Medical Technology

ARDMS
American Registry for Diagnostic Medical Sonography (SPI)

Questions And Answers PDF Format:

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Question: 1

Lateral resolution will be improved if the sonographer performs which operation ?

A. Decreases the scanning depth
B. Increases the number of focal zones
C. Maximizes the output power
D. Uses a lower frequency

Answer: B

Explanation:
Lateral resolution depends on the width of the ultrasound beam. It will be improved if the sonographer increases the number of focal zones while scanning a patient because this is the narrowest portion of the beam (focus). Lateral resolution is enhanced at the focus. This action will, however, slow down the frame rate. Lateral resolution (also referred to as angular, azimuthal, and transverse) describes the capability of the system to demonstrate separate reflectors when they are perpendicular to the ultrasound beam. If the user decreases the scanning depth, this will improve the lateral resolution only when it is the focal point as well, but unlike axial resolution, the lateral resolution does change with the imaging depth. The output power will not affect the lateral resolution. Switching to a lower frequency will generate a wider beam that degrades the lateral resolution.

Question: 2

Which action will NOT increase (or improve) temporal resolution?

A. Increase the imaging depth.
B. Decrease the number of focal zones.
C. Use a sector size that is narrow.
D. Use a low line density.

Answer: A

Explanation:
Temporal resolution describes the capability of the ultrasound machine to image in real time and is dependent on the frame rate. The frame rate depends on the imaging depth and how many pulses are in each frame. One of the most common steps performed to increase temporal resolution is to decrease the depth during an ultrasound exam. A structure that is located deeper in the body will require a greater time of flight because the system is transmitting the pulses into the body

and then back to the transducer to be processed. This additional time will decrease the frame rate and temporal resolution. If the user needs to increase temporal resolution, the scanning depth should always remain as shallow as possible, so there is less time required to process a signal. If a user increases the imaging depth, temporal resolution decreases (slows down) because it takes more time for the signal to return to the system. In other words, an increase in depth decreases the frame rate. When temporal resolution decreases, the operator will notice a lag in the image.

Question: 3

Which name describes how the angles of the incident and transmission beams are related to the speed of the two media?

A. Bernoulli's principle
B. Curie point
C. Huygens' principle
D. Snell's law

Answer: D

Explanation:
Refraction is the bending of a sound beam when it travels from one medium to another. Two conditions must apply for refraction to take place in a clinical setting:

1. There must be an oblique angle of incidence
2. The two media must be traveling at different speeds because refraction cannot take place if the media have identical speeds.

Clinically, an ultrasound beam will bend slightly only at various tissue interfaces. Bone tends to create larger refraction angles because the speed of ultrasound in bone is faster than the speed of sound in soft tissues. Snell's law is used to calculate refraction, and the following equation may be used:

$$\frac{\sin(\text{angle of transmission})}{\sin(\text{angle of incidence})} = \frac{\text{speed in medium 2}}{\text{speed in medium 1}}$$

Bernoulli's principle refers to the correlation between velocity and pressure in a fluid. The Curie point refers to the temperature at which polarization of the active element takes place. Huygens' principle explains the hourglass appearance of an ultrasound beam.

Question: 4

What can be done when investigating a possible kidney stone to better demonstrate shadowing from the stone when using a 3 MHz probe?

A. Position the focal point deeper than the stone.
B. Increase the amount of gain.
C. Increase the frequency to 5 MHz.
D. Decrease the output power of the system.

Answer: C

Explanation:
A sonographer can improve the resolution in what appears to be kidney stones (nephrolithiasis) by two methods. If stones are suspected, but distal acoustic shadowing is not clearly identified with a 3 MHz probe, the sonographer can increase the frequency as high as it will go. Higher frequency transducers will create an ultrasound beam that is narrower. If the ultrasound wave is wider than the stone, the beam picks up signals from either side of the stone, and the shadow may not be visualized as well or at all. In this case, perhaps the operator can bump the frequency all the way up to 5 MHz. Another adjustment that can be performed to create a narrow beam is to place the focal point at the depth of the kidney stones. The gain and output power will not affect visualization of the stones.

Question: 5

If the frequency is doubled, what effect will this have on the wavelength?

A. It will remain the same.
B. It doubles.
C. It increases by a factor of 1.54.
D. It is halved.

Answer: D

Explanation:
The definition of wavelength is the length of one cycle. Wavelength will be displayed in any unit of distance, and the usual range in diagnostic ultrasound imaging is 0.1—0.8 mm. The medium and the sound source are factors that determine the wavelength. Wavelength is not a control on the ultrasound system that a sonographer can change; rather, wavelength changes when changing transducers that have a different frequency. To calculate the wavelength of a sound beam in soft tissue, the following formula can be used:

$$\text{wavelength in soft tissue} = \frac{1.54}{\text{frequency}}.$$

Using this formula, one can visualize the inverse relationship between the wavelength and the frequency, and if the frequency is doubled, the wavelength will be halved, making the only correct choice.

Question: 6

Which part of the transducer is necessary to reduce the amount of ringing of the piezoelectric (PZT) crystal?

A. Matching layer
B. Backing material
C. Transducer housing
D. Wire

Answer: B

Explanation:
The backing material is the component of the transducer that will diminish the time (and length) that the PZT crystal is ringing. This layer is attached to the back of the active element to control any excess vibrations. Longer pulses tend to create images with poor axial resolution. Axial resolution will be improved with a shorter pulse length and duration that the crystal is excited. The backing material is also referred to as the damping element and has an impedance that is similar to PZT while retaining much of the energy of the sound (absorption). The matching layer is situated between the patient and the PZT crystal, and it is there to decrease the impedance at the boundary of the skin and the transducer face. The transducer housing is to protect the patient and the user from electrical shock. The wire couples the PZT crystals and the ultrasound machine.

Question: 7

A given frequency of sound is 4.5 MHz, and it has a wavelength of 0.8 mm. How thick should a manufacturer design the matching layer of a transducer in this scenario?

A. 0.4 mm
B. 0.16 mm
C. 0.2 mm
D. 0.6 mm

Answer: C

Explanation:
The purpose of the matching layer is to enable the ultrasound energy to make a smooth transition from the transducer into the patient's body by curbing the reflections at the skin. Ultrasound gel also helps transmit the sound beam into the body by eliminating the air gap. The thickness of the transducer's matching layer should be one-quarter of the wavelength of the sound beam. In this instance, the length of the wavelength is 0.8(1/4) = 0.2.

Question: 8

Which transducer produced the shape of this image?

A. Linear sequential array
B. Vector array
C. Annular phased array
D. Convex array

Answer: D

Explanation:
The image shape in this question is referred to as a blunted sector. It resembles the classic sector-shaped image at greater depths, but the difference lies at the top of the image. The indentation is associated with the curvature of the transducer face in convex array probes. A linear sequential array produces an image in the shape of a rectangle. A vector array transducer produces an image that is in the shape of a trapezoid. An annular phased array transducer produces images that are sector shaped with a sharp point at the top.

Question: 9

This malfunction takes place in which kind of transducer?

A. Linear sequential array
B. Annular phased array
C. Convex sequential array
D. Mechanical

Answer: B

Explanation:
This image demonstrates an image in which the midportion is lost due to a horizontal band of dropout, which is demonstrated by the black band. The user will still be able to see the rest of the image that is not within this horizontal band. This malfunction has taken place in one of the rings of an annular phased array transducer. If an element malfunctions in either a linear sequential array or a convex sequential array transducer, the result will be a vertical band of dropout beneath the damaged crystal. Recall that a mechanical transducer only has one active element, so if this crystal is damaged, the sonographer will not see an image at all when attempting to scan.

Question: 10

Which statement is NOT true of a linear phased array transducer?

A. The footprint tends to be small.
B. It can alter the number of focal zones and the depth.
C. The image is a rectangle.
D. It uses electronic steering.

Answer: C

Explanation:
There are many advantages of using any transducer with phased array technology. Linear phased array probes have small footprints, enabling easier intercostal scanning. Another advantage is that the sonographer can electronically focus the ultrasound beam at all depths during an exam. Focusing can be optimized regardless of the depth of the anatomical structure being interrogated. Steering is also controlled electronically. With linear phased array transducers, the part that touches the patient is flat, but the beam is sent into the body in a nonlinear fashion, creating an image that is sector shaped. In other words, the pulses can also reach structures in the body that are not directly in front of them.

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