

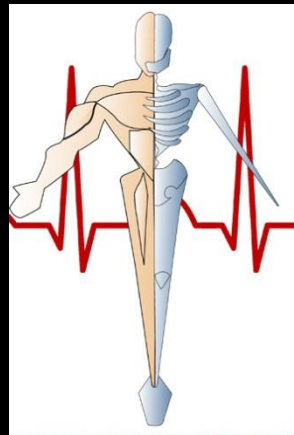
Three Phase CEUs Presents:

Topics in CT Volume II ©

“Mastery Test”

by

John Fleming, M.Ed., RT(R)(MR)(CT)



Please scroll down to proceed.

Forward:

The premise behind the creation of this tutorial is to provide imaging professionals with access to high quality yet affordable continuing education.

Our courses qualify as Category A (technical) points for the following: all ARRT recognized imaging modalities, ARRT-CQR, FDOH-Bureau of Radiation Control, NMTCB, and RCIS.

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Question #1:

The primary purpose of a rotating anode is to:

- a. reduce scatter.
- b. increase spatial resolution.
- c. distribute heat over a larger area.
- d. increase photon energy.

Question #1: Review

- Rotating Anode Design in CT
 - CT tubes use rotating anodes to distribute heat across a larger surface area.
- Benefits:
 - Increased heat capacity
 - Higher exposure capability
 - Extended tube life
- Typical rotation speeds:
 - 3,000–10,000 rpm or higher in modern CT systems
 - High rotation is necessary because CT performs continuous exposures during rapid gantry rotation.

Question #2:

Higher detector efficiency allows:

- a. lower patient dose.
- b. higher mA settings.
- c. increased scan time.
- d. elimination of iterative reconstruction.

Question #2: Review

- Definition of Detector Efficiency

Detector efficiency, often called quantum efficiency (QE), is the fraction of x-ray photons absorbed by the detector that contributes to the signal. It can be described mathematically as:

$$QE = \frac{\text{Number of photons detected}}{\text{Number of photons incident on detector}}$$

High quantum efficiency allows a detector to produce high-quality images with fewer x-rays, which translates directly to lower radiation dose (tube current and voltage) to the patient.

Question #3:

Bowtie filters are used to:

- a. increase beam intensity.
- b. shape the beam and reduce patient dose.
- c. increase focal spot size.
- d. eliminate scatter completely.

Question #3: Review

- Bowtie Filters

CT systems use bowtie filters to shape the x-ray beam.

Functions:

- Reduce dose at patient edges
 - Equalize detector signal
 - Improve image quality
 - Reduce scatter
- Different sizes are selected based on patient anatomy

Question #4:

The primary purpose of patient shielding in CT is:

- a. improve image resolution.
- b. increase scan speed.
- c. replace dose modulation.
- d. reduce radiation exposure to radiosensitive tissues outside the ROI.

Question #4: Review

- Radiation protection is a cornerstone of computed tomography (CT) practice, and patient shielding is a traditional and effective strategy for reducing unnecessary radiation exposure.
- **Shielding involves placing radiopaque materials, most commonly lead or bismuth, over radiosensitive tissues to block scatter and primary x-rays that fall outside the region of interest (ROI).**
- Proper use of shielding, when combined with modern CT dose reduction techniques, helps technologists adhere to ALARA (As Low As Reasonably Achievable) principles, a key element in the ARRT CT content specifications.

Question #5:

What percentage of electrical energy is converted into x-rays in a CT tube?

- a. 10%
- b. 5%
- c. Less than 1%
- d. 50%

Question #5: Review

- Basic Principles of X-Ray Production:

X-rays are produced inside the CT tube when high-speed electrons interact with a metal target.

The process begins at the cathode, where a tungsten filament is heated by an electric current.

This heating causes thermionic emission, releasing a cloud of electrons.

The number of electrons released determines the tube current (mA), which controls the quantity of x-ray photons produced.

A high voltage potential, measured in kilovoltage peak (kVp), is applied between the cathode and anode.

This voltage accelerates electrons across the tube at high speed.

When these electrons strike the tungsten target in the anode, their kinetic energy is converted into x-rays and heat.

The process is inefficient: less than 1% of energy becomes x-rays, while more than 99% is converted to heat.

Question #6:

A patient with a history of severe reaction to iodinated contrast should:

- a. always receive contrast.
- b. be scanned without screening.
- c. be evaluated for premedication or alternative imaging.
- d. be refused imaging.

Question #6: Review

- **Iodinated Contrast Safety Screening**

Iodinated contrast agents enhance diagnostic quality but carry potential risks.

Screening must include:

- Allergy History

Patients should be asked about:

Previous contrast reactions

Severity (mild, moderate, severe)

Other severe allergies or asthma

- **Patients with prior reactions may require:**

Premedication protocols

Use of low-osmolar or iso-osmolar contrast

Alternative imaging if risk outweighs benefit

Question #7:

A CT system enters cool-down mode to prevent:

- a. detector failure.
- b. excessive tube heat damage.
- c. motion artifact.
- d. image noise.

Question #7: Review

- Heat and Tube Protection

Because most energy becomes heat, CT tubes have high heat storage capacity and cooling systems.

Excessive technique factors or repeated scans may exceed heat limits, causing the system to enter a cool-down mode.

Proper technique selection helps extend tube life and prevent equipment damage.

Question #8:

Which of the following medication is most associated with contrast-related complications?

- a. Aspirin
- b. Metformin
- c. Ibuprofen
- d. Acetaminophen

Question #8: Review

- **Iodinated Contrast Safety Screening**

Iodinated contrast agents enhance diagnostic quality but carry potential risks.

Screening must include:

- **Medication Screening**

Certain medications affect contrast safety:

- **Metformin: Risk of lactic acidosis in renal impairment**
- Anticoagulants: Relevant for invasive CT procedures
- Nephrotoxic drugs: Increase kidney risk

Medication review ensures appropriate precautions and patient education.

Question #9:

Bremsstrahlung radiation is produced when electrons:

- a. collide with detectors.
- b. strike the filament.
- c. are decelerated by the nucleus.
- d. exit the patient.

Question #9: Review

- The ARRT CT registry emphasizes knowledge of x-ray interactions at the anode, the factors influencing Bremsstrahlung production, and the clinical implications for image quality and radiation safety.
- Definition and Basic Concept

The term Bremsstrahlung is German for “braking radiation.”

It refers to the radiation produced when high-speed electrons are decelerated or deflected by the electric field of atomic nuclei within the anode target.

In CT systems, electrons emitted from the cathode are accelerated across a high-voltage potential (kVp) and directed toward a tungsten anode.

When these electrons interact with the tungsten nuclei, they lose kinetic energy.

This lost energy is emitted in the form of x-ray photons.

- Bremsstrahlung accounts for approximately 85–90% of the x-rays produced in diagnostic imaging and CT, making it the dominant mechanism of radiation production.

Question #10:

Which lab value is most important before administering iodinated contrast?

- a. WBC
- b. Hemoglobin
- c. INR
- d. eGFR

Question #10: Review

- Importance of Renal Function in CT Imaging: eGFR

Renal function assessment is essential prior to the administration of iodinated contrast media.

Impaired kidney function increases the risk of contrast-associated acute kidney injury (CA-AKI).

- **Estimated Glomerular Filtration Rate (eGFR):**

eGFR is the preferred indicator of renal function because it accounts for age, sex, and body characteristics.

General risk categories:

eGFR	Interpretation	CT Contrast Consideration
≥60 mL/min	Normal	Safe for contrast
30–59 mL/min	Mild–moderate impairment	Use caution, consider hydration
<30 mL/min	Severe impairment	Avoid contrast unless essential

Question #11:

Characteristic radiation is produced when:

- a. an inner-shell electron is ejected and replaced.
- b. electrons slow near the nucleus.
- c. electrons strike the filament.
- d. x-rays interact with the patient.

Question #11: Review

- Characteristic radiation is one of the two primary mechanisms of x-ray production in diagnostic imaging and computed tomography (CT), the other being Bremsstrahlung radiation.
- Although characteristic radiation contributes a smaller portion of the total x-ray beam in CT, understanding its production is essential for ARRT registry preparation.
- Basic Principle of Characteristic Radiation

Characteristic radiation occurs when a high-speed electron from the cathode interacts with and ejects an inner-shell electron from a target atom, typically tungsten.

When this inner-shell vacancy is created, the atom becomes unstable. An electron from an outer shell moves inward to fill the vacancy.

The energy difference between the two shells is released as an x-ray photon.

This emitted photon has a specific (characteristic) energy that is unique to the atomic structure of the target material.

Because tungsten is used in CT x-ray tubes, the energies produced are characteristic of tungsten.

Question #12:

Dose modulation in CT primarily adjusts:

- a. tube current (mA) based on patient anatomy.
- b. tube voltage (kVp) in real time.
- c. scan length only.
- d. slice thickness.

Question #12: Review

- Definition of Dose Modulation

Dose modulation refers to the dynamic adjustment of tube current during a CT scan to deliver the minimum necessary radiation for diagnostic-quality images.

The goal is to maintain adequate signal-to-noise ratio (SNR) while reducing unnecessary exposure to low-attenuation regions.

- Angular modulation: Adjusts tube current during gantry rotation based on patient attenuation at different angles.
- Longitudinal (z-axis) modulation: Adjusts tube current along the length of the scan based on patient thickness.
- Combined modulation: Uses both angular and longitudinal adjustments for optimal dose efficiency.

Question #13:

When referring to the fundamental properties that determine x-ray photon energy, frequency refers to:

- a. distance between wave peaks.
- b. photon intensity.
- c. beam width.
- d. number of cycles per second.

Question #13: Review

- Definition of X-ray Photon Frequency:

Frequency refers to the number of wave oscillations or cycles that occur per second. It is measured in Hertz (Hz).

High-frequency x-rays:

- Have higher photon energy
- Have greater penetrating ability
- Are produced at higher kVp settings
- Contribute to beam hardening

In CT imaging, higher frequency photons are desirable because they pass through the body more effectively and reach the detectors, reducing noise and improving signal.

Question #14:

An eGFR of 25 mL/min indicates:

- a. normal renal function.
- b. mild impairment.
- c. severe renal impairment.
- d. no clinical significance.

Question #14: Review

- Importance of Renal Function in CT Imaging: eGFR

Renal function assessment is essential prior to the administration of iodinated contrast media.

Impaired kidney function increases the risk of contrast-associated acute kidney injury (CA-AKI).

- Estimated Glomerular Filtration Rate (eGFR):

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eGFR	Interpretation	CT Contrast Consideration
≥ 60 mL/min	Normal	Safe for contrast
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<30 mL/min	Severe impairment	Avoid contrast unless essential

Question #15:

Low-frequency x-rays are more likely to:

- a. be absorbed by superficial tissue.
- b. reach the detector.
- c. pass through the patient.
- d. improve image quality.

Question #15: Review

- Beam Spectrum in CT:

The CT x-ray beam contains a range of photon energies (frequencies and wavelengths).

Filtration and bowtie filters remove low-frequency (long-wavelength) photons because they:

- Are absorbed by superficial tissues
- Increase patient dose
- Do not contribute to image formation

This process is known as beam hardening, which increases the average frequency and decreases the average wavelength of the beam.

Question #16:

Which lab test evaluates bleeding risk for a CT-guided biopsy?

- a. D-dimer
- b. INR
- c. WBC
- d. Creatinine

Question #16: Review

- Coagulation Studies: **INR**, PT, and PTT
- Coagulation values are particularly important for interventional CT procedures, biopsies, drain placements, or any procedure involving needle insertion.

International Normalized Ratio (INR)

- **INR standardizes PT values and is commonly used to monitor anticoagulation therapy.**
- **Elevated INR increases the risk of hemorrhage during CT-guided procedures.**

Normal Range: 0.8–1.2

High risk for bleeding: >1.5–2.0 (procedure-dependent)

Question #17:

The primary factor controlling beam quality in CT is:

- a. mAs.
- b. pitch.
- c. slice thickness.
- d. kVp.

Question #17: Review

- Primary Factor Affecting Beam Quality: kVp

The most important factor controlling beam quality in CT is kVp.

Increasing kVp:

- Increases photon energy
- Increases beam penetration
- Reduces image noise
- Reduces contrast (longer gray scale)
- Increases radiation dose

Decreasing kVp:

- Decreases photon energy
- Increases contrast
- Increases attenuation differences
- May increase noise if penetration is inadequate

Typical CT kVp settings range from 80–140 kVp, selected based on patient size and clinical indication.

Question #18:

A prolonged PTT indicates:

- a. increased clotting.
- b. normal coagulation.
- c. infection.
- d. increased bleeding risk.

Question #18: Review

- Coagulation Studies: INR, PT, and **PTT**
- Coagulation values are particularly important for interventional CT procedures, biopsies, drain placements, or any procedure involving needle insertion.

Partial Thromboplastin Time (PTT)

- PTT evaluates the intrinsic clotting pathway.
- Normal range: ~25–35 seconds
- **Prolonged PTT indicates increased bleeding risk and may require correction prior to invasive imaging.**

Question #19:

Added filtration primarily removes:

- a. low-energy photons.
- b. high-energy photons.
- c. characteristic radiation.
- d. scatter radiation.

Question #19: Review

- Filtration and Beam Hardening

Inherent filtration is provided by the:

- Glass envelope
- Insulating oil
- Tube window

Added Filtration

- Additional aluminum or equivalent materials remove low-energy photons.

Purpose of Filtration

- Low-energy photons:
 - Are absorbed in superficial tissues
 - Increase patient dose
 - Do not reach the detector

Removing these photons increases average beam energy, improving beam quality.

Question #20:

For chest and abdominal CT, how should the arms be positioned?

- a. above the head
- b. along the sides of the body
- c. across the chest
- d. below the table

Question #20: Review

- CT Positioning Techniques to Minimize Patient Dose:

Chest CT

- Arms above head reduce beam path through shoulders, lowering dose to lungs.
- Proper head and neck alignment prevents motion artifacts that could necessitate repeat scanning.

Abdominal/Pelvic CT

- Centering reduces overestimation of body thickness, lowering tube current.
- Feet-first positioning may improve patient comfort without increasing dose.

Head CT

- Symmetrical head alignment allows precise dose modulation and reduces lens exposure.
- Use of immobilization devices prevents repeat scans due to motion.

Question #21:

X-ray beam quantity refers to:

- a. photon energy.
- b. average beam penetration.
- c. number of x-ray photons produced.
- d. detector sensitivity.

Question #21: Review

- Definition of Beam Quantity:

Beam quantity refers to the total number of x-ray photons produced by the x-ray tube during an exposure.

It is directly related to the intensity of the x-ray beam.

Higher beam quantity:

- More photons reach the detectors
- Reduced image noise
- Higher radiation dose

Lower beam quantity:

- Fewer photons reach detectors
- Increased quantum noise (mottle)
- Lower radiation dose

In CT, maintaining adequate photon quantity is essential to produce images with acceptable noise levels.

Question #22:

Which lab value helps identify infection?

- a. WBC
- b. INR
- c. Creatinine
- d. hCG

Question #22: Review

- White Blood Cell Count (WBC) reflects immune system activity.

Normal range: 4,000–11,000 cells/ μ L

Elevated WBC suggests:

- Infection
- Inflammation
- Abscess
- Sepsis

CT is often ordered to localize infection sources, such as:

- Appendicitis
- Diverticulitis
- Abscess formation

Severely ill patients with elevated WBC may require priority imaging and careful monitoring.

Question #23:

The primary factor controlling beam quantity is:

- a. kVp.
- b. mAs.
- c. pitch.
- d. slice thickness.

Question #23: Review

- Primary Factor Affecting Beam Quantity: mAs

The most important factor controlling beam quantity is mAs, which is the product of:

$$mAs = mA \times \text{rotation time}$$

mA (milliamperage) controls the number of electrons flowing from the cathode to the anode per second.

Increasing mA increases the number of electrons striking the target.

More electron interactions produce more x-ray photons.

- Key principle:

Beam quantity is directly proportional to mAs.

If mAs doubles, photon quantity doubles, and patient dose approximately doubles.

Question #24:

Elevated D-dimer is most commonly associated with evaluation for:

- a. liver disease.
- b. pulmonary embolism.
- c. kidney failure.
- d. anemia.

Question #24: Review

- D-dimer:

D-dimer is a fibrin degradation product that indicates recent clot formation and breakdown.

- Normal value: Typically $<0.5 \mu\text{g/mL}$ (lab dependent)

Clinical Role in CT:

- Elevated D-dimer is commonly used to evaluate suspected:

Pulmonary embolism (PE)

Deep vein thrombosis (DVT)

- In patients with low clinical probability, a normal D-dimer may eliminate the need for CT pulmonary angiography (CTPA).
- Elevated values often lead to CTA chest imaging.

- Understanding the clinical context helps technologists anticipate exam urgency and protocol selection.

Question #25:

A grainy CT image is most likely caused by:

- a. high kVp.
- b. low beam quantity.
- c. excess filtration.
- d. high beam quality.

Question #25: Review

- Troubleshooting CT Image Issues:

Problem: Grainy image

- **Cause: Low beam quantity**
- Solution: Increase mAs

Problem: Low contrast

- Cause: High beam quality (high kVp)
- Solution: Reduce kVp if appropriate

- Understanding whether the issue relates to quality or quantity prevents unnecessary dose increases.

Question #26:

A low hemoglobin level may indicate:

- a. internal bleeding or anemia.
- b. pregnancy.
- c. kidney failure.
- d. liver disease.

Question #26: Review

- Hemoglobin (Hgb) and Hematocrit:

Hemoglobin measures the oxygen-carrying capacity of blood.

Normal ranges:

- Men: ~13–17 g/dL
- Women: ~12–15 g/dL

Clinical Importance in CT

- Low hemoglobin indicates anemia or possible blood loss.
- CT is frequently used to evaluate:

Internal bleeding

Trauma

Gastrointestinal hemorrhage

In trauma or unstable patients, low Hgb supports the need for rapid CT evaluation.

Severe anemia may also affect patient tolerance for contrast or prolonged procedures.

Question #27:

The primary x-ray beam refers to radiation:

- a. before it enters the patient.
- b. after it exits the patient.
- c. detected by the computer.
- d. scattered within the patient.

Question #27: Review

- The primary x-ray beam is the radiation emitted from the CT x-ray tube and directed toward the patient before it enters the patient.

Characteristics of the primary beam:

- Contains the full photon quantity produced by the tube
- Has a specific energy spectrum determined by kVp and filtration
- Is shaped and limited by collimation
- Is modified by bowtie filters to match patient anatomy
- Represents the maximum beam intensity before attenuation

The primary beam consists of:

- Bremsstrahlung photons (continuous spectrum)
- Characteristic photons (discrete energies)
- A range of photon energies (polyenergetic beam)

Its properties are determined by:

- kVp (beam quality)
- mAs (beam quantity)
- Filtration

Question #28:

CTDI_{vol} is a CT dose measurement technique that measures:

- a. total energy delivered over the entire scan length.
- b. effective dose in mSv.
- c. organ-specific dose.
- d. dose per slice, adjusted for pitch in helical scans.

Question #28: Review

- Key CT Dose Measurements:

1. CT Dose Index (CTDI)

- Represents the radiation dose delivered in a single rotation of the CT scanner.
- CTDI_{vol} accounts for pitch in helical scans and represents dose per slice.
- Used to standardize exposure across different scanners and protocols.
- Helps compare dose levels between studies and facilities.

2. Dose-Length Product (DLP)

- Calculated as $CTDI_{vol} \times \text{scan length (cm)}$.
- Represents the total energy delivered to the patient over the scan volume.
- Useful for estimating cumulative exposure and risk to radiosensitive tissues.

Question #29:

The remnant (exit) x-ray beam is:

- a. consists of scatter radiation only.
- b. the beam before filtration.
- c. the transmitted beam after it passes through the patient.
- d. radiation absorbed by the patient.

Question #29: Review

- Definition of the Remnant (Exit) Beam

The remnant beam (also called the exit beam) is the portion of the primary beam that exits the patient after attenuation.

Characteristics of the remnant beam:

- Reduced photon quantity
- Higher average energy (beam hardening)
- Contains information about tissue attenuation
- Detected by CT detectors to create the image

The remnant beam varies depending on:

- Tissue density and thickness
- Presence of contrast material
- Patient size
- Beam energy (kVp)

Question #30:

Informed consent requires that the patient understand:

- a. risks, benefits, and alternatives.
- b. only the procedure name.
- c. billing information only.
- d. technologist credentials.

Question #30: Review

- Informed Consent: Definition and Purpose

Informed consent is the process by which a patient voluntarily agrees to a medical procedure after understanding:

- The nature of the procedure
- Expected benefits
- Potential risks
- Alternatives
- Consequences of refusing the procedure

Informed consent protects patient autonomy and supports ethical medical practice.

Question #31:

The primary x-ray beam energy spectrum is:

- a. monoenergetic.
- b. single wavelength.
- c. constant energy only.
- d. polyenergetic.

Question #31: Review

- Definition of the Primary X-Ray Beam:

The primary x-ray beam is the radiation emitted from the CT x-ray tube and directed toward the patient before attenuation occurs.

It contains the full intensity and energy spectrum generated during the exposure.

Characteristics of the primary x-ray beam include:

- Polyenergetic energy spectrum
- Maximum photon quantity
- Controlled geometry and shape
- Determined by exposure factors and filtration

Once the beam enters the patient, interactions such as absorption and scatter modify it, producing the remnant beam used for image formation.

Question #32:

Which type of consent is assumed when a patient lies on the CT table after instructions?

- a. written
- b. oral
- c. emergency
- d. implied

Question #32: Review

- Implied Consent:

Implied consent is assumed based on the patient's actions rather than explicit verbal or written agreement.

Examples of Implied Consent

- Patient lies on the CT table after instructions
- Patient extends arm for IV placement
- Patient follows breathing instructions

Implied consent is appropriate only for low-risk, routine procedures.

Question #33:

The inverse square law states that radiation intensity is:

- a. inversely proportional to the square of the distance from the source.
- b. directly proportional to distance from the source.
- c. inversely proportional to distance from the source.
- d. independent of distance from the source.

Question #33: Review

- Definition of the Inverse Square Law:

Radiation intensity is inversely proportional to the square of the distance from the radiation source.

Mathematically:

$$I_1/I_2 = (D_2^2)/(D_1^2)$$

Where:

I_1 = initial intensity

I_2 = new intensity

D_1 = original distance

D_2 = new distance

Question #34:

Written consent would be required for:

- a. CT-guided biopsy.
- b. routine non-contrast CT.
- c. scout images only.
- d. patient positioning.

Question #34: Review

- Written (Expressed) Consent:

Written consent is typically required for higher-risk procedures.

CT Situations Requiring Written Consent:

- Intravenous contrast administration (facility dependent)
- CT-guided biopsies or drain placements
- Sedation procedures
- Interventional CT procedures

The consent form documents that risks and benefits were explained and accepted.

Question #35:

If the distance from a radiation source is doubled, the intensity becomes:

- a. twice as much.
- b. half as much.
- c. one-fourth as much.
- d. one-eighth as much.

Question #35: Review

- Radiation safety is a fundamental responsibility of the CT technologist and a major component of the ARRT CT content specifications.
- One of the most important physical principles affecting radiation exposure to both patients and healthcare workers is the inverse square law.
- This law describes how radiation intensity changes with distance from the x-ray source.

- **Key Concept:**

If distance from the source is doubled:

- Intensity becomes one-fourth ($1/4$)

If distance is tripled:

- Intensity becomes one-ninth ($1/9$)

This rapid decrease in intensity with increasing distance makes distance one of the most effective radiation protection methods.

Question #36:

Dose-Length Product (DLP) is calculated by:

- a. $CTDI_{vol} \times \text{scan length}$
- b. $kVp \times mA$
- c. $\text{scan time} \times \text{pitch}$
- d. $\text{tube voltage} \times \text{slice thickness}$

Question #36: Review

- **Key CT Dose Measurements:**

1. **CT Dose Index (CTDI)**

- Represents the radiation dose delivered in a single rotation of the CT scanner.
- CTDI_{vol} accounts for pitch in helical scans and represents dose per slice.
- Used to standardize exposure across different scanners and protocols.
- Helps compare dose levels between studies and facilities.

2. **Dose-Length Product (DLP)**

- **Calculated as $CTDI_{vol} \times \text{scan length (cm)}$.**
- Represents the total energy delivered to the patient over the scan volume.
- Useful for estimating cumulative exposure and risk to radiosensitive tissues.

Question #37:

Scatter radiation is highest:

- a. behind the control room barrier.
- b. at the gantry console.
- c. outside the CT suite.
- d. near the patient.

Question #37: Review

- Application in CT Radiation Safety:

Staff Protection

- CT technologists are exposed primarily to scatter radiation from the patient, not the primary beam.
- Scatter behaves like radiation from a point source, meaning the inverse square law applies.

Practical Implications

- Standing farther from the gantry significantly reduces exposure
- Doubling distance from the patient reduces scatter exposure by 75%
- Remaining behind the control room barrier provides maximum protection

Question #38:

If a patient is unconscious and requires immediate CT for trauma:

- a. imaging cannot be performed.
- b. written consent is required first.
- c. consent is implied under emergency doctrine.
- d. oral consent must be obtained.

Question #38: Review

- Emergency Situations and Implied Consent:

In emergencies where:

- Immediate imaging is necessary to preserve life or prevent serious harm
- The patient is unconscious or unable to consent
- No legal representative is available

Consent is implied under emergency doctrine.

This allows necessary CT imaging (e.g., trauma CT) without delay.

Question #39:

The three principles of radiation protection are:

- a. time, distance, shielding.
- b. mAs, kVp, pitch.
- c. contrast, dose, noise.
- d. voltage, current, filtration.

Question #39: Review

- Time, Distance, and Shielding:

Radiation protection is based on three principles:

- Time – minimize exposure time
 - Distance – maximize distance (inverse square law)
 - Shielding – use protective barriers
- Among these, distance is often the easiest and most effective method.

Example:

- Instead of relying only on a lead apron, stepping back 1–2 meters can reduce exposure more significantly.

Question #40:

A patient who refuses a CT exam should:

- a. be scanned anyway.
- b. be discharged immediately.
- c. have the refusal documented and provider notified.
- d. be forced to sign consent.

Question #40: Review

- Patient Refusal of Imaging:

Patients have the right to refuse imaging.

If refusal occurs:

- Explain the importance and risks of not performing the exam
- Notify the ordering provider
- Document the refusal
- Do not perform the procedure without consent

Question #41:

X-rays are classified as:

- a. mechanical radiation.
- b. electromagnetic radiation.
- c. particle radiation.
- d. sound waves.

Question #41: Review

- Nature of X-Rays:

X-rays are a form of electromagnetic radiation (EM radiation), similar to visible light, radio waves, and gamma rays.

However, x-rays have much higher energy and shorter wavelengths.

Key characteristics:

- No mass
- No electrical charge
- Travel at the speed of light (3×10^8 m/s)
- Travel in straight lines
- Invisible and cannot be detected by human senses

In CT imaging, x-rays are produced when high-speed electrons interact with the anode target inside the x-ray tube.

Question #42:

Which of the following helps ensure accurate AEC function?

- a. improper centering
- b. patient positioned at isocenter
- c. arms at sides during chest CT
- d. use of metal supports

Question #42: Review

- Importance of Patient Centering:

One of the most critical aspects of CT positioning is isocenter alignment.

Modern CT systems are designed to operate optimally when the patient's anatomy is centered within the gantry.

Incorrect centering may cause:

- Increased radiation dose
- Inaccurate automatic exposure control (AEC) modulation
- Increased image noise
- Beam hardening artifacts

Positioning aids such as sponges and pads help elevate or stabilize the patient to achieve proper centering.

Question #43:

The ability of x-rays to remove electrons from atoms is called:

- a. excitation.
- b. ionization.
- c. transmission.
- d. reflection.

Question #43: Review

- Ionization

X-rays are classified as ionizing radiation. This means they have enough energy to remove electrons from atoms, creating ions.

Ionization effects:

- Enables image formation through tissue interaction
- Can cause biological damage
- Responsible for both diagnostic benefits and radiation risks
- Biological effects may include:

DNA damage

Cellular injury

Increased cancer risk (stochastic effects)

This is why radiation safety and dose optimization are critical in CT.

Question #44:

The primary purpose of a CT time-out is to:

- a. verify correct patient and procedure.
- b. reduce scan time.
- c. increase image quality.
- d. reduce radiation dose.

Question #44: Review

- The Time-Out Process in CT:

A time-out is a standardized safety pause performed immediately before the procedure.

It is part of national patient safety initiatives designed to prevent wrong-patient, wrong-procedure, and wrong-site errors.

Components of a CT Time-Out:

1. Patient identification
2. Procedure verification
3. Clinical indication
4. Allergy and contrast screening
5. Pregnancy screening
6. Consent confirmation
7. Equipment readiness

Question #45:

X-ray attenuation refers to:

- a. a reduction of beam intensity.
- b. an increase in beam intensity.
- c. beam focusing.
- d. photon acceleration.

Question #45: Review

- X-ray attenuation refers to the reduction in beam intensity as x-rays pass through tissue. It occurs due to absorption and scatter.

Factors affecting attenuation:

- Tissue density
- Tissue thickness
- Atomic number
- Beam energy

In CT, attenuation values are converted into Hounsfield Units (HU) to create the image.

Examples:

- Air: -1000 HU
- Water: 0 HU
- Bone: +1000 HU or higher

Question #46:

Which scale is commonly used to assess level of consciousness (LOC)?

- a. AVPU
- b. ABCD
- c. ALARA
- d. NCRP

Question #46: Review

- **Level of Consciousness (LOC):**

Assessment Methods

- Level of consciousness indicates neurological status and overall patient stability.
- Technologists should assess LOC before and after the exam.
- Common categories include:

Alert – Fully awake and responsive

Verbal – Responds to verbal stimuli

Pain – Responds only to painful stimuli

Unresponsive – No response

- This is often referred to as the AVPU scale.

Question #47:

Acquisition geometry in CT refers to:

- a. patient preparation protocols.
- b. position and movement of the x-ray tube, detector, and patient.
- c. scanner software algorithms.
- d. contrast injection techniques.

Question #47: Review

- Definition of Acquisition Geometry in CT:

Acquisition geometry describes the physical arrangement and movement of the CT scanner components during imaging:

- X-ray source (tube): Rotates around the patient
- Detector array: Collects transmitted x-rays from multiple angles
- Patient table (couch): Moves longitudinally during scanning

The geometry determines how radiation is delivered to the patient, how projections are acquired, and ultimately how the image is reconstructed.

Question #48:

Normal pulse oximetry readings are typically:

- a. 70–80%
- b. 80–85%
- c. 90–94%
- d. 95–100%

Question #48: Review

- Pulse Oximetry:

Pulse oximetry measures oxygen saturation (SpO₂) and pulse rate.

Normal Values:

- 95–100%: Normal
- 90–94%: Mild hypoxemia
- <90%: Significant hypoxia

Question #49:

Increasing the CT slice thickness will:

- a. decrease radiation dose.
- b. reduce tissue coverage.
- c. increase volume irradiated per rotation.
- d. eliminate scatter.

Question #49: Review

- Significance of CT Slice Thickness:

Determined by collimation and detector configuration

- Thicker slices increase the volume of tissue irradiated
- Thinner slices reduce volume per rotation but may increase noise, leading to increased mAs and dose

Clinical relevance: Optimize slice thickness based on clinical indication to balance image quality and dose.

Question #50:

When transporting a patient with a chest tube, the drainage system should be kept:

- a. above chest level.
- b. at table level.
- c. below chest level.
- d. clamped.

Question #50: Review

- Chest Tubes:

The purpose of chest tubes is to remove air, fluid, or blood from the pleural space to treat pneumothorax, hemothorax, pleural effusion, or postoperative thoracic conditions.

Chest tubes connect to a drainage unit that typically includes a collection chamber, water seal chamber, suction control chamber (if used)

CT Considerations for Chest Tubes:

- Maintain System Integrity
- **Keep drainage system below chest level**
- Do not clamp unless specifically ordered
- Avoid tipping or disconnecting the unit

Question #51:

A helical scanning pitch of > 1 results in:

- a. overlapping slices and higher dose.
- b. reduced dose per unit length.
- c. no change in dose.
- d. increased slice thickness.

Question #51: Review

- Impact of Pitch in Helical Scanning:

Pitch = table movement per rotation \div total collimation width

- Pitch < 1 : Overlapping slices \rightarrow increased dose, higher resolution
- Pitch = 1: Contiguous slices \rightarrow standard dose
- Pitch > 1 : Gaps between slices \rightarrow reduced dose, potential loss of image quality

Radiation impact: Higher pitch reduces radiation per unit length but may decrease image resolution.

Question #52:

Steroid premedication is used primarily to:

- a. reduce anxiety.
- b. improve image quality.
- c. prevent contrast reactions.
- d. lower blood pressure.

Question #52: Review

- Steroid Premedication for Contrast Allergy:

Patients with a history of prior iodinated contrast reaction may require corticosteroid prophylaxis.

Common Regimen (example)

- Prednisone 50 mg orally at:

13 hours

7 hours

1 hour before contrast

- Diphenhydramine 25–50 mg 1 hour before

Purpose of Steroid Premedication Regimen:

- Reduce risk of allergic-like reactions

Question #53:

Narrow pre-patient collimation during a CT scan:

- a. increases scatter.
- b. reduces patient dose per slice.
- c. increases pitch.
- d. reduces image contrast.

Question #53: Review

- **CT Beam Collimation**

Collimation shapes the primary beam and limits the irradiated volume.

- Pre-patient collimation: Controls slice thickness
- Post-patient collimation: Reduces scatter reaching detectors

Radiation impact:

- **Narrow collimation reduces patient exposure but increases scan time for coverage**
- Wide collimation increases coverage but increases dose to tissues outside the region of interest

Question #54:

Which medication is commonly used for CT-related anxiety?

- a. Metformin
- b. Insulin
- c. Prednisone
- d. Lorazepam

Question #54: Review

- Anti-Anxiety Medications (Anxiolytics):

CT scanners may cause anxiety or claustrophobia in some patients.

Common medications:

- Lorazepam
- Diazepam
- Midazolam (in monitored settings)

Considerations

- Assess level of consciousness
- Monitor vital signs
- Ensure patient has transportation home if sedated
- Implement fall precautions

These medications help reduce motion and improve image quality.

Question #55:

In the photoelectric effect, the x-ray photon:

- a. is deflected.
- b. loses partial energy.
- c. is completely absorbed.
- d. passes through unchanged.

Question #55: Review

- Definition of the Photoelectric Effect:

The photoelectric effect is a type of photon interaction in which:

- An incoming x-ray photon interacts with a tightly bound inner-shell electron.
- The photon transfers all of its energy to the electron and is absorbed.
- The photon disappears completely.
- The electron is ejected from the atom (photoelectron).
- The atom becomes ionized.

Because the photon is completely absorbed, the photoelectric effect contributes directly to beam attenuation.

Question #56:

The most effective method for preventing infection transmission is:

- a. hand hygiene.
- b. wearing gloves.
- c. cleaning the CT table.
- d. using sterile instruments.

Question #56: Review

- Hand Hygiene:

Hand hygiene is the most effective infection control measure.

Methods

- Alcohol-based hand sanitizer (preferred when hands are not visibly soiled)
- Soap and water (required when hands are visibly dirty or after contact with spore-forming organisms such as *C. difficile*)

Hand hygiene should be performed:

- Before and after each patient
- After removing gloves
- After contact with contaminated surfaces
- Before handling clean equipment

Question #57:

The probability of photoelectric interaction increases with:

- a. higher photon energy.
- b. lower atomic number.
- c. higher atomic number.
- d. increased distance.

Question #57: Review

- The Photoelectric Effect and Dependence on Atomic Number (Z):
The probability of photoelectric interaction is strongly dependent on atomic number:
 - This means that tissues with higher atomic numbers are much more likely to undergo photoelectric absorption.
 - Examples:
 - Bone (calcium, higher Z)
 - Iodine ($Z = 53$)
 - Barium ($Z = 56$)
- This is why iodinated contrast media significantly increases attenuation and improves vascular and soft tissue contrast in CT imaging.

Question #58:

Contact precautions require:

- a. N95 respirator only.
- b. gloves and gown.
- c. no PPE.
- d. eye protection only.

Question #58: Review

- Transmission-Based Precautions:

Additional precautions are required for patients with known or suspected infections.

Contact Precautions:

- Examples: MRSA, C. difficile
- **Gloves and gown**
- Dedicated or disinfected equipment
- Thorough room cleaning

Question #59:

The photoelectric effect increases patient dose because:

- a. photons are scattered.
- b. photons are absorbed and deposit energy.
- c. beam divergence increases.
- d. pitch decreases.

Question #59: Review

- The Photoelectric Effect's Contribution to Patient Dose

While beneficial for image contrast, the photoelectric effect also increases patient dose because:

- The photon is completely absorbed.
- Energy is deposited locally in tissue.
- Ionization may cause biological damage.

Thus, balancing contrast and dose is essential in CT protocol optimization.

Question #60:

Which precaution is appropriate for a patient with tuberculosis?

- a. standard precautions only
- b. droplet precautions
- c. airborne precautions with N95 mask
- d. contact precautions only

Question #60: Review

- Airborne Precautions:

Examples: Tuberculosis, measles

- N95 respirator or higher-level protection
- Minimize patient transport
- Coordinate with infection control

Technologists must verify isolation status before transporting or imaging patients.

Question #61:

In a Compton Interaction, the x-ray photon is:

- a. completely absorbed.
- b. reflected with equal energy.
- c. converted into heat.
- d. deflected with reduced energy.

Question #61: Review

- Definition of the Compton Interaction

The Compton Interaction occurs when:

- An incoming x-ray photon interacts with a loosely bound outer-shell electron.
- The photon transfers part of its energy to the electron.
- The electron is ejected from the atom (Compton electron).
- **The photon is deflected (scattered) in a different direction with reduced energy.**
- The atom becomes ionized.

Unlike the photoelectric effect, the photon is not completely absorbed. Instead, it continues traveling with less energy.

Question #62:

Which type of contrast media is most commonly used for IV CT examinations?

- a. ionic high-osmolar contrast
- b. nonionic low-osmolar contrast
- c. barium sulfate
- d. air

Question #62: Review

- Nonionic low-osmolar iodinated contrast agents are the most commonly used CT contrast materials due to iodine's high atomic number ($Z = 53$), which produces strong x-ray attenuation.

Water-Soluble Iodinated Contrast

- These agents are:
 - Hydrophilic
 - Rapidly distributed in extracellular fluid
 - Excreted primarily through the kidneys

Common Uses

- CT angiography (CTA)
- Contrast-enhanced CT of chest, abdomen, pelvis
- Trauma imaging
- Tumor evaluation

Question #63:

Scatter radiation that exposes technologists is primarily due to:

- a. Compton Interactions.
- b. Photoelectric absorption.
- c. characteristic radiation.
- d. tube leakage.

Question #63: Review

- The Impact of the Compton Interaction on Radiation Dose

The Compton Interaction contributes to:

- Patient dose (partial energy absorption)
- Occupational exposure (scatter radiation)

Because scattered photons exit the patient in various directions, they are the primary source of technologist radiation exposure in CT.

Question #64:

In reference to iodinated contrast agents, osmolarity refers to:

- a. thickness of contrast.
- b. iodine concentration.
- c. number of dissolved particles in solution.
- d. injection rate.

Question #64: Review

- Iodinated Contrast Material vs. Osmolarity:

Osmolarity refers to the concentration of osmotically active particles in solution.

- Clinical Significance of Osmolarity:

High osmolarity contrast agents may cause:

- Fluid shifts from cells into the vascular space
- Vascular irritation
- Increased risk of:

Nephrotoxicity

Cardiovascular stress

Discomfort

Low- and iso-osmolar contrast agents are preferred for:

- Patients with renal impairment
- Cardiac disease
- Elderly patients

Question #65:

In coherent scatter, the x-ray photon:

- a. is completely absorbed.
- b. loses energy.
- c. ejects an inner-shell electron.
- d. changes direction without losing energy.

Question #65: Review

- Definition of Coherent (Classical) Scatter:

Coherent scatter, also called classical scatter or Thomson scatter, is a low-energy photon interaction in which:

- An incident x-ray photon interacts with the entire atom.
- The photon excites the atom temporarily.
- No ionization occurs.
- The photon is re-emitted in a different direction.
- The photon retains the same energy (no energy loss).

Unlike the photoelectric effect and Compton interaction:

- No electron is ejected.
- No ionization occurs.
- The photon's wavelength remains unchanged.

Question #66:

High-osmolar iodinated contrast media increase the risk of:

- a. fluid shifts and vascular irritation.
- b. hypoglycemia.
- c. radiation dose.
- d. motion artifact.

Question #66: Review

- Iodinated Contrast Material vs. Osmolarity:
 - Osmolarity refers to the concentration of osmotically active particles in solution.
- Clinical Significance of Osmolarity:
 - High osmolarity contrast agents may cause:
 - Fluid shifts from cells into the vascular space
 - Vascular irritation
 - Increased risk of:
 - Nephrotoxicity
 - Cardiovascular stress
 - Discomfort
 - Low- and iso-osmolar contrast agents are preferred for:
 - Patients with renal impairment
 - Cardiac disease
 - Elderly patients

Question #67:

Does coherent scatter cause ionization?

- a. yes
- b. no
- c. only at high energy
- d. only in bone

Question #67: Review

- **Definition of Coherent (Classical) Scatter**

Coherent scatter, also called classical scatter or Thomson scatter, is a low-energy photon interaction in which:

- An incident x-ray photon interacts with the entire atom.
- The photon excites the atom temporarily.
- No ionization occurs.
- The photon is re-emitted in a different direction.
- The photon retains the same energy (no energy loss).

Unlike the photoelectric effect and Compton interaction:

- No electron is ejected.
- **No ionization occurs.**
- The photon's wavelength remains unchanged.

Question #68:

Which property increases injection pressure during power injection?

- a. low osmolarity
- b. high viscosity
- c. iodine concentration
- d. elevated temperature

Question #68: Review

- Impact of Iodinated Contrast Viscosity:

Viscosity refers to the thickness of the contrast medium.

High viscosity:

- Requires higher injection pressure
- May increase risk of extravasation
- Can be reduced by warming contrast to body temperature

Technologists should understand viscosity when using power injectors.

Question #69:

Coherent scatter is also known as.

- a. Thomson scatter
- b. pair production
- c. Bremsstrahlung
- d. auger emission

Question #69: Review

- Definition of Coherent (Classical) Scatter

Coherent scatter, also called classical scatter or Thomson scatter, is a low-energy photon interaction in which:

- An incident x-ray photon interacts with the entire atom.
- The photon excites the atom temporarily.
- No ionization occurs.
- The photon is re-emitted in a different direction.
- The photon retains the same energy (no energy loss).

Unlike the photoelectric effect and Compton interaction:

- No electron is ejected.
- No ionization occurs.
- The photon's wavelength remains unchanged.

Question #70:

Which oral contrast is contraindicated when bowel perforation is suspected?

- a. water
- b. air
- c. barium sulfate
- d. iodinated contrast

Question #70: Review

- **Barium Sulfate**

Properties

- Insoluble
- High attenuation
- Excellent mucosal coating

Indications

- Routine CT abdomen/pelvis
- Evaluation of bowel anatomy
- Tumor, obstruction, or inflammation assessment

Contraindications

- **Suspected bowel perforation**
 - Postoperative anastomosis risk
 - High aspiration risk
- **If perforation is suspected, water-soluble iodinated oral contrast is used.**

Question #71:

Pitch in helical CT is defined as:

- a. table movement per rotation divided by beam width.
- b. kVp divided by mAs.
- c. beam width divided by table movement.
- d. mAs divided by rotation time.

Question #71: Review

- One of the most important geometric parameters in helical CT scanning is pitch.
- Pitch directly affects scan time, radiation dose, image noise, and spatial resolution.
- When used appropriately, increasing pitch can reduce patient radiation exposure while maintaining diagnostic image quality.
- In helical (spiral) CT, pitch is defined as:

$$Pitch = \frac{\text{Table movement per rotation}}{\text{Total collimated beam width}}$$

Table movement per rotation = distance the patient table travels during one 360° tube rotation

Total collimated beam width = total thickness of the x-ray beam (number of detector rows × slice thickness)

Question #72:

Typical IV iodinated contrast dose is based on:

- a. patient age.
- b. patient weight.
- c. patient height.
- d. room temperature.

Question #72: Review

- Intravenous (IV) Iodinated Contrast Administration

IV contrast is the most common route in CT imaging.

Iodinated contrast agents are administered directly into the bloodstream to enhance vascular structures and soft tissues.

Dose Calculation

- Factors influencing IV iodinated contrast dose:

Patient weight: Standard adult dose: 1–2 mL/kg of low-osmolar contrast

Iodine concentration: Usually 300–370 mg I/mL

Scan type and timing: Bolus tracking may affect dose selection

Example:

- Patient weight: 70 kg
- Dose: $1.5 \text{ mL/kg} \times 70 \text{ kg} = 105 \text{ mL}$ of contrast

Question #73:

Pre-patient collimation primarily controls:

- a. detector efficiency.
- b. beam width.
- c. reconstruction kernel.
- d. window level.

Question #73: Review

- Definition of Collimation in CT

Collimation refers to the restriction and shaping of the x-ray beam to a desired width and thickness.

In CT, there are two types:

- Pre-patient (source) collimation

- Located near the x-ray tube

- Defines total beam width

- Controls slice thickness before the beam enters the patient

- Post-patient (detector) collimation

- Located near the detectors

- Reduces scatter reaching detectors

- Improves image contrast

Pre-patient collimation primarily affects patient dose.

Question #74:

Which site is preferred for high-flow IV contrast injections?

- a. dorsal hand vein
- b. foot vein
- c. forearm vein
- d. antecubital fossa

Question #74: Review

- **Venipuncture Site Selection**

Selecting the appropriate venipuncture site is crucial for patient safety, injection efficiency, and image quality.

Common Sites

- **Antecubital fossa**

- **Most preferred site**

- **Large veins (median cubital, cephalic, basilic)**

- **Allows high-flow injection with reduced risk of extravasation**

- **Dorsal hand veins**

- **Used if antecubital access is unavailable**

- **Lower flow rates tolerated**

- **May be more painful; smaller gauge preferred**

- **Forearm veins**

- **Alternative if antecubital veins unsuitable**

- **Requires assessment of vein straightness and depth**

Question #75:

Overbeaming refers to:

- a. beam wider than detector array.
- b. excessive mAs.
- c. excessive pitch.
- d. increased kVp.

Question #75: Review

- Overbeaming occurs when the x-ray beam is slightly wider than the active detector array.

This is necessary because:

The beam must fully cover all detector rows.

Penumbra regions at beam edges are non-uniform.

- Dose Implication

The portion of the beam that extends beyond the detectors:

Does not contribute to image formation.

Still contributes to patient dose.

Question #76:

Which gauge is generally used for routine CT contrast injections?

- a. 14G
- b. 18–22G
- c. 24–26G
- d. 28G

Question #76: Review

- Venipuncture Best Practices:

<i>Component</i>	<i>Key Points</i>
Site Selection	Prefer antecubital fossa; avoid sites with scarring, edema, fistulas
Needle Gauge	18–22G for routine CT
Injection Rate	Based on gauge (18G = 5–6 mL/sec, 22G = 2–3 mL/sec)
Documentation	Site, amount, concentration, gauge, flow rate, attempts, patient reaction
Complications	Extravasation, hematoma, infection, air embolism; monitor and manage

Question #77:

Post-patient collimation mainly:

- a. controls beam width entering patient.
- b. increases dose.
- c. increases pitch.
- d. reduces scatter reaching detectors.

Question #77: Review

- **Definition of Collimation in CT**

Collimation refers to the restriction and shaping of the x-ray beam to a desired width and thickness.

In CT, there are two types:

- **Pre-patient (source) collimation**

- Located near the x-ray tube

- Defines total beam width

- Controls slice thickness before the beam enters the patient

- **Post-patient (detector) collimation**

- Located near the detectors

- Reduces scatter reaching detectors

- Improves image contrast

Pre-patient collimation primarily affects patient dose.

Question #78:

Extravasation occurs when:

- a. needle passes through the vein.
- b. contrast enters the vein too quickly.
- c. catheter is too short.
- d. contrast leaks into surrounding tissue.

Question #78: Review

- Venipuncture Complications:

- **Extravasation:**

- **Leakage of contrast into surrounding tissue**

- Symptoms: swelling, pain, erythema

- Prevention:

- Select large, straight vein

- Secure catheter and monitor injection

- Management:

- Stop injection immediately

- Apply cold compress

- Document event

Question #79:

Added filtration is typically made of:

- a. lead.
- b. plastic.
- c. tungsten.
- d. aluminum.

Question #79: Review

- Types of Filters in CT

1. Aluminum Filters

- Most common type for standard CT imaging.
- Typically 2–3 mm Al equivalent.
- Removes soft, low-energy photons effectively.

2. Copper Filters

- Higher atomic number than aluminum.
- More efficient in removing low-energy photons.
- Used in pediatric imaging to further reduce dose.

3. Bow-Tie Filters

- Shaped filters designed to match patient anatomy.
- Thicker at the edges, thinner in the center.
- Reduces peripheral skin dose while maintaining adequate exposure in the central body region.
- Compensates for variation in patient thickness.
- Common in modern MDCT scanners.

Question #80:

A timing bolus is used to:

- a. reduce radiation exposure.
- b. determine optimal scan delay for contrast peak.
- c. manually inject contrast at high flow.
- d. monitor renal function.

Question #80: Review

- CT Scanning Techniques: Timing Bolus

CT imaging depends on precise timing of contrast enhancement to optimize visualization of vascular structures, organs, and lesions. Technologists must understand timing bolus, bolus tracking, and scan delay techniques to maximize diagnostic quality while minimizing contrast volume and patient risk.

Timing Bolus (Test Bolus)

- A timing bolus or test bolus involves injecting a small, measured amount of contrast to determine the time it takes for contrast to reach the target vascular structure or organ.
- This allows calculation of the optimal scan delay for full diagnostic enhancement during the main CT scan.

Question #81:

Bow-tie filters:

- a. reduce peripheral skin dose by shaping the beam to patient anatomy.
- b. remove only high-energy photons.
- c. are uniform in thickness.
- d. increase mAs automatically.

Question #81: Review

- Types of Filters in CT:

1. Aluminum Filters

- Most common type for standard CT imaging.
- Typically 2–3 mm Al equivalent.
- Removes soft, low-energy photons effectively.

2. Copper Filters

- Higher atomic number than aluminum.
- More efficient in removing low-energy photons.
- Used in pediatric imaging to further reduce dose.

3. Bow-Tie Filters

- Shaped filters designed to match patient anatomy.
- Thicker at the edges, thinner in the center.
- Reduces peripheral skin dose while maintaining adequate exposure in the central body region.
- Compensates for variation in patient thickness.
- Common in modern MDCT scanners.

Question #82:

Which of the following is a mild contrast reaction?

- a. flushing and mild urticaria
- b. hypotension with airway compromise
- c. cardiac arrest
- d. severe bronchospasm

Question #82: Review

- Side Effects of Iodinated Contrast Media:

Contrast reactions are divided into nonallergic (physiologic) and allergic-like (anaphylactoid) reactions.

- **Mild Reactions:**

Usually self-limited, no long-term sequelae

Common symptoms:

- Flushing
- Mild urticaria (hives)
- Nausea or vomiting
- Mild headache or dizziness

Management:

- Observe patient
- Provide reassurance
- Administer antihistamines if needed

Question #83:

Pediatric CT benefits from filtration because:

- a. children have higher attenuation.
- b. it reduces radiation dose to sensitive organs.
- c. it eliminates the need for mAs adjustment.
- d. it allows use of higher kVp.

Question #83: Review

- Filtration in Pediatric CT

Children are more sensitive to radiation, and the skin-to-organ ratio is higher. Techniques include:

- Use of additional aluminum or copper filtration.
- Bow-tie filters tailored to small patient size.
- Reduced kVp combined with filtration to enhance contrast while minimizing dose.

Question #84:

Moderate contrast reactions include:

- a. diffuse urticaria and mild bronchospasm.
- b. flushing and headache.
- c. cardiac arrest.
- d. unconsciousness.

Question #84: Review

- Side Effects of Iodinated Contrast Media:

Moderate Reactions:

- More pronounced but not immediately life-threatening
- Common symptoms:
 - Diffuse urticaria
 - Mild bronchospasm or wheezing
 - Facial edema
 - Tachycardia or mild hypotension
- Management:
 - Call for medical assistance
 - Administer oxygen and medications (antihistamines, bronchodilators)
 - Monitor vital signs continuously
 - Be prepared to escalate to severe reaction protocol

Question #85:

Gating in CT is primarily used to:

- a. synchronize exposure with the patient's physiological cycle.
- b. increase photon energy.
- c. reduce scan time only.
- d. eliminate contrast use.

Question #85: Review

- Definition of Gating

Gating in CT is the process of coordinating x-ray exposure with a physiologic signal or cycle.

Most commonly, it involves:

- ECG gating: Synchronizes exposure to the cardiac cycle.
- Respiratory gating: Coordinates exposure with phases of respiration (less common in routine CT).
- Gating ensures that x-rays are emitted only when the target organ is in a desired phase, reducing unnecessary radiation to other phases.

Question #86:

Severe contrast reactions require:

- a. observation only.
- b. antihistamines only.
- c. CPR if necessary and epinephrine administration per protocol.
- d. delayed documentation.

Question #86: Review

- Side Effects of Iodinated Contrast Media:

- **Severe Reactions:**

- Life-threatening, require immediate intervention
 - Common symptoms:

- Severe hypotension

- Laryngeal edema, stridor, or airway obstruction

- Bronchospasm with respiratory distress

- Loss of consciousness, cardiac arrest

- **Management:**

- Activate code blue / emergency team immediately

- Administer epinephrine intramuscularly or IV per protocol**

- Begin CPR if necessary**

- Ensure airway management and oxygen support

- Continuous cardiac monitoring

Question #87:

Prospective ECG gating is also called:

- a. retrospective gating.
- b. continuous helical.
- c. tube current modulation.
- d. step-and-shoot.

Question #87: Review

- **Prospective ECG Gating (“Step-and-Shoot”)**

X-ray exposure occurs only during preselected phase of the cardiac cycle (usually end-diastole).

Table moves in discrete steps.

Pros:

- Significant dose reduction (up to 50–80% compared to retrospective gating).
- Reduced motion artifacts.

Cons:

- Limited functional imaging.
- Requires stable and low heart rate (<65 bpm).

Question #88:

The first action if extravasation occurs during contrast injection is:

- a. apply heat compress.
- b. stop the injection immediately.
- c. continue injection at slower rate.
- d. elevate the limb only.

Question #88: Review

- Definition of Extravasation:

Leakage of contrast material from the vein into surrounding tissue, often causing pain, swelling, or tissue injury

Immediate Management to Include:

- Stop injection immediately
- Leave catheter in place (to aspirate any residual contrast if possible)
- Elevate the affected limb
- Apply cold compresses for 15–20 minutes to reduce swelling and pain
- Monitor for skin necrosis, blistering, or prolonged pain
- Document incident and notify supervising radiologist

Question #89:

Retrospective ECG gating typically:

- a. reduces patient dose the most.
- b. allows multiphase reconstruction.
- c. eliminates motion artifacts completely.
- d. does not require ECG monitoring.

Question #89: Review

- **Retrospective ECG Gating:**

Continuous helical scanning throughout the cardiac cycle.

ECG is recorded simultaneously.

Images are reconstructed from selected phases (commonly end-diastole).

Pros:

- **Allows multiphase reconstruction for functional assessment.**

Cons:

- Higher radiation dose due to continuous scanning.
- Dose can be mitigated using ECG-based tube current modulation.

Question #90:

Cold compresses are applied after extravasation to:

- a. reduce swelling and pain.
- b. promote heat-induced tissue healing.
- c. increase contrast absorption.
- d. dilute the contrast chemically.

Question #90: Review

- Definition of Extravasation:

Leakage of contrast material from the vein into surrounding tissue, often causing pain, swelling, or tissue injury

Immediate Management to Include:

- Stop injection immediately
- Leave catheter in place (to aspirate any residual contrast if possible)
- Elevate the affected limb
- **Apply cold compresses for 15–20 minutes to reduce swelling and pain**
- Monitor for skin necrosis, blistering, or prolonged pain
- Document incident and notify supervising radiologist

Question #91:

Iterative reconstruction primarily:

- a. reduces image noise to allow lower mA or kVp settings.
- b. increases scan time without reducing dose.
- c. eliminates the need for ECG gating.
- d. reduces the number of detector rows.

Question #91: Review

- **Definition of Iterative Reconstruction (IR)**

Iterative reconstruction is an advanced technique in which image data are processed multiple times through an algorithm to improve accuracy.

Unlike traditional filtered back projection (FBP), which mathematically back-projects raw data, **IR uses repeated iterations to reduce noise and artifacts.**

This will allow the use of lower mA stations or kVp settings while maintaining image quality.

Types:

1. Statistical Iterative Reconstruction (SIR)
2. Adaptive Statistical Iterative Reconstruction (ASIR)
3. Model-Based Iterative Reconstruction (MBIR)

Question #92:

The primary purpose of CT positioning aids is to:

- a. improve patient comfort and maintain alignment.
- b. increase scan speed.
- c. increase radiation dose.
- d. replace patient instructions.

Question #92: Review

- Purpose of CT Positioning Aids:

CT positioning aids serve several important functions:

- Maintain correct anatomical alignment
- Enhance patient comfort
- Prevent patient motion
- Improve reproducibility for follow-up studies
- Reduce the need for repeat scans
- Support radiation dose optimization
- Assist with special patient populations (pediatric, trauma, elderly)

Improper positioning can result in:

- Anatomy cut off from the scan field
- Increased image noise and motion artifacts
- Incorrect scan centering (leading to higher radiation dose)
- Misregistration in multiplanar reconstructions

Question #93:

Model-based iterative reconstruction (MBIR) achieves:

- a. significant noise suppression and high dose reduction.
- b. less dose reduction than FBP.
- c. only artifact correction.
- d. reduced spatial resolution.

Question #93: Review

- Types of Iterative Reconstruction (IR):

Iterative reconstruction is an advanced technique in which image data are processed multiple times through an algorithm to improve accuracy.

Types:

1. Statistical Iterative Reconstruction (SIR)
2. Adaptive Statistical Iterative Reconstruction (ASIR)
3. **Model-Based Iterative Reconstruction (MBIR)**
 - **Uses sophisticated physical models.**
 - **Achieves higher noise suppression.**
 - **Allows significant dose reduction (up to 60–70%).**

Question #94:

Which oxygen device delivers the highest oxygen concentration?

- a. nasal cannula
- b. simple mask
- c. non-rebreather mask
- d. venturi mask

Question #94: Review

- **Types of Oxygen Delivery Devices:**

- Nasal Cannula

- Low-flow oxygen (1–6 L/min)

- Simple Face Mask

- Moderate oxygen delivery (5–10 L/min)

- Non-Rebreather Mask**

- **Highest oxygen concentration (up to 90–100%)**
 - CT Considerations

- Do not remove without clinical approval

- Monitor closely for respiratory distress

Question #95:

Retrospective reconstruction allows:

- a. real-time ECG gating.
- b. elimination of metal artifacts only.
- c. increasing patient dose automatically.
- d. post-acquisition slice reformatting.

Question #95: Review

- Definition of Retrospective Reconstruction:

Retrospective reconstruction refers to the ability to reconstruct images from existing raw data after acquisition.

Allows reconstruction at different slice thicknesses or orientations.

Reduces the need for additional scans.

Enables dose optimization by tailoring image quality to diagnostic needs post-acquisition.

Clinical Use

- Multiplanar reformats (MPR) and 3D reconstructions.
- Virtual non-contrast imaging from contrast-enhanced datasets.
- Reduces cumulative radiation exposure by eliminating repeat imaging.

Question #96:

Warming iodinated contrast primarily reduces:

- a. osmolarity.
- b. iodine concentration.
- c. allergic reactions.
- d. viscosity.

Question #96: Review

- Impact of Iodinated Contrast Viscosity:

Viscosity refers to the thickness of the contrast medium.

High viscosity:

- Requires higher injection pressure
- May increase risk of extravasation
- **Can be reduced by warming contrast to body temperature**

Technologists should understand viscosity when using power injectors.

Question #97:

Artifact suppression software primarily targets:

- a. tube voltage fluctuations.
- b. pitch optimization.
- c. motion, metal, and beam hardening artifacts.
- d. slice thickness.

Question #97: Review

- **Artifact Suppression Software:**

Artifact suppression algorithms reduce streaks, beam hardening, and motion artifacts, which otherwise require rescanning.

- **Beam hardening correction:** Reduces artifacts near dense structures (e.g., bones or metal implants).
- **Motion correction:** Compensates for patient movement or cardiac motion.
- **Metal artifact reduction (MAR):** Minimizes streaking from prosthetic devices.

By improving image quality on the first scan, these software tools indirectly reduce patient dose by preventing repeat imaging.

Question #98:

Which value indicates significant hypoxia?

- a. SpO₂ 98%
- b. SpO₂ 95%
- c. SpO₂ 92%
- d. SpO₂ 85%

Question #98: Review

- Pulse Oximetry:

Pulse oximetry measures oxygen saturation (SpO₂) and pulse rate.

Normal Values:

- 95–100%: Normal
- 90–94%: Mild hypoxemia
- <90%: Significant hypoxia

Question #99:

Detector efficiency in CT refers to:

- a. the fraction of x-rays absorbed that contribute to image signal.
- b. tube voltage selection.
- c. collimation width.
- d. scan time reduction.

Question #99: Review

- Definition of Detector Efficiency:

Detector efficiency, often called quantum efficiency (QE), is the fraction of x-ray photons absorbed by the detector that contributes to the signal. It can be described mathematically as:

$$QE = \frac{\text{Number of photons detected}}{\text{Number of photons incident on detector}}$$

High quantum efficiency allows a detector to produce high-quality images with fewer x-rays, which translates directly to lower radiation dose to the patient.

Question #100:

Over-ranging in CT refers to:

- a. increasing tube current to improve image quality.
- b. extra rotations of the gantry beyond the ROI for reconstruction.
- c. reducing slice thickness to lower noise.
- d. using contrast media outside the ROI.

Question #100: Review

- Definition of Over-Ranging:

Over-ranging refers to the extra helical rotations or x-ray exposure that occurs beyond the planned region of interest (ROI) in helical (spiral) CT.

It is required because:

- Helical CT acquires data continuously while the table moves.
- Reconstruction algorithms need data from beyond the ROI to accurately generate images at the scan edges.
- This ensures the final images at the start and end of the scan are free from artifacts.

Although essential for image quality, these additional rotations expose tissues adjacent to the ROI, increasing radiation dose outside the intended scan area.

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