Ultrasound Physics - A Rapid Response Registry Review Course

Course Description

The CCI adult echocardiography board examination consists of 175 multiple choice questions (150 are graded – 25 questions are test questions for future examinations) – 13% are ultrasound physics questions (approximately 22 questions).

Below is the CCI outline for the ultrasound physics portion of the CCI adult echocardiography board examination. Test information including the complete adult echocardiography test outline is available at the CCI website - https://cci-online.org

E. Applying the Physics of Ultrasound	13%

1. Identify properties of ultrasound waveforms
2. Recognize artifacts
3. Optimize resolution
4. Optimize frame rate
5. Optimize Doppler waveforms
6. Optimize color Doppler
7. Optimize 2D image
8. Optimize 3D image
9. Optimize contrast image

The rapid response ultrasound physics course presented here provides a question-and-answer format in which a rapid response to each question will provide the participant instant feedback on how well basic ultrasound physics is known and understood and will aid in preparation for the CCI ultrasound physics portion of the adult (and pediatric) echocardiography board exam.

Nature of Ultrasound

1.Sound is a mechanical, _____ wave.
Sound is a mechanical, longitudinal wave.

2.The particles of a longitudinal wave move _____ to the direction of sound travel.
The particles of a longitudinal wave move parallel to the direction of sound travel.

3.Sound travels as a series of high pressure, density regions called: _____ and low-pressure, low-density regions called: _____.
Sound travels as a series of high-pressure, high-density regions called compression(s) and low-pressure, low-density regions called rarefaction(s).

4.One compression and one rarefaction equals _____.
One compression and one rarefaction equal one cycle (1 Hertz). (1 Hz)

5.Sound cannot travel in a _____, it requires a medium.
Sound cannot travel in a vacuum; it requires particles of a medium.

6. Sound carries _____ from one location to another, not matter.
Sound carries energy from one location to another, not matter.

7.Sound travels in a _____ line.
Sound travels in a straight line.

8.As sound travels through the medium, it varies (but does not permanently change) the medium. The four acoustic variables are: 1. _____; 2. _____; 3. _____ and 4. _____.
The four acoustic variables are pressure, density, temperature and particle motion.

9.Sound is a _____ wave.
Sound is a pressure wave.

Frequency (f)
1.The number of cycles which occur per second is the definition for _____.
The number of cycles which occur per second is the definition for frequency.

2.The units for frequency area _____.
The units for frequency are Hertz (Hz)

3.The ranges for sound are: Infrasound:
Less than _____ Hz
Audible sound: _____ Hz to _____ Hz
Ultrasound: _____ Hz
Clinical imaging ultrasound: _____ MHz
Infrasound: Less than 20 Hz
Audible sound: 20 Hz to 20,000 Hz (20 kHz)
Ultrasound: greater than 20, 000 Hz (20 kHz)
Clinical imaging ultrasound: 1.6 MHz (tissue harmonic imaging) and greater

4.As frequency increases, attenuation _____; depth of penetration _____; spatial (axial, lateral) resolution _____.
As frequency increases, attenuation increases, depth of penetration decreases, spatial (axial, lateral) resolution improves.

5.As frequency decreases, attenuation _____, depth of penetration _____, spatial (axial, lateral) resolution _____.
As frequency decreases, attenuation decreases, depth of penetration increases, spatial (axial, lateral) resolution degrades.

6. _____ determines the frequency the sonographer must use.
Image depth (e.g.; carotid artery (shallow depth – higher frequency) vs adult heart (deep depth – lower frequency) determines the frequency the sonographer must use.

7.An increase in frequency decreases: 1. _____, 2. _____, 3. _____, 4. _____, 5. _____, 6. _____, 7. _____, 8. _____, 9. _____ and 10. _____.
An increase in frequency decreases: 1. period, 2. pulse duration, 3. wavelength, 4. spatial pulse length, 5. duty factor, 6. beam width, 7. sound beam angle of divergence, 8. axial resolution (improves), 9. lateral resolution (improves) and 10. depth of penetration.

Tissue Harmonic Imaging (THI)
1.Tissue harmonic imaging transmits a _____ fundamental frequency and receives and displays _____ the fundamental frequency.
Tissue harmonic imaging transmits a low fundamental frequency (e.g., 1.8 MHz) and receives and displays twice the fundamental frequency (3.6 MHz).

2.Tissue harmonic imaging is based on the _____ sound travel through a medium.
Tissue harmonic imaging is based on the non-linear sound travel through a medium.

3._____ technique is used to identify the created tissue harmonic frequencies.
Pulse inversion is a technique in which two pulses with 180-degree phase difference (opposite phase) are transmitted sequentially into the tissue along the same line. The summation of these received pulses results in the fundamental frequency echoes being cancelled with the harmonic frequency components retained and displayed.

4.Tissue harmonic imaging _____ lateral resolution, the signal-to noise ratio with low level echo amplitudes (e.g., clutter, reverberations, side lobes, grating lobes, noise, haze) reduced, contrast resolution because low level signals are ignored, elevational (slice thickness) resolution because the sound beam is “thinner” in the orthogonal plane (e.g., less tissue volume is returned to the transducer).
Tissue harmonic imaging improves lateral resolution, the signal-to noise ratio with low level echo amplitudes (e.g., clutter, reverberations, side lobes, grating lobes, noise, haze) reduced, contrast resolution because low level signals are ignored, elevational (slice thickness) resolution because the sound beam is “thinner” in the orthogonal plane (e.g., less tissue volume is returned to the transducer).

Dynamic Frequency Tuning (Sliding Receiving Filters) (Frequency Compounding) (Frequency Fusion)
1._____allows the “tracking” of the multiple low and high frequencies produced by a wide bandwidth transducer and presenting a frame comprised of those multiple frequencies.
Dynamic frequency tuning allows the “tracking” of the multiple low and high frequencies produced by a wide bandwidth transducer and presenting a frame comprised of those multiple frequencies.

Period (T)
1.The time it takes for one cycle to occur is _____.
The time it takes for one cycle to occur is period.

2.The units for period are units of _____.
The units for period are units of time (e.g., milliseconds (msec), microseconds (µsec).

3.1 ÷ frequency = _____. (inversely related) (reciprocal)
1 ÷ frequency = period. (inversely related) (reciprocal)

4.As frequency increases, period ____.
As frequency increases, period decreases.

5.As frequency decreases, period _____.
As frequency decreases, period increases.

6.Period is not affected by image: _____.
Period is not affected by image depth.

7.An increase in frequency decreases: 1. _____, 2. _____, 3. _____, 4. _____, 5. _____, 6. _____, 7. _____, 8. _____, 9. _____, 10. _____.
An increase in frequency decreases: 1. period, 2. pulse duration, 3. wavelength, 4. spatial pulse length, 5. duty factor, 6. beam width, 7. sound beam angle of divergence, 8. axial resolution (improves), 9. lateral resolution (improves), 10. depth of penetration.

Wavelength (λ)
1.The distance covered by a single cycle is _____.
The distance covered by a single cycle is wavelength.

2.The units for wavelength are units of ____.
The units for wavelength are units of distance (e.g., meters (m), millimeters (mm)

3.Speed of sound (mm/µsec) ÷ frequency (Hz) = ______.
Speed of sound (mm/µsec) ÷ frequency (MHz) = wavelength

4.For soft tissue, as frequency increases, wavelength _____.
For soft tissue, as frequency increases, wavelength decreases.

5.For soft tissue, wavelength is _____ related to frequency.
For soft tissue, wavelength is inversely related to frequency.

6.An increase in frequency decreases: 1. _____, 2. _____, 3. _____, 4. _____, 5. _____, 6. _____, 7. _____, 8. _____, 9. _____, 10. _____.
An increase in frequency decreases: 1. period, 2. pulse duration, 3. wavelength, 4. spatial pulse length, 5. duty factor, 6. beam width, 7. sound beam angle of divergence, 8. axial resolution (improves), 9. lateral resolution (improves), 10. depth of penetration.

Speed of Sound (c)
1.The rate at which sound travels through a medium is called _____.
The rate at which sound travels through a medium is called the speed of sound.

2.The units for speed of sound are _____.
The units for speed of sound are units of distance over time (e.g., meters per second (m/sec), millimeters per microsecond (mm/µsec).

3.The speed of sound is determined by the _____ (bulk modulus) and _____ of the medium.
The speed of sound is determined by the stiffness (bulk modulus) and density of the medium.

4.Which has the greatest effect on determining the speed of sound through a medium: stiffness or density?
Stiffness has the greatest effect on the speed of sound in a medium.

5.Compressibility and elasticity are the _____ of stiffness.
Compressibility and elasticity are the opposite of stiffness.

6.An increase in compressibility or elasticity suggests a decrease in _____ and a_____ in the speed of sound.
An increase in compressibility or elasticity suggests a decrease in stiffness and a decrease in the speed of sound.

7.The **AVERAGE** speed of sound in soft tissue is _____ m/sec or _____ mm/µsec.
The **AVERAGE** speed of sound through soft tissue is 1540 m/sec or 1.54 mm /µsec.

8.The speed of sound through air is _____ msec.
The speed of sound through air is 330 m/sec.

9.The speed of sound through water (room temperature) is _____.
The speed of sound through water (room temperature) is: 1430 m/sec.

10.The speed of sound through fat is _____ m/sec.
The speed of sound through fat is 1450 msec.

11.The **AVERAGE** speed of sound through soft tissue is _____ m/sec.
The **AVERAGE** speed of sound through soft tissue is 1540 m/sec or 1.54 mm/µsec.

12.The speed of sound through blood is _____.
The speed of sound through blood is 1570 m/sec.

13.The speed of sound through muscle is _____ m/sec.
The speed of sound through muscle is 1580 m/sec

14.The speed of sound through bone is _____ m/sec.
The speed of sound through bon is 3500 m/sec.

Amplitude (A)
1.The maximum variation of an acoustic variable is _____.
The maximum variation of an acoustic variable is amplitude.

2.The units for amplitude are the units for the acoustic variable being measured or _____.
The units for amplitude are the units for the acoustic variable being measured or decibels (dB).

3.Amplitude is determined initially by the ultrasound machine instrument control called _____.
Amplitude is determined initially by the ultrasound machine instrument control called transmit gain.

4.As sound travels through the medium, the strength of amplitude _____.
As sound travels through the medium, the strength of amplitude decreases.

5.Power = _____ squared.
Power = Amplitude squared (A^2).

Power (P)
1.The rate of energy transfer is _____.
The rate of energy transfer is power.

2.The units for power are _____ or _____.
The units for power are Watts(W)or milliwatts (mW).

3.Power is determined initially by the ultrasound machine instrument control called _____.
Power is determined initially by the ultrasound machine instrument control called transmit gain.

4.Power = _____
Power = $Amplitude^{2.}$

5.If amplitude is doubled, power is _____.
If amplitude is doubled, power is quadrupled.

6.If amplitude is tripled, power is ____.
If amplitude is tripled, power is nine times greater.

7.If amplitude is halved, power is _____.
If amplitude is halved, power is quartered.

8. If amplitude is decreased by one-third, power is _____.
If amplitude is decreased by one-third, power is one ninth less.

9.As sound travels through the medium, the strength of power is _____.
As sound travels through the medium, the strength of power is decreased.

Intensity (I)
1.Power ÷ Area = _____.
Power ÷ Area = Intensity.

2.The units for intensity are _____ or _____.
The units for intensity are W/cm^2 or mW/cm^2.

3.Intensity is determined initially by the ultrasound machine instrument control called _____.
Intensity is determined initially by the ultrasound machine instrument control called transmit gain.

4.The have been no proven biological effects for focused sound beams below _____.
The have been no proven biological effects for focused sound beams below 1 W/cm^2 spatial peak temporal average (SPTA).

5.There have been no proven biological effects for unfocused sound beams below _____.
There have been no proven biological effects for unfocused sound beams below 100 mW/cm^2 SPTA.

6.As sound travels through the medium, the strength of intensity _____.
As sound travels through the medium, the strength of intensity decreases.

Acoustic Impedance (Z)

1.Acoustic impedance is the _____ to sound as it travels through a medium.
Acoustic impedance is the opposition to sound as it travels through a medium.

2.The symbol for acoustic impedance is _____,
The symbol for acoustic impedance is Z.

3.The unit for acoustic impedance is the _____.
The unit for acoustic impedance is the rayl.

4.Acoustic impedance (Z) = ____ x _____.
Acoustic impedance (Z) = speed of sound (m/sec) x density (kg/m^3)

5.A reflection will occur at the boundary of two media if the acoustic impedances of the two media are: _____.
A reflection will occur at the boundary of two media if the acoustic impedances of the two media are different.

6.The greater the acoustic impedance difference between two media, the _____ the amount of reflection.
The greater the acoustic impedance difference between two media, the greater the amount of reflection.

Specular Reflectors

1.Specular reflectors are _____ compared to the wavelength.
Specular reflectors are large compared to the wavelength.

2.Specular reflectors are _____ surfaced.
Specular reflectors are smooth surfaced.

3.Specular reflectors are _____-like.
Specular reflectors are mirror-like.

4.Specular reflectors are highly _____ dependent.
Specular reflectors are highly angle dependent.

5.Specular reflectors create _____ amplitude reflections.
Specular reflectors create strong amplitude reflections.

6.The best incident angle for specular reflectors is _____ degrees.
The best incident angle for specular reflectors is 90 degrees. (perpendicular).

7.Vessel walls, cardiac valves, organ boundaries are examples of _____ reflectors.
Vessel walls, cardiac valves, organ boundaries are examples of specular reflectors.

Scatter Reflectors (Nonspecular Reflectors)
1.Scatter reflectors are _____ compared to the wavelength.
Scatter reflectors are small compared to the wavelength.

2.Scatter reflectors are _____ surfaced.
Scatter reflectors are rough surfaced.

3.Scatter reflectors are highly _____ dependent, not angle dependent.
Scatter reflectors are highly frequency dependent, not angle dependent.

4.Scatter reflectors create _____ amplitude reflections.
Scatter reflectors create low amplitude (weak) signals.

5.Reflections returned from scatter reflectors are called: _____.
Reflections returned from scatter reflectors are called backscatter.

6.Organ parenchyma, cardiac myocardium are examples of _____ reflectors.
Organ parenchyma, cardiac myocardium are examples of scatter reflectors.

7. _____ scatterers are a special type of scatter reflector because these reflectors scatter sound energy equally in all directions.
Rayleigh scatterers are a special type of scatter reflector because these reflectors scatter sound energy equally in all directions.

8. The best example of a Rayleigh scatterer is the _____.
The best example of a Rayleigh scatterer is the red blood cell.

Perpendicular Incidence (Normal Incidence, Direct Incidence, Orthogonal Incidence)
1.The ultrasound beam strikes the boundary of two media at precisely 90 degrees. This is _____ incidence.
The ultrasound beam strikes the boundary of two media at precisely 90 degrees. This is perpendicular incidence.

2.For perpendicular incidence, a reflection will occur at the boundary of two media if the media acoustic impedances are _____.
For perpendicular incidence, a reflection will occur at the boundary of two media if the media acoustic impedances are different.

3.$[(Z_2 - Z_1) - (Z_2 - Z_1)]^2$ = the _____.
$[(Z_2 - Z_1) - (Z_2 - Z_1)]^2$ = the intensity reflection coefficient (IRC).

4.1 – IRC = _____.
1 – IRC = intensity transmission coefficient (ITC)

5.The IRC for a soft tissue-air interface is _____%.
The IRC for a soft tissue-air interface is 99%

6.The ITC for a soft tissue-air interface is _____%
The ITC for a soft tissue-air interface is 1%.

7.The IRC for a fat-muscle interface is _____%.
The IRC for a fat-muscle interface is 1%.

8.The ITC for a fat-muscle interface is _____%.
ITC for a fat-muscle interface is 99%.

9.The IRC for a soft tissue-bone interface is _____%
The IRC for a soft tissue-bone interface is 60%

10.The ITC for a soft tissue-bone interface is _____%
The ITC for a soft tissue-bone interface is: 40%.

11. _____ reduces the acoustic impedance difference between the ultrasound transducer and the skin surface by eliminating air.
Ultrasound gel reduces the acoustic impedance difference between the ultrasound transducer and the skin surface by eliminating air.

12.For perpendicular incidence, the greater the acoustic mismatch between two media, the _____ the amount of reflection (IRC) with _____ sound energy transmitted (ITC).
For perpendicular incidence, the greater the acoustic mismatch between two media, the greater the amount of reflection (IRC) with less sound energy transmitted (ITC).

Oblique Incidence
1.The incident angle strikes the boundary between two media at an angle other than 90 degrees. This is _____ incidence.
The incident angle strikes the boundary between two media at an angle other than 90 degrees. This is oblique incidence.

2.The incident angle _____ the reflected angle always.
The incident angle equals the reflected angle always.

3. The incident angle is 56 degrees. The reflected angle is _____ degrees.
The incident angle is 56 degrees. The reflected angle is 56 degrees.

4.The change in the direction of sound as it crosses a boundary is _____.
The change in the direction of sound as it crosses a boundary is refraction.

5.According to Snell's law, refraction will occur if the speed of sound between two media are different and there is _____ incidence.
According to Snell's law, refraction will occur if the speed of sound between two media are different and there is oblique incidence.

6.Refraction will not occur if there is _____ incidence.
Refraction will not occur if there is perpendicular incidence.

7.Refraction will not occur if there is oblique incidence and the speed of sound in both media are _____.
Refraction will not occur if there is oblique incidence and the speed of sound in both media are equal.

8.Refraction may result in the artifact called _____.
Refraction may result in the artifact called lateral displacement.

9._____ shadowing is caused by refraction of the sound beam along the edge of a curved structure.
Edge shadowing is caused by refraction of the sound beam along the edge of a curved structure.

Attenuation
1._____ is the loss of sound energy amplitude and intensity as sound travels through the medium.
Attenuation is the loss of sound energy, amplitude and intensity as sound travels through the medium.

2.The units for attenuation are _____.
The units for attenuation are decibels (dB).

3.The three primary causes of attenuation are 1. _____, 2. _____, 3. _____.
The three primary causes of attenuation are absorption, reflection, and scatter.

4.The primary cause of attenuation in soft tissue is _____.
The primary cause of attenuation in soft tissue is absorption.

5. _____ is the conversion of sound energy into heat.
Absorption is the conversion of sound energy into heat.

6.The likely cause of attenuation of sound energy in bone is _____ and: ____.
The likely cause of attenuation in bone is reflection and absorption.

Attenuation Coefficient
1._____ is the rate of attenuation.
Attenuation coefficient is the rate of attenuation.

2.The units for attenuation coefficient are: _____.
The units for attenuation coefficient are decibels/centimeter (dB/cm).

3.For soft tissue, the attenuation coefficient (dB/cm) = _____.
For soft tissue, the attenuation coefficient is 0.5 x frequency.

4.The attenuation coefficient for soft tissue may be written as _____.
The attenuation coefficient for soft tissue may be written as 0.5dB/cm/MHz

5.As frequency increases, attenuation ____ and depth of penetration ____.
As frequency increases, attenuation increases and depth of penetration decreases.

6.As frequency decreases, attenuation _____and depth of penetration ____.
As frequency decreases, attenuation decreases, and depth of penetration increases.

7.0.5 x frequency x path length = _____.
0.5 x frequency x path length = total attenuation.

8.An increase in frequency will _____ total attenuation and _____ the depth of penetration.
An increase in frequency will increase total attenuation and decrease the depth of penetration.

Piezoelectric Effect
1.The conversion of sound energy into electrical energy (reception) and electrical energy into sound energy (transmission) is the _____ effect.
The conversion of sound energy into electrical energy (reception) and electrical energy into sound energy (transmission) is the piezoelectric effect.

2.Ultrasound transducers operate on the _____.
Ultrasound transducers operate on the piezoelectric effect.

3.Quartz, tourmaline, Rochelle salts are naturally occurring materials which possess the _____ property.
Quartz, tourmaline, Rochelle salts are naturally occurring materials which possess the piezoelectric property.

4.Man-made materials such as lead zirconate titanate (PZT) (most common material used for ultrasound transducers), barium titanate, lead metaniobate) are given the _____ property.
Man-made materials such as lead zirconate titanate (PZT) (most common material used for ultrasound transducers), barium titanate, lead metaniobate) are given the piezoelectric property.

5.Man-made materials such as PZT are given the piezoelectric property by exposing the material to high temperature – this process is called _____.
Man made materials such as PZT are given the piezoelectric property by exposing the material to high temperature – this process is called polarization.

6.Extreme heat will destroy the piezoelectric effect properties of an ultrasound transducer. Ultrasound transducers should never be ____
Extreme heat will destroy the piezoelectric effect properties of an ultrasound transducer. Ultrasound transducers should never be autoclaved.

7.The temperature at which ultrasound transducers lose their piezoelectric properties is the _____ temperature.
The temperature at which ultrasound transducers lose their piezoelectric properties is the Curie temperature.

Transducer Construction

1.The center frequency of an ultrasound transducer is primarily determined by the _____.
The center frequency of an ultrasound transducer is primarily determined by the thickness of the piezoelectric element(s) and the speed of sound of the piezoelectric element(s).

2.The thinner the piezoelectric element, the _____ the center frequency.
The thinner the piezoelectric element, the higher the center frequency.

3.The center frequency for a continuous wave transducer is determined by the _____.
The center frequency for a continuous wave transducer is determined by the frequency of the driving voltage.

4.The ____ is placed on the front of the piezoelectric element(s) to reduce the acoustic impedance difference between the piezoelectric element and the soft tissue.
The matching layer is placed on the front of the piezoelectric element(s) to reduce the acoustic impedance difference between the piezoelectric element and the soft tissue.

5.The _____ improves transmission and reception.
The matching layer improves transmission and reception

6. _____ improves transmission and reception.
Ultrasound gel improves transmission and reception.

7.The _____ is placed behind the piezoelectric element(s) to reduce the ringing of the element(s) allowing short pulses of ultrasound to be produced.
The damping material is placed behind the piezoelectric element(s) to reduce the ringing of the element(s) allowing short pulses of ultrasound to be produced.

8.The acoustic impedance value of the damping material is _____ to the piezoelectric elements acoustic impedance value.
The acoustic impedance value of the damping material is equal to the piezoelectric elements acoustic impedance value.

9.The ____ improves axial resolution.
The damping material improves axial resolution.

10. The damping material reduces: 1. _____, 2. _____, 3. _____, 4. _____, 5. _____, 6. _____.
The damping material reduces the 1. pulse duration, 2. spatial pulse length, 3. duty factor, 4. transducer output intensity, 5. transducer sensitivity, 6. quality factor, 7. axial resolution (improves).

11._____ type transducers are transducers where the piezoelectric elements are arranged in a single row (side by side) (lateral) (e.g.; phased array, linear array, curvilinear array tightly curved array) and are beam-steered and beam focused electronically in only one plane (lateral).
1-D (1-dimensional) type transducers are transducers where the piezoelectric elements are arranged in a single row (e.g.; phased array, linear array, curvilinear array tightly curved array) and are beam steered and beam focused electronically in only one plane (lateral).

12._____ type transducers are transducers composed of multiple piezoelectric elements in the lateral dimension and a few (usually three) piezoelectric elements in the elevational plane and are electronically beam steered and beam focused in more than one elevational plane.
1.5 D type transducers are transducers composed of multiple piezoelectric elements in the lateral dimension and a few (usually three) piezoelectric elements in the elevational plane and are electronically beam-steered and beam focused in more than one elevational plane.

13._____ type transducers are composed of 100's of rows and columns of piezoelectric elements – most commonly used to acquire 3-D and 4-D images.
2-D type transducers are composed of 100's of rows and columns of piezoelectric elements – most commonly used to acquire 3-D and 4-D images.

Bandwidth (BW)
1.The range of frequencies produced by a damped piezoelectric element is _____.
The range of frequencies produced by a damped piezoelectric element is bandwidth.

2.Clinical imaging transducers are _____ bandwidth transducers because of damping.
Clinical imaging transducers are wide bandwidth transducers because of damping.

3.CW (non-imaging) transducers are _____ bandwidth transducers because they are not damped.
CW (non-imaging) transducers are narrow bandwidth transducers because they are not damped.

Quality Factor (Q Factor)
1.Q Factor (unitless) =
Q Factor = Center frequency ÷ Bandwidth

2.Clinical imaging transducers are _____ bandwidth transducers with a _____ Q Factor.
Clinical imaging transducers are wide bandwidth transducers with a low Q Factor.

3.CW (non-imaging) transducers are _____ bandwidth transducers with a _____ Q Factor.
CW (non-imaging) transducers are narrow bandwidth transducers with a high Q Factor.

Sound Beam Formation
1.The sound beam is composed of four distinct regions: 1. _____, 2. _____, 3. _____, 4. _____.
The sound beam is composed of four distinct regions: 1. Near field (Fresnel zone) (Near zone), 2. Focus (Focal point), 3. Focal zone (Focal region), 4. Far field (Fraunhofer) (Far zone).

2.The distance from the transducer face to the focus is the _____.
The distance from the transducer face to the focus is the near field (Fresnel zone) (Near zone).

3.The narrowest portion of the sound where sound beam diameter is narrowest, lateral resolution is best and intensity is greatest is the _____.
The narrowest portion of the sound where sound beam diameter is narrowest, lateral resolution is best and intensity is greatest is the focus (focal point).

4.Transducer diameter^2 ÷ 4 x Wavelength = _____.
Transducer diameter^2 ÷ 4 x Wavelength = near field length.

5.The region near the focus is the_____.
The region near the focus is the focal region (focal zone).

6.The widest portion of the sound beam is the _____ where the sound beam diverges.
The widest portion of the sound beam is the far field (Fraunhofer zone) (far zone) where the sound beam diverges.

7.Sound beam formation is based on ____ principle.
Sound beam formation is based on Huygen's principle.

8._____ principle states that the resultant sound beam is a combination of all sound arising from different sources (wavelets) on the transducer element(s) face.
Huygen's principle states that the resultant sound beam is a combination of all sound arising from different sources (wavelets) on the transducer element(s) face.

9._____ interference occurs when two or more sound waves have the same phase (in-phase) relationship which will increase the sound wave strength.
Constructive interference occurs when two or more sound waves have the same phase (in-phase) relationship which will increase the sound wave strength.

10._____ interference occurs when two or more sound waves are out of phase which will decrease the strength of the sound wave.
Destructive interference occurs when two or more sound waves are out of phase which will decrease the strength of the sound wave.

11.Increasing the transducer diameter _____ the near field length and _____ the sound beam angle of divergence.
Increasing the transducer diameter increases the near field length and decreases the sound beam angle of divergence.

12.Increasing the frequency ____ the near field length and decreases the sound beam angle of divergence.
Increasing the frequency increases the near field length and decreases the sound beam angle of divergence.

13.Small transducer diameters have _____ sound beam divergence as compared to larger transducer diameters.
Small transducer diameters have greater sound beam divergence as compared to larger transducer diameters.

14.Strongly focused transducers have _____ sound beam divergence than weak or medium focused transducers.
Strongly focused transducers have greater sound beam divergence than weak or medium focused transducers.

Focusing

1._____ reduces the sound beam width in the near field which improves lateral resolution and transducer sensitivity.
Focusing reduces the sound beam width in the near field which improves lateral resolution and transducer sensitivity.

2.Focusing improves _____ resolution.
Focusing improves lateral resolution.

3.Focusing increases sound beam _____.
Focusing increases sound beam divergence.

4.There are five types of focusing: 1. _____, 2. _____, 3. _____, 4. ____, 5. _____.
There are five types of focusing: 1. Internal, 2. External 3. Electronic transmit, 4. Dynamic receive, 5. Dynamic aperture (variable receive).

5.The elements are curved. This is _____ focusing.
The elements are curved. This is internal focusing.

6.A curved lens is placed on the front of the transducer. This is _____ focusing.
A curved lens is placed on the front of the transducer. This is external focusing.

7.The electrical pulses delivered to the piezoelectric elements are curved. This is _____ focusing.
The electrical pulses delivered to the piezoelectric elements are curved. This is electronic transmit focusing.

8.Multiple focus locations may be chosen by the sonographer when using _____ focusing which improves lateral resolution but will decrease frame rate.
Multiple focus locations may be chosen by the sonographer when using electronic transmit focusing which improves lateral resolution but will decrease frame rate.

9.Delay lines are used during reception. This is _____ focusing.
Delay lines are used during reception. This is dynamic receive focusing.

10. _____ alters the number of active piezoelectric elements receiving returned reflections.
Dynamic aperture (variable receive) alters the number of active piezoelectric elements receiving returned reflections.

11. _____ uses filters to process frequencies received from different image depths.
Dynamic frequency tuning (frequency compounding, frequency fusion) uses filters to process frequencies received from different image depths.

12.The only type of focusing directly controlled by the sonographer is _____.
The only type of focusing directly controlled by the sonographer is electronic transmit focusing.

Focusing Characteristics
1.The _____ is the distance from the transducer face to the focal point.
The focal length is the distance from the transducer face to the focal point.

2.The _____ is the narrowest point of a focused sound beam.
The focus (focal point) is the narrowest point of a focused sound beam.

3.The _____ is defined as that portion of the sound beam up to two times the dimension of the focal point.
The focal region (focal zone) is defined as that portion of the sound beam up to two times the dimension of the focal point.

4.Ultrasound transducers may be: 1. _____, 2. _____, or 3. _____.
Ultrasound transducers may be strongly focused, medium focused or weakly focused.

5.The greater the curvature, the _____ the degree of focusing.
The greater the curvature, the greater the degree of focusing.

6. Focusing (internal, external, electronic transmit) _____ the sound beam angle of divergence.
Focusing (internal, external, electronic transmit) increases the sound beam angle of divergence.

7.Sound beam intensity is greatest at the: _____.
Sound beam intensity is greatest at the focus (focal point).

8.Focusing improves _____ resolution in the near field, focus and focal zone and will degrade lateral resolution in the far field.
Focusing improves lateral resolution in the near field, focus and focal zone and will degrade lateral resolution in the far field.

Lateral Resolution (Angular, Transverse, Azimuthal) (LATA)
1.How close two structures may be perpendicular to the sound beam path and still be resolved as two separate structures is _____ resolution.
How close two structures may be perpendicular to the sound beam path and still be resolved as two separate structures is lateral resolution.

2.Lateral resolution = _____ (mm).
Lateral resolution (mm) = sound beam width (mm).

3.Lateral resolution ____ with the distance from the transducer.
Lateral resolution varies with the distance from the transducer.

4.Lateral resolution may be improved by 3 ways: 1. _____, 2. _____, 3. _____.
Lateral resolution may be improved by 1. Increasing the frequency, 2. Focusing, 3. Increasing the transducer diameter.

Axial Resolution (Longitudinal, Range, Radial Depth) (LARRD)
1.How close two structures may be parallel to the direction of sound travel and still be resolved as two separate structures is _____ resolution.
How close two structures may be parallel to the direction of sound travel and still be resolved as two separate structures is axial resolution.

2.Axial resolution (mm) = _____.
Axial resolution (mm) = Spatial pulse length (mm) ÷ 2.

3.Axial resolution may be improved in two ways: 1. _____, 2. _____.
Axial resolution may be improved two ways: 1. Increasing the frequency, 2. Damping.

4.Increasing the frequency decreases: 1._____, 2._____, 3._____, 4. _____ which improves axial resolution.
Increasing the frequency decreases period, pulse duration, wavelength, spatial pulse length which improves axial resolution.

5.The shorter the pulse (pulse duration, spatial pulse length) the better the _____ resolution.
The shorter the pulse (pulse duration, spatial pulse length) the better the axial resolution.

6. _____ resolution does not change with image depth.
Axial resolution does not change with image depth.

7.Axial resolution and lateral resolution are referred to as _____ resolution or ____ resolution.
Axial resolution and lateral resolution are referred to as spatial resolution or detail resolution.

Temporal Resolution
1.The ability to resolve fast moving structures accurately is ____ resolution.
The ability to resolve fast moving structures accurately is temporal resolution.

2.Increasing the frame rate improves _____ resolution.
Increasing the frame rate improves temporal resolution.

3.Reducing the image depth improves _____ resolution.
Reducing the image depth improves temporal resolution.

4.Reducing the field of view improves _____ resolution.
Reducing the field of view improves temporal resolution.

5.Reducing the number of transmit focuses improves _____ resolution.
Reducing the number of transmit focuses improves temporal resolution.

6.Reducing scan line density improves _____ resolution.
Reducing the scan line density improves temporal resolution.

7.Interpolation improves _____ resolution.
Interpolation improves temporal resolution.

8.Multiple scan lines can be created from a wider transmitted pulse which will increase the frame rate and improve temporal resolution – this technique is called _____.
Multiple scan lines can be created from a wider transmitted pulse which will increase the frame rate and improve temporal resolution – this technique is called parallel processing.

Contrast Resolution
1.____ resolution is the ability to differentiate between different levels of amplitude and is determined by the number of shades of gray displayed.
Contrast resolution is the ability to differentiate between different levels of amplitude and is determined by the number of shades of gray displayed.

2.Adjusting dynamic range (compression), transmit gain, gain, time gain compensation, post-processing curves may improve _____ resolution.
Adjusting dynamic range (compression), transmit gain, gain, time gain compensation, post-processing curves may improve contrast resolution.

3.Choosing a narrow dynamic range will result in a more _____ image with the possibility of important information being omitted.
Choosing a narrow dynamic range will result in a more contrast (black and white) image with the possibility of important information being omitted.

4.Choosing a wide dynamic range will result in _____ shades of gray being displayed with the possibility of important information being displayed (e.g., cardiac valve vegetation, intracardiac thrombus).
Choosing a wide dynamic range will result in more shades of gray being displayed with the possibility of important information being displayed (e.g., cardiac valve vegetation, intracardiac thrombus).

Elevational Resolution (Slice thickness resolution)
1._____ resolution is determined by the thickness (height) of the ultrasound beam.
Elevational resolution (slice thickness resolution) is determined by the thickness (height) of the ultrasound beam.

2.Elevational resolution (mm) = ____ (mm).
Elevational resolution (mm) = sound beam thickness (mm).

3.Focusing may improve _____ thickness.
Focusing may improve elevational resolution.

Signal to Noise Ratio (SNR)
1._____ signal to noise ratios provide better image quality.
High signal to noise ratios provides for better image quality.

2.Coded excitation, spatial compounding, frequency fusion and persistence will _____ the signal to noise ratio.
Coded excitation, spatial compounding, frequency fusion and persistence will improve the signal to noise ratio.

3._____ is an ultrasound technique which improves the signal to noise ratio by transmitting a long binary phase-encoded pulse sequence and then compressing the reflection (echo) into a short, high amplitude pulse upon reception.
Coded excitation is an ultrasound technique which improves the signal to noise ratio by transmitting a long binary phase-encoded pulse sequence and then compressing the reflection (echo) into a short, high amplitude pulse upon reception.

Transducer Types
1.A small, square shaped transducer where all of the piezoelectric elements are electronically fired but with a slight time delay in order to beam steer and beam focus and is the most common cardiac transducer is the _____.
A small, square shaped transducer where all of the piezoelectric elements are electronically fired but with a slight time delay in order to beam steer and beam focus and is the most common cardiac transducer is the sector phased array.

2.A large transducer where all of the piezoelectric elements are arranged in a line and electronically fired with time delays in order to beam steer and beam focus and is the most common vascular transducer is the _____.
A large transducer where all of the piezoelectric elements are arranged in a line and electronically fired with time delays in order to beam steer and beam focus and is the most common vascular transducer is the linear phased array.

3.An arc-shaped transducer with all of the piezoelectric elements arranged in a line and electronically fired with time delays in order to beam steer and beam focus and is the most common transducer in general ultrasound is the _____.
An arc-shaped transducer with all of the piezoelectric elements arranged in a line and electronically fired with time delays in order to beam steer and beam focus and is the most common transducer in general ultrasound is the: curved (curvilinear) phased array.

4.A small, non-imaging dedicated continuous-wave (CW) Doppler transducer with only two piezoelectric elements primarily used to evaluate aortic stenosis is the _____.
A small, non-imaging dedicated continuous-wave (CW) Doppler transducer with only two piezoelectric elements primarily used to evaluate aortic stenosis is the Pedof.

5.Capacitive micromachined ultrasonic transducers (CMUT) are a new type of transducer replacing the piezoelectric model with _____.
Capacitive micromachined ultrasonic transducers (CMUT) are a new type of transducer replacing the piezoelectric model with a silicon based micro-electromechanical system (MEMS).

6.1-D array transducers are comprised of a single row of 128 to 256 piezoelectric elements.
_____ transducers are comprised of a single row if 128 to 256 piezoelectric elements.

7.1.5 array transducers are comprised of multiple rows (e.g; 10 to 15 rows) of piezoelectric elements (e.g.; 64 to 128 piezoelectric elements).
_____ transducers are comprised of multiple rows (e.g; 10 to 15 rows) of piezoelectric elements (e.g.; 128 piezoelectric elements).

8.2-D array (matrix) transducers are comprised of a significant number of rows (e.g.; 50 to 100 rows) with 1000 to 3000 piezoelectric elements which allows for volume scanning (3-D and 4-D ultrasound) to be acquired.
_____ array (matrix) transducers are comprised of a significant number of rows (e.g.; 50 to 100 rows) with 1000 to 3000 piezoelectric elements which allows for volume scanning (3-D and 4-D ultrasound) to be acquired

Range Equation
1.The ____ equation determines the distance to the reflector.
The range equation determines the distance to the reflector.

2.For clinical imaging ultrasound, speed of sound (m/sec) x pulse round trip time (mm/µsec) x 0.5 = _____.
For clinical imaging ultrasound, speed of sound (m/sec) x pulse round trip time (mm/µsec) x 0.5 = distance to the reflector (mm)

3.For soft tissue, it takes _____ µsec to travel one centimeter roundtrip.
For soft tissue, it takes 13 µsec to travel one centimeter roundtrip.

4.For soft tissue, the pulse round trip time is 39 µsec. The distance to the reflector is _____ cm.
For soft tissue, the pulse round trip time is 39 µsec. The distance to the reflector is: 3 cm.

5.For soft tissue, the pulse round trip time is 130 µsec. The distance to the reflector is _____ cm.
For soft tissue, the pulse round trip time is 130 µsec. The distance to the reflector is: 10 cm.

6.For soft tissue, the pulse round trip time is 260 µsec. The distance to the reflector is _____ cm.
For soft tissue, the pulse round trip time is 260 µsec. The distance to the reflector is: 20 cm.

Pulse Repetition Frequency (PRF)
1.The number of pulses created per second is _____.
The number of pulses created per second is pulse repetition frequency (PRF).

2.The units for pulse repetition frequency are _____.
The units for pulse repetition frequency are Hertz (e.g., kHz).

3.Pulse repetition frequency is dependent upon _____.
Pulse repetition frequency is dependent upon image depth.

4.In traditional clinical imaging, only _____ pulse may travel in the body at a time.
Only one pulse may travel in the body at a time.

5.Increasing the image depth will _____ the pulse repetition frequency.
Increasing the image depth will decrease the pulse repetition frequency.

6.Decreasing the image depth will _____ the pulse repetition frequency.
Decreasing the image depth will increase the pulse repetition frequency.

Pulse Repetition Period (PRP)

1.The period of time from the onset of one pulse to the onset of the next pulse is _____.
The period of time from the onset of one pulse to the onset of the next pulse is pulse repetition period (PRP).

2.1 ÷ Pulse repetition frequency = _____.
1 ÷ Pulse repetition frequency = pulse repetition period.

3.As image depth increases, pulse repetition frequency ____ and pulse repetition period _____.
As image depth increases, pulse repetition frequency decreases and pulse repetition period increases.

4.As image depth decreases, pulse repetition frequency ____ and pulse repetition period _____.
As image depth decreases, pulse repetition frequency increases and pulse repetition period decreases.

Pulse Duration (PD)

1.The time it takes for one pulse to occur is: _____.
The time it takes for one pulse to occur is pulse duration (PD).

2.Period (T) (µsec) x number of cycles in a pulse (n) = _____.
Period (T) (µsec) x number of cycles in a pulse (n) = pulse duration (µsec).

3.Increasing frequency ____ pulse duration which improves axial resolution.
Increasing frequency decreases pulse duration which improves axial resolution.
4.Decreasing frequency _____ pulse duration which degrades axial resolution.
Decreasing frequency increases pulse duration which degrades axial resolution.

4.Damping _____ pulse duration which improves axial resolution.
Damping decreases pulse duration which improves axial resolution.

5.A shorter pulse duration improves _____ resolution.
A shorter pulse duration improves axial resolution.

Spatial Pulse Length (SPL)

1.The length of one pulse is _____.
The length of one pulse is spatial pulse length (SPL).

2.The units for spatial pulse length are units of _____.
The units for spatial pulse length are units of distance (e.g., mm).

3.Wavelength (λ) x number of cycles in a pulse (n) = _____.
Wavelength (λ) x number of cycles in a pulse (n) = spatial pulse length (mm).

4.Increasing frequency ____ spatial pulse length which improves axial resolution.
Increasing frequency decreases spatial pulse length which improves axial resolution.

5.Decreasing frequency ____ spatial pulse length which degrades axial resolution.
Decreasing frequency increases spatial pulse length which degrades axial resolution.

6.Spatial pulse length ÷ 2 = ____ resolution.
Spatial pulse length ÷ 2 = axial resolution.

7.The shorter the spatial pulse length (and pulse duration) the better the _____ resolution.
The shorter the spatial pulse length (and pulse duration) the better the axial resolution.

Duty Factor (DF)
1.The time the ultrasound machine spends creating a pulse of ultrasound is _____.
The time the ultrasound machine spends creating a pulse of ultrasound is duty factor (DF).

2.Pulse duration ÷ Pulse repetition period = _____.
Pulse duration ÷ Pulse repetition period = duty factor.

3.Duty factor is expressed as a _____.
Duty factor is expressed as a percentage.

4.The duty factor for continuous wave is _____.
The duty factor for continuous wave is 1 or 100%.

5.The duty factor for pulsed wave is _____.
The duty factor for pulsed wave is less than 1.

Components of a Ultrasound Machine
1.The five basic components of an ultrasound machine are: 1. _____, 2. _____, 3. _____, 4. _____, 5. _____.
The five basic components of an ultrasound machine are: 1. Pulser, 2. Beam former, 3. Receiver, 4. Memory (Digital scan converter), 5. Image Display.

Pulser
1.The ____ produces an electric voltage that activates the piezoelectric element(s) causing the element(s) to expand and contract (vibrate).
The pulser produces an electric voltage that activates the piezoelectric element(s) causing the element(s) to expand and contract (vibrate).

2.The ____ processes electric signals returned from the transducer (ultrasound reflections converted into electric signals by the transducer).
The receiver processes electric signals returned from the transducer (ultrasound reflections converted into electric signals by the transducer).

Beam Former
1.The ____ determines the shape of the electrical voltages being delivered to the piezoelectric elements to beam steer and beam focus and uses tile delays for dynamic receive focusing.
The beam former determines the shape of the electrical voltages being delivered to the piezoelectric elements to beam steer and beam focus and uses tile delays for dynamic receive focusing.

Receiver
1.The _____ processes electric signals returned from the transducer (ultrasound reflections converted into electric signals by the transducer).
The receiver processes electric signals returned from the transducer (ultrasound reflections converted into electric signals by the transducer).

2.The five functions of the receiver are: 1. _____, 2. _____, 3. _____, 4. _____, 5. _____.
The five functions of the receiver are 1. Amplification, 2. Compensation, 3. Compression, 4. Demodulation, 5. Rejection

3._____ amplifies all returning signals regardless of image depth.
Amplification amplifies all returning signals regardless of image depth.

4._____ compensates for attenuation.
Compensation compensates for attenuation.

5._____ is the internal process in which larger echoes are equalized with smaller echoes – compression reduces dynamic range.
Compression is the internal process in which larger echoes are equalized with smaller echoes – compression reduces dynamic range.

6._____ is the range of values from the minimum to the maximum echo amplitudes. It is a ratio of the largest power to the smallest power in the working range of the ultrasound instrument.
Dynamic range is the range of values from the minimum to the maximum echo amplitudes. It is a ratio of the largest power to the smallest power in the working range of the ultrasound instrument.
7._____ is the process of converting voltages delivered to the receiver into a more useful form.
Demodulation is the process of converting voltages delivered to the receiver into a more useful form.

8.The two steps in demodulation are: 1. _____ and 2. _____.
The two steps in demodulation are: 1. Rectification and 2. Smoothing.

9._____ removes the negative components of the electric signal - replaces with a positive value).
Rectification removes the negative components of the electric signal - replaces with a positive value).

10._____ is the averaging of the new rectified electric signal.
Smoothing is the averaging of the new rectified electric signal.

11._____ is the elimination of smaller amplitude signals produced by weak reflectors and noise.
Rejection is the elimination of smaller amplitude signals produced by weak reflectors and noise.

Memory (Digital Scan Converter)
1.The _____ coverts scan line information into a format compatible for image display.
The digital scan converter converts scan line information into a format compatible for image display.

Display
1.LCD (liquid crystal display) is used for the _____.
LCD (liquid crystal display) is used for the ultrasound machine's image display because it is stable, flicker-free, allows for higher frame rates and is light weight.

2.The image display ____ control may be used to increase or decrease the picture contrast.
The image display contrast control may be used to increase or decrease the picture contrast.

3.The image display _____ control may be used to increase or decrease the picture brightness.
The image display brightness control may be used to increase or decrease the picture brightness.

Ultrasound Instrument Imaging Controls
Transmit Gain (Output Power) (Power)
1._____ determines the amount of sound energy emitted by the ultrasound transducer.
Transmit gain determines the amount of sound energy emitted by the ultrasound transducer.

2.The units for transmit gain are _____.
The units for transmit gain are decibels (dB).

3.Transmit gain is controlled by the _____.
Transmit gain is controlled by the sonographer.

4.Increasing the transmit gain _____ depth of penetration.
Increasing transmit gain improves depth of penetration.

5.Increasing transmit gain _____ the brightness (amplitude) if the returning reflections.
Increasing the transmit gain increases the brightness (amplitude) of the returning reflections.

6.Increasing the transmit gain affects the _____ image display.
Increasing the transmit gain affects the entire image display.

7.Increasing the transmit gain _____ the risk of bioeffects.
Increasing the transmit gain increases the risk of bioeffects.

8.Increasing the transmit gain increases the _____ index.
Increasing the transmit gain increases the mechanical index (MI).

9.The acronym ALARA stands for: _____ and is the guide for the use of transmit gain.
The acronym ALARA stands for As Low As Reasonably Achievable and is the guide for the use of transmit gain.

Gain (Receiver Gain) (Overall gain)
1._____ amplifies the strength (amplitude) of all returning signals regardless of image depth.
Gain amplifies the strength (amplitude) of all returning signals regardless of image depth.

2.The units for gain are _____.
The units for gain are decibels (dB).

3.Gain affects the _____ image display.
Gain affects the entire image display.

4. _____ is the preferred choice when choosing between gain and transmit gain because it reduces the risk of bioeffects by reducing the ultrasound dose to the patient.
Gain is the preferred choice when choosing between gain and transmit gain because it reduces the risk of bioeffects by reducing the ultrasound dose to the patient.

Time Gain Compensation (TGC)
1._____ compensates for attenuation by allowing the sonographer to adjust the brightness (amplitude) of the returning signals from a particular image depth using slide pods.
Time gain compensation (TGC) compensates for attenuation by allowing the sonographer to adjust the brightness (amplitude) of the returning signals from a particular image depth using slide pods.

2.The units for time gain compensation are _____.
The units for time gain compensation are decibels (dB).

Display Dynamic Range (Compression)
1._____ is an instrument control which affects the number of gray shades displayed.
Dynamic range is an instrument control which affects the number of gray shades displayed. There are four types of dynamic range (the ratio of the maximum to the minimum amplitude of a signal) – 1. Input dynamic range, 2. Output dynamic range, 3. Display dynamic range, 4. Gain dynamic range.

2.The units for dynamic range are _____.
The units for dynamic range are decibels (dB)

3.Increasing the display dynamic range _____ the number of shades of gray displayed.
Increasing the display dynamic range increases the number of shades of gray displayed.

4.Decreasing the display dynamic range _____ the number of shades of gray displayed.
Decreasing the display dynamic range decreases the number of shades of gray displayed.

Rejection
1._____ reduces or eliminates low level amplitude signals and electronic noise.
Rejection reduces or eliminates low level amplitude signals and electronic noise.

2.The units for rejection are _____.
The units for rejection are decibels (dB).

Preprocessing

1.The term _____ refers to changes made to echo information immediately before it is stored as an image.
The term preprocessing refers to changes made to echo information immediately before it is stored as an image.

2._____ includes frame averaging (persistence), panoramic imaging, compound imaging, write zoom.
Preprocessing includes frame averaging (persistence), panoramic imaging, compound imaging, write zoom.

Frame Averaging (Persistence)

1._____ means that the machine takes the most recently acquired image and averages it with the previous image which may reduce soft tissue speckle but will also reduce frame rate.
Frame averaging means that the machine takes the most recently acquired image and averages it with the previous image which may reduce soft tissue speckle but will also reduce frame rate.

Panoramic Imaging (Extended Field of View Imaging)

1.In _____ the scan is extended providing for a wider field of view.
In panoramic imaging, the scan is extended providing for a wider field of view.

Compound Imaging

1.With _____ several images are formed in rapid succession and combined to form a single compound image which may reduce soft tissue speckle but will also reduce the frame rate.
With compound imaging several images are formed in rapid succession and combined to form a single compound image which may reduce soft tissue speckle but will also reduce the frame rate.

Write Zoom

1. Write zoom may be a way to improve spatial (axial, lateral) resolution. Write zoom is a preprocessing technique which applies more pixels to the zoomed region of interest which should improve axial resolution.
Write zoom may be a way to improve spatial (axial, lateral) resolution. Write zoom is a preprocessing technique which applies more pixels to the zoomed region of interest which should improve axial resolution.

2. ______ zoom may increase line density which should improve lateral resolution.
Write zoom may increase line density which should improve lateral resolution.

Postprocessing

1.____ functions are applied to stored (frozen) images. (e.g., read zoom, B-color, postprocessing curves, edge enhancement, measurements)
Postprocessing functions are applied to stored (frozen) images (e.g., read zoom, B-color, postprocessing curves, measurements, image archiving, PAC system storage).

2._____ includes read zoom, B-mode color, postprocessing curves measurements.
Postprocessing includes read zoom, B-mode color, postprocessing curves measurements.

Read Zoom

1._____ zoom increases the size of each pixel in the zoomed region which will not improve resolution.
Read zoom increases the size of each pixel in the zoomed region which will not improve resolution.

B-Mode Color

1._____ uses color instead of black and white to improve the detection of subtle variations in echogenicity.
B-mode color uses color instead of black and white (grey scale) to improve the detection of subtle variations in echogenicity.

Postprocessing Curves

1._____ allows the sonographer to fine tune the variations in echo strength as they are converted into grey scale.
Postprocessing curves use color instead of black and white to improve the detection of subtle variations in echogenicity.

Edge Enhancement

1._____ is a filtering technique which sharpens the ultrasound image by identifying and enhancing the interfaces or boundaries between two structures which may result in "crisper" images.
Edge enhancement is a filtering technique which sharpens the ultrasound image by identifying and enhancing the interfaces or boundaries between two structures which may result in "crisper" images.

Measurements

1._____ allows the sonographer to make important measurements such distances (length) and areas.
Measurements allow the sonographer to make important measurements such distances (length) and areas.

B-Mode (Brightness Mode)

1._____ displays returning reflections as bright dots – the brighter the dot – the greater the amplitude of the returning signal.
B-mode (Brightness mode) displays returning reflections as bright dots – the brighter the dot – the greater the amplitude of the returning signal.

M-Mode (Time-Motion Mode)

1.A B-mode operation which displays reflector motion and depth over time is _____.
A B-mode operation which displays reflector motion and depth over time is M-mode.

2.The primary advantage of M-mode is _____ resolution.
The primary advantage of M-mode is temporal resolution.

3.The primary disadvantage of M-mode is _____.
The primary disadvantage of M-mode is that it only provides an "icepick" view of the heart.

Two-Dimensional (2-D)
1.______ provides is a B-mode operation which uses bright dots to demonstrate reflector depth and motion. (width and depth)
Two dimensional (2-D) is a B-mode operation which uses bright dots to demonstrate reflector depth and motion. (width and depth)

Three-Dimensional (3-D) and Four-Dimensional (4-D)
1._____ demonstrates depth (distance) width and length.
Three-dimensional (3-D) demonstrates depth (distance) width and length.

2._____ is three-dimensional imaging in real time.
4-D is three-dimensional imaging in real time (motion).

3._____ is acquired by electronically sweeping (scanning) the ultrasound beam through multiple planes nearly instantaneously.
3-D and 4-D is acquired by electronically sweeping (scanning) the ultrasound beam through multiple planes nearly instantaneously.

Frame Rate
1.The number of frames created per second is _____.
The number of frames created per second frame rate.

2.A _____ is composed of individual scan lines – approximately 100 to 120 scan lines per frame
A frame is composed of individual scan lines – approximately 100 to 120 scan lines per frame.

3.The _____ the frame rate, the better the temporal resolution (important when evaluating moving structures as in echocardiography).
The higher the frame rate, the better the temporal resolution (important when evaluating moving structures as in echocardiography).

4.Decreasing the field of view width, decreasing image depth, decreasing the number of focuses, reducing scan line density, parallel processing, interpolation all will _____ the frame rate which will improve temporal resolution.
Decreasing the field of view width, decreasing image depth, decreasing the number of focuses, parallel processing, interpolation all will increase the frame rate which will improve temporal resolution.

Doppler
1.There will be a change in the frequency of sound relative to the motion of the source and/or observer is the: _____.
There will be a change in the frequency of sound relative to the motion of the source and/or observer is the Doppler principle (Doppler effect).

2.The difference between the transmit frequency and the received frequency is the: _____.
The difference between the transmit frequency and the received frequency is the Doppler shift.

3.2 x Transmit frequency (fo) x Red blood cell velocity x Cosine of the incident angle ÷ speed of sound = _____. (Doppler equation)
2 x Transmit frequency (fo) x Red blood cell velocity x Cosine of the incident angle ÷ speed of sound = Doppler shift. (Doppler equation)

4.The transmitted Doppler frequency minus the Doppler received frequency equals the _____.
The transmitted Doppler frequency minus the Doppler received frequency equals the Doppler shift.

5.The transmitted Doppler shift is 2,000,000 Hertz. The received frequency is from moving red blood cells is 2,001,000 Hertz. The Doppler shift is _____ Hertz.
The transmitted Doppler shift is 2,000,000 Hertz. The received frequency is from moving red blood cells is 2,001,000 Hertz. The Doppler shift is 1000 Hertz (1kHz).

6.The Doppler shift may be ____ indicating blood flow moving towards the transducer.
The Doppler shift may be positive, indicating blood flow moving towards the transducer.

7.The Doppler shift may be _____ indicating blood flow moving away from the transducer.
The Doppler shift may be negative, indicating blood flow moving away from the transducer.

8.For clinical Doppler, the Doppler shift may be heard by the sonographer because the Doppler shift is in the _____.
For clinical Doppler, the Doppler shift may be heard by the sonographer because the Doppler shift is in the _____.

9.For conventional Doppler (PW Doppler, CW Doppler) a positive Doppler shift is placed _____ the zero baseline.
For conventional Doppler (PW Doppler, CW Doppler) a positive Doppler shift is placed above the zero baseline.

10.For conventional Doppler (PW Doppler, CW Doppler) a negative Doppler shift is placed _____ the zero baseline.
By convention, a negative Doppler shift is placed below the zero baseline.

11.For color flow Doppler, a positive Doppler shift is encoded with the color _____.
For color flow Doppler, a positive Doppler shift is encoded with the color _____. (BART – Blue Away, Red Towards)

12.For color flow Doppler, a negative Doppler shift is encoded with the color _____.
For color flow Doppler, a negative Doppler shift is encoded with the color blue. (BART – Blue Away, Red Towards)

13.The cosine of 0 degrees (parallel to blood flow) is _____.
The cosine of 0 degrees (parallel to blood flow is 1.

14.The cosine of 20 degrees is _____ which will result in a 6% error in determining the peak velocity of blood flow.
The cosine of 20 degrees is 0.94 which will result in a 6% error in determining the peak velocity of blood flow.

15.The cosine of 60 degrees is _____ which will result in a 50% error in determining the peak velocity of blood flow.
The cosine of 60 degrees is 0.5 which will result in a 50% error in determining the peak velocity of blood flow.

16.The cosine of 90 degrees is _____ which will result in a 100% error in determining the peak velocity of blood flow.
The cosine of 90 degrees is 0 which will result in a 100% error in determining the peak velocity of blood flow.

17.According to the Doppler equation, an increase in red blood cell velocity will result in an _____ in the magnitude of the Doppler shift.
According to the Doppler equation, an increase in red blood cell velocity will result in an increase in the magnitude of the Doppler shift.

18.According to the Doppler equation, a decrease in red blood cell velocity will result in an _____ in the magnitude of the Doppler shift.
According to the Doppler equation, an increase in red blood cell velocity will result in a decrease in the magnitude of the Doppler shift.

19.According to the Doppler equation, an increase in transmit frequency will result in an _____ in the magnitude of the Doppler shift.
According to the Doppler equation, an increase in transmit frequency will result in an increase in the magnitude of the Doppler shift.

20.According to the Doppler equation, a decrease in transmit frequency will result in an _____ in the magnitude of the Doppler shift.
According to the Doppler equation, a decrease in transmit frequency will result in a decrease in the magnitude of the Doppler shift.

21.According to the Doppler equation, as the incident angle increases (e.g., 0 degrees (parallel to blood flow) towards 90 degrees (perpendicular to blood flow), the magnitude of the Doppler shift will _____
According to the Doppler equation, as the incident angle increases (e.g., 0 degrees (parallel to blood flow) towards 90 degrees (perpendicular to blood flow), the magnitude of the Doppler shift will decrease.

22.The optimal Doppler incident angle to use to maximize blood flow peak velocity is _____ degrees because the cosine is 1.
The optimal Doppler incident angle to use to maximize blood flow peak velocity is 0 degrees because the cosine of 0 degrees is 1 (parallel to blood flow).

23.A Doppler incident angle of _____degrees will result in a Doppler shift of 0.
A Doppler incident angle of 90 degrees will result in a Doppler shift of 0.

24._____ is the rapid method of spectral analysis used to display returning Doppler shift signals (PW, CW, High PRF).
Fast Fourier transform (FFT) is the rapid method used to display returning Doppler shift signals (PW, CW, High PRF).

25.Increase in the width of the Doppler spectral waveform which will result in window fill-in is _____.
Increase in the width of the Doppler spectral waveform which will result in window fill-in is spectral broadening.

26.Spectral broadening may indicate _____ blood flow.
Spectral broadening may indicate turbulent (disturbed) blood flow.

27.Pulse repetition frequency (PRF) ÷ 2 = _____.
Pulse repetition frequency (PRF) ÷ 2 = the Nyquist limit.

28.If the magnitude of the Doppler shift exceeds the Nyquist limit, _____ will occur.
If the magnitude of the Doppler shift exceeds the Nyquist limit, aliasing will occur.

29. Apparent flow reversal is _____. (wrap around).
Apparent flow reversal is aliasing. (wrap around).

30._____ Doppler requires one element, uses a sample volume (sample gate) to determine blood flow direction, velocity and character of blood flow (e.g.; laminar (normal) flow, turbulent flow).
Pulsed-wave (PW) Doppler requires one element, uses a sample volume (sample gate) to determine blood flow direction, blood flow velocity and character of blood flow (e.g.; laminar (normal) flow, turbulent flow).

31.The primary advantage of PW Doppler is _____ resolution.
The primary advantage of PW Doppler is range resolution (range discrimination).

32.The primary disadvantage of PW Doppler is: _____.
The primary disadvantage of PW Doppler is aliasing.

33.To avoid aliasing, _____ the Doppler velocity scale which increases the pulse repetition frequency (PRF).
To avoid aliasing, increase the Doppler velocity which increases the pulse repetition frequency (PRF).

34.To avoid aliasing, _____ the image depth which will increase the pulse repetition frequency (PRF).
To avoid aliasing, decrease the image depth which will increase the pulse repetition frequency (PRF).

35.To avoid aliasing, _____ the transmit frequency which will reduce the magnitude of the Doppler shift.
To avoid aliasing, decrease the transmit frequency which will reduce the magnitude of the Doppler shift.

36.To avoid aliasing, _____ the Doppler zero baseline.
To avoid aliasing, shift the Doppler zero baseline.

37.To avoid aliasing, ____ the Doppler incident angle (0 degrees towards 90 degrees) (generally not useful in clinical imaging).
To avoid aliasing, increase the Doppler incident angle (0 degrees towards 90 degrees) (generally not useful in clinical imaging).

38.____ demonstrates the direction and velocity of the heart walls.
Tissue Doppler imaging (TDI) demonstrates the direction and velocity of the heart walls.

39._____ may be used to acquire cardiac strain imaging.
Tissue Doppler imaging may be used to acquire cardiac strain imaging.

40.______ uses a low-pass filter which eliminates low amplitude, high Doppler frequency shifts (high velocity).
Tissue Doppler imaging uses a low-pass filter which eliminates low amplitude, high Doppler frequency shifts (high velocity).

41._____ Doppler uses two elements (one to transmit, one to receive).
Continuous-wave (CW) Doppler uses two elements (one to transmit, one to receive).

42.The primary advantage of CW Doppler is _____ because there is no inherent sampling rate which allows high peak velocities to be resolved.
The primary advantage of CW Doppler is that there is no aliasing because there is no inherent sampling rate which allows high peak velocities to be resolved.

43.The primary disadvantage of CW Doppler is _____.
The primary disadvantage of CW Doppler is range ambiguity (lack of range resolution).

44.A _____ filter eliminates high amplitude (e.g., wall motion, valve motion), low velocity blood flow.
A high pass wall filter eliminates high amplitude (e.g., wall motion, valve motion), low velocity blood flow.

Color Flow Doppler
1.Color flow Doppler is a _____ Doppler technique.
Color flow Doppler is a PW Doppler technique.

2.Because color flow Doppler is a PW Doppler technique, _____ (apparent flow reversal) will occur.
Because color flow Doppler is a PW Doppler technique, aliasing (apparent flow reversal) will occur.

3.Color flow Doppler is _____ gate.
Color flow Doppler is multigate (hundreds of sample gates along each line of color flow Doppler).

4.Color flow Doppler depicts the ___ velocity.
Color flow Doppler depicts the mean velocity.

5._____ is the rapid technique which is used by color flow Doppler to convert Doppler shift information into color.
Autocorrelation is the rapid technique which is used by color flow Doppler to convert Doppler shift information into color.

6. Color flow Doppler uses _____ to convert Doppler shift information into color, conventional Doppler (PW, CW, High PRF) uses autocorrelation to convert Doppler information into direction and velocity information.
Color flow Doppler uses autocorrelation to convert Doppler shift information into color, conventional Doppler (PW, CW, High PRF) uses Fast Fourier Transform (FFT) to convert Doppler information into direction and velocity information.

7._____ is the number of pulses sent down one scan line of color to detect Doppler shift information.
Packet size (dwell time) is the number of pulses sent down one scan line of color to detect Doppler shift information.

8.For packet size, a minimum of _____ pulses must be used per color flow Doppler scan line because autocorrelation is an averaging technique.
For packet size, a minimum of three pulses must be used per color flow Doppler scan line because autocorrelation is an averaging technique.

9.Increasing the packet _____ the estimation of the mean velocity but _____ frame rate.
Increasing the packet size improves the estimation of the mean velocity but decreases the frame rate.

10.The color flow Doppler _____ map depicts only the direction of blood flow.
The color flow Doppler directional map depicts only the direction of blood flow.

11.The color flow Doppler _____ map uses shades of red and blue, provides the direction of blood flow, mean velocity of blood flow and the character of blood flow (e.g., laminar flow, disturbed flow, turbulent flow).
The color flow Doppler enhanced (hue) map uses shades of red and blue, provides the direction of blood flow, mean velocity of blood flow and the character of blood flow (e.g., laminar flow, disturbed flow, turbulent flow).

12.The color flow Doppler called a _____ map uses the color green folded onto an enhanced map to demonstrate turbulent flow.
The color flow Doppler map called a variance map uses the color green folded onto an enhanced map to demonstrate turbulent flow.

13.The ____ color flow Doppler map depicts only the strength (amplitude) of the returning signals and does not demonstrate the direction, mean velocity or character of blood flow.
The power color flow Doppler map depicts only the strength (amplitude) of the returning signals and does not demonstrate the direction, mean velocity or character of blood flow.

14.Color flow Doppler has _____ frame rates as compared to two-dimensional imaging because of the requirement of a minimum of at least three pulses be sent down one scan line to create one scan line of color.
Color flow Doppler has lower frame rates as compared to two-dimensional imaging because of the requirement of a minimum of at least three pulses be sent down one scan line to create one scan line of color.

15.To improve the color flow Doppler frame rate, reduce the _____.
To improve the color flow Doppler frame rate, reduce the field of view.

16.To improve the color flow Doppler frame rate, reduce the _____.
To improve the color flow Doppler frame rate, reduce the image depth.

17.To improve the color flow Doppler frame rate, reduce the _____.
To improve the color flow Doppler frame rate, reduce the packet size.

18.Color flow Doppler ____ affects the amount of color flow Doppler displayed (“dial a jet”).
Color flow Doppler _____ affects the amount of color flow Doppler displayed (“dial a jet”).

19.To set the correct color flow Doppler gain, increase the color flow Doppler gain until ____ is seen and then reduce the color gain until ____ is eliminated.
To set the correct color flow Doppler gain, increase the color flow Doppler gain until speckling is seen and then reduce the color gain until speckling is eliminated.

20.The color flow Doppler _____ affects the amount of color flow Doppler displayed by altering the pulse repetition frequency.
The color flow Doppler velocity scale affects the amount of color flow Doppler displayed by altering the pulse repetition frequency.

21.Reducing the color flow Doppler velocity scale will _____ the amount of color flow displayed.
Reducing the color flow Doppler velocity scale will increase the amount of color flow displayed.

22.Increasing the color flow Doppler velocity scale will _____ the amount of color flow Doppler displayed.
Increasing the color flow Doppler velocity scale will decrease the amount of color flow Doppler displayed.

23.For adult echocardiography, the color flow Doppler velocity scale should be set between _____ to _____ cm/sec.
For adult echocardiography, the color flow Doppler velocity scale should be set between 50 to 70 cm/sec.

24.When evaluating lower velocity flow, (e.g., pulmonary veins, hepatic veins, patent foramen ovale, atrial septal defect) _____ the color flow Doppler velocity scale.
When evaluating lower velocity flow, (e.g., pulmonary veins, hepatic veins, patent foramen ovale, atrial septal defect) decrease the color flow Doppler velocity scale.

Ultrasound Artifacts

1.The inability to resolve two structures parallel to the sound beam path is called the ____ resolution artifact.

The inability to resolve two structures parallel to the sound beam path is called the axial resolution artifact.

2.The inability to resolve two structures perpendicular to the direction of sound travel is called the _____ resolution artifact.

The inability to resolve two structures perpendicular to the direction of sound travel is called the lateral resolution artifact.

3. _____ artifact makes a narrow reflector appear wider than the reflector actually is (e.g., point-spreading).

Beam width artifact makes a narrow reflector appear wider than the reflector actually is (e.g., point-spreading).

4._____ is apparent tissue texture caused by scatter reflectors combining constructively or destructively which may result in an inaccurate presentation of organ parenchyma (e.g., liver, kidney, spleen, thyroid).

Acoustic speckle is apparent tissue texture caused by scatter reflectors combining constructively or destructively which may result in an inaccurate presentation of organ parenchyma (e.g., liver, kidney, spleen, thyroid).

5._____ are multiple echoes, equally spaced usually located close to the transducer.

Reverberations are multiple echoes, equally spaced usually located close to the transducer.

6._____ is a type of reverberation artifact usually associated with a highly reflective structure such as a bullet, prosthetic heart valve.

Comet tail is a type of reverberation artifact usually associated with a highly reflective structure such as a bullet, prosthetic heart valve.

7._____ is a type of reverberation artifact most commonly associated with a gas bubble.

Ring down is a type of reverberation artifact most commonly associated with a gas bubble.

8._____ artifact is a type of reverberation artifact which results in the duplication of a strong reflector.

Mirror image artifact is a type of reverberation artifact which results in the duplication of a strong reflector.

9.______ is a type of reverberation artifact involving two structures. The primary sound beam reflects off anatomy at an angle with a portion of that sound energy returning to the transducer – another portion of the sound energy strikes a second structure before returning to the transducer. The second reflection will be placed deeper than where the true reflector is located.

Multipath is a type of reverberation artifact involving two structures. The primary sound beam reflects off anatomy at an angle with a portion of that sound energy returning to the transducer – another portion of the sound energy strikes a second structure before returning to the transducer. The second reflection will be placed deeper than where the true reflector is located.

10._____ is described as low amplitude echoes located behind a highly reflective structure (prosthetic heart valve, calcified plaque, calcified mitral valve annulus).
Shadowing is described as low amplitude echoes located behind a highly reflective structure (prosthetic heart valve, calcified plaque, calcified mitral valve annulus).

11._____ results from a decrease in reflected echoes due to refraction at rounded boundaries (e.g., reduction in the amplitude of echoes of the antero-lateral wall of the left ventricle and the infero-septal wall in the parasternal short axis of the left ventricle).
Edge shadowing results from a decrease in reflected echoes due to refraction at rounded boundaries (e.g., reduction in the amplitude of echoes of the antero-lateral wall of the left ventricle and the infero-septal wall in the parasternal short axis of the left ventricle).

12.______ (change in sound direction as sound crosses a boundary) may result in lateral displacement (duplication) of structures (e.g., two left ventricles in the subcostal short axis of the left ventricle).
Refraction (change in sound direction as sound crosses a boundary) may result in lateral displacement (duplication) of structures (e.g., two left ventricles in the subcostal short axis of the left ventricle).

13._____ is the increase in the amplitude of reflections from structures located behind a low amplitude reflecting structure (e.g., fluid fill cyst).
Enhancement is the increase in the amplitude of reflections from structures located behind a low amplitude reflecting structure (e.g., fluid fill cyst).

14._____ are extraneous sound beams originating from the primary sound beam – most often associated with array type transducers.
Grating lobes are extraneous sound beams originating from the primary sound beam – most often associated with array type transducers.

15. _____ and _____ reduces grating lobes.
Apodization (performed by the beam former) and sub-dicing reduces grating lobes.

16._____ occurs when the medium sound is traveling in is not 1540 m/sec.
Propagation speed error occurs when the medium sound is traveling in is not 1540 m/sec.

17. The speed of sound is less than 1540 m/sec. The reflector will be placed _____ to the transducer.
The speed of sound is less than 1540 m/sec. The reflector will be placed too far from the transducer.

18. The speed of sound is greater than 1540 msec. The reflector will be placed _____ from the transducer.
The speed of sound is greater than 1540 msec. The reflector will be placed too close to the transducer.

19.______ results from receiving echoes from a previously transmitted pulse. Only one pulse can travel in the body at one time. If a pulse is transmitted before the echoes from the previous pulse are received, those echoes from the previous pulse will be placed too close to the transducer. Pulse repetition frequency may be automatically reduced to avoid the range ambiguity artifact.
Range ambiguity results from receiving echoes from a previously transmitted pulse. Only one pulse can travel in the body at one time. If a pulse is transmitted before the echoes from the previous pulse are received, those echoes from the previous pulse will be placed too close to the transducer. Pulse repetition frequency may be automatically reduced to avoid the range ambiguity artifact.

20.______ occurs with PW Doppler and color flow Doppler (described with color flow Doppler on as apparent flow reversal) when the Doppler exceeds the Nyquist limit.
Aliasing occurs with PW Doppler and color flow Doppler (described with color flow Doppler on as apparent flow reversal) when the Doppler exceeds the Nyquist limit.

21._____ is the placement of Doppler spectral information (e.g., PW Doppler, CW Doppler) on both sides of the zero baseline due to high Doppler gains or a Doppler incident angle close to 0 degrees.
Spectral mirroring is the placement of Doppler spectral information (e.g., PW Doppler, CW Doppler) on both sides of the zero baseline due to high Doppler gains or a Doppler incident angle close to 0 degrees.

22.Doppler _____ is the application of color on moving tissue. The color black with color flow Doppler on may indicate an inappropriate Doppler incident angle (e.g., 90-degree incident angle) or a change in the direction of blood flow.
Doppler flash artifact is the application of color on moving tissue. The color black with color flow Doppler on may indicate an inappropriate Doppler incident angle (e.g., 90-degree incident angle) or a change in the direction of blood flow.

23.The color ____ with color flow Doppler on may indicate an inappropriate Doppler incident angle (e.g., 90-degree incident angle) or a change in the direction of blood flow.
The color black with color flow Doppler on may indicate an inappropriate Doppler incident angle (e.g., 90-degree incident angle) or a change in the direction of blood flow.

Quality Assurance
1.There are three components to quality assurance: 1. _____, 2. _____, 3. _____.
There are three components to quality assurance: 1. Routine preventative maintenance, 2. Routine performance tests, 3. Acceptance testing.

2.Preventative maintenance should be performed: _____.
Preventative maintenance should be performed on a routine scheduled basis.

3.Checking the transducer cables for damage, cracks, separations, discolorations is a _____ responsibility.
Checking the transducer cables for damage, cracks, separations, discolorations is a _____ responsibility.

4.Visually checking for vertical shadows and streaks caused by dead elements of a transducer is a ____ responsibility.
Visually checking for vertical shadows and streaks caused by dead elements of a transducer is a sonographer’s responsibility.

5.Cleaning the gel from the transducer and ultrasound machine is a _____ responsibility.
Cleaning gel from the transducer and ultrasound machine is a sonographer’s responsibility.

6.Cleaning and checking the display monitor for damage-cracks is a _____ responsibility.
Cleaning and checking the display monitor for damage-cracks is a sonographer’s responsibility.

7.Checking for damage to power cords or PACS connections is a _____ responsibility.
Checking for damage to power cords or PACS connections is a sonographer’s responsibility.

8.Identifying and reporting improper operations of switches or knobs is a _____ responsibility.
Identifying and reporting improper operations of switches or knobs is a sonographer's responsibility.

9.Cleaning exam rooms for dust, dirt and infection control is a _____ responsibility.
Cleaning exam rooms for dust, dirt and infection control is a sonographer's responsibility.

10.Cleaning dust from console air filters is a _____ responsibility.
Cleaning dust from console air filters is a sonographer's responsibility.

11.Checking the ultrasound machine for dents and other damage is a _____ responsibility.
Checking the ultrasound machine for dents and other damage is a sonographer's responsibility.

12.Thoroughly cleaning the ultrasound machine console and other equipment in the scan room is a _____ responsibility.
Thoroughly cleaning the ultrasound machine console and other equipment in the scan room is a sonographer's responsibility.

Bioeffects

1.The three primary mechanisms for bioeffects to occur are: 1. _____, 2. _____, 3. _____.
The three primary mechanisms for bioeffects are 1. Thermal (heat), 2. Cavitation (stable, transient), 3. Direct mechanical.

2._____ is the best way to reduce the risk of bioeffects.
Reducing the scan time is the best way to reduce the risk of bioeffects.

3.Unscanned imaging modes such as _____ in general have the highest intensity values.
Unscanned imaging modes such as Doppler (PW, CW) and M-mode, in general, have the highest intensity values.

4.Expansion and contraction of a gas bubble is _____ cavitation.
Expansion and contraction of a gas bubble is stable cavitation.

5.Implosion of a gas bubble is _____ cavitation.
Implosion of a gas bubble is transient cavitation.

6.The mechanical index (MI) (predicts the risk of cavitation) which is required to be displayed on the image display screen while scanning is determined primarily by the instrument control called: _____.
The mechanical index (MI) (predicts the risk of cavitation) which is required to be displayed on the image display screen while scanning is determined primarily by the instrument control called transmit gain.

7.Mechanical index (MI) values below _____ are preferred.
Mechanical index (MI) values below 0.7 are preferred.

8.It is recommended that the mechanical index (MI) be set at ___ for transpulmonary contrast examinations.
It is recommended that the mechanical index (MI) be set at 0.3 for transpulmonary contrast examinations.

9._____ provides the theoretical increase in temperature while scanning and is displayed on the image display screen.
Thermal index (TI) provides the theoretical increase in temperature while scanning and is displayed on the image display screen while scanning.

10.The three types of Thermal Index (TI) are: 1. _____, 2. _____, 3. _____.
The three types of Thermal Index (TI) are 1. Thermal Index Soft tissue (TIS), 2. Thermal Index Bone (TIB), 3. Thermal Index Cranial (TIC).

11.A Thermal Index (TI) of _____ indicates that given certain conditions, the temperature of tissue may be increased by 1 degree Centigrade.
A Thermal Index (TI) of 1.0 indicates that given certain conditions, the temperature of tissue may be increased by 1 degree Centigrade.

12.The Thermal Index (TI) may be reduced by decreasing the time use of _____ modes of spectral Doppler and M-mode and reducing transmit gain.
The Thermal Index (TI) may be reduced by decreasing the time use of unscanned modes of spectral Doppler and M-mode and reducing transmit gain.

13.The exposure level to medical ultrasound is guided by the ___ principle - use diagnostic medical ultrasound for a valid reason, use low transmit gain and more receiver gain, use Doppler efficiently, minimize exam time and minimize repeat exams.
The exposure level to medical ultrasound is guided by the ALARA (As Low As Reasonably Achievable) principle – use diagnostic medical ultrasound for a valid reason, use low transmit gain and more receiver gain, use Doppler efficiently, minimize exam time and minimize repeat exams.

14.The danger associated with using a cracked ultrasound transducer is: _____.
The danger associated with using a cracked ultrasound transducer is electrical shock.

Virtual Beam Sonography (Synthetic aperture ultrasound; Synthetic aperture method)

The principles of virtual sonography are new and proprietary. A multi-array transducer is in use and a small number of elements are used to transmit an unfocused or weakly focused ultrasound pulse and all the transducer array elements receive the returning signals. This transmit-reception is repeated several times (but not as often as conventional sonography's pulse repetition frequency (PRF)). Hundreds of pulses similar to conventional sonography are not required because the unfocused or weakly focused sound beam will fan out to cover the structures needed to be interrogated (similar to radar). The location of the low-resolution reflections returning back to the transducer can be determined by the geometric distance from the transmitting element to the imaging point and the propagation speed of the sound in soft tissue. This is done for every point being imaged and by combining the low-resolution images, full dynamic focusing can be performed for each point (pixel) in the image. Since all points (pixels) will be dynamically (individually) focused means that the highest possible resolution will be achieved for each pixel. Each pixel is synthetically focused. This requires significant computer processing which can be achieved by current graphics processing units (GPU – Sony's reference to the Play-Station console) using parallel processing techniques which can perform 500 billion calculations per second.

Lateral resolution is improved markedly because there is no longer a dependence on the physical characteristics of the transmitted sound beam (physical beam) – near field-focus-focal region-far field. Instead, a virtual sound beam is created which has the characteristics of a narrow, thin, uniform laser beam. The dependence on transmit focus is eliminated which means the image is uniform throughout the display and frame rates can be increased because there is no need for multiple focuses. Contrast resolution is improved because clutter, reverberation, side lobes, grating lobes, noise, haze are no longer a factor. Elevational resolution is improved because the slice thickness (partial-volume artifact) is diminished because the virtual sound beam is used instead of the "thick" transmitted sound beam. Temporal resolution is improved because frame rates are no longer tied to the number of pulses-scan lines produced. Depth of penetration is better because the amplitude in each pixel is maximized. Sensitivity (the ability to detect weak amplitude signals) is improved for the same reason the depth of penetration is improved. Virtual sonography allows for simultaneous triplex Doppler (B-mode imaging + PW/CW Doppler imaging + Color flow Doppler) sonography which improves the real-time presentation of information. Real-time color flow Doppler vector velocity imaging which shows the blood flow direction (arrow direction) and velocity (length of arrow) with arrows is made possible. Retrospective PW Doppler sampling is available with the possibility of sampling multiple sites simultaneously. The color flow Doppler frame rate is increased into the hundreds versus conventional sonography's much lower color flow Doppler frame rates. Flash artifact is eliminated.

The primary point to begin to understand the differences between conventional sonography and virtual beam sonography is that with conventional sonographer the sound beam is "real". The sound beam transmitted in conventional sonography has certain real – physical characteristics (near filed-focus-focal point-focal region-far zone) which implies several inherent challenges. In virtual beam sonographer, there is no real-physical ultrasound beam being transmitted – it is created retrospectively – with powerful processing creating a scan line without the challenges the physical sound beam presents. Simply stated: Conventional sonography uses a "physical" sound beam – Virtual beam sonography uses a created sound beam.