COMPREHENSIVE MOCK EXAM 2

Supplemental to: Clinical Ultrasound Board Review 2026-2027

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ARDMS SPI (Sonography Principles and Instrumentation) Certification Exam — 110 questions, single-best-answer, four options (A–D), domain-weighted per the official ARDMS blueprint: Clinical Safety/Patient Care/QA 11, Physical Principles 16, Ultrasound Transducers 18, Imaging Principles & Instrumentation 31, Doppler Imaging Concepts 34.

Board-Review Questions

1. A sonographer scanning a technically difficult patient increases acoustic output substantially to improve penetration, then forgets to reduce it once the image improves. What ALARA principle has this most directly violated?

A. Output should be reduced again once adequate image quality is achieved, not left elevated indefinitely

B. ALARA applies only to Doppler modes, not to grayscale B-mode acquisition

C. ALARA is a fixed numeric limit the system enforces automatically regardless of operator action

D. Acoustic output has no relationship to exposure time in the ALARA framework

2. Two thermal indices, TIS and TIB, are both displayed depending on the anatomy being scanned. What does the choice between them reflect?

A. Which specific transducer frequency is currently selected

B. Whether the exam is diagnostic or purely for teaching purposes

C. Whether the beam path is primarily through soft tissue or is likely to encounter bone

D. Whether color Doppler or grayscale imaging is currently active

3. A pregnant patient's first-trimester exam requires imaging near the developing skeleton. Which thermal index is most appropriate to monitor?

A. TIS, since soft tissue is the only relevant heating concern in the first trimester

B. TIC, since the cranium is the only structure of concern

C. TIB, since bone is present in the field and bone absorbs acoustic energy more readily than soft tissue

D. No thermal index is relevant during the first trimester specifically

4. Which bioeffect specifically results from the rapid formation and collapse of gas bubbles under acoustic pressure fluctuation?

A. Streaming, a related but distinct effect from bulk fluid motion

B. Thermal injury from direct tissue heating alone

C. Attenuation-related signal loss at depth

D. Cavitation, specifically its inertial (collapse) form

5. A sonographer reviews a referring physician's order and finds it vague regarding the specific clinical question being asked. What is the most appropriate next step?

A. Proceed with a generic, comprehensive survey protocol without further clarification

B. Decline to perform the exam entirely until a new order is submitted

C. Clarify the clinical question directly with the ordering provider or review the available clinical history before scanning

D. Select the protocol used most recently for a different patient with a similar diagnosis code

6. A quality assurance phantom test reveals that a system's depth calibration is measurably inaccurate. What is the most likely underlying cause?

A. An incorrect Options Per Question setting on the console

B. A recent software update unrelated to acoustic performance

C. A miscalibrated assumption about propagation speed, or a genuine hardware issue affecting timing

D. The phantom itself is defective and cannot be a source of true system information

7. Why is routine transducer disinfection between patients considered a genuine patient-safety practice rather than a purely administrative requirement?

A. It directly reduces the risk of transmitting infectious organisms between patients via a shared surface

B. It has no measurable effect on patient safety and exists only for regulatory documentation

C. It is required only for endocavitary transducers and not for external transducers

D. It primarily protects the transducer's internal electronics rather than the patient

8. A sonographer is asked to scan a patient whose specific diagnostic question falls outside the sonographer's usual scope of practice. What is the most professionally appropriate response?

A. Acknowledge the limitation honestly and involve a more experienced colleague or refer appropriately for this case

B. Proceed with the exam regardless, since any scan performed is better than no scan being done at all

C. Decline all future exams of that general category permanently going forward from this point on

D. Perform the exam but quietly omit any measurement the sonographer feels genuinely uncertain about

9. Which statement most accurately describes the relationship between mechanical index (MI) and thermal index (TI)?

A. MI and TI are simply two different names referring to the exact same underlying acoustic measurement

B. TI specifically estimates cavitation likelihood, while MI specifically estimates temperature rise instead

C. Only one of these two specific indices is ever displayed on a given system at once, never both together

D. MI estimates the likelihood of a mechanical bioeffect (cavitation); TI estimates the likelihood of a temperature rise

10. A sonographer documents a technical limitation encountered during a difficult exam, such as poor acoustic access due to overlying bowel gas. Why does this documentation matter?

A. It is required solely for billing purposes and has no bearing on how the images should be interpreted

B. It protects the sonographer from any possible future liability regardless of the actual findings

C. It informs the interpreting physician of a genuine constraint on the exam's diagnostic completeness

D. It is optional documentation that most facilities choose not to require

11. Emerging ultrasound technology increasingly includes AI-assisted measurement tools. What remains the sonographer's core professional responsibility even when such tools are used?

A. Verifying that any AI-assisted measurement or finding is clinically plausible and correctly applied to this specific patient

B. Deferring entirely to the AI tool's output without independent verification

C. Disabling all AI-assisted features regardless of their potential clinical value

D. Documenting the AI tool's internal algorithm in detail within the patient's chart

12. Propagation speed in soft tissue is assumed by ultrasound systems to be a fixed value. What is that standard assumed value?

A. 1,000 m/s

B. 1,250 m/s

C. 1,450 m/s

D. 1,540 m/s

13. A structure with a genuinely faster true propagation speed than the system's assumed value will be displayed at which apparent depth relative to its true depth?

A. Shallower than its true depth, since the echo returns sooner than the assumed speed predicts

B. Deeper than its true depth, since faster propagation always displays as increased depth

C. At exactly the correct depth regardless of the true propagation speed

D. The structure will not be displayed at all under this condition

14. Wavelength and frequency share which specific inverse relationship, propagation speed held constant?

A. They increase together proportionally with no inverse relationship

B. Wavelength is entirely independent of frequency in soft tissue

C. Frequency determines propagation speed, which in turn determines wavelength

D. As frequency increases, wavelength decreases proportionally, and vice versa

15. Attenuation of an ultrasound beam as it travels through tissue results from which combination of mechanisms?

A. Reflection alone, with no other contributing mechanism

B. Refraction alone, independent of any absorption process

C. Propagation speed changes alone, unrelated to energy loss

D. Absorption, scattering, and reflection collectively removing energy from the main beam

16. Acoustic impedance is determined by which two physical properties of a medium?

A. Frequency and wavelength of the transmitted beam

B. Beam intensity and pulse repetition frequency

C. The medium's density and the propagation speed of sound within it

D. Transducer element size and element spacing

17. A large acoustic impedance mismatch at a tissue boundary produces which effect on the returning echo?

A. No measurable reflection occurs regardless of impedance mismatch magnitude

B. A strong reflection, with a correspondingly bright echo displayed at that boundary

C. Complete transmission of the beam with zero reflected energy

D. An effect entirely unrelated to the boundary's impedance mismatch

18. A sonographer notices a structure's apparent lateral position shifts slightly when imaged through an oblique fat-muscle interface compared to a perpendicular approach. This bending of the beam path is best explained by which phenomenon?

A. Attenuation varying by tissue type along the beam path

B. The beam bending at an oblique boundary between two media with differing propagation speeds

C. A simple change in the transducer's transmitted frequency

D. Absorption of the beam occurring only within the transducer housing

19. Which resolution type is most directly determined by pulse length (spatial pulse length)?

A. Axial resolution, the ability to distinguish structures lying along the beam's direction of travel

B. Lateral resolution, governed primarily by the transducer's effective beam width instead

C. Elevational resolution, governed by the slice thickness dimension of the beam itself

D. Temporal resolution, governed entirely by the achieved frame rate of the system

20. A sonographer observes an anechoic band deep to a fluid-filled structure, brighter than the surrounding tissue at the same depth. What artifact does this represent?

A. Posterior acoustic enhancement, from reduced attenuation through the fluid-filled structure

B. Acoustic shadowing, from a highly attenuating structure blocking the beam

C. Reverberation artifact, from beam bouncing between two parallel reflectors

D. Mirror image artifact, from beam reflection off a strong, smooth reflector

21. A series of equally spaced, parallel, progressively fainter bands appears deep to two closely spaced strong reflectors. What artifact does this most likely represent?

A. Posterior acoustic enhancement, arising from a fluid-filled structure with low attenuation

B. Acoustic shadowing, arising from a densely calcified, highly attenuating structure present

C. Reverberation artifact, from the beam bouncing repeatedly between two strong, parallel reflectors

D. Speed propagation artifact, arising from a fat-containing structure along the beam path

22. A structure's true position along the beam is displaced due to a genuine mismatch between true and assumed propagation speed through an intervening fat layer. What is this artifact called?

A. Reverberation artifact, from beam bouncing between two parallel reflectors repeatedly

B. Propagation speed (speed displacement) artifact, from a mismatch in assumed sound speed

C. Refraction artifact, from the beam bending at an oblique tissue boundary present

D. Grating lobe artifact, from off-axis energy inherent to array transducer design

23. A three-dimensional matrix array transducer captures detail not only along depth and the scan-line sweep, but also along a third spatial dimension perpendicular to the imaging plane. What is that third dimension called?

A. Elevational resolution, the slice-thickness dimension

B. Axial resolution, along the beam's direction of travel

C. Lateral resolution, along the scan-line sweep direction

D. Temporal resolution, across successive displayed frames

24. Temporal resolution is most directly related to which system parameter?

A. Transducer element size alone

B. Frame rate, the number of complete images displayed per second

C. Acoustic impedance of the scanned tissue

D. The specific gray-scale map selected for display

25. Increasing transducer frequency has which effect on axial resolution and penetration depth, respectively?

A. Improves both axial resolution and penetration depth simultaneously

B. Worsens both axial resolution and penetration depth simultaneously

C. Improves axial resolution but reduces penetration depth, due to increased attenuation at higher frequency

D. Has no meaningful effect on either axial resolution or penetration depth

26. The Snell's law relationship governing refraction depends most directly on which two quantities?

A. Beam intensity and pulse repetition frequency

B. Transducer element count and element spacing

C. Acoustic impedance values on either side of the boundary

D. The propagation speeds of the two media and the angle of incidence

27. A sonographer notices a duplicated, fainter copy of a real structure appearing symmetrically on the opposite side of a strong, curved reflector such as the diaphragm. What artifact is this?

A. Mirror image artifact, from beam reflection off the strong, smooth diaphragmatic surface

B. Grating lobe artifact, from side-lobe energy striking an off-axis reflector

C. Comet-tail artifact, from a small, highly reflective structure

D. Ring-down artifact, from a resonating fluid-gas interface

28. A technician explains to a trainee that squeezing a specific crystal produces a measurable voltage, and that applying a voltage to that same crystal causes it to physically change shape. Which principle is being described?

A. The piezoelectric effect, the basis for both transducer transmission and reception

B. Permanent magnetization occurring under an applied electric current

C. A color change occurring under varying acoustic pressure

D. Temperature-dependent electrical conduction above a fixed threshold

29. A transducer accidentally left in an autoclave sterilizer at excessive temperature permanently loses its ability to function afterward. What specific temperature threshold was most likely exceeded?

A. The transducer's minimum rated operating temperature

B. The temperature corresponding to peak transducer sensitivity

C. The Curie point, above which piezoelectric properties are permanently lost

D. The temperature at which resonant frequency doubles

30. The damping (backing) material behind a transducer's active element serves which primary function?

A. Shortening the pulse by absorbing excess ringing, improving axial resolution at some bandwidth cost

B. Increasing the transducer's transmitted acoustic output power beyond its default level

C. Matching the transducer's impedance directly to the patient's skin surface instead

D. Filtering out unwanted electrical interference originating from nearby equipment

31. The matching layer positioned in front of a transducer's active element serves which primary function?

A. Reducing impedance mismatch between the crystal and skin, improving transmitted energy

B. Absorbing excess ringing behind the active element specifically to shorten the pulse

C. Generating the electrical signal that ultimately becomes the displayed image itself

D. Physically focusing the beam at one single, fixed, unadjustable depth only

32. Comparing two transducers used on the same superficial structure, one produces a field of view with constant width from near field to far field, while the other produces a field that widens progressively with depth. Which array design produces the constant-width field?

A. Phased array, with its narrow footprint and sector-shaped field

B. Curvilinear array, with its curved footprint and widening field

C. Linear sequential array, producing a rectangular field of constant width

D. Annular array, requiring mechanical steering to sweep the beam

33. During a cardiac exam, the sonographer steers the beam electronically to different angles without any physical movement of the transducer itself. What underlying mechanism makes this possible?

A. Precisely timed firing delays across elements, creating an angled wavefront

B. A small internal motor physically rotating the entire transducer housing

C. A mechanically tilting single large crystal element inside the housing

D. Two entirely separate sets of elements, each dedicated to a different angle

34. Which transducer array design is most classically associated with cardiac imaging, given its small footprint requirement for intercostal access?

A. Linear sequential array, with its rectangular field of view and larger footprint

B. Curvilinear (curved sequential) array, with its wide but still sizable footprint

C. Phased array, given its small footprint and electronic steering capability

D. Mechanical sector array, an older design with genuine moving parts inside

35. Electronic focusing in array transducers is achieved through which mechanism?

A. Physically moving a lens in front of the transducer face

B. Selecting a fixed mechanical focal zone determined at manufacture

C. Changing the transmitted frequency to alter the beam's natural focal point

D. Applying precisely timed firing delays across elements to concentrate the beam at a chosen depth

36. A 2D matrix array transducer, capable of true volumetric (3D) acquisition, achieves elevational steering through which mechanism?

A. A single row of elements mechanically swept through a range of planes

B. A fixed, unadjustable elevational focus set permanently at manufacture

C. Physical rotation of the entire transducer assembly during acquisition

D. Electronic beam steering in the elevational dimension, in addition to the standard azimuthal dimension

37. Bandwidth of a transducer refers to which specific property?

A. The physical width dimension of the transducer's own footprint on the skin

B. The range of frequencies within the transmitted pulse, related to pulse length and damping

C. The maximum achievable imaging depth possible with that specific transducer

D. The total number of individual elements contained within the array itself

38. A transducer's near field (Fresnel zone) is characterized by which beam property compared to the far field?

A. A beam that diverges continuously from the transducer face with no convergence at all

B. A beam identical in width and behavior to the far field in every respect

C. A beam that is relatively narrow and converging before reaching its natural focus

D. A beam present only in continuous wave Doppler, never in pulsed applications

39. Increasing the diameter (aperture) of a transducer element has which effect on the length of the near field, all else equal?

A. Decreases the near field length proportionally as aperture size increases

B. Has genuinely no effect on near field length whatsoever regardless of aperture

C. Eliminates the near field entirely, regardless of the specific aperture size used

D. Increases the near field length, extending the beam's natural focus further out

40. Grating lobes, a genuine artifact source specific to array transducers, arise from which underlying cause?

A. A single continuous crystal with no discrete element structure at all

B. Excessive time gain compensation applied at a specific depth

C. A mismatch between transmitted and received frequency

D. The discrete, regularly spaced element structure inherent to array transducer design

41. A sonographer selects a lower-frequency transducer for an technically difficult, deep abdominal exam. What is the primary rationale for this selection?

A. Lower frequency attenuates less per unit depth, improving penetration to reach the deeper structure of interest

B. Lower frequency always produces superior image resolution regardless of depth

C. Lower frequency eliminates the need for any time gain compensation adjustment

D. Lower frequency is required by regulation for any exam beyond a certain depth

42. Annular array transducers achieve focusing in which specific manner, distinguishing them from linear or phased arrays?

A. Focusing symmetrically in both planes at once, but requiring mechanical steering

B. Focusing only in the elevational plane specifically, and genuinely never in azimuth

C. Focusing that is entirely fixed and cannot be adjusted electronically under any condition

D. Focusing that occurs exclusively through a physical lens, with no electronic component present

43. Endocavitary transducers are typically manufactured with which frequency characteristic relative to standard abdominal transducers?

A. A substantially lower frequency, to maximize penetration depth

B. A higher frequency, since the structure of interest is typically close to the transducer face

C. An identical frequency range to standard abdominal transducers in every case

D. No fixed frequency relationship exists between the two categories

44. A convex (curvilinear) array combines which two characteristics relative to a linear array?

A. An identical flat footprint alongside an identical rectangular field of view

B. A smaller footprint than linear arrays, paired with an identical rectangular field

C. A flat footprint identical to linear arrays, but with a sector-shaped field instead

D. A curved footprint, producing a wider field at depth than a comparable linear array

45. Why does a 2D matrix array transducer generally require substantially more individual elements and electronic channels than a standard 1D linear array?

A. It requires no more elements at all, since matrix and linear arrays share an identical count

B. Because it must independently control elements across two full dimensions, not just one

C. Because matrix arrays operate at a fundamentally different frequency than linear arrays do

D. Because matrix arrays require a physically larger crystal for each individual element used

46. A sonographer sets imaging depth so that the structure of interest sits at the very bottom edge of the display, with no margin beyond it. What is the most likely consequence?

A. No consequence occurs, since depth setting has genuinely no bearing on image usability

B. The structure risks disappearing off the display with minor movement, with no confirming margin

C. Frame rate will automatically increase specifically to compensate for the tight margin

D. The system will automatically add margin regardless of the sonographer's chosen depth setting

47. Which statement correctly distinguishes overall gain from time gain compensation (TGC)?

A. Overall gain and TGC are simply two different names for the identical, single control

B. TGC amplifies uniformly across the field, while overall gain amplifies selectively by depth

C. Overall gain changes the transmitted acoustic output power, while TGC genuinely does not

D. Overall gain amplifies uniformly across the field; TGC amplifies selectively by depth

48. A spectral Doppler waveform image is magnified after acquisition using post-processing (read) zoom. What effect does this have on the underlying resolved detail?

A. No genuine improvement in resolved detail occurs; the existing information is simply displayed larger

B. Resolution improves substantially, since additional scan lines are automatically acquired to fill the enlarged display

C. Axial resolution specifically improves while lateral resolution remains completely unaffected

D. The system automatically re-samples the Doppler signal at a higher rate to add genuine new detail

49. A narrow dynamic range setting is selected specifically to sharply define the boundary between a cystic structure and adjacent solid tissue. What trade-off does this setting introduce?

A. No trade-off exists at all; narrow dynamic range is a universally superior default setting

B. Narrow dynamic range directly increases the acoustic output actually delivered to the patient

C. Narrow dynamic range automatically improves the frame rate achieved during live acquisition

D. Subtle gray-scale gradation elsewhere is sacrificed for the increased boundary contrast gained

50. A sonographer notices that switching a setting reduces near-field clutter and improves image clarity without any increase in the transmitted acoustic output shown on the console. Which signal is this setting now processing to form the image?

A. Harmonic frequencies generated within tissue itself, rather than the transmitted fundamental

B. Only the transmitted fundamental frequency, with harmonics filtered out entirely

C. An equal blend of fundamental and harmonic frequency content

D. Only frequencies reflected from bone or other dense structures

51. A manufacturer advertises that its system achieves stronger returning signal strength on deep, technically difficult patients without raising the displayed acoustic output index. Which technique most plausibly explains this claim?

A. Increasing the number of focal zones used during acquisition

B. Coded excitation, transmitting a longer structured pulse compressed on reception

C. Simply increasing the overall grayscale gain setting

D. Switching automatically to a higher transmitted frequency

52. A high persistence setting is applied while imaging a rapidly beating fetal heart. What is the most likely visible consequence?

A. No visible consequence occurs regardless of persistence setting or structure motion

B. The rapid cardiac motion appears smoothed and blurred, since several sequential frames are averaged together

C. Frame rate automatically increases to compensate for any motion-related blurring

D. Cardiac motion appears sharper and more crisply defined than at a lower persistence setting

53. A system acquires the same field at three different transmitted frequencies in rapid succession and combines the results into one composite frame with visibly less speckle. What is this technique called, and why does it work?

A. Frequency compounding, since speckle patterns genuinely differ by frequency while true structure stays consistent

B. Spatial compounding, since multiple beam angles are combined into one frame

C. Persistence, since multiple sequential frames are averaged together over time

D. Coded excitation, since a longer structured pulse is compressed on reception

54. Spatial compounding, distinct from frequency compounding, combines which specific acquisitions?

A. Sequential images acquired at multiple distinct transmitted frequencies

B. Images of the same field acquired from multiple distinct beam angles

C. A single static three-dimensional volumetric acquisition only

D. Sequential frames averaged together purely over time at one fixed angle

55. Extended field of view (panoramic) imaging specifically requires which technique element during acquisition?

A. A completely stationary transducer maintained throughout the entire acquisition

B. Slow, steady transducer motion along the scanning surface as the system tracks and stitches sequential images

C. Simultaneous activation of both color and power Doppler modes

D. A minimum imaging depth setting of at least twice the structure's true length

56. A prenatal exam captures a continuously updating volumetric view of the fetal face, allowing the parents to watch real-time facial movement in three dimensions. What acquisition technique is being used?

A. Four-dimensional (4D) imaging, real-time 3D acquisition with motion as a fourth dimension

B. Static three-dimensional imaging captured at a single instant

C. Standard two-dimensional imaging displayed at an unusually high frame rate

D. Extended field of view imaging stitched across a sweep of the transducer

57. DICOM, as it relates to PACS, refers to which specific component of medical image storage infrastructure?

A. The specific brand name of one particular PACS vendor's own proprietary system

B. A physical storage device used exclusively for long-term image archiving purposes

C. An outdated storage format that has been fully replaced by modern PACS systems now

D. The standardized format and protocol enabling images to move correctly within a PACS network

58. A sonographer measuring a superficial mass places calipers along a line that does not run perpendicular to the mass's true long axis. Compared to the mass's actual size, how will this specific measurement most likely appear?

A. Identical to the true size, since caliper angle has no bearing on the result

B. Smaller than true size in every case, regardless of the specific angle chosen

C. Foreshortened or elongated relative to the mass's actual true dimension

D. Automatically corrected by the system regardless of the angle chosen

59. A thyroid nodule was measured six months ago using the near-wall-to-near-wall caliper convention. Today's follow-up study uses far-wall-to-far-wall placement instead for the same nodule. What is the most likely consequence for detecting genuine interval change?

A. A real, systematic measurement bias is introduced, potentially making a stable nodule appear to have changed

B. No consequence occurs, since caliper convention has no bearing on measurement accuracy

C. The system will automatically detect and correct for the convention mismatch

D. The measurement will be identical regardless of which wall convention is actually used

60. Which laterality documentation error carries the most significant direct patient-safety consequence?

A. A right-sided finding mislabeled as left-sided, potentially leading to the wrong side being treated

B. A minor inconsistency in font size used across different sections of the same report

C. An image saved in a slightly non-standard, though still readable, file compression format

D. A report generated several minutes later than the facility's typical internal target time

61. A carotid Doppler tracing shows an unexpectedly low peak velocity for a vessel that appears narrowed on grayscale imaging. Review shows the sample volume sits near the vessel wall rather than centered in the lumen. What does this most likely explain?

A. The narrowing seen on grayscale is not actually genuine stenosis

B. The off-center sample volume is likely sampling slower, non-representative flow, producing a falsely low reading

C. The system has automatically corrected the sample volume position already

D. Wall-related turbulence is producing a falsely elevated, not lowered, reading

62. A sonographer notices reduced frame rate after activating spatial compounding on a real-time exam. What is the most likely explanation?

A. Multiple beam angles must be acquired and combined for each displayed composite frame, directly reducing the achievable update rate

B. Spatial compounding automatically increases the imaging depth setting, independently reducing frame rate

C. Spatial compounding requires a fundamentally different, slower transducer than standard imaging

D. No genuine relationship exists between spatial compounding and frame rate

63. A wall filter threshold set too high during pulsed wave Doppler acquisition carries which specific risk?

A. Aliasing artifact will become substantially more pronounced on the resulting display

B. Genuine low-velocity flow signal of real clinical interest may be removed along with the intended low-frequency clutter

C. The transducer's acoustic output power will automatically increase to compensate

D. The sample volume will automatically reposition itself to a different depth

64. Which of the following most directly justifies confident, specific anatomic labeling of a structure on a saved image, rather than a vague, generic description?

A. The specific ultrasound system manufacturer used to acquire that particular image

B. The image's overall brightness and contrast settings selected at the time it was saved

C. The structure's position relative to reliable, well-known anatomic landmarks and their consistent spatial relationships

D. The sonographer's overall years of general clinical experience, independent of the specific image itself

65. A sonographer measures a structure through an intervening layer of fat and obtains a systematic measurement error despite genuinely correct caliper placement. What is the most likely explanation?

A. The caliper placement was actually incorrect despite appearing correct on visual inspection

B. The system's fixed 1,540 m/s propagation speed assumption does not match fat's true, genuinely slower propagation speed

C. Fat tissue physically blocks the beam entirely, preventing any accurate measurement

D. The transducer automatically and silently reduces its frequency whenever fat is detected in the field

66. During a lower-extremity venous study, the sonographer views grayscale anatomy and a real-time spectral waveform on the same screen simultaneously, without switching between separate acquisition modes. What is this simultaneous display called?

A. Duplex scanning, combining grayscale B-mode and pulsed wave spectral Doppler

B. Triplex scanning, adding color Doppler to the same simultaneous display

C. M-mode scanning, sampling a single fixed line repeatedly over time

D. Extended field of view imaging, stitching sequential frames together

67. A sonographer wants to genuinely improve lateral resolution within a small region of interest before acquiring the image, accepting a frame-rate cost as a reasonable trade-off. Which specific technique is most appropriate?

A. Write (pre-processing) zoom, narrowing the scanned sector to increase scan line density

B. Read (post-processing) zoom applied to the already-fully-formed and displayed image

C. An increase in overall gain applied specifically and only to the region of interest

D. A narrower dynamic range setting applied broadly across the entire display field

68. Persistence (frame averaging) reduces random image noise through which specific mechanism?

A. Increasing the acoustic output power delivered specifically to the noisiest regions

B. Blending several consecutive frames, since random noise differs frame to frame while structure remains fixed

C. Applying edge enhancement processing selectively to every single detected boundary

D. Automatically adjusting the wall filter threshold based on the detected noise level

69. Which statement correctly distinguishes PACS from DICOM?

A. PACS is the archiving/retrieval system; DICOM is the format enabling images to move within it

B. PACS and DICOM are two interchangeable names referring to one identical system

C. DICOM is physical hardware infrastructure, while PACS is purely a software-only format

D. PACS has fully replaced DICOM, now considered an obsolete, entirely unused standard

70. A processed image shows crisper, more visually distinct organ boundaries than the raw acquired data would suggest, without any indication that additional scan lines were acquired at those specific locations. What processing step most likely explains this?

A. Write (pre-processing) zoom applied before the image was fully formed

B. An increase in the transmitted acoustic output power at detected boundaries

C. Edge enhancement, selectively increasing contrast at abrupt echo intensity changes without adding new data

D. An automatic increase in imaging depth near the edges of the field

71. A structure appears sharply resolved at one depth on an image but noticeably blurred at a different depth on that same image. What does this finding most likely reflect?

A. Its position relative to the placed focal zone, since resolution is best there and worsens with distance

B. A genuine transducer element malfunction affecting only part of the array itself

C. An incorrect time gain compensation setting entirely unrelated to focal zone placement

D. A reverberation artifact affecting only the specific blurred portion of the display

72. Triplex scanning, distinct from duplex scanning, adds which specific additional information stream?

A. Three-dimensional volumetric acquisition added to a standard two-dimensional duplex display

B. A second, entirely separate spectral Doppler waveform tracing displayed simultaneously

C. Color Doppler flow mapping added to the grayscale and spectral Doppler information duplex already provides

D. Extended field of view imaging added to a standard duplex display

73. A structure's apparent length appears to change measurably depending on which portion of a moving structure's cycle a measurement is taken from. What does this most directly emphasize about measurement technique?

A. Measurement technique is entirely unaffected by any consideration of timing within a moving structure's cycle

B. Cyclic motion has no genuine bearing on caliper-based measurement accuracy

C. This effect occurs only in Doppler-based measurements, never in grayscale caliper measurements

D. Frame selection within a structure's cycle is itself part of the measurement technique that must be matched consistently on any comparison study

74. A structure too large to fit within a single transducer footprint's field of view needs to be documented in one complete image. Which technique is most directly appropriate?

A. Spatial compounding, since it improves boundary definition through multiple beam angles

B. Tissue harmonic imaging, since it specifically reduces near-field artifact present

C. Extended field of view, stitching sequential images into a panoramic field wider than one footprint

D. Frequency compounding, since it reduces speckle noise present across the field

75. A sonographer troubleshoots a disappointing image by working backward through the signal processing chain. An image that is technically bright and well-focused but still lacks adequate anatomic detail most likely points to which upstream step?

A. Transducer or frequency selection, a step no downstream adjustment such as gain or focus can actually correct

B. Overall gain, the amplification step, which is already ruled out by the described brightness

C. Focal zone placement, the beam-shaping step, already ruled out by the described focus quality

D. Time gain compensation specifically, independent of any other instrumentation consideration

76. Which statement most accurately describes the shared relationship among TGC, zoom, and dynamic range?

A. Each directly alters the acoustic output delivered to the patient during the exam

B. Each intervenes at a specific point in the display processing chain without changing the underlying acoustic physics of the returning echo

C. Each is relevant only to Doppler imaging, with no application to standard grayscale B-mode imaging

D. Each requires a completely different, incompatible transducer to be used for the adjustment to take effect

77. A sonographer explains to a patient that the machine can detect blood moving by measuring a genuine change in the returning sound wave's pitch compared to what was sent out. What underlying phenomenon is being described?

A. Attenuation, the gradual loss of beam energy occurring with increasing depth

B. The Doppler effect, the frequency shift from relative motion between transducer and reflector

C. Acoustic impedance mismatch occurring at a genuine tissue boundary

D. Harmonic generation arising from nonlinear beam propagation through tissue

78. A red blood cell moves toward the transducer. What effect does this have on the frequency of the returning echo compared to the transmitted frequency?

A. The returning frequency is lower than the transmitted frequency

B. The returning frequency is identical to the transmitted frequency regardless of motion direction

C. The returning frequency becomes unmeasurable whenever a reflector moves toward the transducer

D. The returning frequency is higher than the transmitted frequency

79. On a spectral tracing of the common carotid artery, the entire waveform is displayed consistently above the baseline throughout the cardiac cycle. What does this positioning indicate about flow direction?

A. Flow is moving away from the transducer throughout the cycle

B. Flow direction is alternating unpredictably between toward and away from the transducer

C. Flow is moving toward the transducer, the standard convention for above-baseline display

D. The baseline position itself has no relationship to flow direction at all

80. The Doppler equation's cosine term specifically relates the calculated velocity to which variable?

A. The angle between the ultrasound beam and the direction of blood flow

B. The propagation speed of sound in the specific tissue being scanned

C. The transmitted frequency selected for the current exam

D. The pulse repetition frequency currently in use

81. A colleague argues that any angle up to 89 degrees is acceptable for Doppler measurement since some signal is still detected. Why is this reasoning genuinely flawed?

A. Because velocity calculation is genuinely unrelated to angle at any value below 90 degrees

B. Because cosine sensitivity to angle error grows sharply near 90 degrees, unlike below 60 degrees

C. Because any angle below 90 degrees produces an identical, angle-independent velocity result

D. Because regulatory standards, not physics, are the only actual reason to avoid steep angles

82. A Doppler measurement is attempted at an angle of insonation at or very near 90 degrees. What is the most likely result?

A. The measurement becomes essentially unusable, since the cosine of 90 degrees approaches zero, predicting little to no detectable frequency shift regardless of true velocity

B. The measurement becomes maximally accurate at exactly 90 degrees specifically

C. The system automatically compensates fully for any angle at or near 90 degrees

D. No relationship exists between insonation angle and measurement reliability at any angle

83. Pulse repetition frequency (PRF) is fundamentally limited by which specific factor?

A. The specific transducer frequency selected for grayscale imaging alongside Doppler

B. The wall filter threshold currently selected for the ongoing acquisition itself

C. The sample volume size currently selected for the ongoing acquisition itself

D. Imaging depth, since a deeper sample volume needs longer round-trip time before the next pulse

84. A sonographer is told that at a PRF of 6,000 Hz, the maximum accurately measurable velocity corresponds to a specific fraction of that number. What is that fraction?

A. Exactly one-half of the current PRF value

B. Exactly double the current PRF value

C. A fixed value entirely independent of the current PRF

D. A value related only to acoustic output power, not PRF

85. During a renal artery Doppler exam, the sonographer observes the spectral trace's peak abruptly appear to continue below the baseline, even though the vessel's true flow direction has not changed. What is the most likely explanation?

A. A true, newly developed reversal of flow direction within the renal artery

B. A transducer malfunction isolated specifically to the Doppler circuitry

C. Aliasing, since true velocity has exceeded the current Nyquist limit at the selected PRF

D. An inappropriately high wall filter threshold for this specific vessel

86. Faced with an aliased spectral waveform, a sonographer wants to correct the display without altering the true flow being measured in any way. Which single adjustment most directly achieves this?

A. Lowering the wall filter threshold to allow more signal through

B. Enlarging the sample volume to capture more of the vessel

C. Increasing the pulse repetition frequency, raising the Nyquist limit above the true velocity

D. Switching to a substantially lower imaging depth setting

87. A vascular lab specifically favors one Doppler mode for routine surveys because it allows flow to be isolated to one exact depth within a vessel, rather than sampling the entire beam path at once. Which mode is being described?

A. Continuous wave Doppler, which samples the entire beam path continuously

B. Pulsed wave Doppler, which offers genuine spatial specificity at one chosen depth

C. Power Doppler, which encodes amplitude rather than a specific depth

D. M-mode, which samples a single line without frequency-shift detection

88. A dedicated cardiac Doppler probe uses two physically separate crystal elements rather than one, with each element performing only a single function throughout acquisition. What capability does this specific two-element design provide?

A. An unlimited theoretical velocity range, since no sampling interval creates a Nyquist limit

B. Improved axial resolution compared to any genuine single-element transducer design

C. The ability to acquire genuine three-dimensional volumetric data specifically

D. Automatic elimination of any angle correction requirement during acquisition

89. A continuous wave Doppler tracing detects a high-velocity signal, but the sonographer cannot determine whether that signal originates from a shallow or a deep segment of the vessel along the same beam path. What limitation does this illustrate?

A. Aliasing, since the detected velocity has exceeded the current Nyquist limit

B. Wall filter threshold set inappropriately for the vessel being studied

C. A limitation specific to sample volume size, not to the acquisition mode itself

D. Range ambiguity, the inability to determine which depth along the beam the signal is coming from

90. A stenotic aortic valve is expected to produce a velocity well beyond what pulsed wave Doppler can display without aliasing at the necessary imaging depth. Which technique should be used to obtain an accurate peak velocity in this specific case?

A. Increase the pulsed wave sample volume size substantially to compensate

B. Raise the wall filter threshold substantially to compensate

C. Switch to M-mode for its superior temporal resolution in this scenario

D. Switch to continuous wave Doppler, which has no theoretical velocity ceiling at any depth

91. Peak systolic and end-diastolic velocity, measured directly from a spectral waveform, are most directly used for which specific purpose?

A. Calculating resistance indices that characterize the waveform's shape and the downstream vascular bed

B. Determining the correct transducer frequency for the remainder of the examination

C. Calculating the appropriate wall filter threshold specifically for the vessel being studied

D. Determining the correct pulse repetition frequency for any subsequent color Doppler imaging

92. A spectral waveform shows substantial forward flow maintained throughout diastole. Which type of vascular bed is this waveform pattern most characteristic of?

A. A high-resistance vascular bed, such as resting skeletal muscle

B. A low-resistance vascular bed, such as the kidney or brain, requiring continuous perfusion

C. A vascular bed with no meaningful resistance characteristics whatsoever

D. A vascular bed that cannot genuinely be characterized by waveform shape under any circumstance

93. Color hue on a standard color Doppler display specifically encodes which information?

A. Flow direction relative to the transducer, following the same convention as spectral Doppler's above/below baseline display

B. The precise peak velocity value measured at each individual sample gate location

C. The specific vascular resistance index value calculated at each individual sample gate

D. The transducer frequency currently being used for the ongoing image acquisition

94. An abrupt color change occurs within a vessel on color Doppler despite no true reversal of flow direction. What does this finding most likely represent?

A. A genuine anatomic branch point where true flow direction actually changes at that location

B. A transducer element malfunction specifically affecting color assignment at that particular location

C. An intentional system feature specifically indicating a stenosis at that exact anatomic point

D. Color aliasing, occurring when true velocity at that point exceeds the current color scale's Nyquist limit

95. Power Doppler encodes which specific signal property, rather than the frequency shift itself?

A. The amplitude (strength) of the returning signal, integrated across the frequency shifts detected

B. The precise direction of flow relative to the transducer face at that location

C. The precise peak velocity value present at each individual sample location

D. The transmitted acoustic output power currently in use for the ongoing acquisition

96. Why is power Doppler often described as more sensitive to slow or poorly angled flow than color Doppler?

A. Amplitude is a more robust signal than a precisely measured frequency shift, making power Doppler less affected by slow flow or a poor insonation angle

B. Power Doppler uses a fundamentally different, higher-frequency transducer than color Doppler

C. Power Doppler eliminates the need for an adequate angle of insonation entirely under any condition

D. Power Doppler automatically increases acoustic output power specifically whenever slow flow is detected

97. Which statement most accurately reflects the relationship between color Doppler and power Doppler?

A. Power Doppler has entirely replaced color Doppler in modern clinical practice due to its superior sensitivity

B. Each displays a different aspect of the Doppler signal, direction/velocity versus amplitude, suiting a different specific clinical question

C. Color Doppler and power Doppler display identical information using different color schemes for the same underlying data

D. Power Doppler requires a fundamentally different, incompatible transducer than standard color Doppler

98. A sonographer sees what appears to be a second, fainter vessel with flow directly beneath the diaphragm on a color Doppler image, at a location where grayscale imaging shows no true second vessel. What artifact best explains this finding?

A. A genuine but previously undocumented accessory vessel at that location

B. Mirror image artifact, from beam reflection off the strong, smooth diaphragmatic surface

C. A transducer malfunction specifically affecting color signal processing

D. An intentional system feature automatically flagging possible pathology

99. A sudden burst of color fills a broad region of tissue during a hepatic Doppler exam, unrelated to any visible vessel, and is no longer present on the very next frame. What characteristic of this finding most strongly suggests artifact rather than true flow?

A. Its color intensity was unusually bright compared to nearby genuine vessels present

B. Its transient, single-frame appearance, consistent with motion-triggered flash artifact

C. Its location was relatively close to the transducer face itself

D. Its color pattern included both red and blue hues simultaneously

100. During an abdominal ultrasound, a sonographer notices a rapidly alternating color signal directly behind a small, strongly echogenic focus in the gallbladder fossa that was otherwise difficult to characterize on grayscale alone. How does this finding actually help the exam?

A. It directly measures the chemical composition of the echogenic focus itself

B. It eliminates any further need for grayscale correlation for the remainder of the exam

C. It directly quantifies blood flow velocity within the echogenic focus itself

D. It supports the presence of a calculus, since twinkle often appears behind a granular surface

101. A Doppler finding at a specific location seems unusual, and the sonographer pauses before documenting anything further. What should be assessed first, before any instrument adjustment is even attempted?

A. The exact model and manufacturer of the transducer currently in use

B. Whether the finding is physiologically plausible given the actual anatomy present at that location

C. The total number of years of experience the sonographer currently has

D. The specific acoustic output power setting used at the moment of acquisition

102. Repositioning the transducer to a different approach angle is a useful confirming technique specifically for which suspected artifact?

A. Twinkle artifact, since it depends entirely on transducer angle relative to the calculus

B. Aliasing, since transducer angle has no genuine relationship to the current Nyquist limit

C. Mirror image artifact, since it depends on a specific beam-reflector geometry that a different angle will typically disrupt

D. Flash artifact, since it depends entirely on maintaining one fixed transducer angle throughout acquisition

103. How is twinkle artifact typically managed clinically once correctly identified?

A. It generally requires no correction, since it is often diagnostically useful, though confirming it is not masking a separate genuine finding remains important

B. It must always be completely eliminated before the examination can genuinely be considered complete

C. It requires immediate, permanent discontinuation of the entire Doppler examination being performed

D. It requires switching specifically to continuous wave Doppler exclusively for the remainder of the exam

104. A suspected mirror image artifact near the diaphragm remains visible even after the sonographer repositions the transducer at several different reasonable approach angles. What should the sonographer do next?

A. Document the finding as artifact, with the reasoning for that conclusion explicitly recorded

B. Report the finding as a confirmed second, genuine vessel at that location

C. End the examination immediately without completing the remaining protocol

D. Substantially increase acoustic output power until the finding eventually disappears

105. Which statement most accurately describes what causes genuine diagnostic harm from a Doppler artifact?

A. The use of color Doppler instead of power Doppler for a given specific examination

B. An unrecognized artifact reported as though it represented genuine pathology, rather than a correctly identified and documented artifact

C. The mere physical presence of any artifact in the acquired image, regardless of whether it is ultimately recognized

D. The specific transducer frequency used during the examination, independent of artifact recognition itself

106. A renal Doppler waveform report lists a specific numeric value intended to characterize downstream vascular resistance in that kidney. Which two waveform measurements were most directly used to calculate that value?

A. The transmitted transducer frequency and the current wall filter setting

B. The current Nyquist limit and the pulse repetition frequency in use

C. The sample volume size and the angle of insonation used

D. Peak systolic velocity and end-diastolic velocity

107. A sonographer confirms a suspected flash artifact by holding the transducer still and minimizing patient motion. What result would confirm the suspicion?

A. The color signal remains completely unchanged in appearance and intensity

B. The color signal resolves within a frame or two once bulk motion is genuinely eliminated

C. The color signal becomes substantially stronger once motion is eliminated

D. No genuine relationship exists between motion and flash artifact's appearance or resolution

108. A finding fails to resolve despite a technique change specifically expected to disrupt the suspected artifact's mechanism. What does this most likely suggest?

A. The finding may represent a genuine, if unusual, finding rather than the artifact initially suspected on first impression

B. The technique change was performed correctly and definitively confirms the artifact regardless of the actual result

C. The sonographer should immediately increase acoustic output power until the finding disappears

D. No further clinical reasoning is required once any technique change has been attempted

109. Why are Doppler artifacts considered a genuine extension of, rather than simply a repeat of, grayscale artifact principles?

A. Doppler artifacts introduce genuinely new failure modes specific to frequency-shift processing, motion detection, and color assignment, with no direct grayscale equivalent

B. Doppler artifacts never actually occur in real clinical practice and exist only as a theoretical teaching concept

C. Doppler artifacts are corrected using exactly the same techniques as grayscale artifacts, with no genuine differences at all

D. Doppler artifacts only occur specifically when grayscale imaging is turned off completely during the examination

110. Why does an unrecognized Doppler artifact carry a particularly significant diagnostic risk compared to some grayscale artifacts?

A. Doppler artifacts are permanently recorded in the patient chart in a way grayscale artifacts genuinely are not

B. Doppler displays are interpreted as representing genuine motion, so an unrecognized artifact risks mimicking real pathology

C. Doppler artifacts always require immediate termination of the entire examination once genuinely detected

D. Doppler artifacts cannot be documented using the same reporting systems covered elsewhere in this book

Answers

1. A. ALARA means using the lowest output and shortest exposure that still yields a diagnostic image; once that image is achieved, output should be reduced back down rather than left elevated for the remainder of the exam. Option B, C, and D each misstate how ALARA actually applies.

2. D. TIS (soft tissue) and TIB (bone) reflect different worst-case heating models depending on whether the beam path is expected to encounter bone; the appropriate index is selected based on anatomy, not frequency, exam purpose, or imaging mode alone.

3. C. TIB (bone) is appropriate when bone is present in the beam path, since bone absorbs acoustic energy more readily than surrounding soft tissue and represents the more conservative heating estimate in this scenario. Option A, B, and D each misidentify the appropriate index or dismiss the concern entirely.

4. D. Cavitation refers to the formation and, in its inertial form, violent collapse of microscopic gas bubbles under acoustic pressure; streaming is a related but mechanistically distinct effect involving bulk fluid motion rather than bubble collapse itself.

5. C. Clarifying the clinical question, either directly with the ordering provider or through available clinical history, allows the exam to be appropriately focused; proceeding blindly, declining outright, or defaulting to an unrelated protocol each fails to serve the patient's actual clinical need.

6. C. A depth calibration error on phantom testing most likely reflects a miscalibrated propagation-speed assumption or a genuine hardware timing issue, both directly testable causes; a phantom is specifically designed to reveal these system-level issues, not to be dismissed as unreliable.

7. A. Transducer disinfection between patients directly reduces the risk of transmitting infectious organisms via a shared contact surface, a genuine patient-safety concern; it is not limited to endocavitary use, nor is its primary purpose protecting equipment.

8. A. Honestly acknowledging a genuine scope limitation and involving a more experienced colleague or making an appropriate referral serves the patient better than proceeding uncertainly, refusing all future similar exams, or silently omitting measurements without disclosure.

9. D. MI and TI are genuinely distinct indices estimating different bioeffect categories — MI for mechanical effects like cavitation, TI for thermal heating — and both are typically displayed simultaneously on modern systems, not interchangeably or exclusively.

10. C. Documenting a genuine technical limitation informs the interpreting physician of a real constraint on the exam's diagnostic completeness, directly affecting how confidently a negative or equivocal finding can be interpreted; it is not merely a billing or liability formality.

11. A. Regardless of what automated tools assist with, the sonographer remains responsible for verifying that any measurement or finding is clinically plausible and correctly applied to the specific patient at hand, not for blind deference or unrelated technical documentation.

12. D. Ultrasound systems assume a fixed soft-tissue propagation speed of 1,540 m/s for all depth and distance calculations; deviation from this true value in an actual tissue produces predictable measurement error.

13. A. A faster true propagation speed means the echo returns sooner than the system's fixed 1,540 m/s assumption predicts, causing the system to calculate and display a shallower-than-true depth for that structure.

14. D. For a constant propagation speed, wavelength and frequency are inversely related — as frequency increases, wavelength decreases proportionally — a direct consequence of the wave equation relating speed, frequency, and wavelength.

15. D. Attenuation results from the combined effects of absorption (conversion to heat), scattering, and reflection, all of which remove energy from the main beam as it travels through tissue; no single mechanism alone accounts for total attenuation.

16. C. Acoustic impedance is the product of a medium's density and the propagation speed of sound within that medium, a property of the tissue itself, not of the transmitted beam's frequency or the transducer's construction.

17. B. A large acoustic impedance mismatch at a boundary produces a strong reflection, displayed as a bright echo, since the fraction of energy reflected versus transmitted depends directly on the magnitude of the impedance difference between the two media.

18. B. The bending of the beam path at an oblique interface between tissues of differing propagation speed is refraction, which can genuinely displace a structure's apparent lateral position; attenuation, frequency, and housing absorption do not produce this specific bending effect.

19. A. Axial resolution, the ability to distinguish two closely spaced structures along the beam's direction of travel, is most directly determined by spatial pulse length — a shorter pulse improves axial resolution, independent of lateral or elevational dimensions.

20. A. Posterior acoustic enhancement appears as an area of increased brightness deep to a structure with lower attenuation than surrounding tissue, such as a simple fluid-filled cyst, since less signal is lost traveling through that structure compared to the adjacent solid tissue.

21. C. Reverberation artifact produces equally spaced, progressively fainter parallel bands when the beam bounces repeatedly between two strong, closely spaced, parallel reflectors before finally returning to the transducer, each bounce interpreted as a deeper structure.

22. B. Propagation speed artifact, sometimes called speed displacement artifact, results from a genuine mismatch between the true propagation speed through an intervening medium such as fat and the system's fixed 1,540 m/s assumption, displacing the structure's apparent position.

23. A. The dimension perpendicular to the standard two-dimensional imaging plane, representing slice thickness, is elevational resolution; axial and lateral resolution describe the two dimensions already captured within that plane, and temporal resolution concerns motion over time, not spatial slice thickness.

24. B. Temporal resolution, the ability to accurately depict motion over time, is most directly related to frame rate; a higher frame rate provides better temporal resolution, since more complete images are captured and displayed per second.

25. C. Increasing frequency shortens wavelength and pulse length, improving axial resolution, but higher-frequency sound also attenuates more rapidly in tissue, reducing achievable penetration depth — a genuine, well-established trade-off.

26. D. Snell's law relates the angle of incidence and the ratio of propagation speeds between the two media at a boundary, predicting the resulting angle of refraction; impedance, element geometry, and intensity are not the governing variables in this specific relationship.

27. A. Mirror image artifact occurs when the beam reflects off a strong, smooth, curved reflector such as the diaphragm, causing a genuine structure on one side to also be displayed as a fainter, duplicated copy on the opposite side at an equidistant position.

28. A. This bidirectional relationship, mechanical deformation producing voltage and applied voltage producing deformation, is the piezoelectric effect itself, the foundational principle underlying both transducer transmission and reception; magnetization, color change, and temperature-dependent conduction are unrelated phenomena.

29. C. Exceeding the Curie point permanently and irreversibly destroys a piezoelectric crystal's piezoelectric properties, a genuine practical hazard during sterilization procedures such as autoclaving; the other options describe values that do not represent this specific, permanent failure threshold.

30. A. The damping (backing) material absorbs excess ringing behind the active element, shortening the transmitted pulse and improving axial resolution, a genuine trade-off against some loss of sensitivity, distinct from the matching layer's separate function.

31. A. The matching layer reduces the significant impedance mismatch between the piezoelectric crystal and the patient's skin, improving the efficiency of acoustic energy transmission into the body, a distinct function from the backing material's pulse-shortening role.

32. C. A linear sequential array produces a rectangular field of view with constant width throughout the image depth, distinct from the widening sector-shaped field characteristic of curvilinear and phased array designs.

33. A. Electronic beam steering, characteristic of phased array design, is achieved through precisely timed firing delays across individual elements, producing an angled resulting wavefront through constructive interference, with no physical movement of the transducer required at all.

34. C. The phased array's small footprint, achieved through electronic rather than physical beam steering, makes it particularly well suited to cardiac imaging, where a limited intercostal acoustic window requires a compact transducer face.

35. D. Electronic focusing applies precisely timed firing delays across the array's elements, causing the resulting wavefronts to converge at a chosen depth, allowing focal depth to be adjusted dynamically without any physical lens movement.

36. D. A true 2D matrix array adds electronic beam steering capability in the elevational dimension, alongside the standard azimuthal steering every array already provides, enabling genuine volumetric acquisition without requiring mechanical sweeping.

37. B. Bandwidth refers to the range of frequencies contained within the transmitted pulse; a well-damped transducer with a short pulse has a wider bandwidth, a property directly related to the damping material's pulse-shortening function.

38. C. The near field (Fresnel zone) is characterized by a relatively narrow, converging beam extending from the transducer face to its natural focus, after which the beam diverges in the far field (Fraunhofer zone) — a genuine, predictable beam geometry.

39. D. A larger aperture (element diameter) increases the near field length, extending the beam's natural focus point further from the transducer face, a direct geometric relationship in transducer beam physics.

40. D. Grating lobes arise specifically from the discrete, regularly spaced element structure inherent to array transducer design, an artifact source that does not occur with a genuinely continuous, non-segmented crystal structure.

41. A. A lower-frequency transducer attenuates less per unit depth than a higher-frequency one, improving penetration to reach a deeper structure, a direct trade-off against the finer resolution a higher frequency would otherwise provide.

42. A. Annular array transducers, with their concentric ring element structure, achieve symmetric electronic focusing in both the azimuthal and elevational planes simultaneously, but require mechanical steering (rather than electronic) to actually sweep the beam and form a two-dimensional image.

43. B. Endocavitary transducers are typically manufactured at a higher frequency than standard abdominal transducers, since the structures of clinical interest are typically close to the transducer face, allowing the resolution benefit of higher frequency without a significant penetration-depth penalty.

44. D. A curvilinear (convex) array's curved element arrangement produces a wider field of view at depth than a comparably sized linear array, while still maintaining a reasonably manageable footprint, distinguishing it from both linear and phased array geometry.

45. B. A 2D matrix array must independently control elements across two full dimensions, azimuthal and elevational, rather than the single dimension a standard 1D linear array controls, requiring substantially more individual elements and electronic channels to achieve true volumetric steering and focusing.

46. B. Setting depth with no margin beyond the structure of interest risks the structure disappearing off the bottom of the display with minor movement, and provides no confirmation that nothing diagnostically relevant lies just beyond the current field — a genuine, avoidable technique error.

47. D. Overall gain amplifies the received signal uniformly across the entire field, while TGC selectively amplifies by depth specifically to compensate for depth-dependent attenuation — genuinely distinct, complementary controls, not interchangeable or reversed in function.

48. A. Post-processing (read) zoom magnifies already-acquired information without adding any new scan lines or genuine additional detail; only pre-processing (write) zoom, applied before acquisition, genuinely improves resolved detail within the zoomed region.

49. D. A narrow dynamic range setting increases contrast to sharply define a specific boundary, but this comes at the cost of subtle gray-scale gradation elsewhere in the image, gradation that is genuinely useful for characterizing solid-organ parenchymal texture in a different clinical context.

50. A. This describes tissue harmonic imaging, which processes harmonic frequencies generated within tissue via nonlinear propagation rather than the fundamental, reducing near-field artifact without any increase in transmitted acoustic output.

51. B. Coded excitation transmits a longer, specially structured pulse and compresses it during receive-side processing, genuinely improving signal strength without increasing transmitted acoustic output, unlike focal zone count, gain, or frequency changes, none of which achieve this specific output-neutral benefit.

52. B. High persistence averages several sequential frames together to reduce random noise, but this same averaging smooths and blurs genuinely rapid motion, making high settings poorly suited to imaging a rapidly beating structure such as a fetal heart.

53. A. This describes frequency compounding specifically, which combines images acquired at multiple distinct frequencies, exploiting the fact that speckle patterns genuinely differ by frequency while true

anatomic structure remains consistent across them, distinct from spatial compounding, persistence, or coded excitation.

54. B. Spatial compounding combines images of the same field acquired from multiple distinct beam angles, improving boundary definition and reducing speckle through angle-dependent averaging, a genuinely different parameter from frequency compounding's frequency-based approach.

55. B. Extended field of view imaging specifically requires slow, steady transducer motion along the scanning surface, allowing the system to track relative motion and stitch sequentially acquired images into a single panoramic composite wider than any one static field of view.

56. A. A continuously updating, real-time volumetric view is 4D imaging, three-dimensional acquisition displayed live with motion as a genuine fourth dimension layered on top of the three spatial dimensions, distinct from a single static 3D snapshot, standard 2D imaging, or panoramic stitching.

57. D. DICOM is the standardized file format and communication protocol that enables an image saved on one manufacturer's system to be correctly opened and displayed elsewhere within the same PACS network, genuine cross-manufacturer interoperability rather than a single vendor's product or an obsolete format.

58. C. Placing calipers at an angle that is not genuinely perpendicular to a structure's true axis produces a foreshortened or elongated apparent dimension relative to its actual size, a real geometric measurement error rather than one the system automatically corrects.

59. A. Switching caliper convention between a baseline and follow-up study introduces a real, systematic measurement bias, since consistently measuring from a different reference wall can make a genuinely stable nodule falsely appear to have grown or shrunk between studies.

60. A. A laterality error, right mislabeled as left or vice versa, can lead directly to the wrong side of the body being biopsied, treated, or monitored going forward, a genuine patient-safety concern distinct from minor formatting or turnaround-time issues.

61. B. A sample volume positioned near the vessel wall rather than centered in the true flow stream samples slower-moving, non-representative flow, a plausible explanation for an unexpectedly low velocity reading in a vessel that otherwise appears narrowed, rather than a genuine absence of stenosis or an automatic correction.

62. A. Spatial compounding's genuine frame-rate cost arises because multiple beam angles must be acquired and combined for each single displayed composite frame, directly reducing the achievable update rate compared to single-angle acquisition.

63. B. An excessively high wall filter threshold removes signal below that threshold indiscriminately, meaning genuine low-velocity flow signal of real clinical interest, such as late diastolic flow, can be removed along with the intended low-frequency clutter it was meant to filter.

64. C. Confident, specific anatomic labeling is genuinely justified by a structure's position relative to reliable, well-known anatomic landmarks and their consistent spatial relationships, not by unrelated factors such as system manufacturer, display settings, or general experience alone.

65. B. The system's fixed 1,540 m/s propagation speed assumption does not match fat's true, genuinely slower propagation speed, producing a predictable, physics-based depth-measurement error even when caliper placement itself is genuinely correct.

66. A. Simultaneous grayscale B-mode imaging and pulsed wave spectral Doppler display, without switching modes, is duplex scanning specifically; triplex adds a third stream (color Doppler), while M-mode and extended field of view describe genuinely different acquisition techniques.

67. A. Write (pre-processing) zoom, applied before the image is fully formed, narrows the scanned sector and increases effective scan line density within that region, genuinely improving lateral resolution at an accepted frame-rate cost, unlike read zoom's purely cosmetic magnification.

68. B. Persistence blends information from several consecutive frames together, exploiting the fact that random noise (speckle) genuinely differs from frame to frame while true anatomic structure remains consistent across those same frames, reducing the composite image's overall noise.

69. A. PACS is the networked archiving and retrieval system; DICOM is the standardized file format and communication protocol that enables images to move correctly and be correctly interpreted within that same PACS network — genuinely distinct, complementary concepts, not interchangeable or sequential replacements.

70. C. Edge enhancement selectively increases visual contrast specifically at locations where existing data shows an abrupt echo intensity change, sharpening the visual presentation of a boundary without acquiring any genuinely new scan lines or information, unlike write zoom, output changes, or depth adjustments.

71. A. Lateral resolution is genuinely best directly at the focal zone and worsens with distance from it, so a structure appearing sharp at one depth and blurred at a different depth on the same image most likely reflects its position relative to the currently placed focal zone.

72. C. Triplex scanning adds color Doppler flow mapping to the grayscale anatomy and spectral Doppler waveform information duplex scanning already provides simultaneously, a third information stream generally coming at a further frame-rate cost beyond duplex alone.

73. D. A structure's apparent size can genuinely differ across a single cardiac or respiratory cycle, making frame selection itself part of the measurement technique, one that must be matched consistently between an original and a comparison study to detect genuine interval change accurately.

74. C. Extended field of view is specifically designed to stitch sequential images together into a panoramic field wider than any single transducer footprint, directly addressing a structure too large to fit within one static field of view.

75. A. An image that is adequately bright and focused but still lacks anatomic detail most likely points upstream to transducer or frequency selection, a step no downstream adjustment like gain or focus can actually correct, since those specific parameters have already been ruled out by the description given.

76. B. TGC, zoom, and dynamic range each intervene at a specific point in the display processing chain, reshaping how already-received signal information is amplified, resolved, or displayed, without altering the underlying acoustic physics of the returning echo itself or requiring different hardware.

77. B. A genuine change in returning frequency (pitch) relative to the transmitted frequency, caused by relative motion between the transducer and a moving reflector such as a red blood cell, is specifically the Doppler effect, distinct from attenuation, impedance mismatch, or harmonic generation.

78. D. A reflector moving toward the transducer produces a positive Doppler shift, meaning the returning frequency is higher than the originally transmitted frequency, the opposite relationship from a reflector moving away.

79. C. A waveform consistently displayed above the baseline reflects flow moving toward the transducer, the standard positive-shift display convention; a waveform below the baseline would instead reflect flow moving away.

80. A. The Doppler equation's cosine term specifically relates calculated velocity to the angle between the ultrasound beam and the true direction of blood flow; cosine's rapid change near 90 degrees is what makes velocity measurement increasingly sensitive to angle error at steep angles.

81. B. While some signal may technically be detectable at a steep angle, cosine's sensitivity to a given angle-placement error grows sharply as the angle approaches 90 degrees, producing a large, unreliable velocity error, unlike the comparatively manageable sensitivity at angles below roughly 60 degrees — a genuine physics limitation, not merely a regulatory convention.

82. B. At or near a 90-degree angle of insonation, the cosine term approaches zero, meaning the Doppler equation predicts little to no detectable frequency shift regardless of the reflector's true velocity, making measurement at this angle essentially unusable.

83. D. PRF is fundamentally limited by imaging depth: a deeper sample volume requires a longer round-trip travel time for each pulse's echo to return, directly capping how frequently the next pulse can be transmitted at that depth.

84. A. The Nyquist limit is mathematically exactly half the current pulse repetition frequency, directly setting the maximum velocity accurately displayable without aliasing at that specific PRF; it is neither double the PRF, a fixed independent value, nor related to acoustic output power.

85. C. A peak wrapping to appear on the opposite side of the baseline despite genuinely unchanged flow direction is the classic signature of aliasing, occurring specifically when true velocity exceeds the current Nyquist limit at the selected PRF, not a true reversal, malfunction, or wall filter issue.

86. C. Increasing PRF directly raises the Nyquist limit; once that raised limit exceeds the true velocity present, the aliasing artifact resolves without altering the actual flow being measured at all, unlike wall filter, sample volume, or depth adjustments, none of which directly address the Nyquist-limit mechanism.

87. B. Genuine spatial specificity, the ability to isolate flow to one precisely chosen depth rather than sampling the entire beam path, is pulsed wave Doppler's defining advantage, distinct from continuous wave Doppler's whole-beam sampling, power Doppler's amplitude-based approach, or M-mode's non-Doppler motion tracing.

88. A. A dedicated two-element design, one continuously transmitting and one continuously receiving, is the defining feature of continuous wave Doppler, eliminating the discrete sampling interval responsible for the Nyquist limit and providing an unlimited theoretical velocity range, not an axial-resolution, 3D, or angle-correction benefit specifically.

89. D. The inability to determine which specific depth along the beam a detected signal originates from is range ambiguity, a genuine and defining limitation of continuous wave Doppler's continuous, non-depth-selective reception, distinct from aliasing, wall filter, or sample volume issues.

90. D. Continuous wave Doppler has no theoretical velocity ceiling regardless of depth, making it the appropriate technique when a velocity, such as a stenotic aortic jet, is expected to exceed pulsed wave Doppler's achievable range; enlarging sample volume, raising wall filter, or using M-mode does not resolve this genuine physical limitation.

91. A. Peak systolic and end-diastolic velocity are the two direct inputs used to calculate resistance indices, which characterize waveform shape and the downstream vascular bed's resistance characteristics, not transducer frequency, wall filter, or PRF selection.

92. C. Substantial forward flow maintained throughout diastole is the characteristic pattern of a low-resistance vascular bed, such as the kidney or brain, organs requiring continuous perfusion, the opposite pattern from a high-resistance bed like resting skeletal muscle.

93. A. Color hue on a standard color Doppler display encodes flow direction relative to the transducer, following the same positive-toward and negative-away convention spectral Doppler uses for its above/below baseline display, not peak velocity, resistance index, or transducer frequency directly.

94. D. An abrupt color change without a genuine flow direction change is the color Doppler equivalent of spectral aliasing, occurring when true velocity at that point exceeds the current color scale's Nyquist limit, not a genuine anatomic change, malfunction, or dedicated stenosis-indicator feature.

95. A. Power Doppler encodes the amplitude (strength) of the returning Doppler signal, integrated across the detected frequency shifts, rather than encoding direction or precise velocity the way color Doppler's hue and brightness scheme does.

96. B. Because amplitude is a more robust signal than a precisely measured frequency shift, power Doppler is genuinely less affected by slow flow or a poor insonation angle than color Doppler, which depends on accurately detecting a directional frequency shift to function correctly.

97. C. Color and power Doppler each display a genuinely different aspect of the underlying Doppler signal, direction and relative velocity versus amplitude, making each appropriate for a different specific clinical question rather than one having replaced the other or displaying identical information.

98. B. Mirror image artifact occurs when the beam reflects off a strong, smooth reflector such as the diaphragm both before and after insonating true flow, displaying a duplicated, fainter flow signal at an implausible depth beyond that reflector where no true vessel actually exists.

99. B. A transient finding present for only a single frame and then gone is most consistent with flash artifact, which is motion-triggered and characteristically resolves within a frame or two, unlike a persistent, reproducible true flow signal; brightness, proximity, and color pattern alone do not reliably distinguish artifact from true flow.

100. D. A rapidly alternating color signal behind a strongly reflective, granular structure is twinkle artifact, which can genuinely help confirm the presence of a small calculus that might otherwise be difficult to characterize confidently on grayscale imaging alone, though it does not measure composition or velocity directly.

101. B. Before any instrument adjustment is attempted, assessing whether a finding is physiologically plausible given the actual anatomy present at that location is the most useful first screening step, the same systematic reasoning applied throughout Doppler and grayscale artifact recognition alike.

102. C. Mirror image artifact specifically depends on a particular beam-reflector geometry that repositioning the transducer to a different approach angle will typically disrupt, making this a useful confirming technique specifically for this artifact rather than twinkle, aliasing, or flash artifact.

103. A. Twinkle artifact generally requires no correction once correctly identified, since it is often diagnostically useful, though confirming it is not masking a separate, genuine finding at the same location remains an important distinction to make rather than an elimination or discontinuation response.

104. A. When a suspected mirror image artifact from an unavoidable strong reflector persists despite reasonable technique adjustment, documenting the finding as artifact with the supporting reasoning explicitly recorded is the appropriate step, not reporting it as a confirmed genuine vessel or resorting to an unrelated, disproportionate response.

105. B. Genuine diagnostic harm arises specifically from an unrecognized artifact reported as though it represented genuine pathology, not from the mere presence of an artifact that has been correctly identified and documented, nor from mode or frequency selection independent of recognition.

106. D. The resistive index, a numeric value characterizing downstream vascular resistance, is calculated directly from peak systolic velocity and end-diastolic velocity, the two values measured directly from the waveform, not from transducer frequency, wall filter, Nyquist limit, PRF, sample volume, or angle correction directly.

107. B. If a suspected flash artifact genuinely resolves within a frame or two once bulk transducer and patient motion is eliminated, this confirms the artifact interpretation, since flash artifact is specifically triggered by non-flow motion rather than persisting independently of it.

108. D. A finding that fails to resolve despite a technique change specifically expected to disrupt the suspected artifact's mechanism deserves reconsideration, since it may represent a genuine, unusual finding rather than the artifact initially suspected, not automatic confirmation or a reason to stop reasoning further.

109. D. Doppler artifacts introduce genuinely new failure modes specific to frequency-shift processing, motion detection, and color assignment, none of which have a direct grayscale equivalent, making this content a real extension of, not a repeat of, grayscale artifact principles.

110. B. Because Doppler displays are specifically interpreted as representing genuine physiologic motion, an unrecognized Doppler artifact is particularly likely to be mistaken for real hemodynamic pathology, a distinct and elevated risk compared to some grayscale artifacts, not a chart-retention, mandatory-termination, or documentation-incompatibility issue.