

Review about Properties of X-Rays

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Abstract:

The nineteenth century AD witnessed a tremendous breakthrough in the sciences of physics, which amplified Many discoveries in the field of electromagnetic induction and waves Michel Faraday (1791-1867 AD) was able to discover Electromagnetism. Laws of magnetic induction, which state that any magnetic field that changes with time is generated Studies by Ampere and Maxwell showed that a changing electric field as well. An electric field varying with time generates a magnetic field varying with time at the same time. Method. Based on these scientific facts, the physicist James Maxwell (1831-1879 AD) was able to derive his famous equation for electromagnetic waves. And formulate his own theories, which define the mutual relationships between the fields Maxwell came up with these theories' Variable electricity and magnetism. To predict the existence of electromagnetic waves that propagate in a vacuum with equal speed (w) , The speed of propagation of visible light in a vacuum ($108 \times 299792 \text{ m}$), which led him to develop the idea that visible light is a form of waves. Electromagnetism, and thus the inclusion of light within these waves [1]. Maxwell's scientific predictions were fulfilled by Henrik Hertz (1857-1894), who. For the first time, he was able to generate electromagnetic waves and detect them Waves in practice. This great discovery was made in the last quarter of the century. The nineteenth century led to ushering in a new era, which is the era of wireless communications that began in Using wireless systems such as radio, radar, and television in communications.

Introduction

Properties of X-rays: example, a sheet of wood 3 c . X-rays penetrate all materials to varying degrees. For thick can be easily penetrated by X-rays, while an aluminum plate 15 mm thick greatly . weakens the intensity of these rays, but it cannot completely erase their effect. it. As if These rays pass through passage Fluorescence can be seen on the screen while X-rays can penetrate lead glass, but they can it penetrates other types of glass that have the same thickness, and if you place the fingers of the palm between the screen . and the tube, the shadows of the finger bones appear on the screen. 2. The screen fluorinated with platinum barium cyanide is affected by X-rays. There are also other fluorinated materials such as stone salt, calcium salts, and uranium glass that are also affected by these ra 3.

Photographic plates and films are quickly affected by these rays, and therefore photography is considered an important means of studying the properties and effects of these rays as well.

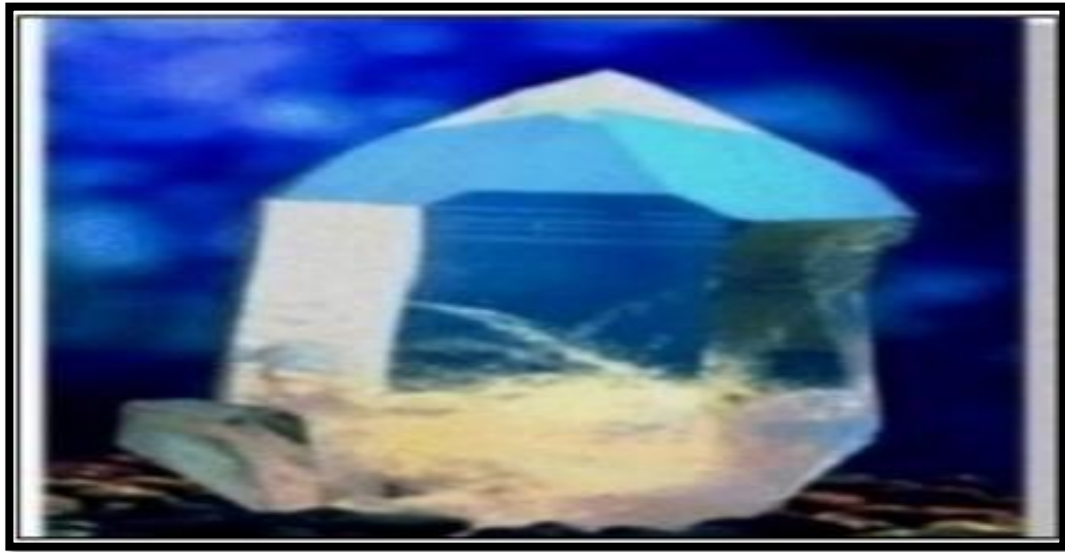


Figure (1-2)

Measuring the separation distance d in a NaCl crystal

The sodium chloride crystal has a special and simple crystal structure and can be used to measure X-ray diffraction. The external shape of the sodium chloride crystal consists of as in the corresponding figure, where the sodium and chlorine atoms are arranged in a successive and symmetrical manner, and the separation distance between two adjacent atoms is calculated. The separation distance is calculated using density and weight. Molecular sodium, chlorine and avocadro number. This is done as follows: • If d is measured in centimeters from the sodium atom to the nearest chlorine atom, there will be d . Therefore, in the cube of sodium and chlorine, the total, 1/atom has a length of 1 cubic centimeter number of atoms per unit volume is $1/3d$ atom, since the molecular weight of sodium is 23 and that of chlorine is 35.45, and therefore the weight is The molecular number of sodium chloride is 58.45, because the avocadro number gives the number of atoms in a gram mole. This means that the number of atoms in 23 grams of sodium is equal to an atom. Likewise, there is the avocadro number of an atom in 35.49 grams of chlorine. Therefore, the number of atoms in sodium chloride, 58.45 grams, is equal to twice the avocadro number, and from the density Sodium 2.163 grams per centimeter cube then:

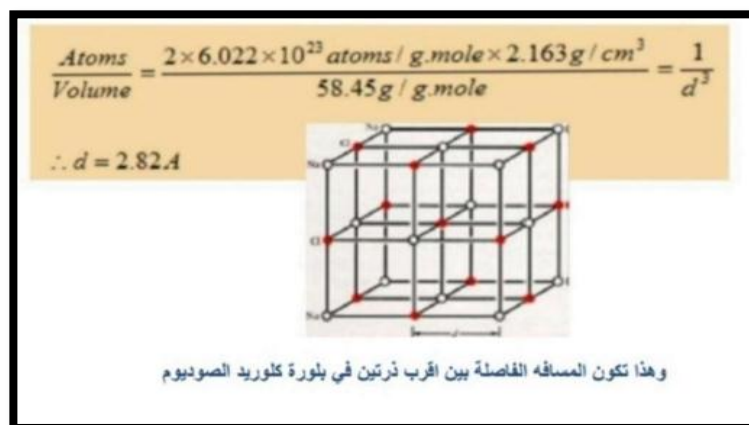


Figure (2-2)

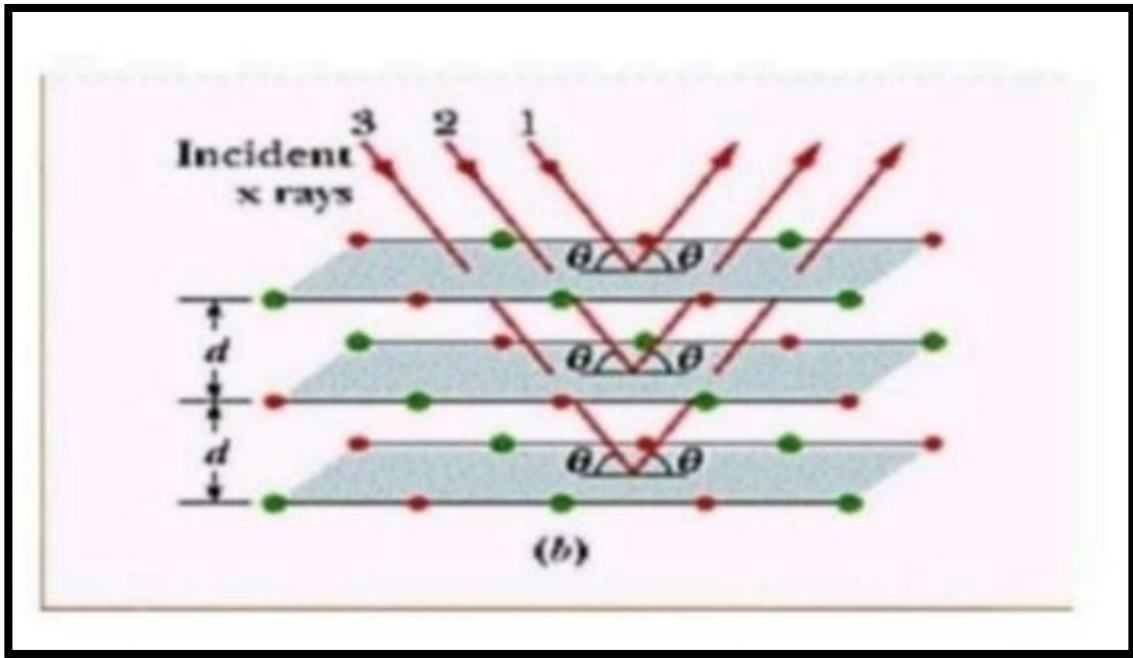


Figure (2-3)

Bragg's Law In a crystal, the atoms are arranged in an organized manner, but in this sodium chloride crystal Atoms form parallel planes separated by a distance d called Bragg planes when rays are incident Rays on the Braggplains plane, part of them is reflected and the other part is transmitted To be reflected at the next level. Thus, the reflected rays will interfere and result in either. Constructive interference or destructive interference, depending on the path difference of the reflected rays, as shown in: . Figure above

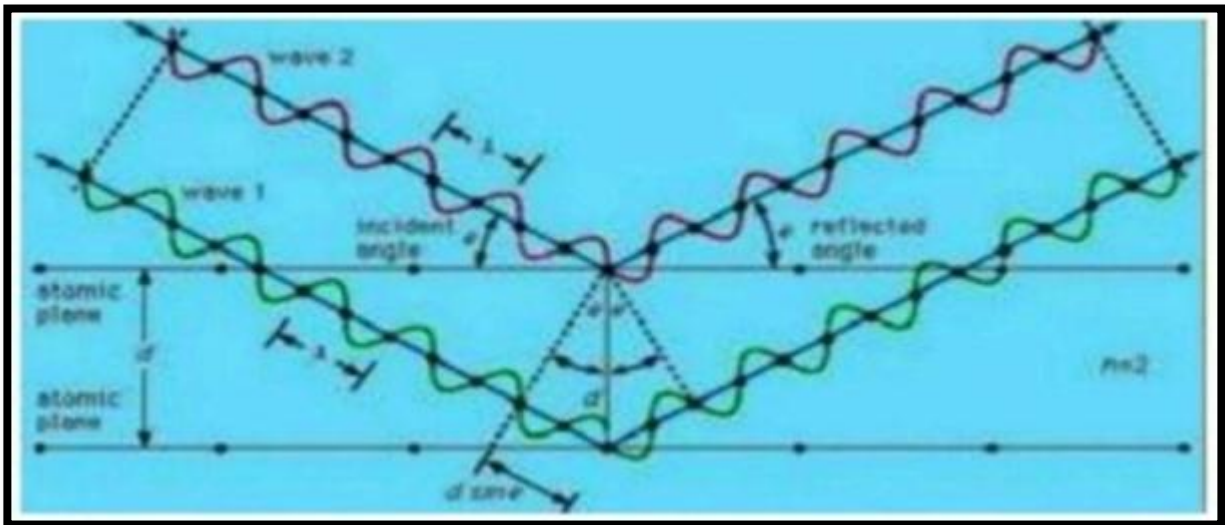


Figure (4-2)

From the previous figure, part of the incident ray is reflected in the first Bragg plane at an angle of θ . Its amount is with the level. The other part of the beam passes through the first plane and part of it is reflected. The interference between the two reflected rays is constructive if.. On the second level, also at an angle of θ . True wavelength. What a luck They have the same phase difference if the path difference is the number of the drawing in the figure above that the path difference is $d \sin 2\theta = n\lambda$ and the condition is to obtain constructive interference. of rays reflected from the Bragg levels (Law

s'Bragg) $n = d \sin^2$ where n is It takes values 1 and 2 True, it is called interference the of order X-ray spectrum when measuring the intensity of the spectrum Continuous

1. Continuous spectrum
2. Linear spectrum

continuous spectrum is produced due to the accelerated electrons losing their energy in the form of radiation when they collide with target particles and slow down. As we explained previously, radiation is emitted when a charged particle accelerates or decelerates. This type of rays is called stop rays, which is produced due to the cessation of the accelerating electrons in the collision. As for the linear spectrum. It is produced due to the radiation resulting from the rearrangement of the orbital electrons in the atoms of the target material (the anode) at different energy levels, which follows the liberation of one of these electrons from the atom as a result of the collision of the electrons. Accelerated by it. Since the energy value of atomic levels is limited. The transfer of electrons The orbit from a high energy level to a low level leads to the radiation of a photon with a certain energy equal to the energy difference between the two levels, and thus it has a specific length and appears in the form of a sharp line in Spectrum. Since the energy value of the atomic levels is a characteristic of the atoms of the target material (the anode), the linear spectrum is also a characteristic of the target material. The spectrum of In the atoms of matter

Types of X-rays

X-rays are divided into several groups according to the voltage of these rays. These groups are:

From 0.1 <u>kv</u> to 20 <u>kv</u>	1 rays-X low energy	
120kv to 20kv from	Diagnostic X-rays 2	
300kv to 120kv	Orthovoltage X-rays <u>Conventional X-rays</u> 3	
From 300 <u>kv</u> to mv1	4 rays-X Intermediate energy	
More than mv1	5 rays-X High voltage	

Brake beams:

There is another type of X-ray radiated from a target when it is bombarded with electrons, and this is known as The name brake rays is derived from a German word As the name indicates, these rays are emitted by projectile electrons when they slow down their movement Suddenly upon collision with the target. We know that any accelerated charge emits radiation Electromagnetism, and then these colliding electrons also emit radiation when they slow down Firmly on target. As the rate of deceleration is large. As a result, the radiation emitted has a different wavelength This is short and the braking rays are in the x-ray range. The brake rays are opposite Characteristic rays have a continuous range of wavelengths.

The Characteristic Rays when the voltage applied between the anode and cathode terminals increases, the values of the curves change and remain . He appears Maintaining its distinct, smooth character up to a certain voltage, depending on the anode material. A noticeable increase in the intensity of the rays

at specific wavelengths. This increase in intensity highlights, The appearance of high-intensity rays with almost specific wavelengths, called characteristic rays the characteristic rays appear to be applied to the white rays, and the characteristic rays actually come out When electrons (from anode atoms) are struck by the inner shells of the atom, radiation is given off. Depending on the outer shell from which the electrons are removed, N, it is M, L K in token obvious that the K beam belongs to the highest energy and shortest resulting wavelength, then it is followed by [and so on. On the other hand, if the electron is expelled from the K shell, an electron will fall from the K shell to the K shell The K envelope to compensate for the deficiency and bring the K atom to the state of the lowest possible free energy, and that this The attempt results in the emission of rays called K, but if the compensation is made by the fall of an electron from...From the M envelope to the K envelope, the emitted rays are called L rays. The increase in intensity stops The distinctive rays are at the level of white rays and at the intensity of the current between the cathode and the anode Critical limit. One of the most important features of distinctive rays is their high intensity, estimated at about 90 times More than the intensity of white rays at the same wavelength, these rays, especially K, play Durham in studying the crystalline structure of solids.

X-ray measuring devices

Any X-ray effect can, in principle, be used to measure intensity X-rays are invisible and the person exposed to them cannot feel their effect. So it is necessary Use specific devices to warn him of them. The intensity of the rays is measured by measuring the intensity of the flora they cause Rays in some materials or by measuring the extent of their effect on the photographic plate or by measuring the amount The temperature rise of a piece of metal when it absorbs radiation, such as lead, as well as by measuring Air was chosen as the ionization material not only because of its availability The amount of ionization it causes. Almost everywhere, but because its components are universally fixed. Roentken detected X-rays by the fluorescence they cause in some substances. And luck It also prevails on photographic plates, and this property can be used to measure the intensity of radiation Sinism Chamber ionization Since Another strengthens the pressure of atmospheric pressure. The X-rays enter the cylinder through a thin window made of mica or aluminum, and when the chamber is operated, it makes the potential of the metal electrode positive with respect to the cylinder, pushing the free electrons into it. A small voltage must be applied to prevent an electrical discharge from occurring in the gas. It is large enough to collect the charges generated before the electrons can recombine with the positive ions. When the X-rays enter the chamber, ions are generated, and each ion moves towards the electrode with the opposite charge to it, and this causes a weak electric current to pass through. It was found that the intensity of the incident X-rays can be amplified and measured by this ionization current, which is proportional to the electrometer. A Caicker counter or scintillation counter is also used to measure the intent.

X- ray generation From the discharge, the current that heats the filament is usually taken from the voltage-reducing transformer, then the electrons released from the cathode are accelerated to the anode. High voltages applied between them are preferred, which may reach 50 kv or more. If the current is low, these voltages are supplied either with a transformer to raise the voltage or with a unit to resist high voltages. Where the electron beam is transmitted towards the anode by a cup surrounding the filament that is formed Its potential is always negative, and since the tube is empty of air, the supply of electrons depends entirely on On the temperature of the filament, and then on the current passing through the filament, this means that the current that flows through the x-ray tube depends entirely on the filament current, regardless of the value of the potential difference. The current passing through the tube is what determines the amount generated by the force through the tube. X-rays, and the value of the tube current, which can be considered a typical value of mA20, is that a small part does not exceed one percent (1%) of the energy of the colliding electrons. The anode is responsible for the formation of the a stream of water inside the anode to cool it. In addition, the

anode may be rotated in a number of cases to continuously change the impact position of the electron beam.

X-ray generating tubes

There are several types of tubes that are used to produce X-rays, including the gas-filled tube, which is a type of cathode ray tube. The cathode is shaped like a cup to direct the electrons and focus them on a metal target. The gas pressure inside the tube usually reaches 0.001 mm Hg, making the potential difference between the cathode and the target between 30 and 50 kilovolts. The electrons emitted from the cathode stop as a result of their collision with the target, which then becomes a source of X-rays, and the X-rays spread. Generated from the target to all directions. There is another type of tube that produces Tungsten or molybdenum. When generating At present, an electrical transformer is used to obtain a voltage higher than the normal alternating voltage. The value of the high voltage difference used depends on the purpose for which the generated x-rays are used, and its value usually ranges between ten thousand volts and one million volts. There is a third type of tube that generates These accelerated electrons in the target generate X-rays and this type of X-rays is used in Nuclear tests.

How X-rays work

Standard X-rays: By placing a part of the body to obtain images in front of the X-ray machine and shooting short pulses of Radiation passes . through muscle, fat and skin easily, but it is absorbed by your bones being denser Bones appear white on the image that is produced, unlike less dense tissues which appear dark

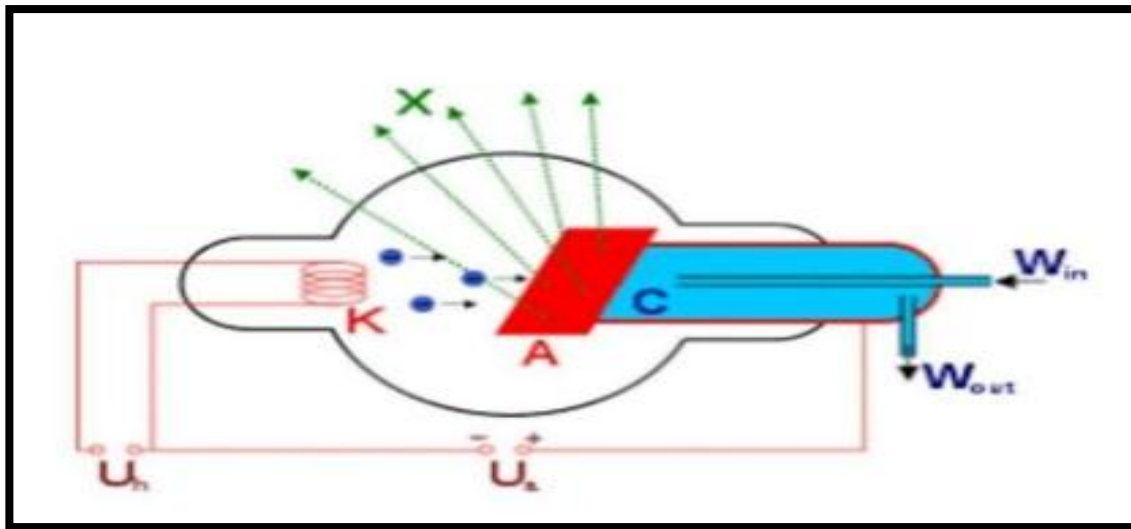


Figure (5-2)

Types of X-rays The most commonly used X-ray images are:

Radiography

is the most common type of X-ray, and is used to detect bone fractures, examine the chest, or at the dentist. Radiography uses the least amount of radiation



Figure (6-2)

Fluoroscopy: This procedure allows X-rays to be viewed in real time, so that images can be taken exactly when needed. Fluoroscopy uses fluoroscopy to look at things such as the intestines, by drinking a drink containing barium, which shows up on an X-ray as it moves through the digestive tract. Endoscopy uses a little more radiation than standard X-rays, but the amount of radiation is more intense than fluoroscopy. It is classified as a very small amount.

Computed tomography

The patient lies on a table over which a ring- The X-ray scanner takes a series of "slices" that allow...



Figure (3-7)

Risks

Radiation occurs naturally around us, as we are exposed to it on a daily basis at levels Very low. However, high doses can cause DNA changes (DNA and cells in our bodies, which may lead to an increased risk of developing cancer later on From our lives. Although undergoing an X-ray examination exposes us to radiation However, the radiation levels we are exposed to during the examination are very low Protective clothing is also provided to wear before the examination The

benefits far outweigh any potential risks Reducing the amount of rays that touch other parts of the body. For example, if you You will undergo an X-ray to examine your arm. You must wear a lead apron to prevent...You should inform your doctor before going Radiation from reaching other areas. If you are pregnant to your baby To the X-ray department, as the radiation may be harmful. Radiation occurs naturally around us, as we are exposed to it on a daily basis at levels Very low. However, high doses can cause DNA changes (DNA and cells in our bodies, which may lead to an increased risk of developing cancer later on From our lives. Although undergoing an X-ray examination exposes us to radiation However, the radiation levels we are exposed to during the examination are very low Protective clothing is also provided to wear before the examination The benefits far outweigh any potential risks Reducing the amount of rays that touch other parts of the body. For example, if you You will undergo an X-ray to examine your arm. You must wear a lead apron to prevent...You should inform your doctor before going Radiation from reaching other areas. If you are pregnant to your baby To the X-ray department, as the radiation may be harmful

Benefits Because imaging using radiation can give doctors an accurate picture of what it is like when combined with imaging Therefore, it is an important part of the diagnostic process. It happens inside your body, with x-rays along with blood tests and physical examinations, it helps doctors to like that In addition to giving you the appropriate treatment for your medical condition. Detect the bug quickly and accurately, Search X-rays sometimes lead to unexpected discoveries when the patient is being examined for .something else entirely

Radiology applications X-ray

X-rays

X-rays came into application immediately after their discovery. The medical field was the first application to benefit from X-rays. Due to its unusual properties that enable us to see the components of the body from the inside without surgery, bloodshed, or even anesthesia. It only takes a few minutes. Medical X-ray imaging used in diagnosis was and still is more widespread than others to this day in order to study the changes that have occurred in the basic structure of the healthy human body, whether in the form of tissue growth Unwanted (Tumors of both types: benign and malignant), the presence of cracks or fractures in the bones, or tooth decay, and so on. In later stages, X-ray production devices were developed, used in the treatment of cancerous diseases.

Types of X-ray imaging in the medical field: X-ray imaging is one of the quickest and easiest methods for the doctor; To examine the body's internal organs; Because it represents an excellent tool that tissues and helps evaluate the condition of the bones, teeth and jaws. It is also used to examine the thoracic cavity area, including the lungs, heart, Also after x-rays . breast examination, digestive tract, kidneys, and gallbladder, by obtaining high-resolution images. It is also used in measuring bone density, orthopedic surgery, and treating various sports injuries. X-rays are an essential pillar in detecting and diagnosing cancer, and then treating it. Diagnostic 1. Ordinary radiography, and tomography, where we obtain a fixed image and display it on a film, or on a computer screen for logic. 2.Fluoroscopy, where we obtain real-time (instantaneous) moving images of the organ directly on a monitor screen or computer, in order to examine functions. Internal in the body.

The importance of the X-ray image An X-ray image is: a tool to help evaluate the patient's condition, that is: a method. Despite this, it does not only affect the diagnosis, but its impact extends to proving the patient's assessment of the possible possibilities, and then choosing the optimal method of treatment. The x-ray imaging process must take place at the appropriate time in the stages of development of the patient's condition, so that the x-ray image must also match and the x-ray image perform its desired role. The necessary technical specifications before examining the image to extract information. The use of X-rays can, God willing, improve the information collected through the examination Clinically, a successful diagnosis requires an appropriate radiograph, a good

clinical examination, and the process of diagnostic

Stages of X-ray imaging

The science of X-ray imaging in the medical field is based on preparing the open; To count the photons, then process the film by chemical or physical means; To finally obtain the radiological image. There are four main stages in the x-ray imaging system, which are designed to improve image quality and reduce the patient's exposure to radiation (see: Figure 3-1) and they are explained as follows:

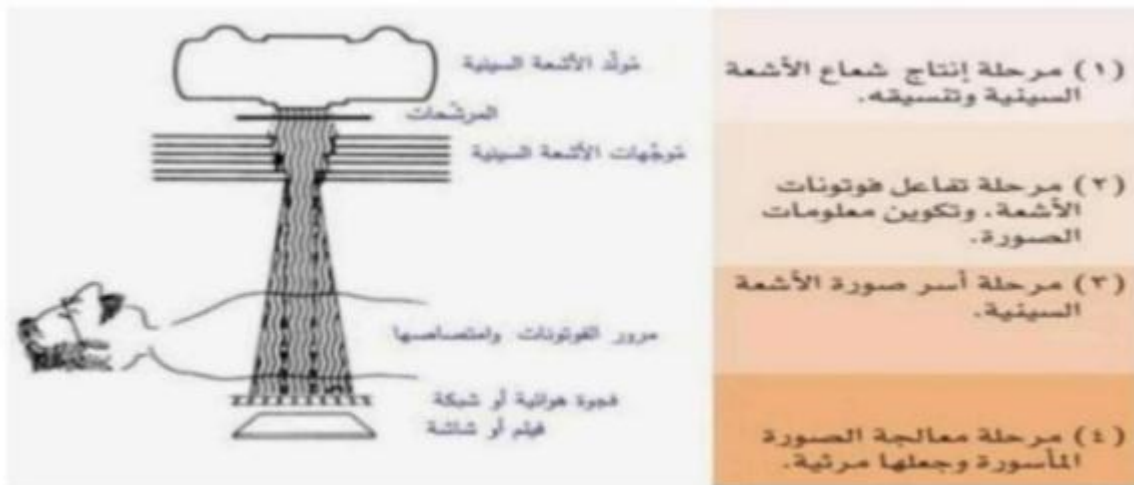


Figure (1-3) A diagram showing the four main stages of diagnostic x-ray imaging

1. The stage of producing and coordinating the X-ray beam: It includes the X-ray tube, filters, and collimators that are designed to direct the beam of X-ray photons of sufficient quality and quantity to the patient; To photograph the part of the body being studied.
2. The stage of interactions of the X-rays that collide with the patient's body; To produce the absorption and attenuation patterns that produce visual information on photographic film.
3. The stage of the image capture and recording systems (film, or electronic means): to capture the pattern of photons that passed through the patient's body to produce the diagnostic image.
4. The stage of processing the interactions that resulted from the captured photons, to make the information contained in the image visible, whether by means of Electronic or film processing.

The ability of X-rays to penetrate through various materials depends on the energy of the rays' photons

Whenever it is X-rays, and the physical properties of matter, such as: the density of the body and its thickness. The density or thickness of the matter is lower, and the ability to penetrate is higher at the same energy. The tissues and organs of the body differ in shape, size and density, and the value of the modulus varies. The attenuation of rays in those tissues occurs within a specific range of energy, as shown in the figure (3-2). Medical radiography chooses X-rays at an ideal energy that equals the greatest contrast in the values of the attenuation coefficient for the components of the body present in the path of the rays, and then we obtain Attenuation coefficient. Good radiographs with clear details contribute to successful diagnosis. The attenuation scale represents the intensity of the X-rays in their path, and is expressed in two ways: linear (cm). X-ray intensity represents the number of X-ray photons incident on the surface (or mass (cm / gram). / cm) per The intensity of the ray flux psecoundit, aarneda i(tmis).ainlso expressed The first definition: The intensity of the rays depends on the distance between the rays source and the measurement location. Therefore, the use of taboos is

absolutely necessary to obtain stable parallel X-rays Intensity regardless of application site and type.

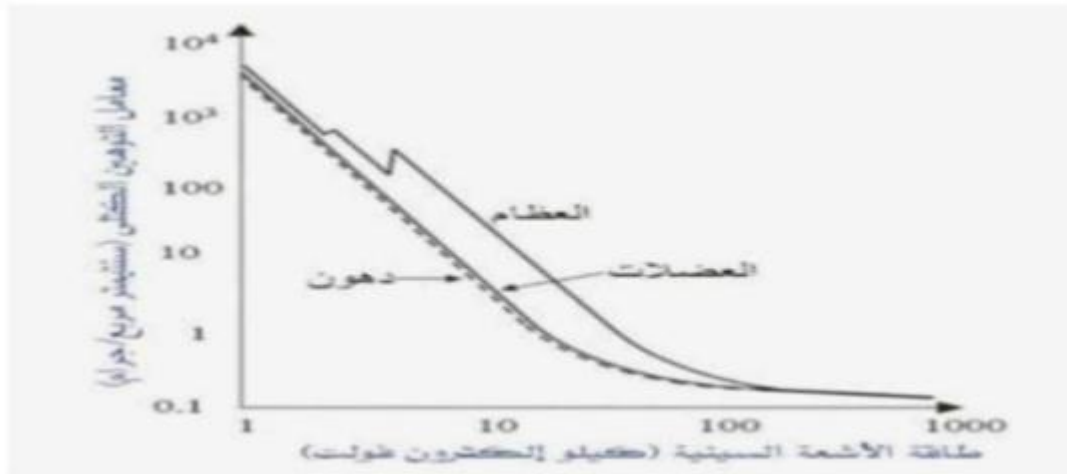


Figure (3-2) Change in the value of the mass attenuation coefficient in different tissues according to the energy of the X-rays

Chest X-ray examination

Chest X-ray examination represents the most complementary examination to radiological imaging in the medical field, as it is estimated at about 45% of the total number of all examinations used in this field. The imaging process only takes a few seconds. Therefore, one might think that, since chest imaging is an easy task, doing this task is easy, but in contrast to that with x-rays, it requires experience and accuracy in performance. In order to obtain an image with specifications that meet its purpose; Because the chest contains tissues of different composition, such as: the lungs, along with thick solid bones. The lungs consist of millions of alveoli, soft tissue with very thin walls, almost filled with air. Therefore, producing an image that provides us with all the precise details of all the structures in the chest requires technology and experience (as shown in Figure (3-3)).

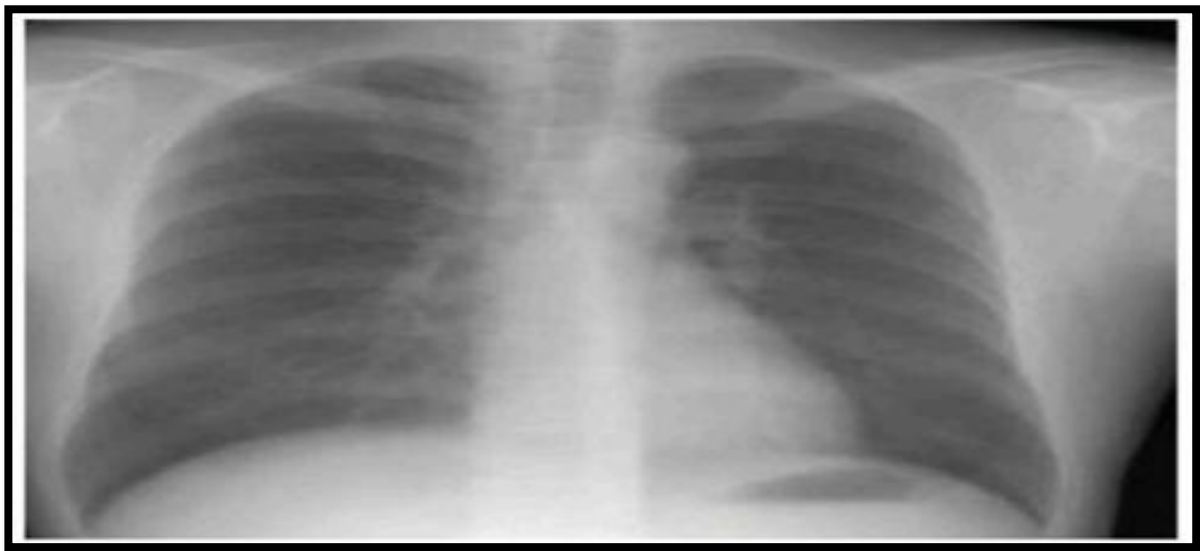


Figure (3-3) An accurate radiograph of the chest area, in which the lungs appear darker than the bone areas. Other benefits of chest Previous surgical procedures, or placing and fixing a thread, tube, or device, as shown in Figure (3-4)

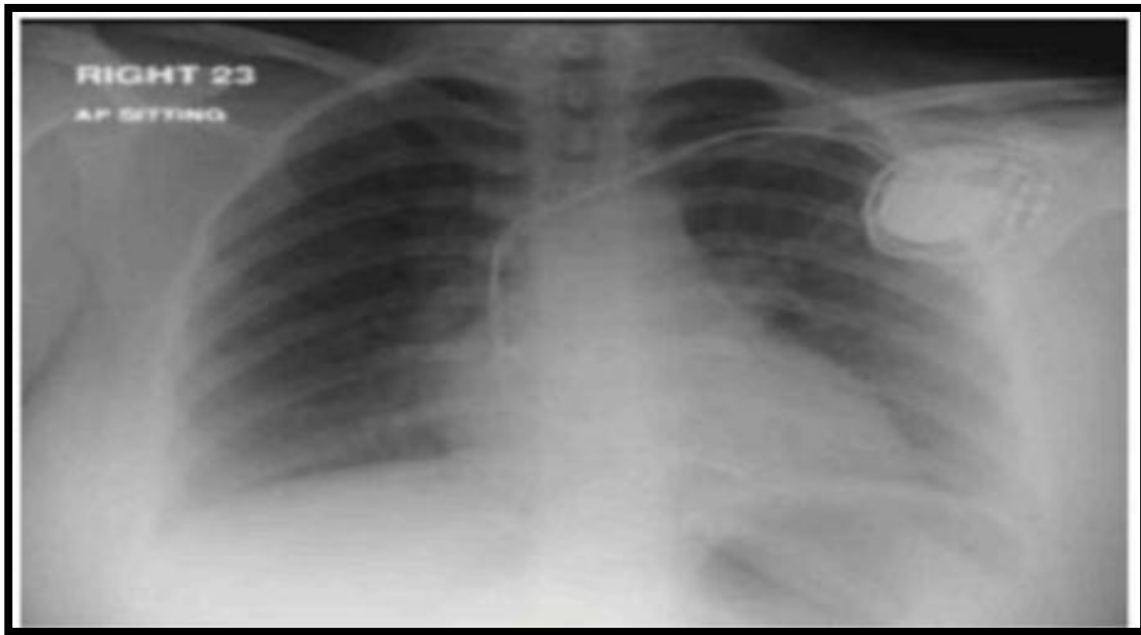


Figure (4-3) Ensuring the stability of the position of the bilateral chamber of the permanent pacemaker

Limitations of using chest x-rays :

1. The two-dimensional x- ray image represents the three-dimensional components of the body, and therefore check depth information details.
2. Congruence of the different levels on one level that represents the location of the contents of the levels. This makes monitoring or detecting anomalies very difficult, especially if they are...

Its dimensions are small. Regular X-rays do not help differentiate between different types of tissue. 3. Images if they are similar in density

Dental X-rays X-rays help the dentist To visualize the teeth and the tissues surrounding them. Then discover problems that cannot be seen with a simple visual examination, find dental problems, and treat them early before their condition becomes worse. This technology does not save us money

Which is spent 7-3 Industrial applications of X-rays:

X-rays are widely used in the industrial field as an aid; To ensure the quality of the product, or to maintain it sterile, as X-ray photography in many industries is a cornerstone for seeing details that are not visible by traditional means, visual inspection and then studying them, identifying the locations of defects during the production stages, or in the final product without damaging it, taking a sample from it.

Radiographs: The radiographic image is represented by a special photographic film that has been treated with acidification and fixation processes after being exposed to x-rays or gamma rays during the imaging process. Now; this is because good viewing conditions can also be very important when interpreting radiological images. Improves or reduces fine details in radiological images. The contents of the radioactive film appear in the form of a sudden or gradual change in the degree of transparency on the surface of the film. It ranges from dark black to transparent. This gradient is affected by a number of factors, such as: The distance between the X-ray source and the sample, as well as the distance between the sample and the film. • Relative movement of the source, sample, and film during imaging. • The angle between the source, sample, and film, the area of the area affected by the rays. • A sudden change in the thickness of the sample or the density of different areas in the sample is

required Photographed. Equipment used, including film quality. If a good type of film is chosen, and all the contributing factors are proven, this will lead to the appearance of sudden changes in the separation of the sample or in the density of the different parts, specifically within areas of gradual change, and defect areas can be detected when there is a change in the distribution of the degree of transparency and blackness on the surface of the film from the image. Expected ideal.

X-rays and quality assurance: X-rays are used to inspect products manufactured from different materials; This is to detect internal defects: such as cracks, fissures, non-contact areas, and other defects that do not appear on the surfaces of the products, especially if they are precise and manufactured in large quantities.

Huge objects such as: fine electronic components.

Testing the accuracy of the X-ray imaging camera: Ensure the power of the industrial X-ray imaging unit before starting to use it. Spatial analysis of the camera used, by examining a double wire sample Standardized by the American Society for Testing and Materials, as indicated by its name (2002ASTME/462-5EN), (see Figure 5-3)

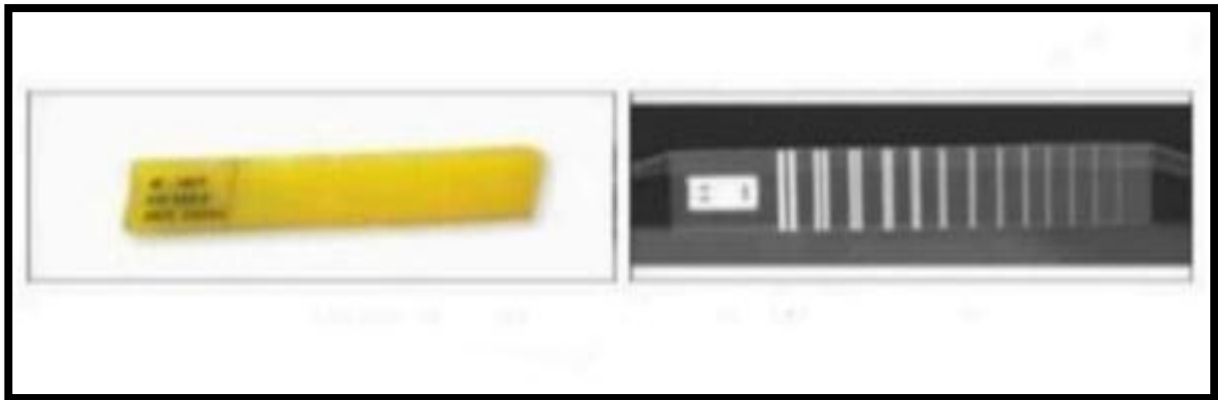


Figure (5-3) X-ray image without magnification of the double wire, where the internal details appear precisely as evidence of the financial analysis of the imaging camera.

X-ray metal welding test: The main point of ensuring quality in most industrial production processes lies in the type Sufficient quality is not easy to achieve by traditional methods Welding at connection lines or points. Often, it can be completed quickly and with reliable accuracy using X-ray imaging technology. Where areas of cracks, pores, installation defects, insufficient welding, etc. can be identified

(See: Figure 6-3)



Figure (6-3) Photography of welding sites in metals showing defects that cannot be seen with the naked eye

The welding areas in the hulls of aircraft and giant ships are fairly long. Therefore, special films are used in the X-ray imaging process. These films are in the form of: Composed rolls that allow the radiographer to cut the film at the desired length. These are provided Films have a great economic

advantage, as they allow a large area to be examined during a single photograph. Take all measures, with for example, the film is wrapped around the fuselage from the outside, securing it from damage, while the radiation source is placed on an axis designed in a way that ensures that the beam source is moved easily towards the required welding locations.

Inspection of pipes and lines: Pipes should be tested not only during production, but also after installation, and during regular work; To ensure security and safety in the chemical industries, the petroleum and petrochemical industry, as well as in nuclear power plants. Digital imaging with And gaps, or an increase in pores, or erosion in the walls (see: Figure 7-3), which could pose catastrophic consequences at any moment.



Figure (7-3) Detecting industrial defects or resulting from the use of pipes using X-ray imaging

Inspection of cutting and grinding discs: After securing the product, it is an urgent necessity; To ensure the safe operation of equipment, especially those used directly by workers, such as: cutting or grinding discs. The disc may appear to be free from X-rays that clearly show a serious defect on visual inspection.

However, it appears as a general weakness in the fiberglass, which may lead to the cutting disc breaking during operation at any moment, which may cause a serious danger to the worker (see: Figure 8-3).

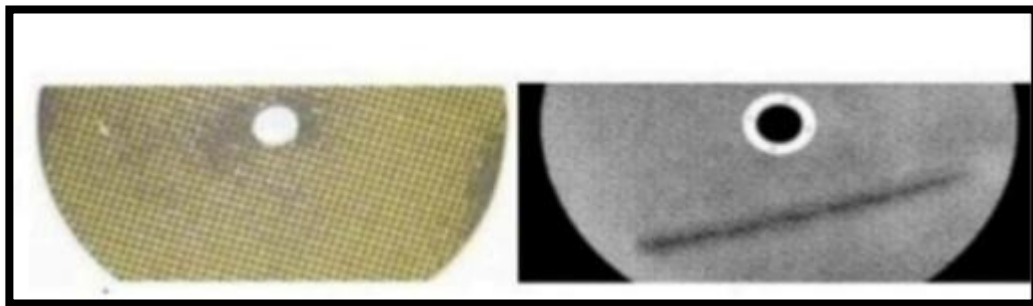
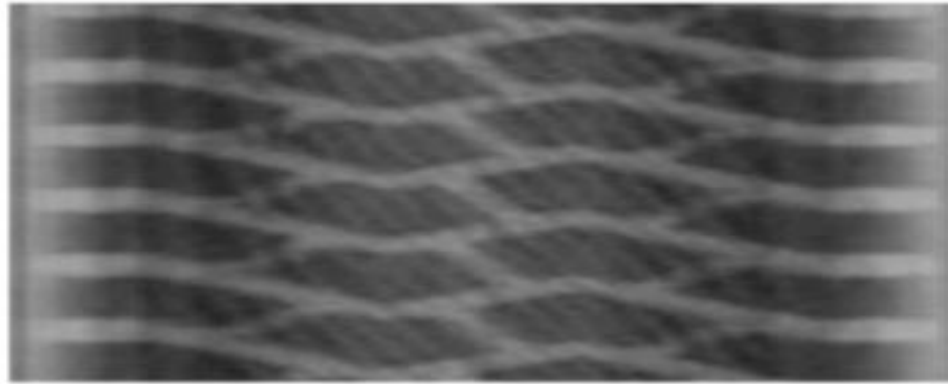


Figure (3-8) X-ray inspection of cutting discs eliminates the possibility of the risk of them breaking during operation

Quality assurance and tire inspection: Tires are subject to high safety standards; To ensure the safety of vehicles and passengers, x-rays) To achieve this, its quality is tested during and after the production process by examining it through pictures (see: Figure 3-9). Examining digital images with X-rays is one of the components of an integrated system in... The production process because of its speed and accuracy. I have developed a letter-shaped camera Specifically for tire inspection; To know the location of the Temple and the Sacred Mosque, the condition of the wires and their direction, and the presence of air gaps; Or unwanted materials within the rubber band, as it is treated Manufacturers of certain types of plastics with X-rays; To strengthen it, as the rays cause a change

These plastics (see: Figure 3.9)



And its internal components Figure (9-3) An X-ray image of the tire showing its condition

Testing electrical circuits: The automotive industry requires ensuring high quality at all stages; Therefore, digital X-ray imaging is used in research, development and production. Examples of this include: testing to ensure testing of electrical circuits. The automobile industry requires ensuring high quality at all stages; Therefore, digital X-ray imaging is used in research, development and production. Examples of this include: testing to ensure correct assembly and the completeness of the components of the car key. In this case, the image of the key is examined with Aggregation, tears in spring parts, as well as defects in welding joints (see: Figure 10-3)



Figure (10-3) Digital X-ray image, components, car key, testing, internal components

Moving parts and contact points in an automatic electrical circuit breaker cannot be monitored after the product is completed except by testing it practically or by radiography. The same inspection methods can be applied with an energy-saving lamp. The digital X-ray imaging method is distinguished by its ability to be applied during the various stages of production, and then It reduces the material losses resulting from completing these stages despite the occurrence of a defect in one of them, such that it cannot be detected in a timely manner (see: Figure 11-3)



Figure (3-11) X-ray images of the finished product of the automatic (automatic) electrical circuit breaker (right), and the energy

Conclusion

X-rays (ray-x) are a type of electromagnetic rays with a wavelength of (0.01-10) nanometers. X-rays are of the same nature as light, that is, they are an electromagnetic wave that differs from the wave of visible light only in that its oscillation is higher than that of visible light. Therefore, the energy it carries is greater than that carried by any visible light. Everything that has been said about the dual nature of light (wave and particle) remains true in the field of x-rays. It was discovered by the German scientist Rotting in 1896 at the University of Wurzenburg, who won the Nobel Prize in Physics in 1901, using a tube with two metal electrodes located in a bottle that radiated air from it and into the laboratory room that became dark, so that Rotting's eyes could avoid something from surprised to see a certain metal plate located not far from Al-Bawiya Crooks. It became extremely bright, and this led him to truly conclude that the tube was emitting an invisible ray that penetrated the black leaves and caused fluorescence in the metal plate. After six weeks of in-depth study, the hitherto little-known physicist announced that in December of the same year, at the Physical and Medical Society in the city of Würzburg, he discovered a new radiation that has the ability to penetrate objects and allow images to be obtained through them. He called it X-rays because the letter "X-rays" means "X-rays". Usually the unknown in the equations is unknown, and the rays are unknown in nature, so he called them x-rays. In less than a month, X-rays became known, and many workers in this field sought to obtain them, study them, and explain the phenomenon they generate. It should be noted that during the historic meeting held by the Physical and Medical Society in Würzburg, during which Höröntgen presented his discovery and showed fluorescence on the plate, the minerals, which we have, have been covered by the sink of the shatter, capable of hacking the bodies, by hacking the black paper, surrounding the tube before reaching the metal painting. Photo by the new rays, and when they wanted to hold the meeting. The photo will be faster, and the audience is able to see the amazing result. And you can visualize the amazing speed, which will be made, and how you can use this supercarium, which enables to create the human and photograph. inside it and so, in view of the horrific result he obtained, Colecker stood in the hall and with great enthusiasm demanded that these rays be called from that day on. This is what is approved in some countries, such as Germany, for example. But the name "X-rays" is X-rays (It is the poison most commonly used Especially in French writings).

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