RADIOGRAPHY & IMAGING TECHNICIAN (2024)

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Answer Sheet No. ________

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RADIOGRAPHY & IMAGING TECHNICIAN (2024)

Section – A is compulsory and comprises pages 1-2. All parts of this section are to be answered on the question papers itself. It should be completed in the first 25 minutes and handed over to the Centre Superintendent. Deleting/overwriting is not allowed. **Do not use lead pencil.**

OBJECTIVE – SECTION A (24 Min.)

Q1. Select the correct option i.e., A / B / C / D.

1. Regarding atomic number, following is TRUE:

A.	It is the number of protons in an atom.	B.	Electrons exist in only outer shell.
C.	All the electrons exist at same energy level for a given element.	D.	The nucleus of an atom has a net positive charge.

2. The following is TRUE for Ultrasound Imaging:

A.	Cannot be used in assessing fetal growth.	B.	Contains ionizing radiation waves.
C.	Provides real time image.	D.	It is a painful procedure.

3. The following contrast agent can be used in MRI Imaging:

A.	Iodinated contrast agent.	B.	Microbubble based contrast agent
C.	Non iodinated contrast agent.	D.	Gadolinium based contrast agent

4. The following is an example of severe contrast reaction:

A.	Headache	B.	Decrease appetite
C.	Anaphylaxis	D.	Cough

5. **Which of the following is a source of fog/overall darkening of X-ray film?**

A.	Excess fixing of film	B.	Excess washing of film
C.	Improper screen cleaning	D.	Exposure to light in dark room

6. **Which of the following is the first step in producing a radiation response?**

A.	Ionization	B.	Latent effect
C.	Manifest lesion	D.	Image formation

7. **Which of the following tissues would be classified as radiosensitive?**

A.	Gonads	B.	Nails
C.	Lungs	D.	Muscle

8. **Human responses to radiation that do not appear for years are called:**

A.	Large effects	B.	Late effects
C.	Latent response	D.	Law effects

9. **The following are the examples of dosimeters except:**

A.	Film badge	B.	Self-indicating pocket dosimeter (SPIPD)
C.	Thermoluminescent badge dosimeter (TBD)	D.	USG probe

10. **What could a radiologic technologist do to reduce the radiation does to the fetus of pregnant patient? If appropriate:**

A.	Decrease kVp and increase mAs.	B.	Increase object to image distance (OID).
C.	Increase the source to image distance (SID) and mAs.	D.	Use specific area shields if appropriate.

11. **A patient is undergo radiographic examination because of low back pain. As she is being positioned, she asks whether this will affect her current pregnancy. What should the radiologic technologist do?**

A.	Ignore the patient	B.	Reassure her and proceed with the examination
C.	Refuse to do the examination	D.	Seek advice from radiologist before proceeding

12. **When a radiologic technologist becomes pregnant, she should be:**

A.	Counseled on proper radiation safety	B.	Fired
C.	Given a temporary leave of absence	D.	Given an additional lead apron.

13. **Which of the following personnel radiation monitors is most sensitive?**

A.	Film badge	B.	Geiger-Mueller tube

C.	Pocket ionization chamber	D.	TLD device

14. Which of the following procedures help to reduce the patient does during radiographic examination?

A.	Cones	B.	Digital detectors
C.	Filtration	D.	Grids

15. Which material is used for radiation protection?

A.	Lead	B.	Silver
C.	Aluminium	D.	Rubber

16. X-Rays produced by the X-Ray tube:

A.	Have positive charge	B.	Have negative charge
C.	Have no charge	D.	Are non-ionizing

17. Maximum radiation is produced in the investigation of:

A.	MRI	B.	X-Ray
C.	C	D.	USG

18. In which condition, film artifacts are decreased:

A.	Poor storage of films	B.	Pressure effects and light exposure
C.	Increased humidity and chemicals	D.	Less handling

19. Most common view for chest x-ray is:

A.	AP	B.	PA
C.	Latent	D.	Oblique

20. Intensifying screen in a cassette is:

A.	Used to produce light photons	B.	Used to increase the amount of radiation.
C.	Made up of simple white paper	D.	Of no significance at all

ANSWERS:

Here are the correct answers to the questions:

1. Regarding atomic number, the following is TRUE:
   - **A. It is the number of protons in an atom.**
2. The following is TRUE for Ultrasound Imaging:
   - **C. Provides real-time image.**
3. The following contrast agent can be used in MRI Imaging:
   - **D. Gadolinium-based contrast agent.**

The following is an example of a severe contrast reaction:

- C. **Anaphylaxis.**

Which of the following is a source of fog/overall darkening of X-ray film?

- D. **Exposure to light in dark room.**

Which of the following is the first step in producing a radiation response?

- A. **Ionization.**

Which of the following tissues would be classified as radiosensitive?

- A. **Gonads.**

Human responses to radiation that do not appear for years are called:

- **B. Late effects.**

The following are the examples of dosimeters except:

- **D. USG probe.**

10. What could a radiologic technologist do to reduce the radiation dose to the fetus of a pregnant patient?
    - **D. Use specific area shields if appropriate.**
11. A patient is undergoing a radiographic examination because of low back pain. As she is being positioned, she asks whether this will affect her current pregnancy. What should the radiologic technologist do?
    - **D. Seek advice from the radiologist before proceeding.**
12. When a radiologic technologist becomes pregnant, she should be:
    - **A. Counseled on proper radiation safety.**
13. Which of the following personnel radiation monitors is most sensitive?
    - **C. Pocket ionization chamber.**
14. Which of the following procedures helps to reduce the patient dose during radiographic examination?
    - **C. Filtration.**
15. Which material is used for radiation protection?
    - **A. Lead.**
16. X-Rays produced by the X-Ray tube:
    - **C. Have no charge.**
17. Maximum radiation is produced in the investigation of:
    - **B. X-Ray.**
18. In which condition, film artifacts are decreased:
    - **D. Less handling.**
19. Most common view for chest X-ray is:
    - **B. PA (Posteroanterior).**
20. Intensifying screen in a cassette is:
    - **A. Used to produce light photons.**

RADIOGRAPHY & IMAGING TECHNICIAN

Time Allowed: 2:20 Hours **Total Marks Sections B and C: 40**

NOTE: Answer any thirteen parts from Section 'B' and any two questions from Section 'C' on the separately provided answer book. Write your answers neatly and legibly.

SECTION – B

Each question carries 2 marks. Attempt any 13 questions.

Q1. *Define the following terms:*

(i)Atomic mass *(ii)Atomic number*

Q2. *What is filtration in X-ray tube?*

Q3. *Describe the principle of computed tomography.*

Q4. *What is the Physics of magnetic resonance imaging?*

Q5. *Discuss isotopes with example.*

Q6. *What are the differences between CT scan and USG?*

Q7. *What type of screens are used in radiology?*

Q8. *Explain the construction of a film cassette with the help of a neat and labelled diagram.*

Q9. *Explain the structure of an atom with the help of a diagram.*

Q10. *Compare and contrast single phase and three phase power systems.*

Q11. *How a diode works? List down its characteristics.*

Q12. *What is the function of grids?*

Q13. *Name different radiations/ waves used in the investigations given below:*

(i)MRI *(ii)X-Ray*

(iii)Nuclear Medicine *(iv)CT* *(v)USG*

Q14. *Write a short note on intensifying screen.*

Q15. *Name different ways for radiation protection in X-ray department. Why is lead shielding used?*

LONG QUESTIONS -- SECTION – C

Note: Attempt any TWO Questions. All questions carry equal marks.

Each question carries 10 marks. Attempt any 3 questions.

Q1. Explain the properties of x-rays in detail.

Q2. Discuss in detail the physics of ultrasound. Explain film development techniques.

Q3. Name 5 different contrast media. Explain only one of them under the heading of route of administration, name of investigation, dosage, and adverse effects.

Q4. Explain with diagram, single and double emission x-ray film.

Q5 Draw a labelled diagram of X-ray tube.

SOLVED

SECTION – B (Marks 26)

Each question carries 2 marks. Attempt any 13 questions.

Q1. Define the following terms:

(i) ***Atomic Mass***:

Atomic mass (or atomic weight) is the weighted average mass of the atoms of an element, measured in atomic mass units (amu). It is approximately equal to the sum of the number of protons and neutrons in an atom's nucleus.

(ii) ***Atomic Number***:

The atomic number (Z) is the number of protons present in the nucleus of an atom. It determines the element's identity and its position in the periodic table.

Q2. What is filtration in X-ray tube?

Filtration in an X-ray tube refers to the process of selectively removing lower-energy (soft) X-rays from the X-ray beam. This is typically achieved by using a material, like aluminum, which is placed in the path of the X-ray beam. Filtration improves the image quality by reducing patient exposure to unnecessary radiation.

Q3. Describe the principle of computed tomography.

Computed Tomography (CT) works on the principle of X-ray attenuation. The patient is placed in a rotating gantry, and X-ray beams are directed through the body from multiple angles. Detectors measure the X-ray attenuation as the X-rays pass through different tissues. A computer then reconstructs the data into cross-sectional images (slices) of the body, allowing detailed visualization of internal structures.

Q4. What is the Physics of magnetic resonance imaging?

Magnetic Resonance Imaging (MRI) relies on the behavior of hydrogen nuclei in a magnetic field. When placed in a strong magnetic field, hydrogen protons align with the field. Radiofrequency (RF) pulses are used to temporarily disturb this alignment. Once the RF pulse is turned off, the protons return to their original position, emitting RF signals in the process. These signals are detected and used to create detailed images of tissues based on their water content.

Q5. Discuss isotopes with example.

Isotopes are atoms of the same element that have the same number of protons but different numbers of neutrons, resulting in different atomic masses. They can be stable or unstable (radioactive). For example, Carbon-12 (12C) and Carbon-14 (14C) are isotopes of carbon. While 12C is stable, 14C is radioactive and used in radiocarbon dating.

Q6. What are the differences between CT scan and USG?

- ***CT Scan***: Uses X-rays to create detailed cross-sectional images of the body. It provides high-resolution images and is often used for imaging bones, soft tissues, and blood vessels.
- ***USG (Ultrasound)***: Uses high-frequency sound waves to create images of internal structures. It is commonly used for monitoring pregnancy, assessing organ function, and visualizing soft tissues.

Key Differences:

- CT uses ionizing radiation; ultrasound does not.
- CT provides detailed images of bones and soft tissues; ultrasound is more effective for soft tissues.
- CT is more expensive and typically requires more time.

Q7. What type of screens are used in radiology?

In radiology, ***intensifying screens*** are commonly used in film-based radiography. These screens are made of phosphorescent materials (such as calcium tungstate or rare earth elements) that emit light when exposed to X-rays. This light enhances the image on the radiographic film, reducing the amount of radiation required for imaging.

Q8. Explain the construction of a film cassette with the help of a neat and labelled diagram.

A film cassette is a light-tight container used to hold the radiographic film and intensifying screens. It typically consists of:

- ***Outer case***: Made of a durable material (usually plastic or metal) to protect the film.
- ***Intensifying screens***: Placed on the inside of the cassette, on both the front and back sides, to enhance the X-ray image.
- ***Radiographic film***: Placed between the two screens. The film records the image formed by the X-ray exposure.

(Since I can't draw diagrams, you can imagine it as a rectangular box with layers: screen-film-screen from front to back.)

Q9. Explain the structure of an atom with the help of a diagram.

The structure of an atom consists of:

- ***Nucleus***: Located at the center, containing protons (positively charged) and neutrons (neutral).

- ***Electrons***: Negatively charged particles that orbit the nucleus in energy levels or shells.

A simple diagram would show a central nucleus with electrons in concentric circles (representing different energy levels or orbitals).

Q10. Compare and contrast single-phase and three-phase power systems.

- ***Single-phase power***: Uses two wires (live and neutral) to supply power. Commonly used in residential areas for smaller loads. It is less efficient for high power demands and leads to fluctuations in voltage.
- ***Three-phase power***: Uses three wires (plus neutral) to supply power. It provides a more stable and continuous supply of power, making it more efficient for industrial applications and larger loads. It also reduces power losses.

Q11. How does a diode work? List down its characteristics.

A ***diode*** is a semiconductor device that allows current to flow in one direction only (forward direction) and blocks current in the reverse direction. This is due to the junction between P-type and N-type semiconductor materials.

Characteristics:

- ***Forward bias***: Current flows when the positive terminal is connected to the P-side and negative terminal to the N-side.
- ***Reverse bias***: No current flows when the voltage is applied in the reverse direction.
- ***Threshold voltage***: The minimum voltage required to forward bias the diode (usually 0.7V for silicon diodes).

Q12. What is the function of grids?

In radiology, ***grids*** are used to reduce the amount of scattered radiation reaching the film or detector. They consist of parallel strips of lead and are placed between the patient and the image receptor. Grids help improve image contrast by blocking scattered X-rays that would otherwise degrade the quality of the image.

Q13. Name different radiations/waves used in the investigations given below:

(i) ***MRI***: Radiofrequency waves (RF).

(ii) ***X-Ray***: X-rays (ionizing radiation).

(iii) ***Nuclear Medicine***: Gamma rays (from radioactive isotopes).

(iv) ***CT***: X-rays (ionizing radiation).

(v) ***USG***: Sound waves (ultrasound).

Q14. Write a short note on intensifying screen.

An ***intensifying screen*** is used in traditional film radiography to increase the efficiency of the X-ray exposure. It contains phosphor crystals that emit visible light when exposed to X-rays. This light reduces the amount of X-ray exposure required to create an image, thus lowering the patient's radiation dose. The two main types of screens are calcium tungstate and rare-earth screens.

Q15. Name different ways for radiation protection in X-ray department. Why is lead shielding used?

Ways to reduce radiation exposure:

1. ***Use of lead aprons and shields***: Protects the patient and staff by absorbing scattered radiation.
2. ***Proper collimation***: Reduces the X-ray field to the area of interest, minimizing unnecessary exposure.
3. ***Use of appropriate exposure settings***: Ensures that the lowest possible radiation dose is used to achieve quality images.
4. ***Lead glass shields or barriers***: Protects personnel from radiation exposure during procedures.
5. ***Distance***: Increasing the distance from the radiation source minimizes exposure due to the inverse square law.
6. ***Time***: Limiting the exposure time reduces the total dose.

Why is lead shielding used? Lead is an excellent material for shielding because it is dense and absorbs X-rays effectively, preventing the radiation from reaching the body or sensitive areas like the thyroid and gonads.

LONG QUESTIONS -- SECTION – C

Note: Attempt any TWO Questions. All questions carry equal marks.

Each question carries 10 marks. Attempt any 3 questions.

Q1. Explain the properties of x-rays in detail.

Ans. **Properties of X-rays**

X-rays are a form of electromagnetic radiation, much like visible light, radio waves, and gamma rays, but with much shorter wavelengths. These properties allow X-rays to have unique characteristics that make them extremely useful in medical imaging and various industrial applications. Below is a detailed explanation of the key properties of X-rays.

1. X-rays are a form of electromagnetic radiation

- X-rays are part of the ***electromagnetic spectrum***, which includes a range of radiation types based on wavelength and frequency. X-rays have wavelengths in the range of approximately 0.01 to 10 nanometers (nm), and frequencies between 30 PHz to 30 EHz (PetaHertz to ExaHertz).

- They are ***high-energy radiation*** with short wavelengths, which gives them their unique ability to penetrate materials and tissues.

2. ***X-rays are ionizing radiation***
    - ***Ionization*** occurs when X-rays interact with matter, particularly atoms, and remove electrons from them, creating positively charged ions. This is a significant property because it can potentially cause damage to living cells or DNA, which is why safety precautions are taken in radiology.
    - X-rays have enough energy to ionize atoms and molecules, leading to chemical changes. This is the basis for X-ray imaging as well as radiotherapy for cancer treatment.
    - The ***ionization process*** can cause biological effects such as cell death, mutation, or cancer, particularly at high doses.

3. ***X-rays can penetrate matter***
    - ***Penetration power***: X-rays can pass through most materials, depending on their energy (wavelength). Their ability to penetrate substances like human tissue, glass, and metals is utilized in medioal imaging (e.g., X-ray radiography, CT scans).
    - The extent to which X-rays penetrate material depends on several factors, including:
        - ***Density***: Denser materials (like bones or metal) absorb or scatter more X-rays, creating varying levels of contrast in the resulting image.
        - ***Atomic number***: Materials with a higher atomic number (e.g., lead, iodine) are more effective at absorbing X-rays.
        - ***X-ray energy (wavelength)***: Higher energy (shorter wavelength) X-rays penetrate more effectively than lower energy (longer wavelength) ones.

4. ***X-rays can produce fluorescent effects***
    - When X-rays strike certain materials, such as phosphorescent crystals or certain chemicals, they can cause these materials to ***fluoresce*** (emit light). This property is used in the intensifying screens used in radiographic imaging. The screens convert X-rays into visible light, which exposes the X-ray film and helps create the image.
    - ***Fluorescent screens*** also play a role in diagnostic radiology, where screens such as calcium tungstate or rare-earth phosphors are used to enhance X-ray images and reduce the amount of radiation needed.

5. ***X-rays are electrically neutral***
    - Unlike alpha or beta particles, X-rays have no ***electric charge***. This is why they do not deflect when passed through an electric or magnetic field. Their neutral charge allows them to travel freely through air, unlike charged particles, which are influenced by magnetic and electric fields.
    - This neutrality allows X-rays to pass through different materials, interact with atoms, and be absorbed or scattered without being influenced by external electric or magnetic fields.

6. X-rays travel at the speed of light

- X-rays, like all forms of electromagnetic radiation, travel at the ***speed of light*** in a vacuum, approximately ***3 x 10^8 meters per second (300,000 km/s)***. This is the same speed at which all electromagnetic waves (such as visible light, radio waves, and gamma rays) travel.
- This rapid speed enables real-time imaging in medical diagnostics, such as during X-ray examinations, CT scans, and fluoroscopy.

7. X-rays can be absorbed and scattered by matter

- ***Absorption***: X-rays lose energy when passing through matter, and this energy is absorbed by the tissue or material. The degree of absorption depends on the material's ***density***, ***atomic number***, and ***thickness***.
  - ***Bone*** (high density and high atomic number) absorbs more X-rays than soft tissue, creating a contrast in X-ray images, where bones appear white (radiopaque) and soft tissues appear darker (radiolucent).
- ***Scattering***: X-rays can also be scattered when they interact with matter, which reduces image quality by producing "fog" or unwanted exposure. This scattering is the basis for techniques like ***grids*** in radiology, which reduce scattered radiation reaching the film or detector.
  - ***Compton scattering*** is a primary type of scattering in diagnostic radiology, which involves the transfer of energy from the X-ray photon to an electron in the tissue, leading to a scattered photon.

8. X-rays are capable of creating photographic images

- ***X-rays can expose photographic film***, producing images that are analyzed to assess internal structures. This property is the basis for traditional radiographic imaging.
  - The ***density differences*** between tissues in the body, such as between bone and soft tissue, result in different amounts of X-ray absorption, creating a ***shadow effect*** on the film that forms the image.
- ***Digital imaging*** technologies, like ***computed radiography (CR)*** and ***digital radiography (DR)***, replace traditional film with digital detectors, but the principle remains the same.

9. X-rays are used for therapeutic purposes

- ***X-rays are used in radiation therapy*** to treat cancer and other diseases. In this context, they are used at much higher doses than in diagnostic radiology to ***damage or kill cancer cells*** by causing DNA damage through ionization.
- ***High-energy X-rays*** are directed precisely at tumors to minimize damage to surrounding healthy tissue. Techniques like ***3D conformal radiation therapy*** and ***stereotactic radiosurgery*** use advanced imaging to target tumors with high precision.

10. X-rays can be detected by special instruments

- Several instruments are used to detect and measure X-rays. These include:
  - ***Ionization chambers***: Measure the ionization produced by X-rays.

- ***Scintillation counters***: Detect flashes of light produced by X-ray interactions with a scintillating material.
- ***Geiger-Müller counters***: Used to detect radiation (including X-rays) by counting ionizing events.
- ***Photographic film or digital detectors***: Used to record X-ray images.

Summary of Key Properties of X-rays:

Property	Description
Electromagnetic radiation	X-rays are part of the electromagnetic spectrum, with shorter wavelengths than visible light.
Ionizing radiation	X-rays have enough energy to ionize atoms and molecules, which can cause biological effects.
Penetrating power	X-rays can pass through materials, depending on their energy and the density of the material.
Fluorescence	X-rays can cause materials to fluoresce, which is used in imaging systems.
Neutral charge	X-rays are electrically neutral and are not deflected by electric or magnetic fields.
Speed of light	X-rays travel at the speed of light (3 x 10^8 m/s) in a vacuum.
Absorption and scattering	X-rays can be absorbed and scattered by matter, affecting image quality.
Photographic effect	X-rays can expose photographic film or digital detectors, creating diagnostic images.
Therapeutic use	X-rays are used in radiation therapy for cancer treatment.
Detection	X-rays can be detected using special instruments like ionization chambers and scintillation detectors.

These properties make X-rays both a powerful tool for medical diagnosis and treatment, and also a potential risk due to their ionizing nature. Understanding their behavior is essential for the safe and effective use of X-rays in healthcare.

Q2. *Discuss in detail the physics of ultrasound. Explain film development techniques.*

Ans. PHYSICS OF ULTRASOUND

Ultrasound is a type of sound wave that has a frequency higher than the upper limit of human hearing (above 20 kHz). It is used extensively in medical imaging for diagnostic purposes, particularly in ***ultrasonography (USG)***. The physics behind ultrasound involves sound wave propagation, reflection, and detection.

1. Nature of Ultrasound Waves

- ***Sound waves***: Ultrasound uses ***mechanical waves***, which require a medium (such as air, water, or tissue) to propagate. These are ***longitudinal waves***, meaning that the particles of the medium vibrate back and forth in the direction of wave travel.
- ***Frequency***: The frequency of ultrasound waves in medical imaging typically ranges from 1 to 15 MHz, though diagnostic ultrasound commonly uses frequencies from 2 to 10 MHz.
- ***Wavelength***: The wavelength (the distance between two successive compressions or rarefactions) is inversely related to the frequency. High-frequency waves have shorter wavelengths and can produce higher resolution images but have less penetration power.

2. Ultrasound Wave Propagation

- ***Transmission***: Ultrasound waves travel through tissues and interact with the different structures based on their ***acoustic impedance***, which is the resistance of a medium to the passage of sound. Acoustic impedance (Z) is the product of the ***density (ρ)*** of the tissue and the ***speed of sound (c)*** in that tissue: Z=ρ×cZ = ρ \times cZ=ρ×c
- ***Tissues with higher acoustic impedance*** (such as bone or air) reflect more ultrasound energy, whereas ***soft tissues*** (like muscles or fat) allow more transmission. The differential reflection and transmission at interfaces between different tissues are the basis for creating images.

3. Reflection and Refraction

- ***Reflection***: When ultrasound waves encounter an interface between two tissues with different acoustic impedances, some of the sound is ***reflected*** back to the transducer, while the rest continues into the next tissue. The amount of reflection depends on the impedance mismatch between the two tissues.
    - ***Strong reflections*** occur at interfaces between highly different impedances, such as between soft tissue and bone or air (e.g., lungs).
- ***Refraction***: When ultrasound waves pass from one medium to another with a different propagation speed, they change direction, an effect known as ***refraction***. This can lead to image distortion if not accounted for.

4. Piezoelectric Effect and Transducer

- ***Piezoelectric crystals***: The heart of an ultrasound machine is the ***transducer***, which converts electrical energy into sound waves and vice versa. It contains piezoelectric crystals, which generate sound waves when an electric current is applied and produce electrical signals when exposed to sound waves.
    - ***Transmission***: The transducer sends out ultrasound pulses in short bursts.
    - ***Reception***: The same transducer also detects the reflected sound waves, converts them into electrical signals, and sends them to the processing unit for image creation.

5. Imaging Techniques

- ***Pulse Echo Technique***: The most common ultrasound imaging technique is the ***pulse-echo method***. In this method, the transducer emits short bursts (pulses) of ultrasound waves. The waves travel through the body, reflect off tissue interfaces, and return to the transducer. The time it takes for the echoes to return is measured, and from this, the depth of the structure is calculated.
- ***Real-time Imaging***: Ultrasound systems can generate ***real-time images*** by continuously sending pulses and receiving echoes, allowing dynamic observation of structures (e.g., organs, blood flow, etc.).

6. Doppler Ultrasound

- ***Doppler effect***: Doppler ultrasound measures the change in frequency of the ultrasound waves reflected from moving objects, such as blood cells. This change in frequency (Doppler shift) is used to assess ***blood flow velocity*** and to identify ***turbulence*** or ***blockages*** in blood vessels.

Key Factors in Ultrasound Imaging:

- ***Resolution***: Higher frequency sound waves produce better resolution but have lower penetration power.
- ***Penetration***: Lower frequency sound waves penetrate deeper tissues but produce lower resolution images.
- ***Artifacts***: Artifacts, such as ***shadowing***, ***enhancement***, and ***reverberation***, can occur when ultrasound waves interact in unexpected ways with tissues.

Film Development Techniques

In radiography, ***film development*** refers to the process of converting a latent image on a photographic film (which is exposed to X-rays or light) into a visible image. The development process involves a series of chemical reactions that produce the final image and must be performed in a controlled manner to ensure high-quality results. There are several steps involved in traditional film development.

1. Film Exposure

- When an X-ray film is exposed to radiation (X-rays), the ***silver halide crystals*** in the emulsion layer are exposed to photons. This creates a latent (invisible) image on the film. The exposed silver halides form an image that is not visible until the film is developed.

2. The Development Process (Chemical Process)

- The film is developed using a ***series of chemical solutions*** that react with the exposed silver halide crystals to form a visible image. The steps are as follows:

a) Developing Solution (Film Developer)

- ***Function***: The developer solution contains reducing agents (such as ***hydroquinone*** and ***phenidone***) that reduce the exposed silver halides (AgBr) to form ***black metallic silver***. The unexposed silver halides remain intact.
- ***Process***: The film is immersed in the developer for a specific amount of time (usually a few minutes) at a controlled temperature (typically 20°C). The

developing solution makes the exposed silver halides visible as a dark image on the film.

b) Stopping Development (Stop Bath)

- ***Function***: The stop bath is a solution (usually diluted ***acetic acid***) that halts the development process by neutralizing the alkaline developer.
- ***Process***: The film is placed in the stop bath for a brief period to stop the chemical reactions and prevent overdevelopment.

c) Fixing (Fixing Solution)

- ***Function***: The fixing solution removes the unexposed silver halides from the film, making the image permanent and light-resistant. The fixative typically contains ***sodium thiosulfate*** (hypo).
- ***Process***: The film is immersed in the fixer for several minutes, which dissolves the remaining unexposed silver halides and stabilizes the image.

d) Washing

- ***Function***: After fixing, the film is thoroughly washed in water to remove any residual chemicals from the film surface. This step ensures the film is safe to handle and prevents the chemicals from degrading the film over time.
- ***Process***: The film is washed under running water for several minutes to ensure complete removal of all fixer and developer residues.

e) Drying

- After washing, the film is carefully dried in a clean, dust-free environment to prevent any contamination or damage to the image.

3. Manual vs. Automatic Film Processing

- ***Manual Processing***: Involves immersing the film into each of the solutions (developer, stop bath, fixer) by hand, at precise times and temperatures. It requires more time and attention to detail.
- ***Automatic Processing***: Uses an automatic processor machine, where the film is fed through a series of rollers that carry it through the developer, stop bath, fixer and wash solutions in a continuous cycle. This method is faster and more consistent.

4. Image Quality and Factors Affecting Development

- ***Temperature***: The temperature of the developer affects the speed of the chemical reactions. Higher temperatures speed up development but may also result in overdevelopment or poor image quality. The ideal temperature for developing X-ray film is around 20°C.
- ***Time***: The film must be exposed to the developer for the right amount of time. Too short or too long an exposure time can result in underdeveloped or overdeveloped images.
- ***Chemical Concentration***: The concentration of chemicals in the developer, stop bath, and fixer affects the development process and the quality of the final image. These solutions must be maintained and replenished regularly.

Ultrasound Physics and Film Development Techniques

- *Ultrasound*: A form of mechanical sound waves that propagate through tissues, reflecting off different structures based on their acoustic impedance. These reflections are detected by a transducer and used to form images. Doppler ultrasound is used for assessing blood flow.
- *Film Development*: A series of chemical processes that convert the latent image on an exposed photographic film into a visible image. The process involves developing, stopping, fixing, washing, and drying the film to produce a permanent, light-resistant image suitable for diagnostic analysis.

These techniques are crucial in their respective fields (ultrasound imaging for real-time visualization of internal structures, and film development for the creation of X-ray or radiographic images). Both processes require precision to ensure high-quality results.

Q3. ***Name 5 different contrast media. Explain only one of them under the heading of route of administration, name of investigation, dosage, and adverse effects.***

Ans. **FIVE DIFFERENT CONTRAST MEDIA**

1. ***Iodinated Contrast Media***
2. ***Barium Sulfate***
3. ***Gadolinium-based Contrast Agents (GBCA)***
4. ***Air or Gas-based Contrast Agents***
5. ***Microspheres (e.g., in MRI for hepatic imaging)***

***Iodinated Contrast Media* (Detailed Explanation)**

1. Route of Administration

Iodinated contrast media are typically administered ***intravenously*** (IV), but they can also be administered ***intra-arterially***, ***orally***, or ***rectally***, depending on the specific medical procedure being performed. The route of administration is determined by the type of investigation or imaging modality being used.

- ***Intravenous (IV) Injection***: For ***CT scans*** and some ***angiograms***.
- ***Intra-arterial Injection***: For ***angiography*** or ***vascular studies***.
- ***Oral or Rectal Administration***: For ***contrast-enhanced X-ray studies*** of the gastrointestinal (GI) tract, such as ***barium swallow*** or ***barium enema***.

2. Name of Investigation

Iodinated contrast media are commonly used in ***Computed Tomography (CT) scans***, particularly for:

- ***CT Angiography (CTA)***: To visualize blood vessels.
- ***CT of the abdomen or pelvis***: To evaluate organs like the liver, kidneys, or intestines.
- ***CT pulmonary angiography (CTPA)***: To check for pulmonary embolism.

They are also used in ***X-ray imaging*** and ***angiography***.

3. Dosage

The dosage of iodinated contrast media depends on several factors, including the ***type of contrast*** used, the ***patient's body weight***, and the ***type of procedure***.

- ***For IV administration (CT scans)***: A typical dose is between ***50-150 mL*** of iodinated contrast for an adult, depending on the type of scan and the patient's clinical condition.
- ***For angiographic studies***: The dose can vary but may range from ***10 mL to 100 mL***, administered intra-arterially.
- ***Oral administration*** (for gastrointestinal imaging): Typically, ***150-250 mL*** of a diluted solution, depending on the type of study.

The contrast volume is adjusted based on the patient's condition and the specifics of the imaging modality.

4. Adverse Effects

While iodinated contrast media are generally safe, they can cause some adverse reactions, ranging from mild to severe:

- ***Mild to moderate reactions***:
  - ***Nausea and vomiting***: Common but usually short-lived.
  - ***Warm sensation***: A feeling of warmth during injection is common.
  - ***Metallic taste***: Some patients report a temporary metallic taste in the mouth.
  - ***Mild allergic reactions***: Rash, itching, or hives.
- ***Severe reactions*** (though rare):
  - ***Anaphylactic reactions***: Symptoms include difficulty breathing, swelling of the face or throat, and severe hypotension. This requires immediate medical intervention.
  - ***Contrast-induced nephropathy (CIN)***: A potential risk for patients with pre-existing kidney disease. CIN can result in acute kidney injury within 48 hours of contrast administration.
  - ***Thyroid dysfunction***: Iodine from iodinated contrast can potentially affect thyroid function, especially in patients with thyroid disease.
  - ***Cardiovascular effects***: In patients with heart disease, contrast media can trigger arrhythmias, bradycardia, or hypotension.
  - ***Severe allergic reactions*** (including shock) may be seen in patients with known allergies to iodine or previous adverse reactions to contrast.

Precautions and Management of Adverse Effects

- ***Hydration***: Ensuring adequate hydration before and after contrast administration can help reduce the risk of ***contrast-induced nephropathy***.
- ***Pre-medication***: Patients with a history of mild contrast reactions may be pre-medicated with ***antihistamines*** or ***steroids*** to reduce the risk of more severe reactions.

- ***Monitoring***: Patients should be monitored for 30 minutes to an hour after the administration of the contrast media, especially if they are at high risk for allergic or anaphylactic reactions.

In cases of severe reactions (e.g., anaphylaxis), immediate treatment with ***epinephrine***, ***antihistamines***, and ***corticosteroids*** may be necessary, and patients should be treated in a setting where emergency medical care is available.

Iodinated Contrast Media

- ***Route of Administration***: IV, intra-arterial, oral, rectal.
- ***Name of Investigation***: CT scans (including CT angiography), angiography, gastrointestinal imaging (X-ray with contrast).
- ***Dosage***: Varies depending on the procedure; typically 50-150 mL for IV administration in CT scans.
- ***Adverse Effects***: Mild reactions include nausea, rash, and warmth; severe reactions include anaphylaxis, contrast-induced nephropathy, and thyroid dysfunction. Pre-medication and hydration are important preventive measures.

Iodinated contrast media play a vital role in enhancing the quality of diagnostic imaging, providing valuable information for the diagnosis and treatment of various conditions. However, awareness of potential adverse effects and careful patient selection are essential for ensuring patient safety.

Q4. Explain with diagram, single and double emission x-ray film.

Ans. **SINGLE AND DOUBLE EMULSION X-RAY FILM**

X-ray films are used to capture images formed by X-rays passing through the body and interacting with the film's emulsion layer. The difference between ***single emulsion*** and ***double emulsion*** X-ray films lies in the number of emulsion layers present on the film.

1. Single Emulsion X-ray Film

A ***single emulsion*** film has only one layer of light-sensitive emulsion on a single side of the film base. This type of film was historically used in radiography but is less common in modern diagnostic radiology. The emulsion is typically made up of silver halide crystals suspended in gelatin, which reacts to X-rays or light during exposure.

Structure of Single Emulsion Film:

- ***Base***: A clear, flexible layer that supports the emulsion. It is usually made of polyester.
- ***Emulsion Layer***: Contains silver halide crystals that react to the X-ray exposure. This layer is applied to only ***one side*** of the film.
- ***Protective Coating***: A thin layer to protect the emulsion from damage or scratches.

Advantages of Single Emulsion Film:

- ***Reduced cost***: Cheaper than double-emulsion films.

- *Simplicity*: Easier to handle and process.

Disadvantages of Single Emulsion Film:

- ***Lower sensitivity***: Less efficient at capturing X-ray images compared to double-emulsion films.
- ***Limited image quality***: Since the X-rays only interact with one emulsion layer, the final image resolution is lower.

2. Double Emulsion X-ray Film

A ***double emulsion*** film has two layers of emulsion, one on each side of the film base. This design enhances the film's ***sensitivity*** to radiation, meaning less exposure is needed to produce a good image, and it improves ***image quality*** by providing a higher ***signal-to-noise ratio***. Double emulsion films are now the standard in medical radiography due to these advantages.

Structure of Double Emulsion Film:

- ***Base***: Similar to single emulsion film, it provides structural support.
- ***First Emulsion Layer***: Applied on the top side of the film base. This layer captures the X-rays and contributes to the image.
- ***Second Emulsion Layer***: Applied on the bottom side of the film base. The second layer captures any additional X-ray exposure or light from the intensifying screen, improving the film's sensitivity and resolution.
- ***Protective Coating***: Thin layers on both sides to protect the emulsion from scratches and physical damage.

Advantages of Double Emulsion Film:

- ***Increased sensitivity***: The film is more sensitive to X-rays, meaning that less radiation is needed to produce the image, which reduces patient exposure to radiation.
- ***Higher image quality***: The dual emulsion layers improve the contrast and resolution of the image, resulting in sharper details.
- ***More efficient***: Double emulsion films work better in conjunction with intensifying screens, which convert X-rays into visible light. This leads to faster imaging and reduced radiation exposure.

Disadvantages of Double Emulsion Film:

- ***Higher cost***: Double emulsion films are more expensive due to the extra layer of emulsion.
- ***Complex processing***: They may require slightly more careful handling during development to avoid damage to the delicate emulsion layers.

Comparison of Single vs. Double Emulsion Films

Feature	*Single Emulsion Film*	*Double Emulsion Film*
Number of Emulsion Layers	1	2

Feature	Single Emulsion Film	Double Emulsion Film
Base	1 side only	Both sides
Sensitivity	Lower sensitivity to radiation	Higher sensitivity to radiation
Image Quality	Lower resolution, lower contrast	Higher resolution, better contrast
Cost	Cheaper	More expensive
Radiation Exposure	Higher patient radiation exposure	Reduced patient radiation exposure
Usage	Less commonly used now	Standard in modern radiography

- ***Single emulsion films*** are now less common, primarily due to their lower sensitivity and image quality, making them less ideal for modern diagnostic imaging.
- ***Double emulsion films*** are preferred for ***X-ray imaging*** because they offer superior sensitivity, image quality, and reduced patient radiation exposure.

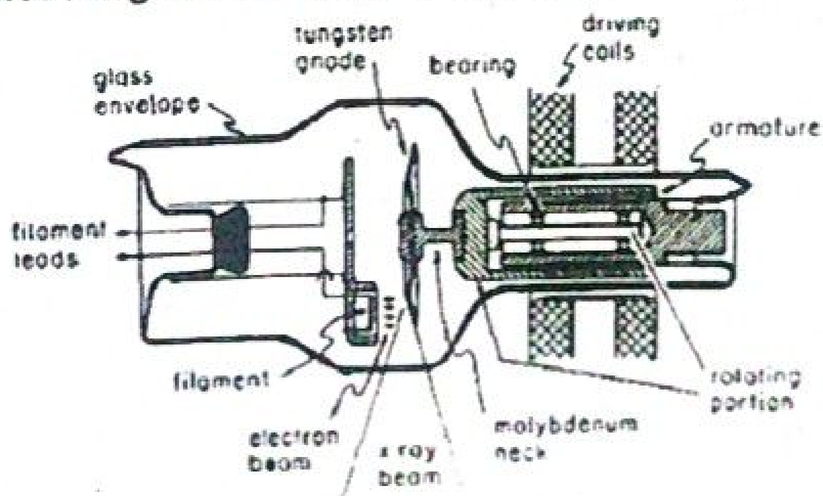
Double emulsion films, especially when used with intensifying screens, significantly enhance the imaging process and have become the standard in medical radiography due to their efficiency and effectiveness.

Q5. *Draw a labelled diagram of X-ray tube.*

Labelled Diagram of an X-ray Tube

An X-ray tube is a device used to produce X-rays. It operates by accelerating electrons from a ***cathode*** (negative side) toward a ***anode*** (positive side), where the kinetic energy of the electrons is converted into X-ray radiation. The structure of the X-ray tube is highly controlled to ensure efficient production of X-rays while minimizing damage to the components.

Here's a ***labelled diagram*** of a typical ***X-ray tube***:



Explanation of Key Components

1. ***Glass or Metal Envelope (Vacuum Tube)***:
   - The X-ray tube is sealed in a glass or metal envelope that maintains a vacuum environment. The vacuum ensures that the electrons can travel freely from the cathode to the anode without interference from air molecules.
2. ***Cathode (Negative Side)***:
   - The cathode consists of a ***filament*** (usually made of tungsten) and a ***focus cup***.
   - ***Filament***: This is a thin wire that heats up when current passes through it, causing the filament to emit electrons (a process known as ***thermionic emission***).
   - ***Focus Cup***: A metal cup that surrounds the filament and focuses the emitted electrons into a narrow beam toward the anode.
3. ***Anode (Positive Side)***:
   - The anode is typically made of tungsten because tungsten has a high atomic number, which is efficient at converting electron energy into X-rays.
   - ***Rotating Anode***: To dissipate the heat generated during the rapid electron impacts, the anode rotates, spreading the heat across its surface.
   - The anode is where the accelerated electrons strike, producing X-rays via ***bremsstrahlung*** (braking radiation) and ***characteristic radiation***.
4. ***High Voltage (kV) Terminal***:
   - The high voltage terminal applies a very high voltage (typically in the range of 30-150 kV) between the cathode and anode. This high voltage accelerates the electrons from the cathode to the anode.
5. ***X-ray Tube Window***:
   - The X-rays produced at the anode are emitted through a small window in the tube, usually made of ***beryllium*** or another material that allows X-rays to pass through but protects the rest of the components of the tube.
6. ***Protective Housing***:
   - The X-ray tube is encased in protective housing that helps to shield the user from scattered X-rays. The housing absorbs most of the unwanted radiation, ensuring that the operator is protected from harmful exposure.
7. ***Cooling System***:
   - Heat is generated during the rapid deceleration of electrons at the anode. The rotating anode and oil or air cooling systems are used to dissipate this heat. Some tubes use oil or a liquid cooling system to maintain the temperature and prevent overheating of the anode.

Function of the X-ray Tube

1. ***Electron Generation***: The filament at the cathode is heated by an electric current, causing it to emit electrons.
2. ***Electron Acceleration***: The high voltage between the cathode and anode accelerates the electrons toward the anode.
3. ***X-ray Production***: When the electrons hit the tungsten anode, their kinetic energy is converted into X-rays. The X-rays are generated by:
   - ***Bremsstrahlung Radiation***: A rapid deceleration of electrons as they interact with the tungsten atoms.
   - ***Characteristic Radiation***: Occurs when electrons eject inner-shell electrons from the tungsten atoms, and the vacancy is filled by higher-energy electrons, releasing energy as X-rays.
4. ***X-ray Emission***: X-rays pass through the anode window and are directed toward the subject being imaged.

The X-ray tube is the core component in the production of X-rays. Its design ensures the efficient production of high-energy radiation while managing heat dissipation and maintaining the vacuum necessary for the smooth passage of electrons. The rotating anode, tungsten target, and careful design of the cathode and anode allow for the creation of X-ray images for diagnostic purposes.

PUNJAB MEDICAL FACULTY------ EXAMINATION JUNE - 2025

RADIOGRAPHY & IMAGING TECHNICIAN

Class: 1st Year
Time: 2 Hours 30 Minutes

Scheme: F.Sc.
Total Marks: 80

OBJECTIVE (Section – A)

Q1. Select the correct option i.e., A / B / C / D.

1. **A patient is undergo radiographic examination because of low back pain. As she is being positioned, she asks whether this will affect her current pregnancy. What should the radiologic technologist do?**

A.	Ignore the patient	B.	Reassure her and proceed with the examination
C.	Refuse to do the examination	D.	Seek advice from radiologist before proceeding

2. **When a radiologic technologist becomes pregnant, she should be:**

A.	Counseled on proper radiation safety	B.	Fired
C.	Given a temporary leave of absence	D.	Given an additional lead apron.

3. **Which of the following personnel radiation monitors is most sensitive?**

A.	Film badge	B.	Geiger-Mueller tube
C.	Pocket ionization chamber	D.	TLD device

4. **Which of the following procedures help to reduce the patient does during radiographic examination?**

A.	Cones	B.	Digital detectors
C.	Filtration	D.	Grids

5. **Which material is used for radiation protection?**

A.	Lead	B.	Silver
C.	Aluminium	D	Rubber

6. **X-Rays produced by the X-Ray tube:**

A.	Have positive charge	B.	Have negative charge
C.	Have no charge	D.	Are non-ionizing

7. **Maximum radiation is produced in the investigation of:**

A.	MRI	B.	X-Ray
C.	C	D.	USG

8. **In which condition, film artifacts are decreased:**

A.	Poor storage of films	B.	Pressure effects and light exposure
C.	Increased humidity and chemicals	D.	Less handling

9. **Most common view for chest x-ray is:**

A.	AP	B.	PA
C.	Latent	D.	Oblique

10. **Intensifying screen in a cassette is:**

A.	Used to produce light photons	B.	Used to increase the amount of radiation.
C.	Made up of simple white paper	D.	Of no significance at all

ANSWERS:

Here are the correct answers to the questions:

1. A patient is undergoing a radiographic examination because of low back pain. As she is being positioned, she asks whether this will affect her current pregnancy. What should the radiologic technologist do?
   - **D. Seek advice from the radiologist before proceeding.**
2. When a radiologic technologist becomes pregnant, she should be:
   - **A. Counseled on proper radiation safety.**
3. Which of the following personnel radiation monitors is most sensitive?
   - **C. Pocket ionization chamber.**
4. Which of the following procedures helps to reduce the patient dose during radiographic examination?
   - **C. Filtration.**
5. Which material is used for radiation protection?
   - **A. Lead.**
6. X-Rays produced by the X-Ray tube:
   - **C. Have no charge.**
7. Maximum radiation is produced in the investigation of:
   - **B. X-Ray.**
8. In which condition, film artifacts are decreased:
   - **D. Less handling.**
9. Most common view for chest X-ray is:
   - **B. PA (Posteroanterior).**
10. Intensifying screen in a cassette is:
    - **A. Used to produce light photons.**

PUNJAB MEDICAL FACULTY----— EXAMINATION JUNE - 2025

RADIOGRAPHY & IMAGING TECHNICIAN

Class: 1st Year
Time: 2 Hours 30 Minutes

Scheme: F.Sc.
Total Marks: 80

SECTION – B

Short Questions (Total Marks: 48)

Q.1 ATTEMPT ANY 16 OUT OF 20. EACH QUESTION CARRIES 3 MARKS.

1. What is milliampere and mA meter?
2. What is kilovoltage and kVp meter?
3. What is a negative contrast media?
4. Write number and location of tarsal bones?
5. What do you understand by PA-View Chest X-Ray?
6. What is ball and socket joint? Give two examples.
7. What is grid ratio? Which grid ratio is usually used in radiography?
8. What is film badge?
9. What is mammography?
10. How will you perform Chest X-Ray of a pregnant Lady?
11. What is the spectrum of electromagnetic radiation?
12. Define inverse square law?
13. State Ohm's Law and give a practical application in radiographic equipment?
14. Name three main reasons for selecting tungsten as material of choice for the target in general radiography?
15. How many generations of CT scanners are available? And which one is most commonly used in diagnostic radiology?
16. Explain the role of hydrogen atoms and relaxation times (T1 and T2) in the formation of MRI images?
17. Write the names of four principal layers of intensifying screen?
18. Explain advantages and disadvantages of non-ionic low osmolar contrast media over high osmolar contrast media?
19. What do you know about personal dosimetry?
20. Draw the diagram of X-ray tube?

SECTION – C

LONG QUESITONS (Total Marks: 32)

Note: Attempt any 4 out of 6. Each question carries 8 marks.

Q.1. **Part (A):** Write four most frequently occurring emergencies after contrast injection?
Part (B): Outline the steps to be taken in each emergency?

Q.2 Describe various adverse effects of IV contrast media and their management

Q.3 Write short note on:

(A) ALARA

(B) MRI

Q.4 Write down the cardinal principles of radiation protection for patient?

Q.5. **Part (A):** Name Different groups of vertebral column and how many vertebrae are present in each group?

Part (B): Draw and label gastrointestinal system relevant to important landmarks on barium follow through and Enema?

Q.6 What are intensifying screens. How they function in radiography what are their uses?

SOLVED

SECTION – B

Short Questions (Total Marks: 48)

Q.1 ATTEMPT ANY 16 OUT OF 20. EACH QUESTION CARRIES 3 MARKS.

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18. Explain advantages and disadvantages of non-ionic low osmolar contrast media over high osmolar contrast media?
19. What do you know about personal dosimetry?

20. Draw the diagram of X-ray tube?

ANSWERS:

1. What is milliampere and mA meter?
Milliampere (mA) is the unit of tube current and represents the number of electrons flowing from cathode to anode per second in an X-ray tube.
An mA meter is an instrument used to measure the tube current flowing through the X-ray circuit during exposure.

2. What is kilovoltage and kVp meter?
Kilovoltage (kV) is the potential difference applied across the X-ray tube that determines the energy and penetrating power of X-rays.
A kVp meter is a device used to measure the peak kilovoltage applied to the X-ray tube.

3. What is a negative contrast media?
Negative contrast media are substances that **appear dark (radiolucent) on X-ray images** and reduce X-ray absorption.
Examples include air, oxygen, and carbon dioxide.

4. Write number and location of tarsal bones?
There are **seven tarsal bones** located in the **ankle and posterior part of the foot**.
They are: talus, calcaneus, navicular, cuboid, and three cuneiform bones.

5. What do you understand by PA-View Chest X-Ray?
PA (posteroanterior) view chest X-ray is taken with the X-ray beam passing **from back to front**, with the patient facing the image receptor. It provides accurate visualization of heart and lung fields.

6. What is ball and socket joint? Give two examples.
A ball and socket joint is a synovial joint in which a spherical head fits into a cup-like socket, allowing movement in all directions.
Examples are shoulder joint and hip joint.

7. What is grid ratio? Which grid ratio is usually used in radiography?
Grid ratio is the ratio of the height of lead strips to the distance between them.
Commonly used grid ratios in radiography are **8:1 or 10:1**.

8. What is film badge?
A film badge is a **personal radiation monitoring device** worn by radiation workers to measure cumulative exposure to ionizing radiation.

9. What is mammography?
Mammography is a **specialized low-dose X-ray imaging technique** used to examine breast tissue for early detection of breast cancer.

10. How will you perform Chest X-Ray of a pregnant lady?

Chest X-ray is performed only if clinically justified.
Protective lead shielding is placed over the abdomen and pelvis.
Minimum exposure factors are used to reduce fetal radiation dose.

11. What is the spectrum of electromagnetic radiation?
The electromagnetic spectrum is the complete range of electromagnetic waves arranged according to wavelength or frequency, including radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma rays.

12. Define inverse square law?
The inverse square law states that **radiation intensity is inversely proportional** to the **square of the distance** from the source.
If distance is doubled, intensity becomes one-fourth.

13. State Ohm's Law and give a practical application in radiographic equipment?
Ohm's Law states that **current equals voltage divided by resistance** (I = V / R)
It is applied in X-ray circuits to control tube current by adjusting resistance.

14. Name three main reasons for selecting tungsten as material of choice for the target in general radiography?
Tungsten has a high atomic number, high melting point, and good thermal conductivity making it suitable for efficient X-ray production.

15. How many generations of CT scanners are available? Which one is most commonly used?
There are **five generations of CT scanners**.
The **third generation CT scanner** is most commonly used in diagnostic radiology.

16. Explain the role of hydrogen atoms and relaxation times (T1 and T2) in MRI image formation?
MRI images are formed using hydrogen atoms present in body tissues.
T1 relaxation time represents longitudinal relaxation, while T2 relaxation time represents transverse relaxation.
Differences in T1 and T2 values produce image contrast between tissues.

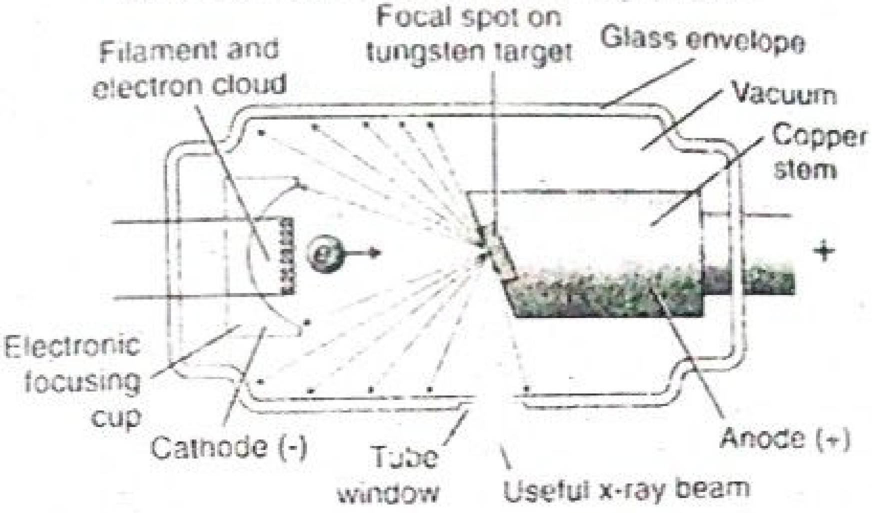
17. Write the names of four principal layers of intensifying screen?
The four principal layers are protective layer, phosphor layer, reflective layer, and base layer.

18. Explain advantages and disadvantages of non-ionic low osmolar contrast media over high osmolar contrast media?
Advantages include fewer allergic reactions, less pain, and better patient tolerance
Disadvantages include higher cost compared to high osmolar contrast media

19. What do you know about personal dosimetry?
Personal dosimetry is the measurement of radiation dose received by individuals working

with ionizing radiation using devices such as film badges, TLDs, and electronic dosimeters.

20. Draw the diagram of X-ray tube?



SECTION – C

LONG QUESITONS (Total Marks: 32)

Note: **Attempt any 4 out of 6. Each question carries 8 marks.**

Q.1. **Part (A):** Write four most frequently occurring emergencies after contrast injection?
Part (B): Outline the steps to be taken in each emergency?

Ans.

Part (A): Four Most Frequently Occurring Emergencies after Contrast Injection

Contrast media used in radiology (iodinated for CT or X-ray, or gadolinium for MRI) can occasionally cause adverse reactions. The ***four most frequent emergencies*** are:

1. ***Mild Allergic Reaction***
   - Symptoms: itching, rash, urticaria (hives), sneezing, mild nausea
2. ***Moderate Allergic Reaction***
   - Symptoms: facial swelling, angioedema, persistent vomiting, mild bronchospasm, moderate hypotension
3. ***Severe Allergic Reaction / Anaphylaxis***
   - Symptoms: severe hypotension, severe bronchospasm, laryngeal edema, cyanosis, loss of consciousness, cardiac arrest
4. ***Cardiovascular Emergencies***
   - Symptoms: arrhythmias, chest pain, hypotension, cardiac arrest, shock

Part (B): Steps to be Taken in Each Emergency

1. Mild Allergic Reaction

- ***Stop contrast injection immediately***
- Monitor vital signs (BP, pulse, respiration)

- Administer antihistamines (e.g., diphenhydramine)
- Reassure patient and observe for 30–60 minutes
- Document the reaction in patient record

2. Moderate Allergic Reaction

- Stop contrast immediately
- Place patient in ***supine position***
- Administer antihistamines and corticosteroids if prescribed
- Provide oxygen therapy if needed
- Monitor vital signs closely
- Prepare for escalation to severe reaction management

3. Severe Allergic Reaction / Anaphylaxis

- Stop contrast immediately
- ***Call for emergency assistance*** (code blue)
- Ensure ***airway patency***; provide oxygen
- Administer ***epinephrine intramuscularly or intravenously*** as per protocol
- Establish IV access for fluids (normal saline or Ringer lactate)
- Monitor vital signs continuously
- Prepare for ***CPR and advanced life support*** if necessary
- Transfer to ICU if available

4. Cardiovascular Emergencies

- Stop contrast injection immediately
- Monitor ECG, BP, and oxygen saturation
- Place patient in ***supine position with legs elevated*** (if hypotensive)
- Administer oxygen and IV fluids
- Treat arrhythmias according to ACLS protocol
- Prepare for resuscitation if cardiac arrest occurs
- Call emergency team immediately

Prompt recognition of the type of reaction and immediate intervention is ***essential for patient safety***. All radiology departments must maintain ***emergency drugs, oxygen supply, and resuscitation equipment*** at hand.

Q.2	Describe various adverse effects of IV contrast media and their management.

Ans.

Adverse Effects of IV Contrast Media and Their Management

Intravenous (IV) contrast media, such as ***iodinated contrast for CT/X-ray*** or ***gadolinium for MRI***, are generally safe but can cause ***adverse reactions ranging from mild to life-threatening***. Proper recognition and management are crucial in radiology practice.

1. Classification of Adverse Effects

Adverse effects of IV contrast media are usually classified as:

A. Mild Reactions

- ***Symptoms:***
  - Nausea and vomiting
  - Sneezing, nasal congestion
  - Mild itching, rash, or urticaria (hives)
  - Flushing or warmth sensation
- ***Onset:*** Usually within minutes to 1 hour after injection

Management:

- Stop contrast if reaction occurs
- Observe patient and reassure
- Administer antihistamines (e.g., diphenhydramine) if needed
- Monitor vital signs until stable
- Document reaction in patient record

B. Moderate Reactions

- ***Symptoms:***
  - Facial or laryngeal edema (angioedema)
  - Persistent vomiting
  - Mild bronchospasm, wheezing, or cough
  - Moderate hypotension
- ***Onset:*** Usually within minutes after injection

Management:

- Stop contrast injection immediately
- Place patient in ***supine position***
- Administer ***antihistamines*** and ***corticosteroids***
- Provide oxygen therapy if respiratory symptoms occur
- Monitor vital signs closely
- Prepare for escalation if reaction worsens

C. Severe Reactions (Life-Threatening / Anaphylaxis)

- ***Symptoms:***
  - Severe hypotension and shock
  - Severe bronchospasm
  - Laryngeal edema causing airway obstruction
  - Cyanosis, loss of consciousness
  - Cardiac arrest

Management:

- ***Call for emergency help immediately***
- Stop contrast injection
- Ensure ***airway patency***; provide ***oxygen***
- Administer ***epinephrine (IM or IV) immediately***
- Establish IV access for rapid fluid resuscitation
- Prepare for ***cardiopulmonary resuscitation (CPR)*** if necessary
- Continuous monitoring of BP, pulse, and oxygen saturation
- Transfer to ICU for further management

D. Late or Delayed Reactions

- ***Symptoms:***
  - Skin rash appearing 1–7 days post-contrast
  - Mild fever or joint pain

Management:

- Usually self-limiting
- Symptomatic treatment with antihistamines or topical corticosteroids if required

E. Nephrotoxic Reactions (Contrast-Induced Nephropathy, CIN)

- ***Risk Factors:*** Pre-existing renal impairment, diabetes, dehydration, high contrast dose

- ***Symptoms:*** Rise in serum creatinine within 48–72 hours
- ***Management:***
    - Ensure adequate ***hydration before and after contrast***
    - Use ***low-osmolar or iso-osmolar contrast agents***
    - Monitor renal function in at-risk patients
    - Avoid nephrotoxic drugs during the procedure

2. Prevention Strategies

- Take ***detailed history*** for allergies, previous contrast reactions, asthma, renal disease
- Pre-medicate high-risk patients with ***antihistamines and corticosteroids***
- Use ***minimal effective contrast dose***
- Maintain ***emergency drugs, oxygen, and resuscitation equipment*** in the imaging suite
- Observe all patients for at least ***15–30 minutes*** post-injection

Adverse effects of IV contrast media range from ***mild reactions*** like itching to ***severe anaphylaxis and nephropathy***. Early recognition, appropriate management, and preventive measures are essential for ***patient safety*** and reducing morbidity and mortality in radiology practice.

Q.3.	Write short note on: **(A)** **ALARA** **(B)** **MRI**

Ans.

(A) ALARA

ALARA stands for ***"As Low As Reasonably Achievable"***. It is a radiation safety principle aimed at ***minimizing radiation exposure*** to patients, staff, and the public while obtaining diagnostic-quality images.

Key Points:

- ***Objective:*** Reduce dose without compromising image quality.
- ***Methods to achieve ALARA:***
    - Use the ***lowest possible exposure settings*** (kVp and mA)
    - Limit ***beam size and collimation*** to the area of interest
    - ***Optimize exposure time*** and avoid repeats
    - Maintain proper ***distance*** from the source
    - Use ***protective shielding*** (lead aprons, thyroid collars, gonadal shields)
    - Educate staff and patients on radiation safety

Importance:

- Reduces the risk of ***stochastic effects*** (cancer, genetic effects)
- Prevents ***deterministic effects*** (skin erythema, cataract)
- Essential in ***pediatric and pregnant patients***

(B) MRI (Magnetic Resonance Imaging)

MRI is a ***non-invasive imaging technique*** that uses ***strong magnetic fields and radiofrequency pulses*** to produce detailed images of soft tissues, organs, and other body structures without ionizing radiation.

Principle:

- Based on ***nuclear magnetic resonance (NMR)*** of ***hydrogen protons*** in body tissues.
- Tissues return to equilibrium after RF pulse; differences in ***T1 (longitudinal) and T2 (transverse) relaxation times*** create contrast in images.

Advantages:

- Excellent ***soft tissue contrast***
- No ionizing radiation
- Multiplanar imaging (axial, coronal, sagittal)
- Functional imaging possible (fMRI, MR angiography)

Disadvantages / Limitations:

- Expensive and less available than X-ray/CT
- Time-consuming procedure
- Not suitable for patients with ***metal implants, pacemakers, or claustrophobia***
- Motion artifacts can reduce image quality

Clinical Applications:

- Brain and spinal cord imaging
- Musculoskeletal imaging (joints, cartilage)
- Abdominal and pelvic organ assessment
- Cardiac imaging
- Detection of tumors, inflammation, and vascular anomalies

Q.4	Write down the cardinal principles of radiation protection for patient?

Ans.

The ***cardinal principles of radiation protection*** are designed to ***minimize radiation exposure to patients*** while ensuring diagnostic-quality imaging. These are based on the ALARA concept (***As Low As Reasonably Achievable***) and international radiation safety standards.

1. Justification

- ***Definition:*** Every radiological procedure must have a ***clear medical benefit*** that outweighs the potential radiation risk.
- ***Application:***
  - Avoid unnecessary X-rays or repeated exposures.
  - Use alternative modalities (e.g., ultrasound, MRI) when feasible.

2. Optimization (Dose Limitation)

- ***Definition:*** Radiation dose should be ***kept as low as reasonably achievable*** while maintaining diagnostic quality.
- ***Application:***
  - Use proper ***kVp and mA settings***
  - Limit ***exposure time***
  - Use ***collimation*** to restrict beam to the area of interest
  - Minimize repeat exposures

3. Dose Limitation (Individual Protection)

- ***Definition:*** Ensure that ***maximum permissible doses*** are not exceeded for patients.
- ***Application:***

- Use ***protective shielding*** (lead aprons, thyroid collars, gonadal shields)
- Special care for ***children and pregnant patients***
- Avoid irradiating non-targeted tissues

4. Distance

- ***Definition:*** Increasing the distance between the radiation source and patient can reduce scatter dose to surrounding tissues.
- ***Application:***
  - Use ***beam positioning devices***
  - Stand at a safe distance when assisting patients if exposure is necessary

5. Shielding

- ***Definition:*** Use ***physical barriers*** to protect sensitive organs and tissues
- ***Application:***
  - Gonadal shielding for reproductive organs
  - Lead aprons for vulnerable body parts
  - Thyroid collars to protect the thyroid gland

By following the ***cardinal principles of justification, optimization, dose limitation, distance, and shielding***, radiographers can ***protect patients from unnecessary radiation exposure***, improve safety, and maintain diagnostic quality in imaging procedures.

Q.5. **Part (A):** Name Different groups of vertebral column and how many vertebrae are present in each group?
Part (B): Draw and label gastrointestinal system relevant to important landmarks on barium follow through and Enema?

Ans.

Part (A): Groups of Vertebral Column and Number of Vertebrae

The vertebral column is divided into ***five main groups***, each with a specific number of vertebrae:

1. ***Cervical Vertebrae***
- ***Number:*** 7 (C1–C7)
- ***Location:*** Neck region
- ***Special Features:*** C1 (atlas) and C2 (axis) allow head movement
2. ***Thoracic Vertebrae***
- ***Number:*** 12 (T1–T12)
- ***Location:*** Upper and mid-back
- ***Special Features:*** Articulate with ribs
3. ***Lumbar Vertebrae***
- ***Number:*** 5 (L1–L5)
- ***Location:*** Lower back
- ***Special Features:*** Large body for weight bearing
4. ***Sacral Vertebrae***
- ***Number:*** 5 (S1–S5) fused
- ***Location:*** Posterior pelvis
- ***Special Features:*** Forms sacrum, articulates with pelvis
5. ***Coccygeal Vertebrae***

- *Number:* 4 fused (Co1–Co4)
- *Location:* Tailbone region
- *Special Features:* Small, rudimentary, fused

Total vertebrae: 33 (24 movable + 9 fused)

Part (B): *Gastrointestinal (GI) System with Important Landmarks for Barium Studies*

Description for Diagram and Landmarks:

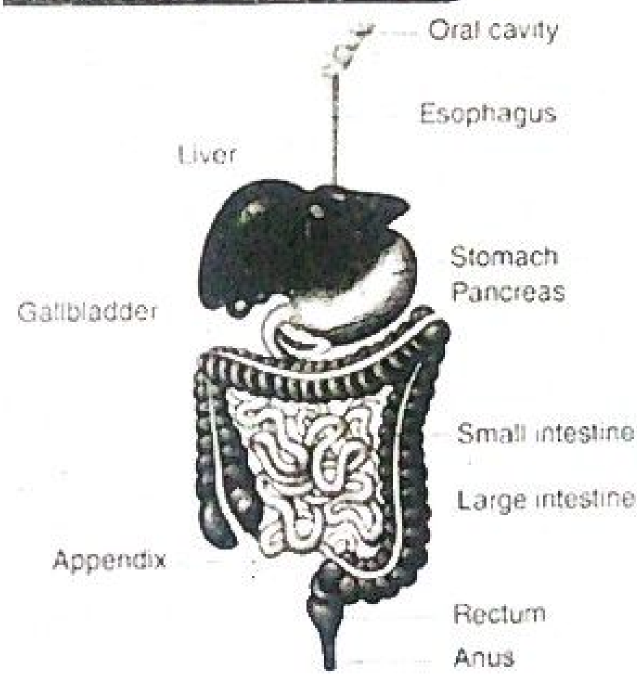
1. Esophagus

- Begins at ***C6 vertebra*** (cricoid cartilage)
- Ends at ***T11 vertebra*** (esophagogastric junction)
- Landmark for ***barium swallow study***

2. Stomach

- Regions: ***Cardia, Fundus, Body, Pylorus***
- Pylorus located at ***L1 vertebra***
- ***Landmark:*** Gastroesophageal junction and pyloric canal visualized in barium meal

GASTROINTESTINAL TRACT



3. Small Intestine

- Duodenum: C-shaped, ***around L1--L3***
- Jejunum: upper left abdomen
- Ileum: lower right abdomen
- ***Barium follow-through*** tracks barium from stomach through small intestine

4. Large Intestine (Colon)

- Sections: ***Cecum, Ascending colon, Transverse colon, Descending colon, Sigmoid colon, Rectum***
- Important landmarks for ***barium enema:***
  - ***Cecum:*** right lower quadrant
  - ***Hepatic flexure:*** below liver
  - ***Splenic flexure:*** below spleen
  - ***Sigmoid colon:*** left lower quadrant
  - ***Rectum:*** anterior to sacrum

5. Rectum and Anus

- Rectum extends from ***S3 vertebra*** to anal canal
- Anal canal ends at ***perineum***
- Visualized in ***barium enema studies***

Diagram Instructions for Exam:

- Draw a ***simple outline of GI tract***: esophagus, stomach, small intestine (duodenum, jejunum, ileum), large intestine (cecum, ascending, transverse, descending, sigmoid colon), rectum
- Label ***barium study landmarks***: esophagogastric junction, pylorus, duodenojejunal junction, hepatic and splenic flexures, sigmoid colon, rectum

Q.6 What are intensifying screens. How they function in radiography what are their uses?

Ans.
An ***intensifying screen*** is a ***fluorescent screen used in radiography*** to ***convert X-ray photons into visible light***, which then exposes the radiographic film. By using an intensifying screen, the ***X-ray exposure required is significantly reduced***, lowering patient dose.

Structure of Intensifying Screens

An intensifying screen typically consists of ***four principal layers***.

1. ***Protective Layer***
   - Transparent plastic layer on the surface
   - Protects the phosphor layer from physical damage and scratches
2. ***Phosphor Layer***
   - Main functional layer
   - Contains ***phosphor crystals*** (commonly calcium tungstate or rare-earth elements)
   - ***Function:*** Absorbs X-ray photons and emits visible light (fluorescence)
3. ***Reflective Layer***
   - Located beneath the phosphor layer
   - Reflects light emitted towards the film, ***increasing screen efficiency***
4. ***Base Layer***
   - Provides mechanical support
   - Usually made of cardboard, polyester, or plastic

Functioning of Intensifying Screens

1. ***X-ray Absorption***
   - When X-rays strike the phosphor layer, a ***portion of their energy is absorbed***
2. ***Emission of Visible Light***
   - The phosphor ***fluoresces***, emitting ***visible light photons*** in all directions.
3. ***Exposure of Radiographic Film***
   - The light photons strike the ***film emulsion***, producing a latent image.
4. ***Dose Reduction***
   - Because visible light exposes the film more efficiently than X-rays, ***less X-ray radiation*** is required, reducing ***patient exposure***.

Uses of Intensifying Screens

1. ***Dose Reduction***
   - Reduces ***patient exposure*** to ionizing radiation by 50–90% compared to direct exposure films.
2. ***Image Formation***
   - Converts X-rays to visible light to ***produce latent image*** on film.
3. ***Special Radiographic Studies***
   - Used in ***general radiography***, ***chest X-rays***, ***skeletal imaging***, and ***paediatric radiography*** where patient dose must be minimal.
4. ***Improving Film Sensitivity***
   - Screens allow ***shorter exposure times***, reducing ***motion blur*** in images.

Advantages of Intensifying Screens

- Significant ***reduction in patient radiation dose***
- Shorter ***exposure times***
- Improved ***film contrast*** and image quality
- Useful in ***paediatric and chest radiography***

Disadvantages / Limitations

- Slight ***loss of image sharpness*** due to light scattering (screen blur)
- Screen-film combination must be ***matched*** properly for correct speed
- Care required to prevent ***scratches and damage*** to the screen

Intensifying screens are an essential component in radiography that ***increase efficiency of X-ray imaging, reduce patient dose, and improve workflow***. Their proper selection, maintenance, and use are critical for high-quality diagnostic imaging.