X-RAY PRODUCTION STUDY GUIDE

Basic Concept of X-rays

- X-rays are a form of electromagnetic radiation
- They have:
  - No mass
  - No charge
  - Travel at the speed of light
- Able to penetrate matter and create images

Main Components of the X-ray Tube

Cathode (Negative Side)

- Contains:
  - Filament (tungsten coil)
  - Focusing cup
- Function:
  - Heats up → releases electrons (thermionic emission)

Anode (Positive Side)

- Contains:
  - Target (tungsten)
- Function:
  - Attracts electrons
  - Converts their energy into X-rays

How X-rays Are Produced (Step-by-Step)

1. Filament heats up
2. Electrons are released (thermionic emission)
3. High voltage (kVp) accelerates electrons to the anode
4. Electrons strike the tungsten target
5. Energy is converted into:
   - 99% heat
   - 1% X-rays

Types of X-ray Radiation

Bremsstrahlung Radiation (Primary type)

- Produced when electrons are slowed down near the nucleus
- Creates a continuous spectrum of energies

Characteristic Radiation

- Occurs when:
  - Electron knocks out an inner-shell electron
  - Outer electron fills the vacancy
- Produces specific energy levels

Key Technical Factors

kVp (Kilovoltage Peak)

- Controls:
  - Speed of electrons
  - Energy of photons
- ↑ kVp →
  - ↑ penetration
  - ↑ scatter
  - ↓ image contrast

mA (Milliamperage)

- Controls:
  - Number of electrons
  - Quantity of X-rays

Exposure Time

- Controls:
  - Length of exposure
- mA × time = mAs
  - **mAs affects quantity ONLY**
  - **kVp affects BOTH quality & quantity**

Beam Quality vs Quantity

- Quantity (Number of X-rays):
  - Controlled by mAs
- Quality (Energy/Penetration):
  - Controlled by kVp

Interactions at the Target

- Heat production (majority)
- X-ray production (small percentage)
  - ~1% X-rays
  - ~99% heat
- Requires cooling systems (rotating anode)

Filtration

- Removes low-energy (weak) X-rays
- Improves image quality
- Reduces patient dose

Collimation

- Narrows the X-ray beam
- Reduces:
  - Patient exposure
  - Scatter radiation
- Improves image quality

Scatter Radiation

Compton Scatter

- X-ray interacts with outer-shell electron
- Causes:
  - Scatter in different direction
  - Image fog
- Main source of exposure to technologist

Photoelectric Effect

- X-ray is completely absorbed
- Produces:
  - Image contrast
  - Patient dose

Important Materials

- Tungsten (W):
  - High atomic number (Z = 74)
  - High melting point
- Used in:
  - Filament
  - Target

Focal Spot

- Area where electrons hit the target
- Smaller focal spot:
  - Better detail
  - More heat concentration

Large focal spot:

- Handles more heat
- Less detail

Line Focus Principle

- Angled target:
  - Creates small effective focal spot
  - Maintains heat distribution

Basic Concept of X-rays

1. X-rays are a form of _____ radiation.
2. X-rays have no _____ and no _____.
3. X-rays travel at the speed of _____.
4. X-rays are able to _____ matter and create _____.

Main Components of the X-ray Tube

Cathode (Negative Side)

5. The cathode contains the _____ and the _____.
6. The filament is made of _____.
7. The process of releasing electrons is called _____ _____.
8. The function of the cathode is to heat up and release _____.

Anode (Positive Side)

9. The anode contains the _____.
10. The target is made of _____.
11. The anode attracts _____.
12. The anode converts energy into _____.

How X-rays Are Produced

13. The filament _____ up.
14. Electrons are released through _____ _____.
15. High voltage measured in _____ accelerates electrons.
16. Electrons strike the _____ target.
17. Approximately _____% of energy becomes heat.
18. Approximately _____% of energy becomes X-rays.

Types of X-ray Radiation

Bremsstrahlung Radiation

19. The primary type of radiation is _____.
20. It occurs when electrons are _____ near the nucleus.
21. It produces a _____ spectrum of energies.

Characteristic Radiation

22. Occurs when an electron removes an _____ shell electron.
23. An _____ electron fills the vacancy.
24. Produces _____ energy levels.

Key Technical Factors

kVp (Kilovoltage Peak)

25. kVp controls the _____ of electrons.
26. kVp controls the _____ of photons.
27. Increasing kVp increases _____.
28. Increasing kVp increases _____.
29. Increasing kVp decreases _____.

---

mA (Milliamperage)

30. mA controls the number of _____.
31. mA controls the _____ of X-rays.

Exposure Time

32. Exposure time controls the length of _____.
33. mA × time = _____.
34. mAs affects _____ only.
35. kVp affects _____ and _____.

Beam Quality vs Quantity

36. Beam quantity is controlled by _____.
37. Beam quality is controlled by _____.

Interactions at the Target

38. Most energy is converted to _____.
39. Only about _____% becomes X-rays.
40. About _____% becomes heat.
41. Cooling is provided by a _____ anode.

Filtration

42. Filtration removes _____ energy X-rays.
43. Filtration helps reduce _____ dose.

Collimation

44. Collimation _____ the X-ray beam.
45. It reduces _____ exposure.
46. It reduces _____ radiation.

Scatter Radiation

Compton Scatter

47. Compton scatter involves _____ shell electrons.
48. It causes _____ fog.
49. It is the main source of exposure to the _____.

Photoelectric Effect

50. In the photoelectric effect, the X-ray is completely _____.
51. It contributes to image _____.
52. It increases patient _____.

Important Materials

53. Tungsten has a high _____ number.
54. Tungsten has a high _____ point.
55. Tungsten is used in the _____ and _____.

Focal Spot

56. The focal spot is where electrons hit the _____.
57. A smaller focal spot produces better _____.
58. A large focal spot can handle more _____.

Line Focus Principle

59. The target is _____ to create a smaller effective focal spot.
60. This helps maintain proper _____ distribution.