

COMPREHENSIVE MOCK EXAM 7

Supplemental to: Clinical Ultrasound Board Review 2026-2027

Travis L. Bricker

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 v17.3

Board-Review Questions

1. Under the FDA's acoustic-output regulatory framework, a manufacturer must label a diagnostic ultrasound system differently depending on whether its output falls within pre-1976 typical levels or exceeds them under the newer, higher allowable limits. What is this labeling system called?
 - A. The Spaulding classification system
 - B. Track 1 versus Track 3 acoustic-output labeling
 - C. The AIUM accreditation labeling system
 - D. The ARDMS credentialing labeling system

2. Before a new diagnostic ultrasound system can be legally marketed in the United States, its manufacturer must obtain a specific type of regulatory clearance demonstrating substantial equivalence to an already-legally-marketed device. What is this regulatory pathway called?
 - A. FDA 510(k) premarket clearance
 - B. AIUM practice accreditation
 - C. ARDMS registry credentialing
 - D. The Output Display Standard certification

3. Decades of epidemiological and laboratory research on diagnostic-level ultrasound exposure have not established a confirmed causal link to adverse fetal or patient outcomes at typical clinical output levels. What does this research conclusion primarily support?
 - A. That ALARA and prudent-use guidance are therefore unnecessary
 - B. That diagnostic ultrasound is confirmed to cause bioeffects at any output level
 - C. The evidence base underlying the continued clinical use of diagnostic ultrasound at typical exposure levels
 - D. That bioeffects research on ultrasound has never been performed

4. Before performing a transvaginal ultrasound, facility policy requires that a second staff member be present in the room in addition to the sonographer, for the comfort and protection of both patient and provider. What is this practice called?

- A.** A chaperone policy for intimate exams
- B.** The Spaulding classification requirement
- C.** The AIUM Statement on Prudent Use
- D.** A patient time-out protocol

5. After years of repetitive scanning motions, a sonographer is diagnosed with a specific overuse injury affecting the tendons of the wrist. What general category of occupational injury does this represent?

- A.** An acute traumatic injury, unrelated to any repetitive scanning technique
- B.** A bioeffect of acoustic exposure to the sonographer's own scanning hand
- C.** A Curie-point-related material failure, unrelated to human tissue
- D.** A cumulative trauma disorder (carpal tunnel, De Quervain's) from repetitive scanning

6. After performing an ultrasound-guided biopsy, the sonographer places the used needle directly into a rigid, puncture-resistant container designated for that purpose, rather than a standard trash bin. What does this practice address?

- A.** Transducer disinfection classification, an unrelated infection-control concept
- B.** Safe biohazard/sharps disposal to prevent needlestick injury
- C.** Output Display Standard compliance, an unrelated acoustic-output concept
- D.** Patient chaperone policy, an unrelated intimate-exam practice

7. A facility restricts which staff members can access, export, or share a patient's stored ultrasound images and video clips, and logs each access event. What regulatory concern does this access-control practice primarily address?

- A.** The Spaulding classification of transducers
- B.** FDA 510(k) premarket clearance
- C.** The AIUM Statement on Prudent Use
- D.** HIPAA-compliant protection of patient health information

8. Before performing a requested ultrasound exam, the sonographer confirms that a valid physician's order exists and that the stated clinical indication supports the exam being requested. What does this verification step primarily support?

- A.** Medical necessity documentation and appropriate exam ordering
- B.** Transducer disinfection level selection
- C.** Acoustic output Track 1 versus Track 3 labeling
- D.** AIUM facility accreditation renewal

9. After being accidentally stuck by a used biopsy needle, a sonographer immediately washes the site and reports the incident through a specific facility protocol for follow-up testing and treatment. What is this protocol called?

- A.** The Spaulding classification protocol, an unrelated disinfection-level concept
- B.** Bloodborne pathogen exposure (needlestick) protocol
- C.** The AIUM Statement on Prudent Use, an unrelated acoustic-output guideline
- D.** A chaperone policy, an unrelated intimate-exam practice

10. A facility's quality assurance program specifies that its tissue-mimicking phantom testing must be performed and logged on a defined recurring schedule, rather than only when a problem is suspected. What does this scheduling requirement primarily ensure?

- A.** Compliance with the Spaulding classification, an unrelated disinfection concept
- B.** Consistent, documented, recurring verification of system performance over time
- C.** FDA 510(k) premarket clearance renewal, an unrelated device-marketing process
- D.** HIPAA-compliant image access logging, an unrelated privacy-control concept

11. Before applying a new disinfectant product to a transducer for the first time, the sonographer checks a specific document to confirm the product will not damage that transducer's materials. What should be checked?

- A.** The AIUM Statement on Prudent Use, an unrelated acoustic-output guideline
- B.** The FDA 510(k) clearance summary, an unrelated device-marketing document

- C. The facility's chaperone policy, an unrelated intimate-exam practice
- D. The transducer manufacturer's disinfectant compatibility list

12. The audible pitch heard through an ultrasound system's Doppler speaker, representing the Doppler shift itself, falls in a range of roughly a few hundred hertz to a few kilohertz. How does this compare to the frequency of the transmitted imaging beam that produced it?

- A. The audible Doppler shift is far lower than the transmitted beam frequency, which is in the megahertz range
- B. The audible Doppler shift and the transmitted beam frequency are always numerically identical
- C. The audible Doppler shift is always higher than the transmitted beam frequency
- D. The transmitted beam frequency has no defined range at all, unlike the Doppler shift

13. A transducer's face has a certain physical surface area that is actively transmitting and receiving sound, which may be smaller than the total housing footprint. What is this specific active radiating surface area called?

- A. The effective radiating area (ERA)
- B. The near-zone length, a beam-geometry depth concept
- C. The dead zone, a near-field imaging limitation
- D. The kerf, the inter-element gap in an array

14. Within a transmitted beam's cross-section, the ratio of the intensity at the single hottest (spatial-peak) point to the intensity averaged across the entire beam area describes how concentrated or spread out the beam's energy is. What is this ratio called?

- A. The duty factor, an unrelated transmit-timing ratio
- B. The fractional bandwidth, an unrelated frequency-range ratio
- C. The half-value layer, an unrelated attenuation-depth measure
- D. The beam uniformity coefficient (spatial-peak to spatial-average intensity ratio)

15. A pulse consists of 3 cycles at a wavelength of 0.3 mm, giving a spatial pulse length of 0.9 mm. If the propagation speed is 1540 m/s, what related time-domain quantity can be calculated by dividing that spatial pulse length by the propagation speed?

- A.** The pulse duration (the actual time the pulse takes to occur)
- B.** The pulse repetition frequency, a distinct timing parameter
- C.** The Doppler shift frequency, a distinct velocity-related value
- D.** The Nyquist limit, a distinct sampling-rate concept

16. A transducer has a bandwidth of 3 MHz centered on a nominal frequency of 5 MHz. What is this transducer's fractional bandwidth, expressed as a percentage?

- A.** 60% (bandwidth divided by center frequency)
- B.** 3% (bandwidth alone, expressed as a percent)
- C.** 5% (center frequency alone, expressed as a percent)
- D.** 15% (bandwidth multiplied by center frequency)

17. A single resolvable unit of a 3D ultrasound dataset is defined by the combination of axial, lateral, and elevational resolution together at a given point in the beam. What is this combined 3D unit called?

- A.** The near zone, a beam-geometry depth concept
- B.** The dead zone, a near-field imaging limitation
- C.** The resolution cell (voxel)
- D.** The kerf, the inter-element gap in an array

18. Very close to a transducer's face, the emitted sound behaves approximately as a series of expanding spherical wavefronts from many point sources, rather than as a single flat, parallel wavefront. Where does the wavefront begin approximating a more plane-like, parallel shape?

- A.** Farther from the transducer, in the far zone, as the individual spherical wavefronts combine and the beam approximates a plane wave
- B.** Immediately at the transducer face, which always produces a perfect plane wave, per this view

- C. Only within the dead zone, and never at any distance beyond it
- D. Plane-wave behavior never occurs at any distance from a diagnostic transducer, per this view

19. A piezoelectric transducer element converts electrical energy into mechanical (acoustic) energy, and vice versa, but not with perfect 100% efficiency. What term describes the fraction of energy successfully converted between these two forms?

- A. The duty factor, an unrelated transmit-timing ratio
- B. The Nyquist limit, an unrelated sampling-rate concept
- C. The electromechanical coupling coefficient (conversion efficiency)
- D. The half-value layer, an unrelated attenuation-depth measure

20. A sonographer must image a deep structure at 16 cm and is choosing between a 3 MHz and a 7 MHz transducer for the exam. Which factor most directly explains why the lower frequency (3 MHz) is generally the better choice for reaching that depth?

- A. Lower frequencies always produce sharper axial resolution than higher frequencies
- B. Lower frequencies travel faster through soft tissue than higher frequencies
- C. Lower frequencies have a longer wavelength, which increases attenuation and reduces penetration
- D. Lower frequencies attenuate less per centimeter than higher frequencies, improving penetration to that depth

21. Comparing the beam's acoustic output at the transducer face to the much weaker signal that actually reaches the display after passing through the entire imaging chain, engineers describe the overall reduction in usable signal strength introduced by the system itself. What is this overall system sensitivity loss called?

- A. The duty factor, an unrelated transmit-timing ratio
- B. The Nyquist limit, an unrelated sampling-rate concept
- C. Insertion loss (overall system sensitivity loss)
- D. The half-value layer, an unrelated attenuation-depth measure

22. Beyond thermal heating and cavitation, a third mechanical bioeffect mechanism describes sound-induced steady movement of fluid within tissue, driven by the momentum of the traveling wave itself. What is this bioeffect mechanism called?

- A.** The piezoelectric effect, an unrelated material-conversion property
- B.** Refraction, an unrelated beam-bending phenomenon
- C.** Acoustic streaming (sound-induced fluid motion)
- D.** Specular reflection, an unrelated mirror-like echo phenomenon

23. When an ultrasound beam is absorbed or reflected by tissue, it exerts a small, steady, unidirectional push on that tissue in the direction of beam travel, distinct from the oscillating pressure of the sound wave itself. What is this steady pushing force called?

- A.** The piezoelectric effect, an unrelated material-conversion property
- B.** Acoustic streaming, a related but distinct fluid-motion effect
- C.** The Doppler shift, an unrelated frequency-change phenomenon
- D.** Radiation force (a steady, unidirectional force from the beam)

24. In the far zone, a diagnostic ultrasound beam is often modeled mathematically as an idealized plane wave for simplicity, even though the beam is actually diverging and losing intensity with distance. What does this illustrate about the plane-wave model?

- A.** The plane-wave model perfectly describes the beam with no error at any distance
- B.** The far zone does not actually exist in any real diagnostic transducer
- C.** Diverging beams cannot be mathematically modeled in any way at all
- D.** It is a useful simplification with real limits, since the actual beam still diverges

25. A physicist describes a beam's geometry using three mutually perpendicular directions: along the beam's central axis (range/depth), side to side within the scan plane (azimuth), and perpendicular to the scan plane (elevation). What is this three-axis framework used to describe?

- A.** The Nyquist sampling limit, an unrelated sampling-rate concept
- B.** The Spaulding classification, an unrelated disinfection concept

- C. The three orthogonal reference axes used to describe ultrasound beam geometry
- D. The duty factor calculation, an unrelated transmit-timing ratio

26. A quality-control instrument uses the small, steady pushing force exerted by an absorbed ultrasound beam on a target to physically measure the beam's total transmitted acoustic power. What is this measurement instrument called?

- A. A tissue-mimicking distance phantom
- B. An electrical leakage-current tester
- C. An Output Display Standard verifier
- D. A radiation-force balance (power meter)

27. During pulse-echo imaging, the exact same piezoelectric element first transmits a short pulse and then, a very short time later, switches roles to receive the returning echo from that same pulse. What principle allows a single element to serve both functions in sequence?

- A. The Curie point, an unrelated heat-induced depoling temperature
- B. Reciprocity (the same element can act as both transmitter and receiver)
- C. The Spaulding classification, an unrelated disinfection concept
- D. Apodization, an unrelated aperture-weighting technique

28. A newer matrix transducer design controls its elements using separate row and column electrodes rather than one dedicated electrode per individual element, substantially reducing the number of independent channels needed for a large 2D array. What is this design called?

- A. Row-column addressed (RCA) array design
- B. Annular array design
- C. Micro-convex array design
- D. Mechanical (motorized) volume-probe design

29. A specialized transducer element is manufactured from a flexible polymer film rather than a rigid ceramic, offering a piezoelectric material option distinct from PZT ceramic or single-crystal PMN-PT, used in some specialized high-frequency or receive-focused applications. What is this polymer material called?

- A.** PVDF (polyvinylidene fluoride), a flexible polymer piezoelectric material
- B.** PZT ceramic, a rigid crystalline material class
- C.** PMN-PT single crystal, a rigid crystalline material class
- D.** A CMUT membrane, a non-piezoelectric MEMS technology

30. During transducer acceptance testing, a facility's policy specifies the maximum percentage of non-functioning elements a probe may have before it fails QA and must be sent for repair. What does this percentage represent?

- A.** The Curie point of the transducer
- B.** The transducer's fractional bandwidth
- C.** The transducer's effective radiating area
- D.** The dead-element acceptability threshold for QA pass/fail

31. A biomedical engineering department tracks each transducer's age and storage history, since piezoelectric bonding and internal materials can degrade gradually over years even without any single dramatic failure event. What does this tracking primarily address?

- A.** Shelf-life/storage-condition effects on long-term piezoelectric and bonding integrity
- B.** The Curie point of the piezoelectric ceramic material
- C.** The Spaulding classification of the transducer
- D.** The transducer's Nyquist limit, an unrelated sampling concept

32. In a densely packed array transducer, vibration from one element can partially couple into and interfere with its immediate neighbors, degrading beam quality. What is this unwanted inter-element interference called?

- A.** Apodization, an intentional aperture-weighting technique

- B.** Cross-talk between adjacent array elements
- C.** Dynamic aperture, an intentional depth-based widening technique
- D.** Multiplexing, an intentional channel-switching technique

33. Between individual elements of an array transducer, a narrow gap is cut and filled with a damping material specifically to reduce unwanted vibration coupling between neighboring elements. What is this gap called?

- A.** The kerf (inter-element damping-filled gap)
- B.** The near zone, a beam-geometry depth concept
- C.** The dead zone, a near-field imaging limitation
- D.** The matching layer, an acoustic-transmission component

34. A flexible endoscope is fitted with a high-frequency transducer at its tip and passed through the mouth into the stomach and duodenum to obtain very close-range images of the pancreas and adjacent structures. What is this instrument called?

- A.** A transesophageal echocardiography (TEE) probe
- B.** An intraoperative sterile probe
- C.** An endoscopic ultrasound (EUS) probe
- D.** A transvaginal endocavity probe

35. A miniature transducer is mounted on the tip of a catheter and threaded into a coronary artery to image the vessel wall from inside the lumen itself, rather than from outside the body. What is this device called?

- A.** A TEE probe, imaging the heart via the esophagus
- B.** An EUS probe, imaging the GI tract via an endoscope
- C.** A micro-convex probe, a small curved external footprint
- D.** An intravascular ultrasound (IVUS) catheter transducer

36. To image the heart transthoracically, the sonographer must angle the beam through a specific intercostal space free of lung and rib interference. What general term describes this required anatomic path for the beam to reach its target?

- A.** The near zone, a beam-geometry depth concept, unrelated here
- B.** The dead zone, a near-field imaging limitation, unrelated here
- C.** The acoustic window, the anatomic path required for the beam to reach its target
- D.** The kerf, the inter-element gap in an array

37. An intraoperative probe is specifically constructed and rated so it can be safely brought into the powerful magnetic field of an MRI suite for use during an MRI-guided procedure. What describes this probe's design requirement?

- A.** MR-safe or MR-conditional housing and materials
- B.** Track 1 acoustic-output labeling
- C.** A Spaulding semicritical rating
- D.** An embedded probe-recognition ID chip

38. During manufacturing, a piezoelectric ceramic element is exposed to a strong electric field that permanently aligns its internal molecular dipoles in one direction, which is what actually gives the material its piezoelectric properties in the first place. What is this manufacturing step called?

- A.** Apodization, an aperture-weighting technique
- B.** Multiplexing, a channel-switching technique
- C.** Dicing, an element-cutting manufacturing step
- D.** Poling (the polarization manufacturing process)

39. For a curved (convex) array, beamforming calculations treat the scan lines as if they all originated from and diverge outward from a single fixed point located behind the actual curved transducer face. What is this reference point called?

- A.** The near-zone origin
- B.** The dead zone

- C. The kerf
- D. The virtual apex

40. A phased array's beamforming electronics can generate the precise, individually adjustable timing delays needed for each element using either a fully digital calculation method or an older analog method using physical delay lines. What are these two competing implementation approaches called?

- A. Apodization versus dynamic aperture, an unrelated pair of aperture techniques
- B. True time delay versus analog delay-line beamforming
- C. Multiplexing versus dicing, an unrelated pair of manufacturing/switching terms
- D. RCA versus CMUT array design, an unrelated pair of array architectures

41. Some modern transducers contain built-in circuitry that automatically checks the function of every individual element the moment the probe is connected to the system, without requiring the operator to manually run a separate diagnostic image test. What is this automatic verification circuitry called?

- A. Apodization circuitry, an unrelated aperture-weighting technique
- B. A radiation-force balance, an unrelated power-measurement instrument
- C. An electromechanical coupling coefficient sensor, an unrelated efficiency metric
- D. Built-in self-test (BIST) automatic element-verification circuitry

42. Over its operational lifetime, a transducer's acoustic output may gradually drift from its original calibrated value, which acceptance and periodic QA testing are designed to detect. What does this drift-detection testing monitor?

- A. The transducer's Curie point, an unrelated heat-induced depoling temperature
- B. The transducer's kerf spacing, an unrelated inter-element gap
- C. Acoustic output stability (drift) over the transducer's operational lifetime
- D. The transducer's effective radiating area, an unrelated fixed surface-area spec

43. A modern high-frame-rate system synthesizes each displayed image line using multiple simultaneously acquired receive beams per single transmit event, rather than one receive beam per transmit. What is this technique called?

- A.** Multi-line acquisition (MLA), increasing beam density per transmit event
- B.** Apodization, tapering amplitude across the aperture
- C.** Dynamic aperture, widening active elements with depth
- D.** Multiplexing, switching element groups onto limited channels

44. To create the individual elements of an array transducer from a single solid block of piezoelectric ceramic, a manufacturer uses a precision saw to make a series of parallel cuts through the material. What is this manufacturing process called?

- A.** Poling, the electric-field polarization manufacturing step, unrelated here
- B.** Dicing, precision-cutting a solid ceramic block into individual array elements
- C.** Apodization, an aperture-weighting technique
- D.** Multiplexing, a channel-switching technique

45. Beyond the acoustic matching layer that improves sound transmission into tissue, engineers also design the transducer's electrical connection to the system cable to minimize electrical signal loss between the element and the system's receiver circuitry. What is this electrical design consideration called?

- A.** Electrical impedance matching (transducer-to-cable), distinct from the acoustic matching layer
- B.** The Curie point of the piezoelectric material, an unrelated heat property
- C.** The Spaulding classification of the transducer, an unrelated disinfection concept
- D.** The transducer's effective radiating area, an unrelated fixed surface-area spec

46. Each individually acquired scan line in an ultrasound image corresponds to one or more transmitted pulses along a specific beam direction, before being combined with all other lines to form a complete frame. What is this individual line of acquired data called?

- A.** A frame, the full assembled image made of many lines

- B.** A cine loop, a buffer of multiple frames
- C.** A scan line (A-line), one direction of acquired pulse-echo data
- D.** A voxel, a 3D volume-element resolution unit

47. A monitor redraws its screen at a fixed number of times per second regardless of how quickly new ultrasound image data is arriving, which can differ from the actual rate at which new frames are being acquired. What two distinct rates does this describe?

- A.** PRF versus duty factor, an unrelated pair of timing terms
- B.** Display refresh rate versus the underlying image acquisition frame rate
- C.** Nyquist limit versus aliasing threshold, an unrelated pair of sampling terms
- D.** TGC slope versus overall gain, an unrelated pair of gain controls

48. Along one edge of the displayed image, a labeled strip shows a graded series of gray shades from black to white, letting the viewer visually confirm the monitor's grayscale rendering. What is this reference strip called?

- A.** The biopsy guide-line, an unrelated needle-path overlay
- B.** The color box, an unrelated Doppler region-of-interest tool
- C.** The focal-zone indicator, an unrelated focus-depth marker
- D.** The on-screen grayscale calibration bar

49. A control lets the sonographer mirror the displayed image left-to-right on the screen, without changing the transducer's actual position, purely to match a preferred viewing orientation. What is this control called?

- A.** The orientation marker, an unrelated probe-to-screen correlation feature
- B.** The image flip (left-right mirror) control
- C.** Grayscale inversion, an unrelated black/white swap feature
- D.** Read zoom, an unrelated pixel-data magnification feature

50. Rather than blending several complete frames together over time (as with persistence), a different noise-reduction technique averages several receive lines acquired from the same single transmit event. What is this technique called?

- A.** Persistence, an unrelated frame-to-frame averaging technique
- B.** Spatial compounding, an unrelated multi-angle blending technique
- C.** Elevational compounding, an unrelated adjacent-slice technique
- D.** Receive-line averaging (distinct from frame-to-frame persistence)

51. A system uses several different transmit focal zones to build a single frame, then joins the best-focused portion from each zone together into one composite displayed image. What is this within-frame compositing technique called?

- A.** Persistence, an unrelated frame-to-frame averaging technique
- B.** Spatial compounding, an unrelated multi-angle blending technique
- C.** Focal-zone stitching within a single frame
- D.** Panoramic imaging, an unrelated wide-image stitching technique

52. When measuring cardiac wall thickness on an M-mode tracing, the standard convention specifies measuring from one specific edge of a structure's leading border to the corresponding leading border of the next structure, rather than center-to-center. What is this measurement convention called?

- A.** The dead-zone convention, an unrelated near-field imaging term
- B.** The Nyquist convention, an unrelated sampling-rate term
- C.** The Spaulding convention, an unrelated disinfection-level term
- D.** Leading-edge-to-leading-edge measurement convention

53. During a procedure, an external electromagnetic field generator and a small sensor attached to the biopsy needle allow the system to display the needle's real-time position and projected path on the image, independent of the needle's echogenicity. What technology does this describe?

- A.** Beam-steering needle-enhancement software, a related but distinct technique
- B.** Electromagnetic (EM) tracking-based needle-tip localization

- C. The biopsy guide-line overlay, a fixed non-tracking reference line
- D. Automatic Doppler envelope tracing, an unrelated spectral feature

54. To align a previously acquired MRI dataset with the live ultrasound image for fusion imaging, the software can match corresponding anatomic landmarks selected by the operator, or instead match the overall shape of a segmented organ surface between the two datasets. What are these two alignment approaches called?

- A. Spatial versus elevational compounding
- B. Point-based versus surface-based registration
- C. Preprocessing versus postprocessing
- D. Real-time versus static imaging

55. A dedicated system automatically sweeps a wide-footprint transducer across the entire breast in a standardized, operator-independent pattern to acquire a complete 3D volume dataset for later physician review. What is this system called?

- A. A handheld linear array survey
- B. An intraoperative sterile probe exam
- C. A duplex scanning protocol
- D. An automated breast volume scanner (ABVS)

56. During a contrast-enhanced ultrasound exam, the sonographer applies a brief burst of high-power ultrasound to intentionally destroy the microbubbles within the imaging plane, then observes how quickly new contrast reperfuses the tissue. What is this quantitative perfusion technique called?

- A. Destruction-replenishment perfusion imaging
- B. Spatial compounding, an unrelated multi-angle blending technique
- C. Coded excitation, an unrelated penetration technique
- D. Elevational compounding, an unrelated adjacent-slice technique

57. To reduce cardiac motion artifact during a liver elastography exam, image acquisition is automatically triggered to occur at a specific, consistent point in the patient's heartbeat, synchronized to a simultaneously recorded electrical signal. What is this technique called?

- A. Respiratory gating
- B. Cardiac (ECG) gating
- C. Persistence
- D. Spatial compounding

58. To reduce motion artifact from a patient's breathing during a liver exam, image acquisition can instead be triggered to occur at a consistent point in the patient's breathing cycle, monitored by a separate sensor. What is this technique called?

- A. Cardiac (ECG) gating
- B. Persistence
- C. Spatial compounding
- D. Respiratory gating

59. A distinct image-quality metric describes how strong the true signal is relative to random background electronic noise in the system, as opposed to describing the system's ability to distinguish two genuine but similar gray-scale echo levels from each other. What is this metric called?

- A. Contrast-to-noise ratio
- B. Signal-to-noise ratio (SNR)
- C. Contrast resolution
- D. Dynamic range

60. In shear-wave elastography, the measured shear wave propagation speed is converted into a quantitative stiffness value (Young's modulus) using a specific physics formula involving tissue density. What is this conversion formula?

- A. $E = c / 2$, where c is the shear wave speed
- B. $E = 3 \times \text{density} \times (\text{shear wave speed})^2$

- C. $E = \text{density} / \text{shear wave speed}$
- D. $E = \text{shear wave speed} \times \text{frequency}$

61. When several individually acquired frames are stitched together into one extended panoramic image, each contributing frame's own brightness level is automatically adjusted so the entire final composite image appears evenly lit rather than showing visible brightness bands at the seams. What does this automatic adjustment address?

- A. Misregistration artifact, a structural rather than brightness distortion
- B. The dead-zone limitation, an unrelated near-field imaging concept
- C. Automatic brightness normalization across the stitched panoramic image
- D. The Nyquist sampling limit, an unrelated sampling-rate concept

62. During a biopsy, the operator gently moves the needle slightly back and forth and watches for a corresponding subtle motion on the B-mode image to manually confirm the needle tip's true location, without relying on any tracking software. What is this manual technique called?

- A. The needle micro-motion ("jiggle") confirmation technique
- B. Electromagnetic needle-tip tracking, a distinct sensor-based technique
- C. Automatic Doppler envelope tracing, an unrelated spectral feature
- D. Beam-steering needle enhancement, a distinct specular-reflection technique

63. When a sonographer selects a pediatric exam preset, the system automatically caps the maximum allowable Mechanical Index and Thermal Index output below the levels permitted for adult presets. What does this preset-linked capping represent?

- A. The Output Display Standard's basic display requirement, without any capping
- B. A built-in safety interlock automatically reducing maximum output for a more vulnerable patient population
- C. The AIUM Statement on Prudent Use, applied manually rather than automatically
- D. The Spaulding classification of the transducer, an unrelated disinfection term

64. A point-of-care ultrasound device automatically transmits completed exam images over a wireless network connection directly to a cloud-based PACS archive, without requiring the device to be physically docked to a workstation. What capability does this describe?

- A.** Wireless/cloud PACS upload from a point-of-care device
- B.** Modality worklist integration with the RIS/HIS
- C.** DICOM lossy compression
- D.** A structured report-generation template

65. A sonographer says a spoken command aloud, and the ultrasound system responds by freezing the image or adjusting a setting, without the operator touching the control panel. What is this control method called?

- A.** AI-assisted automatic view recognition
- B.** Automatic Doppler envelope tracing
- C.** Voice-command (hands-free) system control
- D.** Remote/tele-ultrasound guidance

66. After the sonographer manually traces the left ventricular endocardial border on two orthogonal cardiac views at end-diastole and end-systole, the system automatically calculates the ejection fraction using a standard disk-summation method. What is this calculation method called?

- A.** Simpson's biplane method for automated ejection fraction calculation
- B.** The ellipsoid volume formula, an unrelated organ-volume calculation
- C.** The Hadlock fetal-weight formula, an unrelated obstetric calculation
- D.** Pressure half-time calculation, an unrelated valve-severity metric

67. A cardiac imaging technique tracks the natural, unique speckle pattern within the myocardium frame to frame throughout the cardiac cycle, calculating regional wall deformation (strain) from that tracked motion, without relying on a separate stiffness-inducing wave. What is this technique called?

- A.** Speckle-tracking strain echocardiography
- B.** Shear-wave elastography

- C. Automatic Doppler envelope tracing
- D. Pulse inversion harmonic imaging

68. After the sonographer places calipers on the near and far walls of the carotid artery, the system automatically identifies the lumen-intima and media-adventitia interfaces along a defined segment and calculates an average thickness value. What software feature does this describe?

- A. Automated ejection fraction calculation, an unrelated cardiac metric
- B. Automated fetal-weight calculation, an unrelated obstetric metric
- C. Automated bladder-volume calculation, an unrelated organ-volume metric
- D. Automated carotid intima-media thickness (IMT) measurement software

69. After the sonographer measures the left ventricular outflow tract diameter and its velocity-time integral, along with the velocity-time integral across the aortic valve, the system automatically applies the continuity equation to calculate the effective valve area. What is this software feature called?

- A. Automated aortic-valve-area calculation via the continuity equation
- B. Automated carotid IMT measurement, an unrelated vascular metric
- C. Automated ejection fraction calculation, an unrelated cardiac metric
- D. Automated bladder-volume calculation, an unrelated organ-volume metric

70. On a cardiac ultrasound display, a small on-screen marker moves along a simultaneously displayed ECG trace, indicating exactly which point in the cardiac cycle the currently displayed frame corresponds to. What does this marker/display feature provide?

- A. Automatic Doppler envelope tracing, an unrelated spectral feature
- B. Respiratory gating status, an unrelated breathing-cycle trigger
- C. Cardiac-cycle-phase frame indexing, synchronized to the displayed ECG trace
- D. The color box boundary, an unrelated Doppler region-of-interest tool

71. During a cardiac ultrasound exam, a continuously updating electrocardiogram trace is displayed alongside the B-mode image purely as a timing reference for the interpreting physician, without necessarily triggering image acquisition itself. What does this ECG trace primarily provide?

- A.** A simultaneous on-screen ECG reference trace for correlating the image with the cardiac cycle
- B.** Cardiac (ECG) gating, which actively triggers acquisition rather than just displaying
- C.** Automated ejection fraction calculation, an unrelated cardiac metric
- D.** Respiratory gating status, an unrelated breathing-cycle trigger

72. A small number is continuously displayed in the corner of the live ultrasound image, updating in real time to show the operator exactly how many frames per second the system is currently acquiring. What is this on-screen element called?

- A.** The focal-zone position indicator
- B.** The depth-scale marker
- C.** The dead-zone marker
- D.** The real-time frame-rate (fps) readout

73. During an elastography acquisition, the system continuously monitors for excessive probe or patient movement and displays a warning if too much motion is detected during the measurement, since motion can invalidate the stiffness reading. What does this warning feature address?

- A.** Automatic Doppler envelope tracing accuracy, an unrelated spectral feature
- B.** The dead-zone limitation, an unrelated near-field imaging concept
- C.** Automatic patient/probe-motion detection for elastography quality assurance
- D.** The Nyquist sampling limit, an unrelated sampling-rate concept

74. For a patient under serial surveillance for an abdominal aortic aneurysm, the system stores each exam's maximum aortic diameter measurement and automatically displays the trend and rate of growth compared to prior exams. What software feature does this describe?

- A.** Automated ejection fraction calculation, an unrelated cardiac metric
- B.** Automated serial aortic-diameter measurement and growth-tracking software

- C. Automated carotid IMT measurement, an unrelated vascular metric
- D. Automated bladder-volume calculation, an unrelated organ-volume metric

75. At the end of a scanning session, the sonographer copies a patient's DICOM image files directly onto a USB flash drive from the ultrasound console itself, rather than relying on the network-based PACS archive. What does this represent?

- A. Modality worklist integration, an unrelated scheduling-data feature
- B. Wireless/cloud PACS upload, an unrelated network-transmission feature
- C. USB/removable-media DICOM export directly from the console
- D. DICOM lossy compression, an unrelated file-size reduction technique

76. After tracing the left ventricular endocardial and epicardial borders at end-diastole, the system automatically calculates the total muscle mass of the left ventricular wall using a validated geometric formula. What is this software feature called?

- A. Automated ejection fraction calculation
- B. Automated aortic-valve-area calculation
- C. Automated left ventricular mass calculation
- D. Automated bladder-volume calculation

77. In a pregnancy with suspected fetal growth restriction, the ratio of the fetal middle cerebral artery pulsatility index to the umbilical artery pulsatility index is calculated as a single composite marker of fetal wellbeing. What is this composite ratio called?

- A. The cerebroplacental ratio (CPR)
- B. The renal-aortic ratio
- C. The ankle-brachial index
- D. The velocity ratio used in arterial stenosis grading

78. Beyond the umbilical artery, middle cerebral artery, ductus venosus, and uterine artery, Doppler of a fifth major fetal vessel can also be used to help assess a growth-restricted fetus's cardiovascular status. Which vessel is this?

- A.** The fetal aorta, a fifth distinct fetal vessel
- B.** The maternal renal artery, an unrelated maternal vessel
- C.** The maternal ophthalmic artery, an unrelated maternal vessel
- D.** The fetal hepatic artery, not a standard vessel for this

79. A pregnant patient taking an NSAID medication is found to have elevated, turbulent Doppler velocity through a narrowing fetal ductus arteriosus, raising concern for a specific complication. What does this finding suggest?

- A.** Normal, expected ductal flow at this gestational age
- B.** A patent, fully open, unobstructed ductus arteriosus
- C.** Reversed umbilical artery diastolic flow
- D.** Premature constriction/narrowing of the fetal ductus arteriosus

80. A patient with chronic pelvic pain undergoes transvaginal Doppler, which shows dilated, tortuous parauterine veins with slow, reversed flow on Valsalva. What condition does this finding suggest?

- A.** Ovarian torsion, an unrelated adnexal finding
- B.** Pelvic congestion syndrome (ovarian vein reflux)
- C.** A carotid body tumor, an unrelated neck mass
- D.** Popliteal artery entrapment, an unrelated leg finding

81. A young woman presents with left leg swelling. Duplex ultrasound shows compression of the left common iliac vein by the overlying right common iliac artery against the vertebral body, with elevated Doppler velocity at the compression point. What condition does this describe?

- A.** May-Thurner syndrome (left common iliac vein compression)
- B.** Nutcracker syndrome, an unrelated renal-vein compression

- C. Subclavian steal, an unrelated vertebral-flow reversal
- D. Popliteal artery entrapment, an unrelated leg finding

82. A patient with known cirrhosis develops sudden ascites and abdominal pain. Doppler of the hepatic veins shows absent or markedly abnormal flow with a flattened, non-phasic waveform. What condition does this raise concern for?

- A. Normal hepatic vein triphasic flow, the opposite finding here
- B. Nutcracker syndrome, an unrelated renal-vein compression
- C. May-Thurner syndrome, an unrelated iliac-vein compression
- D. Budd-Chiari syndrome (hepatic vein/IVC outflow obstruction)

83. In an infant with a weak femoral pulse and hypertension in the arms but not the legs, Doppler of the descending aorta distal to a focal narrowing shows diminished, continuous, non-pulsatile flow with visible collateral vessels. What congenital condition does this suggest?

- A. Patent ductus arteriosus
- B. Coarctation of the aorta
- C. Subclavian steal
- D. Popliteal artery entrapment

84. A young patient with diminished arm pulses and elevated inflammatory markers undergoes carotid duplex, which shows smooth, circumferential, homogeneous thickening of the arterial wall (a "macaroni sign") with reduced flow, rather than a focal atherosclerotic plaque. What does this appearance suggest?

- A. A simple atherosclerotic plaque, a focal rather than circumferential finding
- B. Large-vessel vasculitis (e.g., Takayasu arteritis)
- C. A carotid body tumor, an unrelated hypervascular neck mass
- D. A pseudoaneurysm, an unrelated focal wall-defect finding

85. A patient has a palpable mass behind the knee. On ultrasound, color Doppler shows the mass to be entirely avascular and anechoic, communicating with the joint space, rather than showing internal venous flow or a non-compressible tubular structure. What does this help distinguish?

- A.** A popliteal artery aneurysm, a vascular rather than cystic finding
- B.** Popliteal vein thrombosis, a flow-filled rather than avascular finding
- C.** Popliteal artery entrapment, a dynamic arterial-compression finding
- D.** A Baker's (popliteal) cyst, distinguished from popliteal vein thrombosis

86. Following catheter-directed thrombolysis for an acutely occluded artery, serial Doppler exams are performed over the following hours. What is the primary purpose of this serial Doppler monitoring?

- A.** To measure the transducer's Curie point during treatment
- B.** To confirm restoration of antegrade arterial flow as the thrombolytic agent takes effect
- C.** To calculate the ankle-brachial index only once, before treatment begins
- D.** To assess unrelated venous reflux in the contralateral leg

87. Before placing a central venous catheter, the proceduralist uses real-time ultrasound with color Doppler to positively identify the internal jugular vein and confirm it is patent and distinguishable from the adjacent carotid artery. What is the primary purpose of this Doppler use?

- A.** Procedural guidance, confirming venous identity and patency before needle insertion
- B.** Screening for peripheral arterial disease, an unrelated purpose here
- C.** Assessing for hepatic artery thrombosis, an unrelated purpose here
- D.** Measuring the ankle-brachial index, an unrelated purpose here

88. An infant presents with a soft-tissue mass that shows intense, disorganized internal color flow with a low-resistance, high-velocity arterial waveform pattern on Doppler. This flow pattern helps distinguish a high-flow vascular lesion from which alternative diagnosis?

- A.** A simple lymphocele, an unrelated avascular fluid collection
- B.** A low-flow venous malformation, which would show minimal or absent arterial-type flow

- C. A thrombosed pseudoaneurysm, an unrelated flow-absent finding
- D. A simple reactive lymph node, an unrelated benign nodal finding

89. On ultrasound of a patient with suspected ovarian torsion, color Doppler of the adnexa shows the ovarian vascular pedicle twisted upon itself in a distinct coiled pattern. What is this specific sonographic sign called?

- A. The whirlpool sign (twisted vascular pedicle)
- B. The macaroni sign, a vasculitis wall-thickening finding
- C. The string sign, a near-occlusion trickle-flow finding
- D. The lyre sign, a carotid-splaying tumor finding

90. After a renal biopsy, a follow-up ultrasound identifies a simple-appearing perinephric fluid collection. Color Doppler is used to confirm the collection itself shows no internal flow, helping distinguish it from a vascular complication. What is this Doppler use primarily distinguishing the collection from?

- A. A normal renal artery, an unrelated structure here
- B. A normal renal vein, an unrelated structure here
- C. A pseudoaneurysm, which would show internal flow instead of none
- D. A normal ureter, an unrelated structure here

91. A patient with acute scrotal pain undergoes Doppler ultrasound, which shows markedly increased arterial and venous flow to the affected testicle compared to the normal side, along with epididymal enlargement. What does this hyperemic pattern suggest, in contrast to absent flow?

- A. Epididymo-orchitis (inflammatory hyperemia), unlike the absent flow of torsion
- B. Testicular torsion, the opposite (absent-flow) finding here
- C. A varicocele, an unrelated venous-dilation finding
- D. Testicular rupture from trauma, an unrelated disrupted-contour finding

92. A patient with a previously placed arterial stent undergoes surveillance duplex, which shows a focal area of markedly elevated peak systolic velocity within the stent compared to velocities proximal and distal to it. What does this focal elevation suggest?

- A.** In-stent restenosis at that specific location
- B.** Normal, uniform flow throughout a widely patent stent
- C.** Complete stent occlusion at that location
- D.** A technically inadequate Doppler angle limited to that segment

93. A patient with abdominal pain and known hypercoagulability is found to have echogenic material filling the superior mesenteric vein, with absent flow on Doppler at that location. What does this describe?

- A.** Chronic mesenteric ischemia from arterial stenosis
- B.** Mesenteric venous thrombosis
- C.** A normal postprandial mesenteric velocity increase
- D.** Median arcuate ligament syndrome

94. A young, thin patient presents with left flank pain and hematuria. Doppler shows the left renal vein compressed and narrowed as it passes between the aorta and the superior mesenteric artery, with elevated velocity at that point and dilation proximal to it. What condition does this describe?

- A.** May-Thurner syndrome, an unrelated iliac-vein compression
- B.** Nutcracker syndrome (left renal vein compression between the aorta and SMA)
- C.** Budd-Chiari syndrome, an unrelated hepatic-vein obstruction
- D.** Popliteal artery entrapment, an unrelated leg finding

95. A patient with a suspected aortic dissection undergoes Doppler, which shows one channel with brisk, pulsatile antegrade flow and a second, adjacent channel with sluggish, sometimes reversed or absent flow. What do these two distinct flow patterns typically represent?

- A.** Two entirely separate, unrelated vessels, not a single dissected aorta
- B.** A normal aortic finding requiring no further workup

- C. The true lumen (brisk flow) versus the false lumen (sluggish/reversed flow) of the dissection
- D. A technically inadequate angle limited to just one of the two channels

96. A neonate develops high-output cardiac failure shortly after birth. Cranial ultrasound with Doppler reveals a large, tangled vascular structure in the midline brain with very high-velocity, low-resistance arterial flow directly feeding a dilated venous structure. What congenital condition does this describe?

- A. A simple choroid plexus cyst
- B. Normal neonatal cerebral blood flow
- C. A vein of Galen malformation
- D. A subependymal hemorrhage

97. Several days after a percutaneous liver biopsy, a follow-up Doppler ultrasound identifies an abnormal direct communication between a hepatic artery branch and an adjacent portal vein branch, with turbulent, high-velocity flow at the connection. What does this represent?

- A. A normal expected post-biopsy finding requiring no further action
- B. An iatrogenic (biopsy-related) arteriovenous fistula
- C. A congenital hepatic vein of Galen malformation
- D. Normal portal vein hepatopetal flow

98. A patient with sickle cell disease and left upper quadrant pain undergoes ultrasound, which shows a peripheral, wedge-shaped area of the spleen with no internal color Doppler flow, in contrast to the surrounding normally perfused splenic parenchyma. What does this finding suggest?

- A. A normal splenic vein
- B. A splenic hemangioma with normal flow
- C. A splenic infarct (wedge-shaped avascular area)
- D. Normal splenic parenchymal perfusion throughout

99. A patient several weeks after renal transplant develops acute graft swelling and decreased urine output. Doppler shows absent flow in the main renal vein along with reversed diastolic flow in the renal artery. What complication does this combination suggest?

- A.** Renal vein thrombosis, suggested by this specific combination of findings
- B.** Simple postoperative swelling with no vascular complication
- C.** Normal expected transplant arterial waveform
- D.** Ureteral obstruction alone, with entirely normal vasculature

100. A thin patient reports abdominal pain that worsens after eating and improves with certain postures. Doppler of the celiac artery shows markedly elevated velocity during expiration that improves substantially during deep inspiration. What condition does this respiratory-related change suggest?

- A.** Median arcuate ligament syndrome (celiac compression varying with respiration)
- B.** Chronic mesenteric ischemia from atherosclerotic stenosis alone
- C.** Mesenteric venous thrombosis, an unrelated venous finding
- D.** A normal celiac artery waveform, without this variation

101. A patient presents with sudden neck pain and a partial Horner's syndrome after a chiropractic neck manipulation. Doppler of the vertebral artery shows an abnormal, narrowed flow channel with a surrounding crescent-shaped area concerning for intramural blood. What does this suggest?

- A.** Normal vertebral artery flow
- B.** Subclavian steal physiology
- C.** A simple vertebral artery variant
- D.** Vertebral artery dissection

102. A patient with type 1 diabetes and end-stage renal disease receives a combined kidney-pancreas transplant. In addition to the renal graft, serial Doppler surveillance of the pancreatic graft's arterial and venous flow is also performed. What is the purpose of this additional surveillance?

- A.** To monitor the pancreatic graft's own vascular patency and detect early graft complications
- B.** To measure the ankle-brachial index of the transplanted pancreas

- C. To assess for testicular torsion in an unrelated organ system
- D. To calculate the renal-aortic ratio of the native kidneys only

103. A patient undergoing evaluation for erectile dysfunction receives an intracavernosal injection, after which Doppler measures the peak systolic and end-diastolic velocities in the cavernosal arteries. How does this evaluation differ in purpose from Doppler assessment of priapism?

- A. Functionally identical to priapism evaluation, with no real difference in purpose
- B. It assesses baseline/post-injection competence for ED, not a high-flow-vs-low-flow emergency
- C. Exclusively venous flow measurement, with arterial flow never assessed
- D. No Doppler assessment at all, relying only on physical examination

104. On thyroid ultrasound, a nodule shows prominent internal (rather than purely peripheral) color Doppler vascularity. What is the significance of this specific vascularity pattern?

- A. It confirms the nodule is a simple colloid cyst
- B. It is a normal finding in virtually all thyroid nodules
- C. It indicates the nodule is entirely avascular
- D. It is considered a feature that raises concern for malignancy risk

105. A patient with a soft-tissue abscess undergoes ultrasound, which shows a hypoechoic collection with a rim of increased color Doppler flow surrounding a central avascular area. What does this specific vascular pattern typically represent?

- A. A simple, entirely avascular seroma, without this peripheral hyperemic rim
- B. Peripheral inflammatory hyperemia surrounding a central necrotic, non-perfused core
- C. A vascular malformation with no true fluid component at all
- D. Normal surrounding tissue perfusion, without any abnormality present

106. A patient with known autosomal dominant polycystic kidney disease undergoes renal Doppler, which shows an elevated resistive index compared to a normal kidney. What does this elevated RI most likely reflect in this specific condition?

- A.** Increased intrarenal vascular resistance from parenchymal compression by numerous cysts
- B.** A normal expected finding in every young, healthy kidney
- C.** Acute renal artery stenosis unrelated to the underlying cystic disease
- D.** A technically inadequate Doppler angle throughout the entire kidney

107. On pelvic ultrasound, a large uterine mass shows a peripheral rim of color Doppler vascularity with relatively sparse central flow. What does this vascularity pattern help characterize?

- A.** A simple ovarian cyst, an unrelated adnexal finding
- B.** Normal endometrial vascularity alone, an unrelated finding
- C.** A uterine fibroid, characterized partly by this peripheral vascularity pattern
- D.** A normal, non-enlarged uterus, an unrelated baseline finding

108. After blunt scrotal trauma, ultrasound with color Doppler is used to assess testicular contour and internal vascularity, helping determine whether the tunica albuginea has ruptured and whether the testicle remains viably perfused. What is the primary purpose of the Doppler component of this exam?

- A.** To measure the ankle-brachial index of the lower extremity
- B.** To calculate the renal-aortic ratio
- C.** To assess for chronic mesenteric ischemia
- D.** To assess testicular perfusion/viability following traumatic injury

109. Following facial trauma, a patient develops a pulsatile bulging eye and an audible bruit. Doppler of the superior ophthalmic vein shows abnormal, high-velocity, arterialized, pulsatile flow rather than normal low-velocity venous flow. What does this finding suggest?

- A.** A normal ophthalmic vein waveform
- B.** A carotid-cavernous fistula (arterialized flow in the superior ophthalmic vein)

- C. Simple ophthalmic artery reversal from carotid stenosis
- D. A normal finding after facial trauma, requiring no further workup

110. A patient has a pulsatile mass behind the knee. Ultrasound confirms a focally dilated, true popliteal artery segment with turbulent, swirling flow within the dilation itself, rather than a to-and-fro pattern confined to a narrow neck. What does this describe?

- A. A true popliteal artery aneurysm (turbulent flow within a focally dilated arterial segment)
- B. A pseudoaneurysm with a narrow neck, a different focal wall-defect entity
- C. Popliteal artery entrapment syndrome, a dynamic compression process
- D. A Baker's cyst, an entirely avascular cystic structure

Answers

1. B. Track 1 versus Track 3 labeling is the FDA's regulatory system distinguishing devices operating within pre-1976 typical acoustic-output levels (Track 1) from those cleared under higher allowable limits requiring real-time output display (Track 3, effectively superseded by the current Output Display Standard framework). The Spaulding classification concerns disinfection level, and AIUM/ARDMS labeling systems are unrelated to this specific FDA output-labeling framework.

2. A. FDA 510(k) premarket clearance is the regulatory pathway manufacturers use to demonstrate a new diagnostic ultrasound device is substantially equivalent to an already-legally-marketed predicate device, allowing it to be marketed. AIUM accreditation and ARDMS credentialing are practice/individual-level, not device-marketing, processes, and the Output Display Standard is a display-indicator requirement, not the marketing clearance pathway itself.

3. C. The absence of a confirmed causal link between diagnostic-level ultrasound exposure and adverse outcomes, established through extensive research, supports the ongoing evidence base for the continued clinical use of diagnostic ultrasound at typical exposure levels. This research does not make ALARA/prudent-use guidance unnecessary (the absence of confirmed harm does not eliminate the value of minimizing exposure), does not confirm bioeffects occur at any level, and substantial research has, in fact, been performed.

4. A. A chaperone policy requires a second staff member present during an intimate exam such as a transvaginal ultrasound, protecting both patient comfort and provider liability. The Spaulding classification concerns disinfection, the AIUM Statement on Prudent Use concerns acoustic output minimization, and a time-out protocol concerns patient/procedure identity confirmation, none of which describe this specific chaperone practice.

- 5. D.** A cumulative trauma disorder, such as carpal tunnel syndrome or De Quervain's tenosynovitis, is a specific overuse injury type resulting from repetitive scanning motions over time, a recognized occupational hazard for sonographers. This is not an acute traumatic injury, is unrelated to acoustic bioeffects on the sonographer's own tissue, and is unrelated to the Curie point, a transducer material property.
- 6. B.** Placing a used needle into a rigid, puncture-resistant sharps container is the standard practice for safe biohazard/sharps disposal, preventing needlestick injury to staff. This is unrelated to transducer disinfection classification, the Output Display Standard, or chaperone policy.
- 7. D.** Restricting and logging access to a patient's stored images and video primarily addresses HIPAA compliance, protecting patient health information from unauthorized access, export, or disclosure. This is unrelated to transducer disinfection classification, FDA device clearance, or the AIUM Statement on Prudent Use.
- 8. A.** Confirming a valid physician order and supporting clinical indication before performing an exam supports medical necessity documentation, ensuring the exam is appropriately ordered and justified. This is unrelated to disinfection-level selection, acoustic-output labeling tracks, or facility accreditation renewal.
- 9. B.** Immediate site care and formal incident reporting after a needlestick injury follows the facility's bloodborne pathogen exposure protocol, which triggers appropriate follow-up testing and treatment. This is unrelated to the Spaulding classification, the AIUM Statement on Prudent Use, or a chaperone policy.
- 10. B.** A defined, recurring QA testing and documentation schedule ensures consistent, ongoing verification of system performance over time, rather than relying only on reactive testing when a problem is already suspected. This scheduling requirement is unrelated to the Spaulding classification, FDA clearance renewal, or HIPAA access logging.
- 11. D.** Checking the transducer manufacturer's disinfectant compatibility list before first use of a new disinfectant product confirms the specific chemical will not damage that transducer's materials (housing, lens, cabling). The AIUM Statement on Prudent Use, FDA 510(k) clearance summary, and chaperone policy are unrelated documents for this specific verification.
- 12. A.** The audible Doppler shift frequency (roughly hundreds of Hz to a few kHz) is far lower than the transmitted imaging beam frequency, which operates in the megahertz range; the shift is a small fractional change relative to the much higher transmitted frequency. The two are not numerically identical, the shift is not higher than the transmitted frequency, and the transmitted beam frequency does have a well-defined diagnostic range (roughly 2-15 MHz).
- 13. A.** The effective radiating area (ERA) is the specific active surface area of the transducer face that transmits and receives sound, which can be smaller than the full physical housing footprint. The near-

zone length and dead zone describe beam-depth characteristics, and the kerf refers to the gaps between individual array elements, none of which describe the active radiating surface area itself.

14. D. The beam uniformity coefficient (BUC) is the ratio of spatial-peak to spatial-average intensity within the beam's cross-section, describing how concentrated the beam's energy is at its hottest point relative to the overall average. Duty factor, fractional bandwidth, and half-value layer are unrelated parameters describing timing, frequency range, and attenuation depth, respectively.

15. A. Pulse duration is the actual time a pulse takes to occur, calculated by dividing spatial pulse length by propagation speed ($0.9 \text{ mm} / 1540 \text{ m/s}$), making it the time-domain counterpart to the distance-based SPL. PRF, Doppler shift frequency, and the Nyquist limit are distinct parameters not calculated this way from SPL and propagation speed.

16. A. Fractional bandwidth is calculated as bandwidth divided by center frequency, expressed as a percentage: $3 \text{ MHz} / 5 \text{ MHz} = 60\%$. Expressing bandwidth or center frequency alone as a percent, or multiplying them together, does not correctly calculate fractional bandwidth.

17. C. The resolution cell (voxel) is the combined 3D unit defined by axial, lateral, and elevational resolution together at a given point, representing the smallest volume the system can resolve as distinct at that location. The near zone, dead zone, and kerf are unrelated beam-geometry or transducer-construction terms, not this combined resolution concept.

18. A. Farther from the transducer, in the far zone, the individually diverging spherical wavefronts from the transducer's many point sources combine and the beam increasingly approximates a plane wave, an idealization useful for far-zone beam modeling. A true plane wave does not occur immediately at the face, the concept is not restricted to the dead zone, and plane-wave approximation does meaningfully occur at typical diagnostic imaging distances.

19. C. The electromechanical coupling coefficient describes the fraction of energy successfully converted between electrical and mechanical (acoustic) forms by a piezoelectric element, since this conversion is never perfectly 100% efficient. Duty factor, the Nyquist limit, and half-value layer are unrelated timing/sampling/attenuation parameters, not a conversion-efficiency metric.

20. D. Lower-frequency beams attenuate less per centimeter of tissue traveled than higher-frequency beams, allowing them to penetrate to greater depths with adequate signal remaining -- the physical basis for choosing lower frequency at greater target depths. Lower frequency does not improve axial resolution (it worsens it), propagation speed is essentially frequency-independent, and it is attenuation (not wavelength itself, though related) that directly explains the penetration advantage.

21. C. Insertion loss describes the overall reduction in usable signal strength introduced by the entire imaging chain, from the transducer face's initial output to the much weaker signal actually available for display, reflecting the system's overall sensitivity loss. Duty factor, the Nyquist limit, and half-value layer are unrelated parameters that do not describe this whole-system sensitivity loss.

22. C. Acoustic streaming is a mechanical bioeffect describing steady, sound-induced fluid motion within tissue, driven by the momentum carried by the traveling wave, distinct from thermal heating and cavitation. The piezoelectric effect, refraction, and specular reflection are unrelated physics concepts, not a bioeffect mechanism.

23. D. Radiation force is the small, steady, unidirectional push exerted on tissue by an absorbed or reflected ultrasound beam, distinct from the rapidly oscillating pressure of the sound wave itself and from acoustic streaming (the resulting fluid motion this force can produce). The piezoelectric effect and Doppler shift are unrelated concepts, not a description of this steady pushing force.

24. D. The plane-wave model is a useful mathematical simplification for far-zone beam behavior, but it has real limitations since the actual beam continues to diverge and lose intensity with distance, unlike a true, non-diverging plane wave. The model does not perfectly describe the beam with no error, the far zone does exist in real transducers, and diverging beams can in fact be modeled mathematically (just with added complexity beyond the simple plane-wave approximation).

25. C. Range (depth, along the beam axis), azimuth (side to side within the scan plane), and elevation (perpendicular to the scan plane) are the three mutually perpendicular reference axes used to describe ultrasound beam geometry, underlying concepts like axial, lateral, and elevational resolution. The Nyquist limit, Spaulding classification, and duty factor are unrelated concepts, not this geometric axis framework.

26. D. A radiation-force balance is a QA instrument that physically measures a beam's total transmitted acoustic power by detecting the small, steady radiation force the beam exerts on a target within the device. A tissue-mimicking distance phantom, electrical leakage-current tester, and Output Display Standard verifier are distinct QA tools measuring different parameters, not total transmitted power via radiation force.

27. B. Reciprocity is the principle that allows the same piezoelectric element to function first as a transmitter and then, immediately after, as a receiver for the same pulse-echo cycle, underlying standard pulse-echo imaging operation. The Curie point, Spaulding classification, and apodization are unrelated concepts, not the principle enabling this dual transmit/receive function.

28. A. Row-column addressed (RCA) array design uses orthogonal row and column electrodes to control a full 2D element grid, dramatically reducing the number of independent channels needed compared to a fully individually addressed matrix array. Annular, micro-convex, and mechanical volume-probe designs are distinct transducer architectures that do not use this row/column addressing scheme.

29. A. PVDF (polyvinylidene fluoride) is a flexible polymer piezoelectric material, a distinct material class from rigid PZT ceramic or single-crystal PMN-PT, used in specialized high-frequency or receive-focused applications where its flexibility and low acoustic impedance are advantageous. PZT and PMN-PT are both piezoelectric materials but are not polymer-based, and CMUT is an entirely non-piezoelectric MEMS technology.

30. D. The dead-element acceptability threshold is the maximum percentage of non-functioning elements a facility's QA policy allows before a transducer fails acceptance testing and requires repair. The Curie point, fractional bandwidth, and effective radiating area are unrelated transducer specifications, not this QA pass/fail percentage.

31. A. Tracking transducer age and storage history addresses shelf-life and storage-condition effects on long-term piezoelectric and bonding integrity, since these materials can degrade gradually over years even without a single dramatic failure event. The Curie point, Spaulding classification, and Nyquist limit are unrelated concepts, not this long-term degradation tracking concern.

32. B. Cross-talk describes unwanted vibrational coupling between adjacent array elements in a densely packed transducer, degrading beam quality by interfering with intended element-by-element control. Apodization, dynamic aperture, and multiplexing are distinct, intentional design/operational techniques, not this unwanted interference phenomenon.

33. A. The kerf is the narrow, damping-material-filled gap cut between individual array elements, specifically intended to reduce unwanted vibration coupling (cross-talk) between neighboring elements. The near zone, dead zone, and matching layer are unrelated beam-geometry or acoustic-transmission concepts, not this inter-element gap.

34. C. An endoscopic ultrasound (EUS) probe combines a flexible endoscope with a high-frequency transducer at its tip, passed through the mouth into the GI tract for very close-range imaging of the pancreas and adjacent structures. A TEE probe images the heart via the esophagus, an intraoperative probe is used during open surgery, and a transvaginal probe is used for a different anatomic route entirely.

35. D. An intravascular ultrasound (IVUS) catheter transducer is a miniature transducer mounted on a catheter tip and threaded into a vessel (such as a coronary artery) to image the vessel wall from within the lumen itself. TEE, EUS, and micro-convex probes are distinct transducer types used via different anatomic routes, not from within a blood vessel's lumen.

36. C. The acoustic window is the general term for the specific anatomic path (such as an intercostal space) required for the ultrasound beam to reach its target without interference from bone or gas. The near zone, dead zone, and kerf are unrelated beam-geometry or transducer-construction terms, not this anatomic-path concept.

37. A. MR-safe or MR-conditional housing and materials describe a probe specifically constructed and rated to be safely used within an MRI suite's powerful magnetic field during an MRI-guided procedure. Track 1 labeling, Spaulding classification, and a probe-recognition ID chip are unrelated specifications, not this MRI-compatibility design requirement.

38. D. Poling is the manufacturing step in which a piezoelectric ceramic element is exposed to a strong electric field that permanently aligns its internal dipoles, which is what actually gives the material its

piezoelectric properties before it can be used in a transducer. Apodization, multiplexing, and dicing are distinct manufacturing/operational steps, not this polarization process.

39. D. The virtual apex is the fixed reference point located behind a curved (convex) array's actual face from which beamforming calculations treat all scan lines as originating and diverging. The near-zone origin, dead zone, and kerf are unrelated beam-geometry or construction concepts, not this beamforming reference point specific to curved arrays.

40. B. True time delay uses fully digital calculation to generate precise per-element timing delays, while analog delay-line beamforming uses older physical delay-line hardware to achieve a similar effect -- two competing implementation approaches for phased-array beam steering and focusing. Apodization/dynamic aperture and multiplexing/dicing are unrelated pairs of concepts, not these two beamforming implementation methods.

41. D. Built-in self-test (BIST) circuitry automatically verifies every individual element's function the moment a probe is connected, without requiring a separate manual diagnostic image test by the operator. Apodization circuitry, a radiation-force balance, and an electromechanical coupling coefficient sensor are unrelated concepts, not this automatic per-element verification system.

42. C. Acceptance and periodic QA testing for acoustic output stability monitors whether a transducer's output has gradually drifted from its original calibrated value over its operational lifetime. The Curie point, kerf spacing, and effective radiating area are unrelated fixed specifications, not this longitudinal output-drift monitoring.

43. A. Multi-line acquisition (MLA) synthesizes each displayed image line using multiple simultaneously acquired receive beams per single transmit event, increasing beam density and enabling higher frame rates than one receive beam per transmit. Apodization, dynamic aperture, and multiplexing are distinct, unrelated transducer/beamforming techniques, not this receive-beam-density technique.

44. B. Dicing is the manufacturing process of using a precision saw to cut a series of parallel cuts through a solid piezoelectric ceramic block, creating the individual elements of an array transducer. Poling, apodization, and multiplexing are distinct manufacturing/operational steps, not this element-cutting process.

45. A. Electrical impedance matching between the transducer element and the system cable minimizes electrical signal loss along that connection, a distinct engineering consideration from the acoustic matching layer, which improves sound transmission into tissue at the transducer face. The Curie point, Spaulding classification, and effective radiating area are unrelated specifications, not this electrical-connection design consideration.

46. C. A scan line (sometimes called an A-line, referencing the underlying A-mode data along that direction) is the individual line of acquired pulse-echo data along one beam direction, and many such lines together form a complete frame. A frame is the full assembled image, a cine loop is a buffer of

multiple frames, and a voxel is a 3D volume-element unit, none of which describe this single acquired line.

47. B. Display refresh rate (how often the monitor redraws the screen) and image acquisition frame rate (how often new ultrasound data is actually generated) are two distinct rates that can differ from one another, an important distinction from PRF/duty factor, Nyquist/aliasing, or TGC/gain, which describe entirely different system parameters.

48. D. The on-screen grayscale calibration bar displays a graded series of shades from black to white along the image edge, letting the viewer visually confirm the monitor's grayscale rendering is accurate. The biopsy guide-line, color box, and focal-zone indicator are unrelated on-screen elements serving different purposes.

49. B. The image flip control mirrors the displayed image left-to-right purely as a viewing-preference adjustment, without changing the transducer's actual physical position or orientation. The orientation marker correlates probe and screen orientation (a different concept), grayscale inversion swaps black/white brightness assignment, and read zoom magnifies already-acquired pixel data -- none of which describe left-right mirroring.

50. D. Receive-line averaging combines several receive lines acquired from the same single transmit event to reduce noise, distinct from persistence (which averages across multiple separate frames over time) or spatial/elevational compounding (which blend multiple beam angles or adjacent slices, not multiple receive lines from one transmit event).

51. C. Focal-zone stitching combines the best-focused portion of the image from each of several transmit focal zones into one composite frame, a within-frame compositing technique distinct from persistence (frame-to-frame averaging), spatial compounding (multi-angle blending), or panoramic imaging (stitching sequential frames into an extended wide image).

52. D. Leading-edge-to-leading-edge measurement is the standard M-mode convention for measuring cardiac wall thickness, consistently measuring from one structure's leading border to the corresponding leading border of the next structure, avoiding ambiguity in where exactly to place calipers. The dead-zone, Nyquist, and Spaulding terms are unrelated concepts, not a measurement convention.

53. B. Electromagnetic (EM) tracking-based needle-tip localization uses an external field generator and a needle-mounted sensor to display the needle's real-time position and path on the image, working independently of the needle's own echogenicity -- a distinct technology from beam-steering software (which relies on improving the needle's own specular reflection) or the fixed biopsy guide-line overlay.

54. B. Point-based registration aligns two datasets using corresponding operator-selected anatomic landmarks, while surface-based registration instead matches the overall shape of a segmented organ surface between the two datasets -- two distinct fusion-imaging alignment approaches.

Spatial/elevational compounding, preprocessing/postprocessing, and real-time/static imaging are unrelated pairs of concepts.

55. D. An automated breast volume scanner (ABVS) automatically sweeps a wide-footprint transducer across the entire breast in a standardized, operator-independent pattern to acquire a complete 3D dataset for later review, distinct from a handheld linear-array survey, an intraoperative exam, or a general duplex protocol.

56. A. Destruction-replenishment perfusion imaging intentionally destroys contrast microbubbles within the imaging plane using a high-power burst, then quantifies perfusion by observing the rate of new contrast reperfusion -- a specific quantitative CEUS technique distinct from spatial compounding, coded excitation, or elevational compounding.

57. B. Cardiac (ECG) gating triggers image acquisition at a consistent point in the cardiac cycle, synchronized to a recorded electrical signal, reducing cardiac motion artifact. Respiratory gating instead synchronizes to breathing, and persistence/spatial compounding are unrelated noise-reduction and blending techniques, not motion-synchronized triggering.

58. D. Respiratory gating triggers image acquisition at a consistent point in the patient's breathing cycle, monitored by a separate sensor, reducing respiratory motion artifact -- distinct from cardiac (ECG) gating, which synchronizes to the heartbeat instead, and from persistence/spatial compounding, which are unrelated techniques.

59. B. Signal-to-noise ratio (SNR) describes how strong a true signal is relative to random background electronic noise, distinct from contrast-to-noise ratio (signal versus tissue background), contrast resolution (distinguishing two genuine gray-scale echo levels from each other), or dynamic range (the ratio of largest to smallest detectable signal).

60. B. The standard shear-wave elastography formula converts measured shear wave speed into Young's modulus (stiffness) using $E = 3 \times \text{density} \times (\text{shear wave speed})^2$, based on the physics relationship between shear wave propagation and tissue elasticity. The other formulas do not correctly represent this established conversion.

61. C. Automatic brightness normalization adjusts each contributing frame's brightness during panoramic stitching so the final composite image appears evenly lit without visible seams, a distinct concern from misregistration artifact (structural, not brightness, distortion from motion), the dead zone (a near-field depth limitation), or the Nyquist limit (a sampling-rate concept).

62. A. The needle micro-motion ("jiggle") technique is a manual confirmation method where the operator gently moves the needle and watches for corresponding subtle B-mode motion to confirm true tip location, distinct from EM tracking (sensor-based), automatic Doppler envelope tracing (a spectral waveform feature), or beam-steering needle enhancement (which improves specular reflection, not motion confirmation).

- 63. B.** Automatically capping maximum MI/TI output when a pediatric preset is selected functions as a built-in safety interlock, reducing maximum acoustic output for a more vulnerable patient population without relying solely on manual operator judgment. This goes beyond the basic Output Display Standard (which only displays values, without capping them), is not simply the manually-applied AIUM statement, and is unrelated to the Spaulding classification.
- 64. A.** Wireless/cloud PACS upload allows a point-of-care device to automatically transmit completed exam images over a wireless network directly to a cloud-based archive, without physically docking to a workstation -- distinct from modality worklist integration (pulling scheduling data), DICOM lossy compression (a file-size technique), or structured reporting (a documentation template feature).
- 65. C.** Voice-command (hands-free) control allows the operator to freeze the image or adjust settings using spoken commands rather than touching the control panel, distinct from AI-assisted view recognition (automatic view/measurement suggestions), automatic Doppler envelope tracing (a spectral waveform feature), or remote tele-ultrasound guidance (a different operator entirely, working remotely).
- 66. A.** Simpson's biplane method automatically calculates ejection fraction from traced endocardial borders on two orthogonal views at end-diastole and end-systole, using a standard disk-summation approach -- a specific cardiac calculation distinct from the ellipsoid volume formula (organ volume), the Hadlock formula (fetal weight), or pressure half-time (mitral stenosis severity).
- 67. A.** Speckle-tracking strain echocardiography tracks the myocardium's natural speckle pattern frame to frame to calculate regional wall deformation (strain) from that tracked motion, distinct from shear-wave elastography (which uses an induced mechanical wave, not natural speckle tracking), automatic Doppler envelope tracing (a spectral feature), or pulse inversion harmonic imaging (a signal-processing technique).
- 68. D.** Automated carotid IMT measurement software identifies the lumen-intima and media-adventitia interfaces along a defined arterial segment after the operator places initial calipers, then calculates an average thickness value -- a specific software feature distinct from automated ejection fraction, fetal-weight, or bladder-volume calculations, which apply to entirely different anatomic measurements.
- 69. A.** Automated aortic-valve-area calculation applies the continuity equation to placed LVOT diameter, LVOT VTI, and aortic valve VTI measurements to calculate effective valve area -- a specific cardiac software feature distinct from carotid IMT, ejection fraction, or bladder-volume calculations, which measure entirely different structures.
- 70. C.** A cardiac-cycle-phase frame index marker moving along a simultaneously displayed ECG trace shows exactly which point in the cardiac cycle the current frame represents, a display/reference feature distinct from automatic Doppler envelope tracing, respiratory gating status, or the color box boundary.
- 71. A.** A continuously displayed ECG trace during a cardiac exam primarily serves as a simultaneous on-screen timing reference for correlating the image with the cardiac cycle, which is distinct from

cardiac (ECG) gating, which actively triggers image acquisition at a specific cardiac phase rather than simply displaying the trace for reference.

72. D. The real-time frame-rate (fps) readout continuously displays the current acquisition rate in a corner of the live image, a distinct on-screen element from the focal-zone position indicator, depth-scale marker, or dead-zone marker, which convey different information entirely.

73. C. An automatic patient/probe-motion detection warning during elastography monitors for excessive movement that could invalidate the stiffness measurement, a quality-assurance feature distinct from automatic Doppler envelope tracing accuracy, the dead zone (a near-field depth limitation), or the Nyquist sampling limit.

74. B. Automated serial aortic-diameter measurement and growth-tracking software stores each surveillance exam's maximum diameter and automatically displays the trend and growth rate over time compared to prior exams, a specific longitudinal-tracking feature distinct from ejection fraction, carotid IMT, or bladder-volume calculations.

75. C. Copying DICOM files directly onto a USB flash drive from the console represents local removable-media export, distinct from modality worklist integration (pulling scheduling data in), wireless/cloud PACS upload (automatic network transmission), or DICOM lossy compression (a file-size reduction technique), none of which describe this direct local-media export method.

76. C. Automated left ventricular mass calculation uses traced endocardial and epicardial borders at end-diastole with a validated geometric formula to calculate total LV muscle mass, a specific cardiac software feature distinct from ejection fraction, aortic valve area, or bladder-volume calculations, which measure different clinical values entirely.

77. A. The cerebroplacental ratio (CPR) combines the fetal MCA pulsatility index and the umbilical artery pulsatility index into a single composite marker, providing additional information about fetal wellbeing beyond either measurement alone, particularly in growth-restricted pregnancies. The renal-aortic ratio, ankle-brachial index, and arterial stenosis velocity ratio are unrelated ratios used in entirely different clinical contexts.

78. A. The fetal aorta is a fifth fetal vessel, beyond the umbilical artery, MCA, ductus venosus, and uterine artery, that can be interrogated by Doppler to help assess a growth-restricted fetus's cardiovascular status. The maternal renal artery, maternal ophthalmic artery, and fetal hepatic artery are not standard vessels used for this specific fetal wellbeing assessment.

79. D. Elevated, turbulent velocity through a narrowing ductus arteriosus, particularly in the setting of maternal NSAID exposure, suggests premature constriction of the ductus, a recognized risk requiring close monitoring. This is not normal expected flow, does not describe a fully open, unobstructed ductus, and is unrelated to umbilical artery diastolic flow findings.

80. B. Dilated, tortuous parauterine veins with slow, reversed flow on Valsalva are characteristic Doppler findings of pelvic congestion syndrome, caused by ovarian vein reflux. Ovarian torsion typically shows an enlarged ovary with absent or diminished flow rather than dilated venous structures, and a carotid body tumor or popliteal entrapment are unrelated conditions in entirely different anatomic locations.

81. A. May-Thurner syndrome describes compression of the left common iliac vein by the overlying right common iliac artery against the vertebral body, with elevated Doppler velocity at the compression point and often left leg swelling from impaired venous return. Nutcracker syndrome involves the left renal vein, subclavian steal involves the vertebral/subclavian circulation, and popliteal entrapment is an arterial, not venous, compression syndrome.

82. D. Absent or markedly abnormal hepatic vein flow with a flattened, non-phasic waveform, particularly with new ascites in a patient with liver disease, raises concern for Budd-Chiari syndrome, hepatic vein/IVC outflow obstruction. This is the opposite of a normal triphasic hepatic vein waveform, and is unrelated to nutcracker or May-Thurner syndrome, which involve different vessels entirely.

83. B. Diminished, continuous, non-pulsatile flow with collateral vessels distal to a focal aortic narrowing, combined with differential arm/leg pulses and blood pressure, is characteristic of coarctation of the aorta. Patent ductus arteriosus produces a different flow pattern within the ductus itself, and subclavian steal and popliteal entrapment involve different vessels and clinical presentations entirely.

84. B. Smooth, circumferential, homogeneous arterial wall thickening (the "macaroni sign") with reduced flow, rather than a focal atherosclerotic plaque, is characteristic of large-vessel vasculitis such as Takayasu arteritis, particularly in a younger patient with elevated inflammatory markers. A simple plaque is typically focal and irregular rather than circumferentially smooth, and a carotid body tumor or pseudoaneurysm produce entirely different sonographic appearances.

85. D. An entirely avascular, anechoic mass communicating with the joint space is characteristic of a Baker's (popliteal) cyst, helping distinguish it from popliteal vein thrombosis, which instead shows a non-compressible, often partially flow-filled tubular venous structure. A popliteal artery aneurysm and entrapment syndrome involve arterial, not simple cystic, findings.

86. B. Serial Doppler monitoring after catheter-directed thrombolysis confirms restoration of antegrade arterial flow as the thrombolytic agent progressively dissolves the occluding thrombus, guiding treatment duration and effectiveness assessment. This is unrelated to the Curie point, is not limited to a single pre-treatment ABI measurement, and is not assessing unrelated contralateral venous reflux.

87. A. Using color Doppler to positively identify the internal jugular vein and confirm its patency before central line placement serves as procedural guidance, helping avoid inadvertent arterial puncture and confirming a suitable, patent vessel for cannulation. This is unrelated to peripheral arterial disease screening, hepatic artery assessment, or ankle-brachial index measurement.

88. B. Intense, disorganized, low-resistance, high-velocity arterial-type flow helps distinguish a high-flow vascular lesion (such as an arteriovenous malformation or hemangioma with high-flow components) from a low-flow venous malformation, which would show minimal or absent arterial-type flow instead. Lymphoceles, thrombosed pseudoaneurysms, and reactive lymph nodes show different, distinguishable flow patterns from this specific high-flow arterial signature.

89. A. The whirlpool sign describes the twisted, coiled appearance of the ovarian vascular pedicle on color Doppler in ovarian torsion, a specific and helpful diagnostic sign. The macaroni sign describes vasculitis-related wall thickening, the string sign describes trickle flow through a near-total vascular occlusion, and the lyre sign describes carotid body tumor splaying of the carotid bifurcation -- all distinct signs in different contexts.

90. C. Confirming a fluid collection shows no internal color Doppler flow helps distinguish a simple fluid collection (such as a post-biopsy hematoma or urinoma) from a vascular complication such as a pseudoaneurysm, which would show internal flow (often with a characteristic swirling pattern) connecting to the parent vessel. This use of Doppler is not primarily about evaluating a normal renal artery, vein, or ureter directly.

91. A. Markedly increased arterial and venous flow to the affected testicle, along with epididymal enlargement, is characteristic of epididymo-orchitis, an inflammatory hyperemic process that contrasts directly with the absent or markedly diminished flow seen in testicular torsion. This hyperemic pattern is not consistent with torsion, a varicocele (a distinct venous dilation finding), or traumatic rupture (which shows a different, disrupted contour).

92. A. A focal area of markedly elevated peak systolic velocity within a stent, compared to velocities elsewhere in the stent, suggests in-stent restenosis at that specific location, analogous to velocity elevation at a native arterial stenosis. This is not normal uniform flow, does not indicate complete occlusion (which would show absent, not elevated, flow), and a focal, reproducible finding is not simply a technical angle limitation confined to that one segment.

93. B. Echogenic material filling the superior mesenteric vein with absent Doppler flow at that location describes mesenteric venous thrombosis, a distinct venous counterpart to arterial mesenteric ischemia. This is not chronic mesenteric ischemia (an arterial process), a normal postprandial velocity increase, or median arcuate ligament syndrome, which involves the celiac artery, not the mesenteric vein.

94. B. Compression and narrowing of the left renal vein between the aorta and superior mesenteric artery, with elevated velocity at the compression point and proximal dilation, describes nutcracker syndrome, which can cause flank pain and hematuria. May-Thurner syndrome involves the iliac veins, Budd-Chiari syndrome involves the hepatic veins/IVC, and popliteal entrapment is an unrelated lower-extremity arterial condition.

95. C. In an aortic dissection, the true lumen typically shows brisk, pulsatile antegrade flow, while the false lumen typically shows sluggish, sometimes reversed or absent flow, reflecting the different

hemodynamics of the two channels created by the intimal flap. These are not two unrelated vessels, this is not a normal finding, and a genuine, reproducible flow difference between the two channels is not simply a technical angle error confined to one channel.

96. C. A large, tangled vascular structure in the midline brain with very high-velocity, low-resistance arterial flow directly feeding a dilated venous structure, presenting with neonatal high-output cardiac failure, describes a vein of Galen malformation, a congenital high-flow arteriovenous shunt. A choroid plexus cyst, normal cerebral flow, and subependymal hemorrhage present with entirely different sonographic appearances and do not explain high-output cardiac failure.

97. B. An abnormal direct communication between a hepatic artery branch and an adjacent portal vein branch with turbulent, high-velocity flow, appearing after a percutaneous liver biopsy, represents an iatrogenic arteriovenous fistula, a recognized biopsy complication. This is not a normal expected post-biopsy finding, is unrelated to a vein of Galen malformation (an intracranial entity), and is distinct from normal portal vein flow.

98. C. A peripheral, wedge-shaped area of the spleen with no internal color Doppler flow, contrasting with normally perfused surrounding parenchyma, is characteristic of a splenic infarct, a recognized complication in sickle cell disease. This is not a normal splenic vein finding, is not consistent with a hemangioma (which would show its own vascular pattern rather than complete absence of flow), and is not normal parenchymal perfusion throughout.

99. A. Absent main renal vein flow combined with reversed diastolic flow in the renal artery, in a patient with acute graft swelling and decreased urine output, is a classic combination suggesting renal vein thrombosis, a urologic/vascular emergency requiring prompt recognition. This is not simple postoperative swelling without a vascular complication, is not a normal transplant arterial waveform, and is not explained by ureteral obstruction alone, which would not typically produce this specific venous/arterial Doppler combination.

100. A. Markedly elevated celiac artery velocity during expiration that substantially improves with deep inspiration is characteristic of median arcuate ligament syndrome, in which the ligament compresses the celiac artery in a respiratory-phasic pattern. This is distinct from chronic mesenteric ischemia from fixed atherosclerotic stenosis (which does not typically show this respiratory variation), mesenteric venous thrombosis (a different vessel entirely), and a normal celiac waveform (which would not show this marked respiratory-dependent change).

101. D. A narrowed vertebral artery flow channel with a surrounding crescent-shaped area concerning for intramural blood, following neck manipulation and with a partial Horner's syndrome, is concerning for vertebral artery dissection, a recognized complication of cervical manipulation. This is not normal vertebral artery flow, is not subclavian steal physiology (a different mechanism involving reversed flow from a proximal subclavian stenosis), and is not a simple anatomic variant given the acute presentation and imaging findings.

102. A. Serial Doppler surveillance of a transplanted pancreatic graft monitors that graft's own vascular patency and helps detect early complications such as thrombosis, analogous to surveillance performed for kidney and liver transplants but specific to the pancreatic graft's vessels. This is not an ankle-brachial index measurement, is unrelated to testicular torsion, and is not the same as calculating a renal-aortic ratio of the native (non-transplanted) kidneys.

103. B. Doppler evaluation for erectile dysfunction assesses baseline and post-injection arterial inflow (PSV) and venous competence (EDV) in the cavernosal arteries to characterize the underlying vasculogenic cause of ED, a different clinical purpose from priapism evaluation, which instead distinguishes a prolonged-erection emergency's high-flow (arterial) versus low-flow (venous occlusive) cause. The two evaluations use overlapping anatomy but serve genuinely different diagnostic purposes, and both assess arterial and venous components, not just one.

104. D. Prominent internal (rather than purely peripheral) vascularity on a thyroid nodule is considered a sonographic feature that raises concern for malignancy risk, prompting closer evaluation alongside other suspicious features. This finding does not confirm a simple colloid cyst, is not seen in virtually all thyroid nodules (most benign nodules show peripheral or absent vascularity), and clearly does not indicate the nodule is avascular.

105. B. A hypoechoic collection with a rim of increased color Doppler flow surrounding a central avascular area is a characteristic abscess pattern, reflecting peripheral inflammatory hyperemia surrounding a central necrotic, non-perfused core. A simple seroma would not typically show this peripheral hyperemic rim, this pattern does not indicate an entirely solid vascular malformation, and it clearly represents abnormal, not normal, surrounding tissue findings.

106. A. In autosomal dominant polycystic kidney disease, elevated renal resistive index reflects increased intrarenal vascular resistance from parenchymal compression by numerous expanding cysts, a recognized Doppler finding in this condition. This is not a normal finding in every healthy kidney, is not the same as acute renal artery stenosis (a distinct focal vascular lesion), and a reproducible, diffuse RI elevation is not explained by a technical angle problem throughout the entire kidney.

107. C. A peripheral rim of color Doppler vascularity with relatively sparse central flow is a characteristic pattern that helps characterize a uterine fibroid (leiomyoma), among other imaging features used for this diagnosis. A simple ovarian cyst and normal endometrial vascularity present with entirely different appearances, and this pattern by definition does not describe a normal, non-enlarged uterus.

108. D. The Doppler component of a scrotal trauma exam primarily assesses testicular perfusion and viability following traumatic injury, complementing grayscale assessment of tunica albuginea integrity and testicular contour. This is unrelated to lower-extremity ankle-brachial index, the renal-aortic ratio, or chronic mesenteric ischemia assessment, which apply to entirely different clinical scenarios.

109. B. Abnormal, high-velocity, arterialized, pulsatile flow in the superior ophthalmic vein, with a pulsatile bulging eye and audible bruit after facial trauma, is characteristic of a carotid-cavernous fistula, an abnormal direct communication between the carotid artery and cavernous sinus. This is distinct from a normal ophthalmic vein waveform, from simple ophthalmic artery flow reversal (a different vessel and mechanism, related to carotid stenosis rather than fistula), and this is not a normal post-traumatic finding.

110. A. A focally dilated, true popliteal artery segment with turbulent, swirling flow throughout the dilation itself describes a true popliteal artery aneurysm, distinct from a pseudoaneurysm (which shows to-and-fro flow confined to a narrow neck connecting to the parent vessel) or entrapment syndrome (a dynamic compression process without true focal dilation). A Baker's cyst is an entirely avascular cystic structure, not a vascular finding at all.