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Paper : Radiation Science and Technology

Question-1

Answer

Characteristic Radiation:

If the projectile electron interacts with an inner-shell electrons of the target atom rather than with an outer-shell electron, characteristic x-rays can be produced. characteristic x-rays result when the interaction is sufficiently violent to ionize the target atom through total removal of an inner-shell electron.

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Similar characteristic x-rays are produced when the target atom is ionized by removal of electrons from shells other than the K shell.

Similary M-characteristic x-rays N-characteristic x-rays and even O-characteristic x-rays can be produced in a tungsten target.

~~Although~~ Although many characteristic x-rays can be produced these can be produced only at specific energies, equal to the differences in electron-binding energies for the various electron transition.

Except for K-X-rays all of the characteristic x-rays have very low energy. The L-x-rays with approximately 12KeV of energy.

The electron binding energy for every element is different. The energy of characteristic X-rays produced in various element is all different. The effective energy of characteristic X-rays increase with increasing atomic number of the target element.

Bremsstrahlung Radiation:

The production of heat and characteristic X-rays involves interactions between the projectile electrons and the tube target electrons of X-rays atoms. A third type of interaction in which the projectile electrons can lose its kinetic energy is an interaction with the nuclear field of a target atoms. In this type of interaction the kinetic energy of the projectile electron is also converted into electromagnetic energy.

A projectile electron that completely avoids the orbital electrons as it passes through a target atom may come sufficiently close to the nucleus of the atom to come under the influence of its electric.

Bremsstrahlung x-rays result from the interaction between a projectile electron and a target nucleus.

Bremsstrahlung x-rays are produced when a projectile electron is slowed by the nuclear field of a target atom nucleus.

Bremsstrahlung is a German word that means 'slowed-down radiation.

Bremsstrahlung x-rays can be considered radiation that results from the braking of projectile electron by

the nucleus.

Question- 2

Answer:

factors that Affect X-ray Quantity:

Some of the factors that affect x-ray quantity have no effect on x-ray quality. Other factors affect both x-ray quantity and quality.

Kilovolt Peak. As the (KVP) is increased so is x-ray beam quality and therefore the HVL. An increase in KVP results in a shift of the x-ray emission spectrum toward the high energy side indicating an increase in the effective energy of the beam. The result is

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Five factor that affect Subject Contrast:

1- Coherent Scattering
2- Compton Scattering
3- photoelectric Effect
4- Pair Production
5- photodisintegration.

1- Coherent Scattering :

X-rays with energies below approximately 10keV interact with matter by coherent scattering Sometimes called classical scattering or Thompson scattering.

Thompson was the physicist to first describe coherent scattering.

Coherent scattering primarily involves low-energy x-rays which contribute little to the medical image.

2- Compton Scattering :

: X-rays throughout the diagnostic range can undergo an interaction with outer-shell electrons that not only scatters the x-ray but reduces its energy and ionizes the atoms as well. This interaction is called Compton Scattering.

In Compton Scattering the incident x-ray interacts with an outer-shell electron and ejects it from the atom thereby ionizing the atom.

Compton scattering occurs between moderate energy x-rays and outer-shell electrons. It results in ionization of the target atom a change in x-ray direction and a reduction in x ray energy.

3- Photoelectric effect :

X-rays in the diagnostic range also undergo ionizing interaction with inner-shell electrons. The x-ray is not scattered but it is totally absorbed. This process is called photoelectric effect and earned Albert Einstern the 1921 Nobel prize in Physics.

The photoelectric effect occurs when an incident x-ray is totally absorbed during the ionization of an inner-shell electron.

The probability of photoelectric effect is directly proportional to the third power of atomic number of the absorbing material.

A photoelectric interaction cannot occur unless the incident x-ray has energy equal to or greater than the electron

binding energy.

4- Pair Production:

If an incident x-ray has sufficient energy it may escape interaction with electrons and come to close enough to the nucleus of the atom to be influenced by the strong nuclear field. The interaction between the x-ray and the nuclear field causes the x-ray to disappear and in its place two electrons appear one positively charged and one negatively charged. This process is called pair production.

Pair production occurs with x-ray that have energies greater than 1.02 MeV. The x-ray interacts with the nuclear field and two electrons that have opposite

electronstatic charges are created.

5- Photodisintegration :

X-rays with energy above approximately 1 MeV can escape interaction with electrons and the nuclear field and be absorbed directly by the nucleus. when this happens the nucleus is raised to an excited state and instently emits a nucleon or other nuclear fragment. This process is called photodisintegration.

photodistegration does not occur in diagnostic imaging.

photodistegration is an interaction between high-energy x-rays and the nucleus. The x-ray is absorbed by the nucleus and a nuclear fragment

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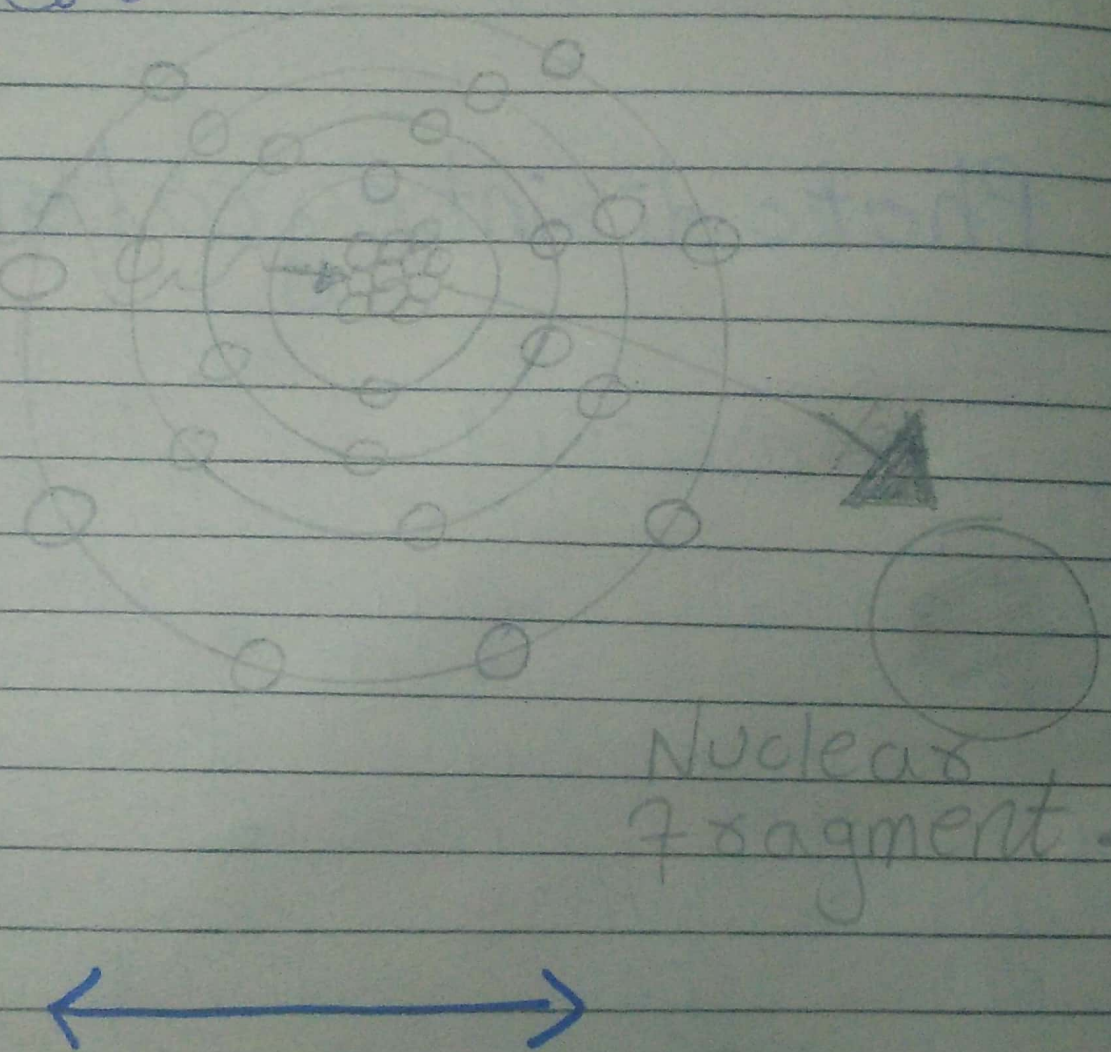
emitted.



Question-4

Answer

1: Aperture diaphragm:

Aperture diaphragm is the simplest of All beam-restricting devices. It is basically a lead or lead lined metal diaphragm that is attached to the x-ray tube head.

The opening in the diaphragm usually is designed to cover just less than the size of image receptor used.

The most familiar clinical example of aperture diaphragms may be radiographic imaging system for trauma. The typical trauma system has a fixed source to image receptor distance.

Aperture diaphragm is fixed lead opening designed for a fixed image receptor size and constant source to image receptor distance source to diaphragm distance.

2 Collimator filtration:

Collimator filtration may be necessary to produce high-quality radiographs with minimum patient exposure. Some collimator housings are designed to allow easy changing of the added filtration- filtration stations of 0, 1, 2 and 3mm Al are the most common.

The added filtration of the collimator assembly is equivalent to approximately 1 mm Al.

Total Filtration = Inherent Filtration + Added Filtration.

3. Image Contrast :

Image Contrast the visible difference between the light and dark areas of an image. Contrast is the degree of difference in OD between areas of a radiographic image. Contrast resolution is the ability to image and distinguish soft tissue.

Reduced image contrast result from scattered X-rays.

Dark to light corresponding to the bone-soft tissue interface would be very abrupt therefore image contrast would be high.

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Question- 5

Answer

Compton Scattering:

X-rays throughout the diagnostic range can undergo an interaction with outer-shell electrons that not only scatters the x-ray but reduces its energy and ionizes the atom as well. This interaction is called Compton scattering.

In Compton scattering the incident x-ray interacts with an outer-shell electron and ejects electron is called a compton electron. The x-ray continues in a different direction with less energy.

The energy of compton scattered x-ray is equal to the difference between the energy of incident x-ray and the

energy of the ejected electron. The energy of ejected electron is equal to its ~~at~~ leaves the atom.

Compton scattering occurs between moderate energy x-rays and the outer-shell electrons. It result in ionization of the target atom, a change in x-ray direction and a reduction in x-ray energy. The wavelength of the scattered x-ray is greater than that of incident x-ray.

During Compton scattering most of the energy is divided between the scattered x-ray and the Compton electron. Usually scattered x-ray retain most of the energy.

Compton scattered x-rays can be ~~divi~~ 1

deflected in any direction including 180 degree from the incident x-ray.

The probability of compton scattering is inversely proportional to x-ray energy and independent of atomic number.

Compton scattering in tissue can occur with all x-rays and therefore is of considerable importance in x-ray imaging.