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38	A	B	C	D	E
39	A	B	C	D	E

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9

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QUESTION 1

SINGLE CHOICE

A radiographer is preparing to perform a portable chest examination on a patient in the intensive care unit. Which combination of actions best applies the ALARA principle for personnel and others in the immediate area?

- ☐ **A** Stand within 1 meter of the patient without shielding, and have the nurse remain at the bedside to assist with the patient.
- ☒ **B** Maintain the greatest reasonable distance from the patient during the exposure, wear a lead apron, and ensure that ancillary personnel are either behind a lead shield or positioned at the maximum practical distance.
- ☐ **C** Stand directly at the side of the patient during the exposure so that the primary beam can be observed for centering.
- ☐ **D** Remove all personnel from the room, then enter immediately after the exposure to reposition the patient for the next view.

ANSWER B

WHY ALARA is implemented through the three cardinal principles of radiation protection: time, distance, and shielding. Maximizing distance from the patient during the exposure reduces scattered radiation dose. Wearing a lead apron provides personal shielding, and ensuring that ancillary staff are behind lead barriers or as far away as practical further reduces their exposure. Standing within 1 meter without shielding (option A) and standing directly beside the patient during exposure (option C) both increase personnel dose. Re-entering immediately after exposure is unrelated to dose reduction during the exposure itself.

QUESTION 2

SINGLE CHOICE

Which statement correctly describes the production of bremsstrahlung (braking) x-ray radiation within the x-ray tube?

- ☒ **A** It is produced when a high-speed projectile electron passes near the nucleus of a target atom and is slowed and deflected, converting kinetic energy into an x-ray photon.
- ☐ **B** It is produced when an inner-shell electron is ejected from a target atom and an outer-shell electron fills the vacancy, emitting a photon with energy equal to the difference between the two shells.
- ☐ **C** It is produced by the radioactive decay of unstable isotopes within the anode.
- ☐ **D** It is produced when the cathode filament emits electrons that are accelerated through the glass envelope directly to the patient.

ANSWER A

WHY Bremsstrahlung ('braking radiation') is generated when a high-speed electron from the cathode passes close to the nucleus of a target atom in the anode. The electron is decelerated and deflected by the nuclear field, and a portion of its kinetic energy is emitted as an x-ray photon. The spectrum of bremsstrahlung photons is continuous because the amount of energy lost per interaction varies. Option B describes characteristic radiation (which has a line spectrum, not a continuous one). Option C describes radioactive decay, not x-ray tube emission. Option D is incorrect because electrons do not leave the tube through the glass envelope to strike the patient.

QUESTION 3

SINGLE CHOICE

When all other factors remain constant, which change in technique will increase the number of x-ray photons reaching the image receptor and therefore decrease patient dose per examination?

- ☒ **A** Increase kVp and decrease mAs
- ☐ **B** Decrease kVp and increase mAs
- ☐ **C** Increase both kVp and mAs equally
- ☐ **D** Decrease both kVp and mAs

ANSWER A

WHY The number of photons reaching the receptor is governed primarily by mAs (which controls the quantity of x-ray photons produced), while kVp controls the average energy/penetrating quality of the beam. Raising kVp increases penetration so that a given receptor exposure can be achieved with fewer mAs, which lowers patient dose while maintaining adequate image density. Decreasing kVp requires an increase in mAs to maintain exposure, which increases dose. Increasing both factors increases dose. Decreasing both reduces receptor exposure and increases quantum noise.

QUESTION 4 SINGLE CHOICE

Which component of a digital radiography system is responsible for converting the latent x-ray image into a digital signal that can be processed and displayed?

- ☐ A The high-voltage generator
- ☐ B The automatic exposure control (AEC) photomultiplier
- ☒ C The detector (such as a flat-panel detector or computed radiography plate reader)
- ☐ D The collimator

ANSWER C

WHY In digital radiography, the detector is the component that captures the x-ray pattern after it has passed through the patient. In indirect flat-panel systems, a scintillator (typically cesium iodide or gadolinium oxysulfide) converts x-rays to light, which is then detected by an array of photodiodes and converted into a digital signal. In computed radiography, a storage phosphor plate stores a latent image that is read out by a laser-stimulated luminescence reader. The high-voltage generator produces the x-rays, the AEC terminates the exposure, and the collimator restricts the beam — none of these convert the image to a digital signal.

QUESTION 5 SINGLE CHOICE

On a properly positioned PA chest radiograph, which structure is normally projected as an air-filled structure to the right of the upper mediastinum, just inferior to the medial end of the right clavicle?

- ☐ A Right mainstem bronchus
- ☒ B Trachea
- ☐ C Aortic arch
- ☐ D Azygoesophageal recess

ANSWER B

WHY The trachea is the air-filled tubular structure that overlies the upper mediastinum on a PA chest radiograph and is visible as a vertical lucent column extending from the thoracic inlet to the carina, just to the right of the upper mediastinum and inferior to the medial end of the right clavicle. The right mainstem bronchus is seen lower at the level of the carina. The aortic arch forms a contour on the left upper mediastinum. The azygoesophageal recess is on the right side of the lower mediastinum, not the upper mediastinum.

QUESTION 6

SINGLE CHOICE

For an AP axial (Towne) projection of the skull, which positioning line should be perpendicular to the image receptor, and what is the central ray angled relative to the image receptor?

- ☐ A The infraorbitomeatal line (IOML) is perpendicular to the image receptor; the central ray is angled 30 degrees caudad.
- ☒ B The orbitomeatal line (OML) is perpendicular to the image receptor; the central ray is angled 30 degrees caudad.
- ☐ C The midsagittal plane is perpendicular to the image receptor; the central ray is angled 15 degrees cephalad.
- ☐ D The glabellomeatal line is perpendicular to the image receptor; the central ray is angled 45 degrees caudad.

ANSWER B

WHY For the AP axial (Towne) projection, the patient is supine or erect with the back of the head against the image receptor. The orbitomeatal line (OML) is positioned perpendicular to the image receptor, and the central ray is angled 30 degrees caudad to enter at the level of the foramen magnum (approximately 2 to 3 inches above the glabella). This projects the dorsum sellae and posterior clinoids into the foramen magnum. The infraorbitomeatal line (IOML) is used for other projections; the midsagittal plane perpendicular with 15 degrees cephalad does not match the Towne projection; and a 45-degree caudad angle is not the standard Towne technique.

QUESTION 7

SINGLE CHOICE

A patient receiving an intravenous iodinated contrast injection develops generalized hives, facial swelling, and mild wheezing. According to standard emergency response, what is the most appropriate first pharmacologic intervention?

- ☒ **A** Administer oxygen by mask, stop the injection, and prepare to administer epinephrine intramuscularly while summoning emergency assistance.
- ☐ **B** Continue the injection at a slower rate and observe the patient for one additional minute.
- ☐ **C** Administer a sedative such as diazepam to reduce the patient's anxiety.
- ☐ **D** Disconnect the patient from the injector and immediately begin chest compressions.

ANSWER A

WHY Hives, facial swelling, and mild wheezing indicate an evolving anaphylactoid reaction to iodinated contrast. The injection must be stopped immediately, emergency medical assistance summoned, oxygen administered, and the patient monitored. For mild-to-moderate reactions with these findings, intramuscular epinephrine is the first-line pharmacologic treatment, along with antihistamines and corticosteroids as indicated. Continuing the injection (option B) would worsen the reaction. A sedative does not address the underlying allergic response. Chest compressions are not indicated unless the patient is in cardiac arrest, which has not been described.

QUESTION 8

SINGLE CHOICE

Which of the following practices most directly reduces patient dose during a routine radiographic examination?

- ☒ **A** Using the smallest appropriate field size (tight collimation) to the anatomy of interest.
- ☐ **B** Removing the grid for all pediatric and adult examinations.
- ☐ **C** Using the highest available kVp setting for every projection.
- ☐ **D** Increasing source-to-image distance (SID) is not a means of reducing patient dose.

ANSWER A

WHY Tight collimation restricts the primary beam to the anatomy of interest, which both reduces patient dose by limiting irradiated tissue volume and improves image contrast by reducing scatter. Grids are removed only in specific circumstances (e.g., small anatomy, mobile pediatric imaging) and removing a grid for adults actually increases patient dose by requiring higher mAs. There is no single 'highest kVp' appropriate for every projection. Increasing SID does reduce patient dose (per the inverse square law for entrance skin exposure), so option D's premise is incorrect.

QUESTION 9

SINGLE CHOICE

During a routine radiographic examination, which combination of technical factors most directly reduces patient radiation dose while maintaining acceptable image quality?

- ☐ **A** Decreasing kVp and increasing mAs
- ☒ **B** Increasing kVp and decreasing mAs
- ☐ **C** Increasing kVp and increasing mAs
- ☐ **D** Decreasing kVp and decreasing mAs

ANSWER B

WHY Increasing kVp improves penetration and reduces the mAs required to produce an acceptable image, which lowers patient dose because dose is more directly proportional to mAs than to kVp. Lowering kVp while raising mAs would increase dose, and the other combinations do not optimize the dose-image quality relationship.