced with 65 kVp is the result of characteristic interactions. The electrons must have at least 69.5 keV to produce characteristic radiation.

REF: 20 OBJ: 5

40. With a standard x-ray tube, _____% of the x-ray beam produced with 90 kVp is the result of characteristic interactions.
- a. 0
 - b. 15
 - c. 85

d. 100

ANS: B

With a standard x-ray tube, 15% of the x-ray beam produced with 90 kVp is the result of characteristic interactions.

REF: 20

OBJ: 5

41. X-ray photon energy is measured in:

- a. kVp
- b. mA
- c. Angstroms
- d. keV

ANS: D

X-ray photon energy is measured in keV.

REF: 20

OBJ: 6

42. The highest energy x-ray photons produced with a 100 kVp exposure will be:

- a. 50 keV
- b. 75 keV
- c. 100 keV
- d. 125 keV

ANS: C

In that the *p* in kVp stands for peak, the highest energy produced with a 100 kVp exposure is 100 keV.

REF: 20-21

OBJ: 6

43. When making an exposure, which of the following does not occur when just the rotor, or prep button, is activated?

- a. The anode begins to rotate.
- b. Voltage is applied across the tube.
- c. Current is applied to the filament.
- d. A space charge is created.

ANS: B

Voltage is not applied across the tube until the exposure button has been pressed.

REF: 21-22

OBJ: 5

44. Filament current is approximately:

- a. 0.5 to 2 milliamperes
- b. 3 to 5 milliamperes
- c. 0.5 to 2 amperes
- d. 3 to 5 amperes

ANS: D

It takes about 3 to 5 amperes of current passing through the filament to produce enough thermionic emission to create a space charge.

REF: 21

OBJ: 6

45. During x-ray production, the energy of the moving electrons is converted to:
- Kinetic energy
 - Thermal energy
 - Electromagnetic energy
 - B and C

ANS: D

The kinetic energy of the electrons is converted into thermal (heat) and electromagnetic (x-ray) energy.

REF: 23 OBJ: 5

46. The quality of the x-ray beam indicates:
- The number of photons
 - The ability of the photons to penetrate
 - The quantity of radiation
 - Whether or not the photons were made well

ANS: B

X-ray beam quality refers to the penetrability of the photons.

REF: 24 OBJ: 6

47. Doubling mA results in:
- Doubling the tube current
 - Doubling the quantity of x-ray photons
 - Doubling the thermionic emission
 - All of the above

ANS: D

Doubling the mA results in twice the thermionic emission, twice the tube current, and twice the number of x-ray photons produced.

REF: 27 OBJ: 6

48. Decreasing the exposure time results in:
- Fewer x-ray photons
 - More x-ray photons
 - Higher photon energy
 - Lower photon energy

ANS: A

Fewer x-ray photons are produced when the exposure time is shortened.

REF: 28 OBJ: 6

49. How much is the mAs when 400 mA and 100 ms are used?
- 4 mAs
 - 40 mAs
 - 400 mAs
 - 4000 mAs

ANS: B

Since mAs is $\text{mA} \times \text{exposure time}$, $400 \text{ mA} \times 0.100 \text{ s}$ is equal to 40 mAs.

REF: 29 OBJ: 6

50. The larger the anode angle, the:
- Larger the actual focal spot
 - Smaller the actual focal spot
 - Larger the effective focal spot
 - Smaller the effective focal spot

ANS: C

Based on the line-focus principle, the larger the anode angle, the larger the effective focal spot.

REF: 30 OBJ: 7

51. Due to the anode heel effect, the differences in intensities between the ends of the x-ray field can be as much as:
- 10%
 - 25%
 - 45%
 - 60%

ANS: C

The intensities between the anode and cathode ends of the x-ray field can vary as much as 45% due to the anode heel effect.

REF: 32 OBJ: 7

52. Added tube filtration is typically made of:
- Lead
 - Tungsten
 - Glass
 - Aluminum

ANS: D

Added tube filtration is usually made of aluminum.

REF: 33 OBJ: 9

53. X-ray tubes operating above 70 kVp must have total filtration of at least _____ of aluminum, or its equivalent.
- 0.5 mm
 - 1 mm
 - 2 mm
 - 2.5 mm

ANS: D

X-ray tubes operating above 70 kVp must have total filtration of at least 2.5 mm of aluminum, or its equivalent.

REF: 33 OBJ: 9

54. How many HU are produced when using a single phase x-ray unit, 400 mA, 200 ms, and 70 kVp?
- a. 5600 HU
 - b. 7560 HU
 - c. 5,600,000 HU
 - d. 7,560,000 HU

ANS: A

Heat units for a single phase unit are equal to the $\text{kVp} \times \text{mA} \times \text{exposure time} \times 1$, which in this case equals $400 \times 0.2 \times 70 \times 1$, or 5600 HU.

REF: 36 OBJ: 10

55. Setting identical exposure factors, which type of x-ray unit will produce the greatest heat?
- a. Single phase
 - b. Double phase
 - c. Three phase
 - d. High frequency

ANS: D

A high frequency x-ray generator will produce the greatest heat.

REF: 36 OBJ: 10

56. In order to produce 12 mAs, how long should the exposure time be when using 600 mA?
- a. 0.002 s
 - b. 0.02 s
 - c. 0.2 s
 - d. 2 s

ANS: B

Since mAs is equal to $\text{mA} \times \text{exposure time}$, exposure time is equal to the mAs divided by the mA. In this example that would be 12 mAs divided by 600 mA or 0.02 s.

REF: 29 OBJ: 6

57. Which of the following practices will extend the life of the x-ray tube?
- 1. Use low mA and longer exposure time.
 - 2. Warm up the tube as appropriate.
 - 3. Hold down the rotor button for a long time, to keep the tube warmed up.
- a. 1 & 2 only
 - b. 1 & 3 only
 - c. 2 & 3 only
 - d. 1, 2, & 3

ANS: A

In order to have the tube last longer, it is recommended that lower mA, longer exposure time, and tube warm-up as appropriate be practiced. The rotor button should be depressed for as little time as possible.

REF: 38 OBJ: 12

TRUE/FALSE

1. When an electron from the L-shell of the tungsten atom is ejected from its orbit by a projectile electron, high energy x-ray photons are produced.
A. True
B. False

ANS: F

Very low energy x-rays are produced when an L-shell electron is ejected from its orbit.

REF: 19-20 OBJ: 5

2. The x-ray beam produced with 120 kVp will consist primarily of x-rays produced by bremsstrahlung interactions.
A. True
B. False

ANS: T

Approximately 85% of the x-ray beam produced at 120 kVp will consist of x-rays produced by bremsstrahlung interactions.

REF: 19 OBJ: 5

3. Electrons can flow from cathode to anode or from anode to cathode during the x-ray exposure.
A. True
B. False

ANS: F

Electrons can only flow from cathode to anode during x-ray production.

REF: 23 OBJ: 5