Answers and Explanations

Principles of Radiation Physics

1. The correct answer is (D).

An X-ray tube is constructed of two major components: a positively charged anode and a negatively charged cathode. The cathode contains a thin wire called a *filament*, through which a large number of electrons are forced during a radiographic exposure. Because large numbers of electrons are forced through such a small wire, a great deal of heat is produced and individual electrons are forced out of the wire through a process called *thermionic* (ionization due to increased heat) *emission* (forcing out). Thermostatic (A and C) refers to temperature regulation. Electrification (A and B) refers to the charging of an object generally by adding electrons, not ejecting them.

2. The correct answer is (C).

Electrons travel from the negatively charged cathode to the positively charged anode. Due to the extremely high voltage applied to the X-ray circuit, electrons from the negatively charged cathode are very quickly accelerated to nearly half the speed of light. This acceleration takes place over the very small distance of 2 cm.

3. The correct answer is (B).

Electrons carry a negative charge and will tend to move away from each other (diverge) once they have left the cathode filament. The negatively charged focusing cup prevents the electrons from straying too far away from each other by focusing the electrons into a smaller area. This is possible because like charges repel each other; therefore, the negatively charged focusing cup will repel the negatively charged electrons. The smaller electron stream results in the electrons striking a smaller area of the anode and ultimately a smaller focal spot size.

4. The correct answer is (A).

X-ray production is a very inefficient process. When incident electrons slam into the anode, heat is the most common result. Slightly more than 99 percent of the interactions caused by incident electrons lead to heat being created in the anode; therefore, slightly less than 1 percent of these interactions lead to the production of X-rays. Approximately 15 percent (B) of the interactions leading to X-ray production result in characteristic X-rays, while 85 percent (C) lead to bremsstrahlung X-ray production.

5. The correct answer is (A).

Bremsstrahlung is a German word meaning *braking* or *slowing*. As incident electrons enter the target material, they interact with the force field of the atomic nucleus, causing the electrons to slow down. When the incident electron slows down, kinetic energy is given off in the form of an X-ray. Characteristic interactions (B) are caused by the interactions of incident electrons with orbital electrons. Both Compton interactions (C) and coherent interactions (D) are the result of X-rays interacting with matter.

6. The correct answer is (B).

An X-ray created through a characteristic interaction is produced when an incident electron strikes an inner shell electron out of orbit and is replaced by an outer shell electron. The strength of the resulting X-ray is determined by the difference between the binding energies of the two orbital electrons involved. For example, if a K-shell (quantum number 1) electron is ejected and replaced by an electron from the L-shell (quantum number 2), the resulting X-ray would have a strength of 20 kEv (50 kEv - 30 kEv).

7. The correct answer is (A).

Frequency is the number of *pulses* in a wave—that is, the number of times a wave will pass a fixed point in a given period of time. Wavelength is the distance between waves. X-rays, like all other forms of electromagnetic radiation, follow the wave equation: speed = wavelength × frequency. Because all electromagnetic radiation travels at the speed of light and is therefore constant, wavelength will be decreased as frequency is increased. It is not possible, then, for electromagnetic radiation to demonstrate long wavelength and high frequency (D) or short wavelength and low frequency (B). X-rays are some of the most powerful types of electromagnetic radiation and demonstrate high frequency and low wavelength. A good rule of thumb is to equate frequency with energy; the higher the frequency, the higher the energy.

8. The correct answer is (D).

kVp controls the amount of energy given to the incident electrons that strike the target and create X-rays. When the incident electrons are given increased energy, more energy is given to the X-rays created through bremsstrahlung interactions. The amount of energy in the X-ray beam controls the quality of the beam; as energy increases, quality also increases.

9. The correct answer is (C).

Increasing the mA increases the number of electrons that are sent in the electron stream from the cathode to the anode. Increasing the time increases the amount of time that electrons are streaming from cathode to anode; this increases the total number of electrons. Increasing the kVp increases the number of X-rays that are produced but changes the average energy of the X-ray beam (quality).

10. The correct answer is (C).

The beam of X-rays that exits the X-ray tube is called *primary* radiation (A). As the X-rays pass through a patient's body, some are absorbed (attenuated; D) and some are misdirected (scattered; B). The remaining X-rays pass through the patient's body to form the latent image. The remaining radiation is called *remnant* radiation and is sometimes also referred to as *exit* radiation.

11. The correct answer is (B).

X-rays are produced *isotopically*, or in all directions from the target. The usable X-ray beam exits the X-ray tube as a cone-shaped beam with the base of the cone becoming wider as the distance from the target increases. This divergence spreads the X-rays over a wider area as they travel from the target, which reduces the intensity in a given area. X-rays are only slightly attenuated by the molecules in the air (A), and they do weaken as they travel (B). All X-rays travel at the speed of light and will not slow down (D) until they are absorbed.

12. The correct answer is (B).

Ionization is the process of removing or adding an electron to an atom. In this question the only answer that is possible is the removal of an electron from the atom, which would result in a positively charged calcium atom. This atom may remain positive for a very short period of time until a free electron fills the void created by the ionization. X-rays in the diagnostic range do not possess enough energy to remove a proton (C) or neutron (D) from the nucleus.

13. The correct answer is (A).

The Compton effect, also referred to as *Compton scatter*, occurs when an X-ray removes an outer shell electron from orbit; the X-ray then continues its journey, often in a different direction.

14. The correct answer is (B).

Photoelectric absorption occurs when an X-ray strikes an inner shell electron and removes it from orbit. During this interaction the X-ray and its energy are totally absorbed by the ejected electron; the X-ray is absorbed, not scattered. The void left by the ejected inner shell electron is filled by an outer shell electron, and a weak characteristic photon is created.

15. The correct answer is (D).

Coherent scattering occurs only when very low energy X-ray photons (10 kEv or below) interact with a single electron or all of the electrons in an atom. The energy of the incoming X-ray is absorbed, causing the electron(s) to vibrate and create a new X-ray. This new X-ray contains the same energy level as the incoming X-ray but it travels in a different direction. Because no electrons are ejected during this interaction, no ionization occurs.

16. The correct answer is (B).

The chances that an X-ray will be absorbed through the process of photoelectric absorption increases dramatically when the atomic number of the tissue or matter is increased. This is due in large part to the increased number of orbital electrons present. For example, bone has a higher average atomic number than soft tissue; more X-rays are absorbed in bone. Elements such as lead easily absorb X-rays in the diagnostic range because of its very high atomic number. When the energy of the X-ray beam is increased (A or D), the chances of a photoelectric absorption interaction actually decrease. Although increased SID (C) will lead to decreased intensity of radiation and the illusion of increased absorption, this is due to a decreased number of X-rays interacting with tissue but does not affect the interactions of a single X-ray photon.

17. The correct answer is (A).

When the thickness or density of body tissue increases, there is an increased chance of a photoelectric absorption interaction because an increased number of electrons are present and an increased chance that an X-ray will interact with one of these electrons. Of course, the increased number of atoms also leads to an increase in scatter production (B and C) and a decrease in the amount of radiation that will strike the image receptor (D) and create the latent image.

18. The correct answer is (D).

The process of thermionic emission greatly increases the heat present in the cathode filament. Heating the filament raises the energy state of orbital electrons, moving them further from the

atomic nucleus and making them easier to remove. This increases the number of electrons that are available to stream from cathode to anode during the radiographic exposure. Thermionic emission does place a great deal of stress on the filament (B), however, and manufacturers have built in safeguards to protect the filament. The free electrons created through the process of thermionic emission do not directly affect scatter production (C) or the strength of resulting X-ray photons (A).

19. The correct answer is (C).

Many more electrons are present in the cathode prior to exposure, giving the cathode a negative charge when compared to the anode. These *free* electrons congregate near the cathode during the process of thermionic emission but cannot migrate to the anode due to the distance. Once the exposure button is pressed and the high voltage interacts with the free electrons near the cathode, they are quickly accelerated over the relatively short distance (2 cm) between the cathode and the anode.

20. The correct answer is (D).

X-rays produced through characteristic interactions are produced when an incident electron strikes an inner shell electron and knocks it out of orbit. To fill the void left by the ejected electron, an outer shell electron drops down to fill the void and gives off excess energy in the form of an X-ray photon. Bremsstrahlung photons are created by the interaction of an incident electron and an atomic nucleus (A). Both Compton and coherent (B and C) interactions are the result of an X-ray's interaction with orbital electrons.

21. The correct answer is (A).

Bremsstrahlung X-rays are produced when incident electrons interact with the nucleus of an atom. The closer the incident electron passes the nucleus, the more kinetic energy is given off in the form of an X-ray. An X-ray with increased kinetic energy (more energy) will have more energy available to release in the form of an X-ray. X-rays created through a bremsstrahlung interaction do not interact with orbital electrons; therefore, the binding energies of these electrons is insignificant to the strength of bremsstrahlung X-rays.

22. The correct answer is (C).

The distance between identical areas of an electromagnetic wave is called the *wavelength*. In the present case, the arrows identify the distance between the peaks of two separate waves. The height of the electromagnetic wave is called the amplitude (B). The frequency (A) of the wave is determined by how many waves pass a fixed point in a given period of time.

23. The correct answer is (A).

When mAs increases, the total number of electrons that travel from the cathode to the anode will increase; this increases the total number of X-rays created. When kVp is increased, X-ray photons more easily penetrate the tissue being exposed and reach the image receptor.

24. The correct answer is (A).

The beam of X-rays emitted from the X-ray tube is referred to as the primary beam. The primary beam has not yet undergone attenuation or scattering interactions. Secondary radiation (B) refers to the X-rays that are produced in the body as a result of photoelectric absorption. Scatter radiation

(C) refers to the portion of the primary beam that is deviated from its original path. X-rays that pass all the way through the body and form the latent image on the image receptor are referred to as remnant radiation (D).

25. The correct answer is (A).

In order to answer this question, the inverse square law must be used:

Original Intensity/New Intensity = New Distance^2/Old Distance^2

In the present case the original intensity is 3 mGy at an 80 cm SID. The new distance is 120 cm, so the problem should be set up like this:

New Intensity = 3‴×‴80^2/120^2

New Intensity = 3 × 6,400/14,400

New Intensity = 19,200/14,400

New Intensity = 1.3

26. The correct answer is (C).

During a photoelectric absorption interaction, an incident X-ray photon removes an inner shell electron from orbit. The binding energy of the orbital electron is the amount of energy needed to knock the electron out of orbit. The energy of the incident photon must by equal to or greater than the binding energy of the orbital electron in order for the orbital electron to be ejected. Because the energy of the incident photon is completely transferred during this interaction, some of the energy is used to eject the orbital electron (now called the *photoelectron*) and the remainder is given to the photoelectron in the form of kinetic energy.

27. The correct answer is (B).

The percentage of interactions that lead to Compton scatter range from 60 to 75 percent when a kVp exceeding 70 kVp is utilized. The next most common interaction is photoelectric absorption (25 to 37 percent). Coherent scatter production results in less than 1 percent of all interactions. The percentage of X-rays that do not interact with matter and are transmitted all the way through matter is dependent on tissue thickness but rarely exceeds 20 percent.

28. The correct answer is (A).

Coherent scattering is not an important factor in diagnostic imaging because it only occurs at very low energy levels. Most X-ray photons below 10 kEv have been removed from the beam as a result of beam filtration.

29. The correct answer is (A).

Tissues that contain high atomic numbers attenuate the X-ray beam more effectively because more electrons are available to interact with incident X-ray photons. Increased density also increases the number of electrons available for interaction in a given volume of tissue.

Radiographic Equipment

1. The correct answer is (A).

Adjustments to radiographic technique are made at the operating console that is always located behind a protective barrier. In addition to mAs and kVp, adjustments to time and focal spot size can also be made at the operating console. Adjustments to distance, tube angle, central ray alignment, and patient positioning are almost always made in the examination room. Some newer equipment is capable of adjusting SID, tube angle, and central ray alignment at the operating console, but this is the exception in radiographic equipment, not the rule.

2. The correct answer is (C).

When an X-ray tube uses a *dual focus* arrangement, two different filaments are built into the focusing cup. One of these filaments will produce a large stream of electrons, while the second, smaller filament will produce a smaller stream of electrons. The large and small streams of electrons correspond with the large and small focal spots created as the stream of electrons slam into the anode.

3. The correct answer is (D).

Tungsten is an excellent choice as a target material for all of the reasons listed in this question. The high melting point of tungsten (3,370°C) means that it is capable of managing the high number of heat interactions that occur when electrons strike it. In addition, tungsten's ability to conduct heat helps to protect the anode from heat-related damage. Tungsten's atomic number, specifically its K-shell binding energy of 69.5 kEv, leads to the production of characteristic X-rays in the perfect range for diagnostic imaging.

4. The correct answer is (D).

The induction motor, or stator, is responsible for turning the rotor that turns the anode inside the X-ray tube. The spinning anode greatly reduces the ability of the anode to handle the heat created during X-ray production. The induction motor is located outside of the X-ray tube and spins the rotor through the use of a series of electromagnets.

5. The correct answer is (B).

An ionization chamber terminates an exposure when a preset amount of radiation has been detected. The ionization chamber sits between the table and the image receptor and does not normally appear on a finished image because it is very thin (approximately 5 mm). Older automatic exposure control systems known as phototimers are located behind the image receptor (A).

6. The correct answer is (B).

At kVp settings in the diagnostic range (above 50 kVp), a backup time is set to ensure that the generator does not continue to produce X-rays when a problem occurs with the AEC. This time should ideally be set at 150 percent of the anticipated time; if this does not occur, the generator must terminate the exposure when 600 mAs is reached.

7. The correct answer is (D).

Automatic exposure control (AEC) manages the time or mAs setting during a radiographic exposure; kVp must be manually set by the operator. *Density controls* allow the operator to increase or decrease the amount of radiation that must be detected by the ionization chamber in order to terminate the exposure. These controls allow the operator to compensate for anatomical or positioning variations that cannot otherwise be adjusted. A setting of -1 would decrease the mAs, while a setting of +1 would increase the mAs. Most radiographic equipment includes density controls with several steps; for example: -3, -2, -1, 0, +1, +2, +3.

8. The correct answer is (A).

A *dead-man* exposure switch ends an exposure when the switch is released. This prevents the X-ray equipment from continuing to produce radiation when the operator enters the room. It also protects the patient because the operator can release the switch and terminate the exposure prematurely if the technologist observes patient movement during the exposure.

9. The correct answer is (A).

When a cassette is placed into the Bucky assembly, the size is detected by the PBL system and the collimated area is adjusted accordingly. This ensures that the collimated area does not exceed the size of the image receptor, thereby needlessly exposing areas to radiation that will not add to the radiographic image.

10. The correct answer is (B).

In order to create voltage high enough to produce X-rays, a step-up transformer is necessary. A step-up transformer consists of two coils of wire, a primary coil (the one supplied with current) and a secondary coil (the coil in which current is induced). If the number of turns in the secondary coil exceeds the number of turns in the primary coil, voltage will be increased. If the number of turns in the secondary coil is less than the number of turns in the primary coil, voltage will be decreased (step-down transformer). All transformers need the varying magnetic field created by alternating current in order to induce voltage in a secondary coil. Eddy current refers to the current loss in a transformer as a result of conflicting forces.

11. The correct answer is (B).

Rectification refers to the changing of alternating current to pulsating direct current. This is a critical adjustment in the X-ray circuit because this type of generator waveform ensures that electrons travel only from the cathode to the anode during X-ray production. In this example, the entire waveform has been rectified so that the electrons move in pulses in the same direction rather than alternating their movement. The *phase* of the waveform refers to the number of waveforms produced by the generator. In this question, there is only one waveform so it is termed single-phase.

12. The correct answer is (D).

The image intensification tube alters energy as it travels from input screen to output screen. X-rays exit the patient and strike the input phosphor. The input phosphor immediately changes the energy from the X-rays into light photons, which are changed to electrons by the photocathode.

13. The correct answer is (C).

The limiting factor of video viewing systems is the *raster pattern* of the monitor, or the number of lines in the video image. Video viewing systems are only capable of producing resolutions of 1 to 2 lp/mm.

14. The correct answer is (D).

Storing a fluoroscopic image on Cine film or videotape may be a good short-term storage solution. However, if digital imaging is utilized and the image is digitized, an unlimited number of copies can be created without damage to the original image. In addition, the image can be sent through a PACS for remote viewing, storage, or printing.

15. The correct answer is (B).

Automatic brightness control (also known as automatic dose control or automatic brightness stabilization) automatically increases or decreases kVp and mA to compensate for changes in subject density and contrast. These adjustments maintain satisfactory density and contrast of the fluoroscopic image. Automatic gain control (A) adjusts density and contrast through the use of video adjustment but does not use changes in mA and kVp to make this alteration.

16. The correct answer is (B).

During digital imaging utilizing a computed radiography system, the latent image is captured on a photostimulable phosphor (PSP) plate. The PSP plate is fed into an analog-to-digital converter (ADC) where a laser releases the latent image in the form of light photons. The light photons are then converted to a digital image and sent to a computer for processing, or sent to a laser printer in order to print a hard-copy film.

17. The correct answer is (D).

Thin-film transistors (TFTs) are tiny components of a direct digital radiography flat-panel imaging plate. TFTs detect and capture electric charges created by the interaction of the flat-panel plate and incident X-rays. These charges are then transferred to a computer for processing by the TFTs.

18. The correct answer is (B).

Detents are preset locking positions that assist in the alignment of the tube with the image receptor, or lock in the X-ray tube tower at a desired SID. When a release button is pushed by an operator, the X-ray tube tower can be freely moved into a desired position. At specific points, the tower release will lock into position as the tube travels past a point where the tube is longitudinally or transversely centered to the image receptor.

19. The correct answer is (B).

The cord on the mobile radiographic machine ensures that the operator can stand as far as possible from the *patient*. Because scattered radiation from the patient is the primary source of radiation exposure to the radiographer, care must be taken to increase the distance from the patient with the use of the exposure control cord.

20. The correct answer is (D).

Molybdenum offers several advantages as a target material in mammography. The primary advantage of using molybdenum is that characteristic photons created in a molybdenum target contain energies in the 17 to 20 kEv range. This range of energies makes visualization of breast anatomy easier because at this energy level increased photoelectric absorption interactions occur.

21. The correct answer is (B).

Frequency refers to the number of lines per inch of lead strips that a grid contains. If the grid ratio remains constant and the frequency increases, the number of lead strips per inch will increase and the strips will become thinner and be less noticeable on the finished image. Increasing grid ratio (A) increases the thickness of the grid or the grid lines, making the grid lines even more noticeable. Increasing the grid conversion factor (D) is the same as increasing the grid ratio. Increasing the focus of the grid (C) does not affect the thickness of the lead strips.

22. The correct answer is (D).

The Bucky assembly is named after Gustav Bucky, the person who invented the radiographic grid. The Bucky assembly refers to the mechanical devices that lie between the radiographic table (or wall board) and the image receptor as well as the tray that holds the cassette in position during the exposure.

23. The correct answer is (D).

Unlike radiographic film, the phosphor plates used in computed radiography are not as sensitive to ambient room light. In fact, a phosphor plate can be removed from the cassette in normal room light and returned to the cassette prior to exposure without damage to the future latent image. The phosphor plate does, however, become slightly more sensitive to light after exposure. Although the cassette used in computed radiography does a fairly good job of keeping ambient light away from the phosphor plate, it is not considered to be as lightproof as a film-screen cassette.

24. The correct answer is (C).

The letter C in the illustration identifies the cathode. The cathode is the negatively charged side of the X-ray tube from which electrons are emitted. This emission occurs when a large cloud of electrons, separated from the cathode filament due to the effects of thermionic emission, is very quickly accelerated from the cathode to the anode by high voltage. As the electrons are quickly decelerated in the anode (A), X-rays are created and exit the tube (B).

25. The correct answer is (A).

The output of all X-ray generators fluctuates as it produces X-rays. Some generators fluctuate a great deal; for example, a single-phase unit produces X-rays and stops producing X-rays 120 times per second. The output of a single-phase unit is very inefficient due to the starting and stopping of X-ray production. High-frequency generators produce a much more constant waveform, and therefore, a much more constant production of X-rays.

26. The correct answer is (C).

When incident electrons bombard the anode, the majority of the interactions are heat interactions. Because so much heat is generated in the anode, it must be warmed up prior to use at the beginning of the day; this prevents cracking of the anode. Stress-relieved anodes are able to disperse heat much more quickly than other types of anodes and do not need to be warmed up.

27. The correct answer is (B).

The step-up transformer raises voltage from about 220 volts to more than 50,000 volts. Although receiving an electrical shock is seldom a pleasant event, an electric shock of 50,000 volts is much more dangerous than a 220-volt shock. The primary side of the step-up transformer is the side supplied with power—prior to stepping up the voltage to extremely high levels. Therefore, it is much safer to adjust the kVp on the low-voltage side of the X-ray circuit.

28. The correct answer is (D).

Photoelectrons are emitted by the photocathode inside of the image intensification tube. The fluoroscopic image is *minified* (made smaller) inside the image intensification tube as the photoelectrons travel from the photocathode to the output screen because of the actions of the electrostatic lenses. The electrostatic lenses carry a negative charge and funnel the negatively charged photoelectrons into a thinner stream as they travel. Manipulation of the electrical charge and voltage of the electrostatic lenses can affect the magnification of the fluoroscopic image as well.

29. The correct answer is (A).

The exposure angle is the distance the tomographic tube moves during the exposure. As the angle increases, the amount of blurring that occurs also increases, making a thin area of sharpness appear at the fulcrum point. The more complex the tube motion becomes, the more blurring also occurs; this also leads to a smaller section of sharpness.

Quality Control of Radiography Equipment and Accessories

1. The correct answer is (A).

When a radiographic exposure is produced, the radiation field should not extend beyond the edge of the image receptor. When this occurs, additional anatomy is exposed to radiation without contributing diagnostic information. If the resulting radiation field is smaller than the light field used for positioning, important anatomy may be omitted and the image may have to be repeated. In order to ensure that the light field used for positioning closely matches the resulting radiation field, tests are conducted to ensure that the radiation field does not vary from the light field by more than 2 percent of the SID. For example, if the SID is 100 cm, the light field and the radiation field can vary by no more than 2 cm.

2. The correct answer is (A).

The center of the Bucky tray can vary from the center of the X-ray field by no more than 1 percent of the SID. In this question the SID is 70 cm, so the variation may not exceed 1 percent of 70 cm, which is 0.7 cm.

3. The correct answer is (C).

The kVp may vary from the selected kVp by no more than 5 percent. In the present case the kVp is set to 70, so a reading greater than 5 percent, or 3.5 kVp, would indicate a problem. The kVp reading is 10 percent greater than the selected kVp, so a problem exists. The other factors are within tolerance limits (Time ± 5 percent; SID ± 2 percent).

4. The correct answer is (C).

The tool in the radiograph displayed in this image is a line pair test tool that measures resolution. Resolution is the measurement of how well small structures can be seen on a completed radiograph. Measurement is made in line pairs per millimeter (LP/mm). As the number of visible line pairs increases, the lines in the test tool become smaller and harder to discriminate from each other. Imaging systems that are able to display a higher number of line pairs are said to display increased resolution.

5. The correct answer is (A).

Both the pinhole camera and the star resolution pattern can be used to estimate the size of the true focal spot size. The synchronous spinning top is used to measure timer accuracy.

6. The correct answer is (D).

A lead apron should be inspected when it is purchased to make sure that no manufacturing defects are present. In addition, the apron should also be inspected every 6 months to ensure that cracks or shifting of the lead sheeting has not occurred. Whenever a problem is suspected with a lead apron, it should also be inspected. Problems may be suspected if cracking or shifting of the lead sheeting can be felt or seen, or if a lead apron has been folded for an extended period of time.

7. The correct answer is (B).

The reciprocity law states that a specific mAs setting should result in the same radiation output regardless of the combinations of mA and time used. In this question two mA and time settings are used to produce 50 mAs. The different mAs settings do not result in the same tube output, however, indicating a failure of the reciprocity law. Anytime the optical density of two images produced with the same mAs vary by more than 0.2, the reciprocity law is said to fail.

8. The correct answer is (D).

The collimated field size may not exceed the size of the collimated light field by more than 2 percent of the SID. In this question the SID is 80 cm, so the variation may not exceed 2 percent of 80 cm, which is 1.6 cm.

9. The correct answer is (D).

In order to test the contact of an intensification screen and radiographic film in a film-screen cassette, a wire mesh test tool is placed on the cassette and an image is produced. If an area of poor film-screen contact exists, an area of increased density and blur appears due to increased diffusion of light from the intensification screen. Cassettes with poor film-screen contact should not be used for patient examinations because spatial resolution will be decreased, important anatomy may be obscured, or the blur may imitate certain pathologies.

10. The correct answer is (A).

Dirt and dust in a radiographic cassette will eventually work their way in between the intensification screen and radiographic film. When this occurs, light from the intensification screen is not able to reach the film and a tiny area of decreased density (white speck) will occur. Dirt or dust will not affect the entire radiograph, only the area where the dust or dirt is located.

11. The correct answer is (B).

Lead aprons and gloves must provide radiation protection while still providing practicality and some degree of comfort. A lead-equivalent thickness of 0.5 mm provides radiation protection while still making an apron practical to wear for long fluoroscopic procedures.