**Chapter 3: Physics**

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|  | Question | Answer | Chapter | Difficult |
|  | 3.1 Ultrasound Waves |  |  |  |
|  | Sound can travel through a vacuum without any medium. | F | 3.1 |  |
|  | Sound waves need the presence of particles to be transmitted. | T | 3.1 | / |
|  | Sound waves consist of areas of compression and rarefaction. | T | 3.1 |  |
|  | Sound waves are longitudinal mechanical waves. | T | 3.1 | / |
|  | Sound waves are electromagnetic waves. | F | 3.1 | / |
|  | The amplitude of a sound wave indicates its strength. | T | 3.1 |  |
|  | 3.2 Ultrasound Waves Formula |  |  |  |
|  | The propagation velocity of sound waves in the heart is approximately 1540 m/s. | T | 3.2 |  |
|  | The wavelength of sound waves is inversely related to frequency. | T | 3.2 |  |
|  | A frequency of 5 kHz would result in a wavelength of approximately 0.308 m. | T | 3.2 | / |
|  | Using higher frequencies always improves penetration in ultrasound imaging. | F | 3.2 |  |
|  | Paediatric echo typically uses lower frequencies than adult echo. | F | 3.2 | / |
|  | The sonographer can alter the propagation velocity of sound waves. | F | 3.2 | / |
|  | Shorter wavelengths provide better spatial resolution in echocardiography. | T | 3.2 | / |
|  | A sound wave with 100 oscillations per second has a frequency of 200 Hz. | F | 3.2 |  |
|  | The frequency range for audible sound is 20 Hz to 20,000 Hz. | T | 3.2 | / |
|  | Wavelength is measured in units such as metres or millimetres. | T | 3.2 |  |
|  | The frequency of a sound wave is measured in decibels. | F | 3.2 |  |
|  | Ultrasound used for echocardiography usually lies in the frequency range of 1.5–7 MHz. | T | 3.2 | / |
|  | The unit of frequency is measured in Hertz (Hz). | T | 3.2 |  |
|  | Attenuation is greater at higher frequencies of ultrasound. | T | 3.2 | / |
|  | 3.3 Ultrasound Transducer |  |  |  |
|  | The piezoelectric crystals can help to focus the ultrasound beam. | F | 3.3 | / |
|  | The piezoelectric effect allows crystals to generate ultrasound when an electrical voltage is applied. | T | 3.3 |  |
|  | The backing layer in an ultrasound transducer is used to enhance the signal. | F | 3.3 | / |
|  | The backing layer in an ultrasound transducer is made of a material with low impedance. | F | 3.3 | / |
|  | 3.4 Ultrasound Beam |  |  |  |
|  | Imaging quality is best in the far field of the ultrasound beam. | F | 3.4 |  |
|  | Higher transducer frequencies result in a greater length of the near field. | T | 3.4 | / |
|  | Focusing the ultrasound beam increases the length of the near field. | F | 3.4 | / |
|  | The near field is also known as the Fraunhofer zone. | F | 3.4 |  |
|  | The near field is also known as Fresnel zone | T | 3.4 |  |
|  | The length of the near field is independent of the transducer diameter. | F | 3.4 | / |
|  | The near field is where the ultrasound beam diverges. | F | 3.4 | / |
|  | 3.5 Harmonic Imaging |  |  |  |
|  | Second harmonic imaging uses the fundamental frequency of the transmitted signal to build up an image. | F | 3.5 | / |
|  | Harmonic imaging uses the non-linear properties of tissue to create sharper, clearer ultrasound images | T | 3.5 | / |
|  | Second harmonic imaging improves image resolution for far-field structures. | T | 3.5 | / |
|  | Second harmonic imaging requires a higher power output compared to fundamental imaging. | T | 3.5 | / |
|  | 3.6 Axial Resolution |  |  |  |
|  | Axial resolution is primarily determined by transducer frequency and pulse length. | T | 3.6 | / |
|  | Higher frequency transducers result in worse axial resolution. | F | 3.6 | / |
|  | Shorter pulse lengths improve axial resolution. | T | 3.6 | / |
|  | Axial resolution is typically around 1 mm. | T | 3.6 |  |
|  | Axial resolution is typically around 3 mm. | F | 3.6 |  |
|  | 3.7 Lateral Resolution |  |  |  |
|  | Lateral resolution is also known as azimuthal resolution. | T | 3.7 |  |
|  | Lateral resolution is typically around 1 mm. | F | 3.7 |  |
|  | Lateral resolution is typically around 3 mm. | T | 3.7 |  |
|  | The gain settings can affect the quality of lateral resolution. | T | 3.7 | / |
|  | Increasing the gain setting always improves image resolution. | F | 3.7 | / |
|  | Higher gain settings can worsen lateral resolution. | T | 3.7 |  |
|  | The width of the ultrasound beam does not affect lateral resolution. | F | 3.7 | / |
|  | Axial resolution relates to objects that lie side by side, perpendicular to the ultrasound beam. | F | 3.7 | / |
|  | 3.8 Temporal Resolution |  |  |  |
|  | M-mode has a better temporal resolution than B-mode | T | 3.8 |  |
|  | M-mode allows a lower frame rate and thus, better temporal resolution than B-mode ultrasound. | F | 3.8 | / |
|  | The pulse repetition frequency in M-mode imaging can reach around 1800 times per second. | T | 3.8 | / |
|  | Reducing the sector width can increase the frame rate in 2D imaging. | T | 3.8 | / |
|  | The depth setting affects the frame rate of the ultrasound imaging. | T | 3.8 | / |
|  | A higher depth setting will increase the frame rate. | F | 3.8 |  |
|  | Temporal resolution is important for distinguishing events that occur close together in time. | T | 3.8 | / |
|  | Temporal resolution is unrelated to the sector width and depth in ultrasound imaging. | F | 3.8 |  |
|  | The depth of the image does not affect the time taken to generate an image frame in 2D imaging. | F | 3.8 |  |
|  | 3.9 Acoustic Shadowing |  |  |  |
|  | Acoustic shadowing occurs when ultrasound can penetrate highly echo-reflective structures. | F | 3.9 | / |
|  | Echo dropout can occur due to acoustic shadowing from structures like mechanical valve prostheses. | T | 3.9 |  |
|  | 3.10 Reverberation |  |  |  |
|  | Reverberation leads to “ghost image” occurring in near field | F | 3.10 |  |
|  | Reverberation artefacts move in tandem with the structure that caused the reverberation | T | 3.10 | / |
|  | 3.11 Beam Width Artefact |  |  |  |
|  | Beam width artifact in echocardiography occurs when the ultrasound beam is too narrow for the target structure. | F | 3.11 | / |
|  | Optimizing the focus at the level of the target structure can help improve lateral resolution in echocardiography. | T | 3.11 | / |
|  | Beam width artifacts can enhance the assessment of small structures like heart valves. | F | 3.11 |  |
|  | 3.12 Side Lobe Artefact |  |  |  |
|  | Side lobe artefacts are caused by secondary sound waves reflecting off adjacent structures. | T | 3.12 |  |
|  | Tissue harmonic imaging can help minimize side lobe artefacts. | T | 3.12 | / |
|  | Turning down the gain can potentially get rid of side lobe artefacts | T | 3.12 | / |