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:
   a. Anode
   b. Cathode
   c. Window
   d. 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.
   a. 3200
   b. 5000
   c. 10,000
   d. 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?
   a. Molybdenum
   b. Tungsten
   c. Rhenium
   d. 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?
   a. Focal spot
   b. Focal point
   c. Focal range
   d. 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?
   a. Stator
   b. 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. Bremmstrahlung 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.
    a. Saturation emission
    b. Thermionic emission
    c. Filament transport
    d. 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:
    a. Tube current
    b. Filament current
    c. Anode current
    d. 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.
    a. Filament current
    b. Tube current
    c. Space charge
    d. Thermionic emission

    ANS: B
    mA, or milliampere, 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?
    a. Decrease the tube current
    b. Increase the speed of the electrons
    c. Increase the penetrability of the beam
    d. 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:
    a. kVp
    b. Voltage ripple
    c. mA
    d. 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?
    a. Actual focal spot
    b. Target focal spot
    c. Filament focal spot
    d. 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:
    a. Increased beam quantity
    b. Increased beam quality
    c. Lower average energy photons
    d. 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?
    a. The oil in the transformer
    b. The collimator mirror
    c. The tube envelope
    d. 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:
    a. Wedge filtration
    b. HVL
    c. 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:
    a. Kinetic energy
    b. Thermal energy
    c. Electromagnetic energy
    d. 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:
    a. The number of photons
    b. The ability of the photons to penetrate
    c. The quantity of radiation
    d. 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:
    a. Doubling the tube current
    b. Doubling the quantity of x-ray photons
    c. Doubling the thermionic emission
    d. 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:
    a. Fewer x-ray photons
    b. More x-ray photons
    c. Higher photon energy
    d. 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?

a. 4 mAs
b. 40 mAs
c. 400 mAs
d. 4000 mAs

ANS: B
Since mAs is mA ´ exposure time, 400 mA ´ 0.100 s is equal to 40 mAs.

REF: 29 OBJ: 6

50. The larger the anode angle, the:
a. Larger the actual focal spot
b. Smaller the actual focal spot
c. Larger the effective focal spot
d. 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:
a. 10%
b. 25%
c. 45%
d. 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:
a. Lead
b. Tungsten
c. Glass
d. 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.
a. 0.5 mm
b. 1 mm
c. 2 mm
d. 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 kVp ´ mA ´ exposure time ´ 1, which in this case equals 400 ´ 0.2 ´ 70 ´ 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 mA ´ 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