COMPREHENSIVE MOCK EXAM 7

Supplemental to: Ultrasound Physics Board Review 2026-2027

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ARDMS SPI (Sonography Principles and Instrumentation) Examination, Inteleos -- 110 questions, single-best-answer, four options (A-D), domain-weighted per official ARDMS SPI Content Outline

Board-Review Questions

1. The AIUM Prudent Use Statement advises that diagnostic ultrasound should be used:

A. At maximum output for every exam

B. Only for research purposes exclusively

C. Only when medically indicated, at low output

D. Exclusively performed by physicians alone

2. The Output Display Standard (ODS) requires ultrasound systems to display real-time values for:

A. Frame rate and line density

B. Transducer serial number and warranty status

C. Mechanical Index (MI) and Thermal Index (TI)

D. Patient billing codes

3. A department stocks non-latex probe covers as standard practice primarily to:

A. Improve overall image resolution

B. Reduce allergic reaction risk in sensitive patients

C. Increase the probe's frequency range

D. Eliminate disinfection requirements entirely

4. The HIPAA minimum necessary standard requires that access to a patient's protected health information be limited to:

A. Only the referring physician

B. Anyone in the hospital system

C. The patient's immediate family

D. Only the minimum information needed

5. Wearing gloves for every patient contact involving mucous membranes or body fluids, regardless of known infection status, reflects the core principle of:

A. Spaulding classification

B. The Prudent Use Statement

C. Transmission-based precautions only

D. Standard precautions

6. Routine quality control testing results should be documented:

A. Only when a problem appears

B. On a regular, defined schedule always

C. Once, at system purchase time

D. Only during accreditation visits

7. For a high-level disinfectant to be effective on a semicritical device, it must remain in contact with the device surface for:

A. The full manufacturer-specified minimum contact time

B. At least 5 seconds

C. However long is convenient for workflow

D. Contact time is not relevant to disinfection efficacy

8. The AIUM's position on non-medical, "keepsake" fetal ultrasound imaging performed outside a medically indicated exam is that it:

A. Fully endorsed and encouraged

B. Requiring no physician involvement

C. Exempt from ALARA considerations

D. Discouraged, since it offers no medical benefit

9. Before an endocavity exam, a sonographer notices a small tear in the probe cover after insertion. The appropriate action is to:

A. Continue, since the probe was covered initially

B. Finish quickly to minimize risk

C. Document the tear afterward only

D. Stop, replace the cover, follow protocol

10. Performing an ultrasound exam beyond the scope of the original physician's order, without an amended or new order, is generally considered:

A. Acceptable if the sonographer deems it indicated

B. Required whenever new findings appear

C. Outside the sonographer's authority without an updated order

D. Mandatory under the ALARA principle

11. Used biopsy needles and other sharps must be disposed of in:

A. The regular trash bin

B. A puncture-resistant, labeled container

C. A double-wrapped plastic bag

D. The same bin as probe covers

12. The far-field divergence angle of an unfocused, flat circular transducer is approximately proportional to:

A. Wavelength divided by element diameter, roughly

B. Element diameter alone, independent of wavelength

C. The system's frame rate

D. The pulse repetition frequency

13. For two transducers of the same operating frequency but different active element diameters, the transducer with the larger diameter will, all else being equal, produce a far-field beam that:

A. Diverges more than the smaller-diameter transducer's beam

B. Has a shorter near zone than the smaller-diameter transducer

C. Diverges less than the smaller-diameter transducer's beam

D. Cannot be focused under any circumstances

14. Temporal resolution refers to a system's ability to:

A. Distinguish two closely spaced reflectors along the beam axis

B. Distinguish two side-by-side reflectors

C. Accurately display rapidly changing events over time

D. Measure absolute distance accurately

15. For a constant propagation speed, frequency and wavelength are related such that:

A. Increasing frequency increases wavelength proportionally

B. Increasing frequency decreases wavelength, since the two are inversely related

C. Frequency and wavelength are entirely independent of each other

D. Wavelength depends only on transducer diameter

16. Using the general 0.5 dB/cm/MHz rule, the total attenuation for a 6 MHz beam traveling 4 cm through soft tissue is closest to:

A. 12 dB

B. 6 dB

C. 24 dB

D. 3 dB

17. Ranking typical soft-tissue attenuation coefficients from lowest to highest, which sequence best reflects real tissue values?

A. Bone, then muscle, then blood

B. Blood, then muscle, then bone

C. Bone, then blood, then muscle

D. Muscle, then bone, then blood

18. For most soft tissues, within the normal physiologic temperature range, an increase in tissue temperature tends to:

A. Slightly increase propagation speed, similar to water over this range

B. Decrease propagation speed to zero

C. Have a completely unpredictable, random effect

D. Have no relationship to propagation speed whatsoever

19. In diagnostic ultrasound, sound travels through soft tissue as a:

A. A longitudinal wave, motion parallel to travel

B. A transverse wave, motion perpendicular to travel

C. A simple surface wave only

D. A standing wave, exclusively

20. As a longitudinal sound wave travels through tissue, regions of high molecular density alternate with regions of low molecular density; these are termed, respectively:

A. A crest and a trough

B. A compression and a rarefaction

C. A node and an antinode

D. A peak and a valley

21. Amplitude is defined as:

A. The maximum height above the average value

B. The number of cycles per second

C. The time to complete one cycle

D. The distance of one full cycle

22. If the transmitted intensity is 10 mW/cm^2 and the received intensity is 1 mW/cm^2, the loss expressed in decibels is closest to:

A. 10 dB

B. 1 dB

C. 100 dB

D. 3 dB

23. Refraction (bending of the beam) at a tissue interface requires both an oblique angle of incidence and:

A. A large impedance mismatch

B. A high beam intensity

C. A difference in propagation speed

D. A very high frequency

24. Huygens' principle describes how a wavefront can be modeled as being composed of:

A. Many small point sources, each a wavelet

B. A single fixed point source

C. The transducer's electrical circuit

D. Reflected echoes exclusively

25. Diffraction refers to the bending or spreading of sound waves as they:

A. Reflect off a smooth interface

B. Travel through a uniform, boundless medium

C. Undergo mode conversion

D. Pass by an edge comparable to the wavelength

26. A transducer has a focal length of 60 mm and an active aperture diameter of 20 mm. Its F-number, calculated as focal length divided by aperture diameter, is:

A. A value of 3

B. A value of 0.33

C. A value of 6

D. A value of 1200

27. The resonance (operating) frequency of a piezoelectric element is determined primarily by the element's:

A. The backing material's color

B. Its physical thickness

C. The housing's shape

D. The cable's length

28. Testing individual element function/integrity in an array transducer is important because a small number of nonfunctional elements may:

A. Always obvious on every image

B. Automatically repaired by software

C. Have no effect on image quality

D. Subtly degrade quality without being obvious

29. A vector array transducer produces a trapezoidal field of view by:

A. A linear near-field with diverging far lines

B. Using a single rotating element instead

C. Requiring an external motor to work

D. Eliminating the need for any beamforming

30. A mechanical sector transducer, largely historical, produces its sector image by:

A. Electronically delaying element firing

B. Using a large flat array

C. Physically rotating a single element

D. Requiring no moving parts

31. Compared with modern array transducers, older single-element transducers were generally limited by:

A. A fixed focus with no electronic steering

B. An inability to produce any image

C. Requiring higher frequencies only

D. Being incompatible with disinfection

32. A transducer with heavy internal damping (low Q-factor) produces a shorter pulse and correspondingly:

A. Wider bandwidth and improved axial resolution

B. Narrower bandwidth and reduced axial resolution

C. No change in bandwidth

D. Elimination of the need for a matching layer

33. Prolonged continuous scanning, especially with Doppler modes, can cause a transducer's face to warm; sonographers should be aware that excessive transducer surface heating is primarily a concern for:

A. Improving overall image quality

B. Increasing the overall frame rate

C. Patient skin discomfort or thermal injury

D. Reducing the overall bandwidth

34. Proper transducer storage (e.g., in a designated rack, cable uncoiled and unstressed) primarily helps prevent:

A. Cable and connector stress damage

B. Improved overall bandwidth performance

C. Automatic recalibration every time

D. Increased operating frequency range

35. The frequency range printed or labeled on a transducer's housing indicates:

A. The single fixed frequency always used

B. The bandwidth range the probe operates within

C. The maximum safe exposure time

D. The disinfection compatibility rating

36. A modern 'broadband agile' transducer allows the operator to select different operating frequencies within a single probe primarily because the probe's:

A. Wide bandwidth design supports a range of usable frequencies

B. Housing physically changes shape

C. Crystal is replaced electronically each time

D. Backing material is removed and reinstalled

37. Compared with fixed mechanical (lens-based) focusing, electronic focusing used in array transducers allows:

A. Only a single, fixed focal depth

B. An adjustable focal depth for different exams

C. No focusing capability whatsoever

D. Focusing only in one plane

38. A curvilinear (convex) transducer's footprint is described as:

A. Flat and simply rectangular

B. Small and cylindrical in shape

C. Reduced to a single point element

D. Curved, producing a diverging sector view

39. The locking mechanism securing a transducer's connector to the ultrasound system primarily ensures:

A. A stable, reliable electrical connection

B. Automatic frequency selection

C. Waterproofing of the connector

D. Sterilization compatibility only

40. In array transducer manufacturing, a single piezoelectric slab is diced (cut) into many small individual elements primarily to:

A. Reduce manufacturing cost only

B. Allow each element to be independently driven

C. Increase the operating frequency

D. Eliminate the backing layer

41. Which of the following is most likely to shorten a transducer's usable lifespan?

A. Proper storage between uses

B. Routine phantom-based QA testing

C. Following manufacturer disinfection guidelines

D. Repeated dropping or impact damage

42. A manufacturer's acoustic output calibration certificate for a transducer documents that the probe's:

A. The probe's warranty status

B. Its verified output matches specifications

C. A permanent frequency change

D. Its disinfection cycle reset

43. A single broadband agile abdominal transducer that can operate effectively for both routine abdominal imaging and, at a lower frequency setting, deeper penetration in a larger patient illustrates the practical benefit of:

A. Mechanical 3D sweep capability alone

B. A dedicated CW Doppler design

C. A wide operating bandwidth for flexibility

D. Simple annular array ring focusing

44. A mechanical 3D/4D transducer acquires volume data by:

A. Using a matrix array with no moving parts

B. An internal motor sweeping a 1D array

C. Manual rotation of the probe by hand

D. Eliminating the need for array elements

45. Detecting a subtle drop-out artifact during routine phantom QA testing most directly suggests a possible issue with:

A. System software licensing

B. One or more transducer elements

C. The ultrasound gel brand

D. The patient's body habitus

46. A grayscale lookup table (LUT) determines how:

A. Frame rate changing with depth

B. Doppler shift converted to color

C. Echo amplitude mapped to gray shades

D. Frequency converted to wavelength

47. Pre-processing image adjustments, applied before the image is stored, differ from post-processing adjustments in that pre-processing:

A. Affects the raw data actually acquired and stored

B. Can always be fully undone after storage

C. Only affects the printed hard copy

D. Has no effect on the final displayed image

48. Line density, the number of scan lines per unit width of the image, affects:

A. Axial resolution only, not other factors

B. PRF exclusively, with nothing else

C. Transducer frequency, and nothing else

D. Lateral resolution and frame rate together

49. Selecting multiple focal zones to improve lateral resolution at several depths will typically:

A. Reduce frame rate, needing more pulses

B. Increase the overall frame rate

C. Have no effect on frame rate

D. Automatically reduce line density

50. After freezing an image for measurement, moving to a stored cine-loop frame before placing calipers allows the sonographer to:

A. Automatically recalculate TGC

B. Change the transducer frequency retroactively

C. Select the technically optimal frame for the most accurate measurement

D. Increase the stored image's resolution beyond what was acquired

51. Real-time ultrasound imaging, as opposed to a single static image, allows the sonographer to:

A. Eliminate the need for freeze function

B. Continuously observe motion and adjust plane

C. Avoid the need for measurements

D. Automatically generate a diagnosis

52. Spatial resolution (the ability to distinguish two separate structures) is a distinct concept from contrast resolution, which refers to:

A. The system's overall frame rate

B. The transducer's operating frequency

C. The overall depth of penetration

D. Subtle echo intensity differences between tissues

53. Increasing the number of scan lines used to form each image generally:

A. Decreases image quality

B. Has no relation to resolution

C. Increases frame rate always

D. Improves resolution, may reduce frame rate

54. A biplane (dual-image) display showing two simultaneously acquired imaging planes side by side is useful for:

A. Increasing the transducer's operating frequency

B. Directly comparing two anatomic planes at the same moment in time

C. Eliminating the need for freeze-frame

D. Automatically correcting Doppler angle

55. Facility image retention policy, specifying how long stored ultrasound images and reports must be kept, is generally governed by:

A. Sonographer personal preference

B. Available hard drive space

C. Transducer manufacturer guidelines

D. State and accreditation-body requirements

56. Dynamic receive focusing continuously adjusts the focal point of the receive beamformer as echoes return from progressively deeper structures, which:

A. Requires no processing beyond transmit focusing

B. Improves lateral resolution across a range of depths in real time

C. Is only possible with mechanical transducers

D. Eliminates the need for any transmit focusing

57. The 'query/retrieve' function of a PACS system allows a user to:

A. Search for and pull up a patient's prior stored exams

B. Permanently delete old studies automatically

C. Adjust the current live image's gain

D. Recalibrate the transducer

58. Frame rate, typically expressed in frames per second, describes:

A. How many complete images are displayed and updated each second

B. The number of focal zones selected

C. The total number of scan lines in a single image

D. The system's PRF exclusively, unrelated to image updates

59. Compared with interlaced display scanning, progressive scan display:

A. Always lower image quality

B. Alternating odd and even lines

C. Only used in older CRT monitors

D. Drawing every line in one pass

60. Periodic monitor grayscale calibration, using a standardized test pattern, ensures that:

A. The transducer's frequency stays accurate

B. TGC is automatically optimized

C. The image accurately represents true gray shades

D. The PRF stays within a safe range

61. Lossy image compression, sometimes used to reduce PACS storage requirements, differs from lossless compression in that lossy compression:

A. Always produces a larger file

B. Has no effect on image data

C. Permanently discards some data for smaller files

D. Is required by accreditation standards

62. Selecting the correct exam-type preset (e.g., 'abdomen,' 'thyroid,' 'cardiac') before scanning primarily ensures that the system starts with:

A. A permanently fixed, unadjustable image

B. Appropriate default settings for that exam type

C. Automatic diagnosis generation

D. Eliminating the need for TGC

63. Using the annotation tool to label a specific structure directly on a stored image primarily helps:

A. Automatically calculate its volume

B. Communicate exactly what is shown to the physician

C. Increase the system's frame rate

D. Improve axial resolution there

64. A split-screen display showing a current image alongside a prior exam's stored image is used primarily to:

A. Increase the current frame rate

B. Automatically calculate interval change

C. Eliminate the need for measurements

D. Allow direct visual comparison of findings

65. By convention, the indicator/marker on a transducer corresponds to a specific side of the displayed image; correctly maintaining this orientation throughout scanning is essential for:

A. Improving overall frame rate

B. Reducing artifact overall

C. Correct TGC application

D. Accurate anatomic left/right orientation

66. A pixel represents a single picture element in a 2D image, while the analogous unit in a 3D dataset, representing a small volume element, is called a:

A. A single volume element, or voxel

B. A Doppler sample volume marker

C. A single processing kernel

D. A single scan line trace

67. Post-processing edge enhancement sharpens the appearance of tissue boundaries by:

A. Reacquiring additional scan lines

B. Increasing the transducer's frequency

C. Increasing contrast at echo transitions

D. Reducing gray shades to only two

68. Placing a focal zone at the depth of the structure of interest improves lateral resolution at that depth because the beam is:

A. At its widest at that point

B. At its narrowest at that point

C. Completely absent at that point

D. Diverging most rapidly at that point

69. Contrast resolution is best defined as the system's ability to:

A. Distinguish reflectors along the beam axis

B. Update the display many times per second

C. Penetrate to greater depth

D. Distinguish subtle echogenicity differences

70. Residual near-field clutter, sometimes seen immediately beneath the transducer face, results from:

A. Brief ring-down after transmission ends

B. Excessive TGC set at that depth

C. An incorrect Doppler angle setting

D. Aliasing of the color Doppler signal

71. A system's bit depth determines:

A. The transducer's operating frequency

B. The number of gray shades displayed

C. The system's PRF

D. Axial resolution directly

72. Reviewing a freeze-frame image immediately after acquisition, before the patient leaves, allows the sonographer to:

A. Confirm quality before ending the exam

B. Automatically generate the report

C. Recalibrate the transducer

D. Change the scheduled exam type

73. Continuously adjusting gain, focal zone position, and depth while scanning, rather than only at the start of the exam, reflects the principle of:

A. Fixed, static image acquisition only

B. Ongoing real-time optimization throughout the exam

C. Following a fixed preset scan

D. Post-processing adjustments only

74. Switching a broadband transducer's frequency setting mid-exam, from a higher frequency for a superficial structure to a lower frequency for a deeper structure, illustrates:

A. Selecting the frequency that best suits the target

B. A malfunction needing probe replacement

C. An error in preset selection

D. A violation of the ALARA principle

75. Using a standardized exam worksheet or protocol template during scanning primarily helps ensure:

A. Automatic diagnosis generation

B. Eliminating physician interpretation

C. Consistent coverage of required elements

D. Increased frame rate overall

76. Performing a brief visual/functional check of the transducer and system before starting a patient's exam is intended to:

A. Catch obvious equipment problems early

B. Replace periodic phantom QA testing

C. Calibrate the transducer's frequency

D. Satisfy HIPAA requirements

77. Increasing the size of the color Doppler box (region of interest) will typically:

A. Increase overall frame rate

B. Decrease frame rate, needing more processing

C. Have no effect on frame rate

D. Automatically increase the PRF

78. Spectral (Doppler) gain and color gain are adjusted independently because:

A. Always the identical setting

B. Spectral Doppler unaffected by gain

C. Color gain has no effect

D. Each optimizes a different displayed signal

79. A normal fasting superior mesenteric artery Doppler waveform is characteristically:

A. High-resistance, with minimal or absent diastolic flow

B. Low-resistance, with continuous forward diastolic flow

C. Completely absent

D. Identical to its postprandial waveform

80. The 'heel-toe' technique, tilting a linear array transducer along its long axis without changing its position, is used primarily to:

A. Increase the system's overall frame rate

B. Reduce color gain artifact buildup

C. Achieve a usable angle on a parallel vessel

D. Improve overall grayscale contrast resolution

81. The Doppler frequency shift itself is not identical to blood flow velocity; velocity must be calculated from the shift using the Doppler equation because the shift also depends on:

A. The sample volume size

B. The wall filter setting

C. The color scale

D. The transmit frequency and angle

82. Doppler demonstrating markedly elevated celiac artery velocity on expiration that substantially improves on deep inspiration, in a patient with postprandial abdominal pain, is a pattern most consistent with:

A. A mesenteric venous thrombosis

B. A median arcuate ligament (celiac) compression

C. A splenic artery aneurysm here

D. A portal vein thrombosis instead

83. The continuity equation, applied to blood flow, states that for an incompressible fluid, flow velocity must increase as vessel cross-sectional area:

A. Also increases proportionally with it

B. Remains completely constant instead

C. Becomes entirely irrelevant

D. Decreases, such as at a stenosis

84. The Bernoulli principle explains why blood flow velocity increases and pressure decreases:

A. Uniformly throughout the entire vascular system

B. As blood passes through a focal narrowing (stenosis)

C. Only in veins, never arteries

D. Only when Doppler angle exceeds 60 degrees

85. A high Reynolds number, reflecting factors such as high velocity and vessel irregularity, predicts:

A. Purely laminar flow

B. Absence of any flow

C. A transition to turbulent flow

D. Reversed flow direction

86. Laminar flow describes blood movement in which:

A. All velocities within the vessel are chaotic and random

B. Fluid moves in smooth, parallel layers

C. Flow direction reverses every cardiac cycle

D. Flow is present only during diastole

87. A parabolic flow velocity profile, typical of steady laminar flow in a straight vessel, is characterized by:

A. Uniform velocity across the lumen

B. Fastest velocity at the wall

C. Zero velocity throughout

D. Fastest at the center, slowing outward

88. Plug flow, in which velocity is relatively uniform across most of the vessel lumen, is typically seen:

A. Near a vessel origin, close to its parent

B. Only within venous structures generally

C. Only under turbulent flow conditions

D. Only within the descending aorta specifically

89. Vascular beds supplying organs with continuous, high resting metabolic demand (such as the brain or kidney) typically show:

A. High-resistance waveforms with absent diastolic flow

B. Low-resistance waveforms with continuous forward diastolic flow

C. Waveforms identical to resting skeletal muscle

D. No detectable diastolic component at all

90. A normal splenic artery Doppler waveform in the fasting state is typically:

A. Monophasic and absent in diastole

B. Reversed during systole

C. Identical to the hepatic vein

D. Low-resistance with forward diastolic flow

91. Normal inferior vena cava diameter varies with the respiratory cycle, typically:

A. The IVC diameter staying completely fixed

B. Simply increasing in size with inspiration

C. Becoming smaller with any breath-hold effort

D. Collapsing with inspiration, distending with expiration

92. The normal internal jugular vein Doppler waveform reflects central venous pressure changes and is typically:

A. Purely arterial in character

B. Phasic, reflecting the cardiac cycle

C. Completely flat and nonpulsatile

D. Reversed vs the subclavian vein

93. On color Doppler, a thyroid nodule with vascularity concentrated at its periphery, surrounding the nodule, is typically described as having:

A. Internal (central) vascularity

B. Absent vascularity

C. Peripheral vascularity

D. Mixed diffuse vascularity throughout the gland

94. Routine Doppler surveillance of a renal transplant is used to assess overall graft perfusion and screen for complications such as:

A. Simple gallstone formation over time

B. A separate episode of acute appendicitis

C. Vascular stenosis or thrombosis affecting the graft

D. The incidental presence of thyroid nodules

95. The internal carotid artery (ICA) is typically distinguished from the external carotid artery (ECA) on duplex by all of the following EXCEPT:

A. The ICA's low-resistance waveform

B. The ICA's absence of extracranial branches

C. The ECA's temporal tap response

D. Diameter alone, always identical

96. Normal vertebral artery flow, arising from the subclavian artery, is directed:

A. Away from the head, toward subclavian

B. In a to-and-fro pattern at rest

C. Cephalad, toward the brain

D. Reversed compared with the carotid arteries

97. A well-functioning, mature AV fistula typically shows a Doppler waveform characterized by:

A. High-velocity, low-resistance, continuous forward flow

B. High-resistance flow with absent diastole

C. A completely reversed flow direction

D. A pattern indistinguishable from a normal artery

98. Doppler demonstrating greater than 0.5 seconds of reversed flow in the great saphenous vein following release of manual calf compression is consistent with:

A. Normal, competent venous valve function

B. A simple arterial insufficiency

C. An acute deep venous thrombosis

D. Superficial venous reflux from valve incompetence

99. Manual calf compression during femoral vein Doppler assessment, producing a brisk, transient increase in venous flow toward the transducer, is called:

A. The classic Valsalva maneuver

B. Augmentation, confirming a patent segment

C. The classic heel-toe maneuver

D. A simple angle correction

100. Absent flow with echogenic material filling the lumen of the brachiocephalic vein, often encountered in a patient with a central venous catheter, is most consistent with:

A. A normal anatomic variant requiring no further action

B. Brachiocephalic vein thrombosis

C. Lymphedema

D. Arterial dissection

101. A normal axillary artery Doppler waveform, supplying the upper extremity at rest, is typically:

A. Continuous and monophasic, similar to a vein

B. Completely absent during diastole in every normal patient

C. Triphasic, reflecting the high peripheral resistance typical of a resting limb artery

D. Reversed in direction compared with the brachial artery immediately downstream

102. A perivascular color signal not corresponding to true blood flow, caused by tissue vibration from a high-velocity jet or an AV fistula, is termed a:

A. Simply described as a flash artifact

B. A perivascular tissue vibration, or pseudo-flow, artifact

C. Simply described as a twinkle artifact

D. Simply described as a mirror-image artifact

103. Increasing color Doppler sensitivity (e.g., by lowering PRF or increasing dwell time per line) generally comes at the cost of:

A. Improved spatial resolution

B. Increased penetration only

C. Improved axial resolution

D. Reduced frame rate

104. When performing umbilical artery Doppler, sampling from a free-floating loop of cord rather than at a fixed point (such as at the placental or fetal insertion) is generally preferred because a free loop:

A. Always shows higher velocities

B. Reduces variability from local compression

C. Is required by governing bodies

D. Eliminates the need for angle correction

105. The normal hepatic artery Doppler waveform is characterized by:

A. A monophasic pattern, no diastolic flow

B. A triphasic pattern like the hepatic vein

C. Low-resistance, rapid upstroke, forward diastolic flow

D. Reversed flow throughout diastole

106. Normal splenic vein flow is directed:

A. Away from the liver

B. Toward the liver, hepatopetal

C. In a to-and-fro pattern

D. Absent under normal conditions

107. When evaluating suspected testicular torsion, comparing Doppler flow directly between the symptomatic and asymptomatic testes is valuable because:

A. Using the normal side as a reference

B. Both testes always show identical flow

C. Only the symptomatic side needs scanning

D. Comparison only helps in adults

108. Assessing both the superior and inferior thyroidal arteries during a thyroid Doppler exam provides a more complete picture of:

A. Isolated parathyroid function alone

B. The gland's overall arterial supply pattern

C. Venous drainage exclusively, not arterial

D. Regional lymph node status

109. Because isolated calf vein (soleal or gastrocnemius vein) thrombosis can be more difficult to detect than femoropopliteal DVT, its evaluation typically relies more heavily on:

A. Spectral waveform shape alone, no compression

B. Direct compression applied specifically to the calf

C. Umbilical artery Doppler criteria

D. Carotid duplex velocity criteria

110. Following a vascular bypass graft procedure, Doppler surveillance is used primarily to:

A. Confirm patency and detect early stenosis

B. Measure overall cardiac output

C. Diagnose unrelated pathology

D. Replace the need for follow-up

Answers

1. C. The Prudent Use Statement's core guidance is to use ultrasound only when clinically indicated and to keep acoustic output as low as reasonably achievable, not to maximize output or restrict use to physicians only.

2. C. The Output Display Standard requires real-time on-screen display of MI and TI so the operator can monitor acoustic output relative to bioeffect risk throughout the exam, distinct from administrative or equipment-tracking data.

3. B. Non-latex covers protect latex-sensitive patients and staff from allergic reactions, an infection-control and safety consideration unrelated to image resolution, frequency range, or disinfection needs.

4. D. The minimum necessary standard restricts access to only the PHI actually needed for a given purpose, rather than granting broad access to an entire care team, family, or health system by default.

5. D. Standard precautions are applied universally to every patient contact involving mucous membranes or body fluids regardless of known infection status, distinguishing them from transmission-based precautions, which are added only for specific known or suspected infections.

6. B. QC documentation on a defined recurring schedule, whether or not a problem is found, is what allows trends and equipment drift to be tracked over time, rather than only reacting after a problem is already apparent.

7. A. Disinfectant efficacy depends on maintaining contact for the specific minimum time validated by the manufacturer for that product; shortening contact time undermines the disinfection process regardless of convenience.

8. D. Because keepsake imaging provides no medical benefit to justify any acoustic exposure, the AIUM discourages this non-medical use, consistent with the broader ALARA principle of exposure only when medically indicated.

9. D. A torn probe cover during an endocavity exam compromises the infection-control barrier; the correct response is to stop, replace the cover, and follow facility protocol (including any needed probe reprocessing), not to continue or delay documentation.

10. C. Sonographers work within the bounds of the physician's order; extending an exam beyond that scope without appropriate communication and an updated order falls outside the sonographer's authority, regardless of personal clinical judgment about what seems indicated.

11. B. Sharps require disposal in a dedicated, puncture-resistant, labeled container specifically designed to prevent injury and contamination, distinct from general trash or other waste streams.

12. A. Far-field beam divergence for an unfocused circular transducer is approximately given by wavelength divided by element diameter, meaning a larger active aperture produces a less divergent, more tightly collimated far-field beam; frame rate and PRF are timing/display parameters unrelated to beam divergence.

13. C. A larger active aperture reduces far-field divergence angle and also lengthens the near zone, the opposite of options A and B; aperture size does not prevent focusing.

14. C. Temporal resolution reflects how accurately and quickly a system can display change over time, closely tied to frame rate, distinct from the spatial resolution concepts of axial or lateral resolution.

15. B. Because wavelength equals propagation speed divided by frequency, and propagation speed is fixed for a given tissue, frequency and wavelength are inversely related: raising frequency shortens wavelength.

16. A. Using the standard 0.5 dB/cm/MHz rule, total attenuation = 0.5 x frequency (MHz) x path length (cm) = 0.5 x 6 x 4 = 12 dB.

17. B. Blood has a very low attenuation coefficient, muscle is intermediate, and bone attenuates far more strongly than either soft tissue, reflecting the general trend that denser, more heterogeneous tissue attenuates more.

18. A. Because soft tissue is largely water-based, propagation speed tends to rise slightly with temperature over the physiologic range, mirroring water's own known temperature-speed relationship, rather than being unrelated or producing an extreme effect.

19. A. Diagnostic ultrasound in soft tissue propagates as a longitudinal wave, where particles oscillate parallel to the direction of wave travel, in contrast to transverse waves used in some specialized elastography applications.

20. B. Compression describes the region of increased molecular density and pressure, while rarefaction describes the adjacent region of decreased density, the fundamental alternating pattern of a longitudinal pressure wave.

21. A. Amplitude specifically measures how far an acoustic variable (such as pressure) deviates from its baseline average value at its peak, distinct from frequency (cycles per second), period (time per cycle), or wavelength (distance per cycle).

22. A. Decibels = 10 x log10(intensity ratio) = 10 x log10(10/1) = 10 x 1 = 10 dB.

23. C. Refraction only occurs when a beam crosses an interface obliquely AND the two media have different propagation speeds; if speeds are equal, the beam passes straight through even at an oblique angle.

24. A. Huygens' principle models a propagating wavefront as the sum of countless secondary wavelets originating from every point along the wavefront, a foundational concept underlying beam formation and diffraction.

25. D. Diffraction describes the spreading or bending of a wave as it passes an edge or through an aperture whose size is comparable to the wavelength, distinct from reflection, mode conversion, or propagation through a uniform medium.

26. A. F-number = focal length / aperture diameter = 60 mm / 20 mm = 3.

27. B. An element's resonance frequency is set by its physical thickness relative to the speed of sound within the piezoelectric material itself, with a thinner element resonating at a higher frequency.

28. D. A small number of nonfunctional elements can subtly reduce overall image quality or introduce faint artifact without being obviously apparent on casual visual inspection, which is why dedicated element-function QA testing is valuable.

29. A. A vector array electronically steers its outer beams to diverge, producing a trapezoidal field that is narrower near the transducer face (linear-like) and wider at depth, combining features of linear and phased array designs.

30. C. Mechanical sector transducers generate their image by physically moving (rotating or oscillating) a single element or small group of elements within the housing, unlike array transducers, which steer electronically with no moving parts.

31. A. A single, non-array element has a fixed acoustic lens and cannot apply the electronic delay patterns used by arrays to steer the beam or dynamically shift the focus during scanning, limiting flexibility compared with modern array designs.

32. A. Heavy damping shortens the pulse, which broadens its frequency content (wider bandwidth) and improves axial resolution, at some cost to sensitivity -- the classic bandwidth/resolution trade-off of transducer design.

33. C. Because a warm transducer face held stationary against skin for an extended period can cause patient discomfort or, in extreme cases, thermal injury, sonographers should be mindful of prolonged contact during high-output modes like spectral or color Doppler.

34. A. Proper storage avoids repeated coiling, kinking, or crushing of the cable and connector, which are common mechanical failure points; it has no bearing on bandwidth, calibration, or frequency.

35. B. The labeled frequency range describes the operating bandwidth the transducer is designed to work within, not a single fixed frequency, an exposure-time limit, or a disinfection rating.

36. A. A broadband agile transducer's wide bandwidth design inherently supports transmission and reception across a range of frequencies, allowing the operator to select the frequency best suited to a given depth or application without changing probes.

37. B. Because array elements can be fired with variable timing delays, the beam's focal depth can be electronically adjusted by the operator or automatically by the system for different exam needs, unlike a fixed mechanical lens, which sets a single unchangeable focal depth.

38. D. A curvilinear transducer's convex, curved element arrangement produces a sector-shaped field of view that diverges (widens) with depth, distinct from the flat rectangular footprint of a linear array.

39. A. The connector's locking mechanism physically secures the electrical contacts in place, preventing intermittent connection or signal loss during active scanning; it does not control frequency, waterproofing, or sterilization.

40. B. Dicing the piezoelectric material into discrete elements allows each one to be independently wired and electronically controlled, which is the fundamental requirement for beam steering and electronic focusing in array transducers.

41. D. Physical impact damage, such as dropping the probe, can crack elements, damage the acoustic lens, or disrupt internal wiring, directly shortening usable lifespan, unlike proper storage, routine QA, or correct disinfection, which all help preserve it.

42. B. An acoustic output calibration certificate confirms that a probe's actual measured output has been checked against and matches its labeled specifications, a quality assurance record distinct from warranty, frequency changes, or disinfection tracking.

43. C. The scenario describes selecting different frequencies within the same probe's operating range for different clinical needs, which is only possible because of the transducer's wide (broadband) bandwidth design, not because of any 3D, CW, or annular array feature.

44. B. A mechanical 3D/4D transducer contains an internal motor that automatically sweeps a conventional 1D array through an arc, acquiring a series of 2D slices that are reconstructed into a volume, distinct from a matrix array's fully electronic volume acquisition.

45. B. A drop-out artifact reproducibly appearing on a controlled phantom image, where the true internal structure is known and consistent, points most directly to a transducer element problem rather than to software, gel, or patient-related factors.

46. C. The grayscale lookup table maps the range of received echo amplitudes to the corresponding shades of gray displayed on screen, a core post-processing step distinct from frame rate, color assignment, or frequency-wavelength conversion.

47. A. Pre-processing adjustments are applied before the image data is finalized and stored, so they affect what is actually captured and saved, unlike post-processing adjustments, which can be modified after storage without altering the underlying stored data.

48. D. Higher line density improves lateral resolution by sampling more positions across the field of view, but because each additional line requires additional time, it can reduce frame rate -- a direct trade-off between the two.

49. A. Each additional focal zone requires its own separate pulse-echo cycle at that specific focal depth, so selecting more focal zones increases the total time needed to form one complete image, reducing frame rate.

50. C. Scrolling through a cine loop after freezing lets the sonographer identify the single frame with the clearest, best-positioned view of the structure before placing calipers, improving measurement accuracy compared with using whatever frame happened to be frozen.

51. B. Real-time imaging continuously updates the displayed image, allowing the sonographer to observe motion as it happens and adjust the scan plane or transducer position dynamically, which a single static image cannot provide.

52. D. Contrast resolution specifically refers to the ability to differentiate subtle differences in echo intensity (echogenicity) between adjacent tissues, a distinct concept from spatial resolution, frame rate, frequency, or penetration.

53. D. More scan lines sample the field of view more finely, improving resolution, but because forming each additional line takes additional time, this can come at the cost of a lower frame rate.

54. B. A biplane display's key value is showing two different imaging planes acquired at the same instant, allowing direct comparison of two anatomic views without needing to physically move the transducer back and forth between them.

55. D. Image and report retention duration is set by applicable state regulations and accreditation-body requirements, not by individual preference, available storage space alone, or transducer-related guidelines.

56. B. By continuously shifting the receive focal point to match the depth from which echoes are currently returning, dynamic receive focusing maintains improved lateral resolution across a range of depths within a single pulse-echo cycle, in real time.

57. A. Query/retrieve is the PACS function that allows a user to search the archive and pull up a specific patient's previously stored exams for review or comparison, distinct from live image adjustment or transducer functions.

58. A. Frame rate describes how many complete images the system displays and refreshes each second, directly reflecting how smoothly motion is portrayed, distinct from focal zone count, scan line count, or PRF considered in isolation.

59. D. Progressive scan draws every line of the image in a single sequential pass, generally producing a smoother, less flickering image than interlaced scanning, which alternates odd and even line sets across two passes.

60. C. Monitor calibration against a known standardized test pattern verifies that the displayed brightness and gray-shade range accurately represent the true data the system generated, independent of transducer frequency, TGC, or PRF.

61. C. Lossy compression achieves greater file size reduction specifically by permanently discarding some image data, trading some fidelity for storage efficiency, unlike lossless compression, which reduces file size without losing any original data.

62. B. An exam-type preset loads appropriate default settings (frequency, depth, processing curves, and measurement packages) suited to that specific exam type, giving the sonographer an appropriate starting point rather than a fixed, unadjustable image.

63. B. Annotating a structure directly on the image clearly communicates to the interpreting physician exactly what structure or finding is being shown, an important part of accurate image documentation rather than a measurement or resolution tool.

64. D. Displaying a current image alongside a prior stored exam side by side allows direct visual comparison of findings across time, supporting assessment of interval change, though the comparison itself still requires the interpreting physician's judgment.

65. D. Consistently maintaining the conventional relationship between the transducer's physical marker and its corresponding side of the displayed image ensures that anatomic left/right and superior/inferior orientation on the stored image is accurate and reliably interpretable.

66. A. A voxel is the 3D analog of a 2D pixel, representing a small volume element within an acquired 3D dataset, distinct from a Doppler sample volume, a processing kernel, or a scan line.

67. C. Edge enhancement selectively boosts contrast specifically at locations where echo amplitude changes rapidly (tissue boundaries), making transitions appear crisper, rather than affecting scan line count, frequency, or overall gray-shade count.

68. B. The beam is narrowest at its focal point, so placing a focal zone at the depth of interest minimizes beam width there, directly improving lateral resolution at that specific depth.

69. D. Contrast resolution is defined as the ability to differentiate subtle echogenicity differences between adjacent tissues as distinguishable shades of gray, a concept distinct from axial resolution, temporal resolution, or penetration depth.

70. A. The transducer element briefly continues to vibrate (ring down) after the transmit pulse before it can reliably switch to sensitive receive mode, producing residual clutter in the very near field closest to the transducer face.

71. B. Bit depth determines how many discrete brightness levels (gray shades) the system can represent and display, a digital processing parameter distinct from frequency, PRF, or axial resolution.

72. A. Reviewing the freeze-frame while the patient is still present allows the sonographer to catch technical problems or missing views and rescan if needed, rather than discovering gaps only after the patient has already left.

73. B. Continuously fine-tuning settings throughout the exam, rather than setting them once at the start and leaving them fixed, reflects the practice of ongoing real-time optimization to maintain the best possible image as conditions change.

74. A. Because the probe's broad bandwidth supports a range of usable frequencies, the operator can select whichever frequency within that range best balances resolution and penetration for each specific structure being imaged during the same exam.

75. C. A standardized worksheet or protocol template functions as a checklist ensuring that every required anatomic element and measurement for that exam type is consistently captured, reducing the risk of an incomplete study.

76. A. A brief pre-exam functional check is meant to catch obvious, immediately apparent equipment problems (such as a damaged cable or an obviously malfunctioning probe) before they affect patient care, complementing rather than replacing formal periodic phantom QA testing.

77. B. A larger color box requires the system to interrogate more scan lines for Doppler information on top of the grayscale image, which takes additional time per frame and therefore reduces frame rate.

78. D. Spectral gain governs the appearance of the waveform trace while color gain governs the color-filled flow display; because each controls a different displayed signal, excessive gain in one produces a different type of artifact (waveform noise vs color bleeding) than excessive gain in the other.

79. A. In the fasting state the SMA supplies bowel with lower metabolic demand and shows a high-resistance waveform with minimal diastolic flow; after a meal, resistance drops and diastolic flow increases, so fasting and postprandial waveforms are expected to differ.

80. C. A linear array's natural beam is perpendicular to the skin, and thus to a superficial vessel running parallel to it; the heel-toe tilt angles the beam relative to flow, achieving a workable, non-perpendicular Doppler angle without electronic steering or a different probe.

81. D. The Doppler equation shows that frequency shift depends on both the transmit frequency and the cosine of the insonation angle, in addition to velocity itself, which is why the same true velocity can produce different shift values under different transmit frequencies or angles.

82. B. Median arcuate ligament syndrome results from external compression of the celiac artery by the diaphragmatic ligament, which characteristically worsens with expiration and improves with inspiration as the diaphragm moves; none of the other listed entities show this specific respiratory-phase dependence.

83. D. The continuity equation requires that flow velocity increase where cross-sectional area decreases (such as at a stenosis) to maintain constant volume flow through the vessel, since the fluid is essentially incompressible.

84. B. As blood accelerates through a focal narrowing, the Bernoulli principle predicts a corresponding drop in pressure at that point, a relationship specifically relevant at localized areas of narrowing rather than uniformly throughout the vasculature.

85. C. A higher Reynolds number reflects conditions (high velocity, vessel irregularity, or larger diameter) that favor a transition from smooth laminar flow to disorganized turbulent flow, rather than predicting the absence of flow or reversed direction.

86. B. Laminar flow is defined by fluid moving in smooth, organized, parallel layers (laminae) sliding past one another, in contrast to the chaotic, disorganized motion of turbulent flow.

87. D. In a parabolic profile, friction with the vessel wall slows flow near the periphery while the central stream moves fastest, producing the characteristic curved (parabolic) velocity distribution across the lumen.

88. A. Near a vessel's origin from a larger parent vessel, flow has not yet developed the friction-driven parabolic profile seen further downstream, so velocity remains relatively uniform (plug-like) across the lumen.

89. B. Organs like the brain and kidney require continuous perfusion regardless of the cardiac cycle phase, which is reflected in their supplying arteries showing low-resistance waveforms with sustained forward flow even during diastole.

90. D. The fasting splenic artery, supplying an organ with ongoing baseline perfusion needs, characteristically shows a low-resistance waveform with continuous forward diastolic flow, similar in principle to other low-resistance visceral arterial beds.

91. D. Normal inspiration decreases intrathoracic pressure, promoting venous return and causing the IVC to narrow (collapse), while expiration or a Valsalva maneuver increases intrathoracic pressure and distends the IVC -- the basis of the sniff test.

92. B. Because the internal jugular vein is in direct continuity with the right atrium, its waveform reflects the same cardiac-cycle-driven pressure phasicity seen in the hepatic veins, rather than a flat or purely arterial pattern.

93. C. Vascularity concentrated around the outer margin of a nodule, sparing its center, is described as peripheral vascularity, a distinct pattern from internal/central vascularity or diffusely mixed vascularity.

94. C. Renal transplant Doppler surveillance specifically screens for vascular complications affecting the transplanted kidney's blood supply, such as arterial stenosis or venous thrombosis, rather than unrelated organs like the gallbladder, appendix, or thyroid.

95. D. ICA and ECA are distinguished by waveform character (low-resistance ICA vs higher-resistance ECA), the ICA's lack of visible extracranial branches, and the ECA's positive temporal tap response -- not by a fixed, always-identical diameter relationship, which is not a reliable distinguishing feature.

96. C. Normal vertebral artery flow travels cephalad (toward the brain) from its subclavian origin, supplying the posterior circulation, the opposite of the reversed, caudal flow pattern seen in subclavian steal.

97. A. A properly matured, functioning AV fistula develops a distinctive high-velocity, low-resistance waveform with continuous forward flow throughout the cardiac cycle, reflecting the low-resistance shunt directly connecting artery to vein.

98. D. Prolonged reversed flow after compression release indicates the venous valves are not closing properly to prevent retrograde flow, the hallmark of venous reflux, rather than normal valve function, arterial disease, or acute thrombus, which would show absent or reduced flow rather than reflux.

99. B. A brisk augmented flow response to distal calf compression indicates the venous segment being examined is open and uninterrupted between the compression site and the probe; the Valsalva maneuver, heel-toe tilt, and angle correction are distinct, unrelated techniques.

100. B. Echogenic intraluminal material with absent flow is the direct sonographic sign of thrombus; central venous catheters are a recognized risk factor for central vein thrombosis, distinguishing this from a normal variant, an arterial process, or lymphedema.

101. C. Like other resting peripheral limb arteries, the normal axillary artery shows a triphasic waveform reflecting high downstream resistance in resting skeletal muscle, rather than a continuous venous-type pattern or a direction reversed from its own downstream continuation.

102. B. High-velocity turbulent flow, such as at a stenosis or AV fistula, can cause adjacent soft tissue to physically vibrate; the Doppler system detects this vibration and displays a color signal in the surrounding tissue that does not represent true blood flow, termed a perivascular tissue vibration or pseudo-flow artifact.

103. D. Techniques that increase color Doppler sensitivity, such as spending more time interrogating each line, necessarily reduce how many complete color frames can be produced per second, lowering frame rate.

104. B. Sampling at a fixed insertion point risks artificially altered velocities from local compression or cord positioning at that specific spot, while a free-floating loop provides a more representative, reproducible measurement of true umbilical artery flow.

105. C. Like other organ-supplying arteries with continuous perfusion needs, the normal hepatic artery shows a low-resistance waveform with a rapid systolic upstroke and sustained forward flow through diastole.

106. B. Normal splenic vein flow travels toward the splenoportal confluence and then into the liver (hepatopetal direction), consistent with the normal direction of portal venous system flow overall.

107. A. Comparing the symptomatic testis against the patient's own normal contralateral testis provides an internal physiologic reference point, helping confirm that any apparent flow reduction on the affected side is truly abnormal rather than simply reflecting technical factors.

108. B. Because the thyroid receives arterial supply from both superior and inferior thyroidal arteries, assessing both provides a more complete picture of the gland's overall vascular supply and helps detect diffuse or focal vascularity changes that might be missed by evaluating only one source vessel.

109. B. Calf veins are smaller and more numerous than the femoropopliteal system, making direct compression at the calf level, in addition to standard color/spectral duplex, important for reliably detecting isolated calf vein thrombosis that could otherwise be missed.

110. A. Postoperative graft Doppler surveillance is specifically aimed at confirming ongoing patency and catching early hemodynamic signs of developing stenosis or thrombosis before the graft fails outright, allowing timely intervention.