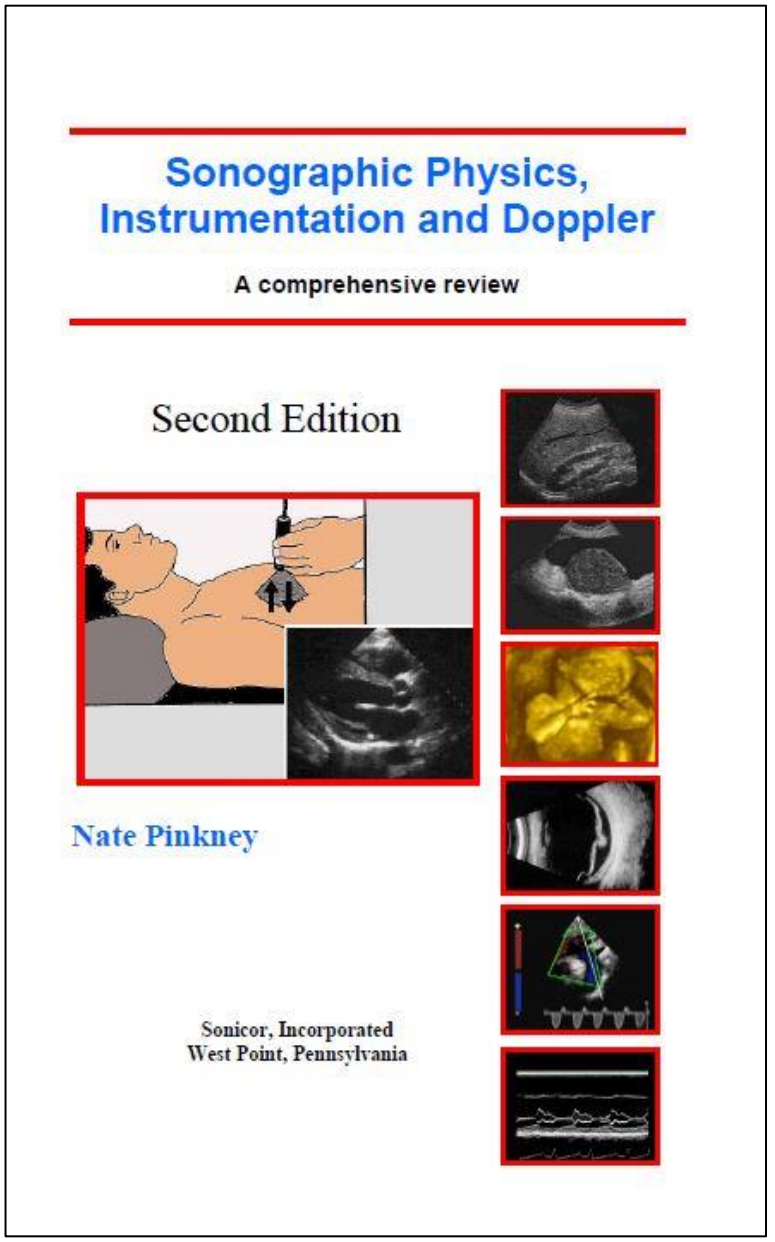
Lesson 04:

Resolution and Attenuation

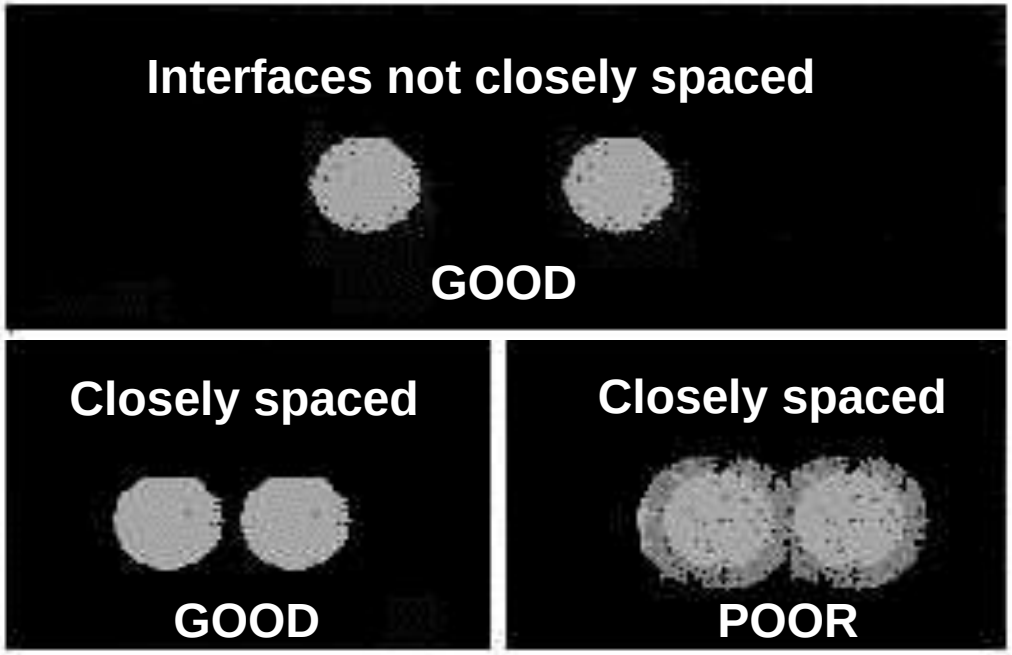
This lesson contains 16 slides plus 18 multiple-choice questions.

Accompanying text for the slides in this lesson can be found on pages 15 through 21 in the textbook:

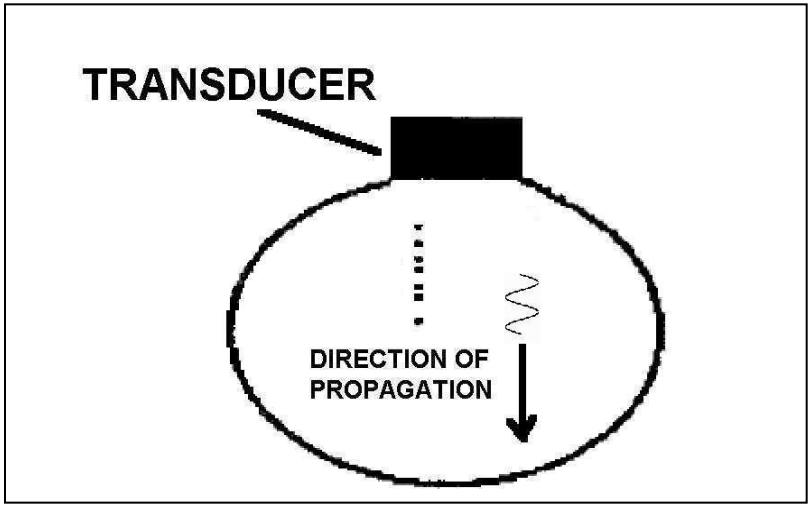


Resolution and Attenuation

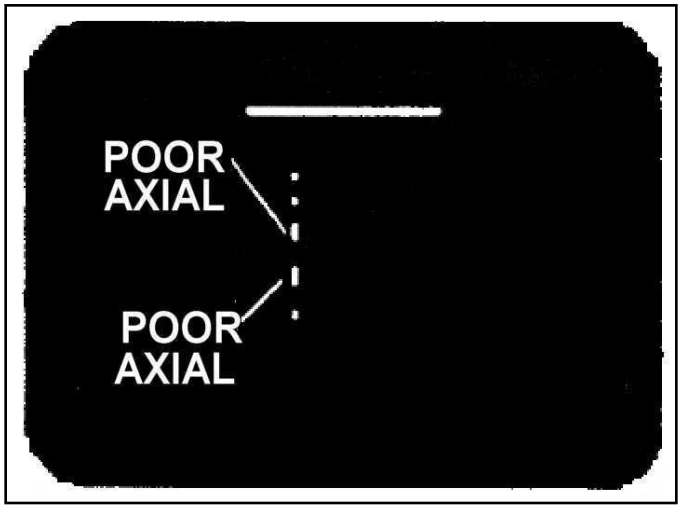
RESOLUTION


Interfaces not closely spaced
GOOD
Closely spaced
GOOD
Closely spaced
POOR

AXIAL RESOLUTION

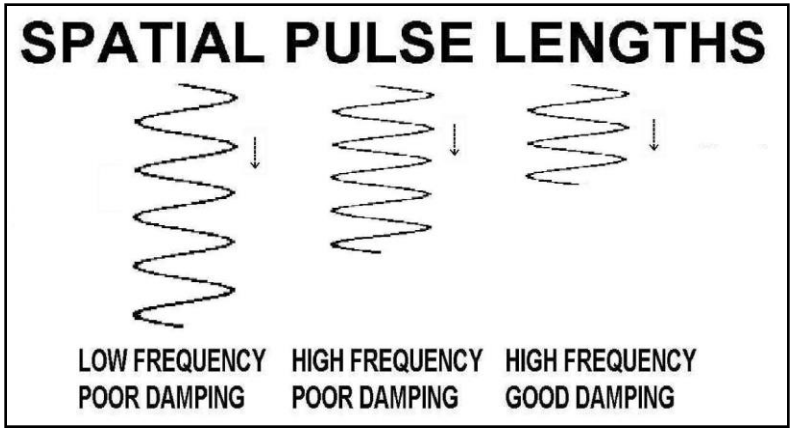


SCANNED STRUCTURE



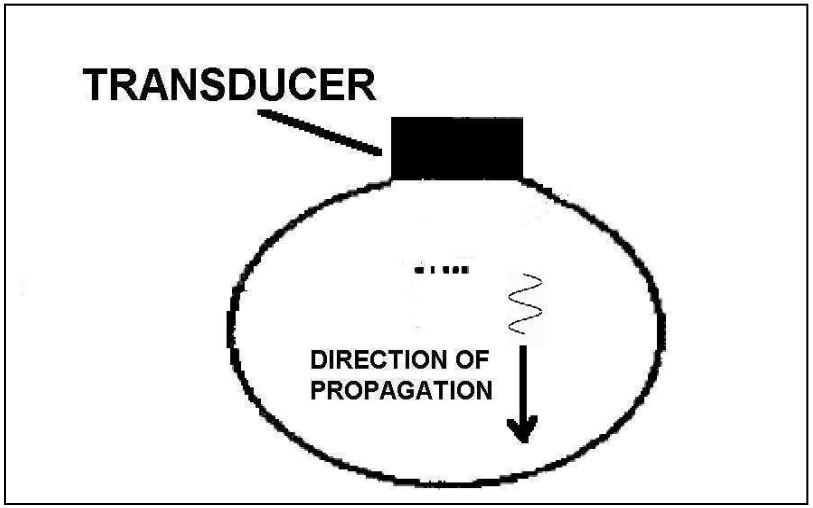
DISPLAYED IMAGE

AXIAL RESOLUTION

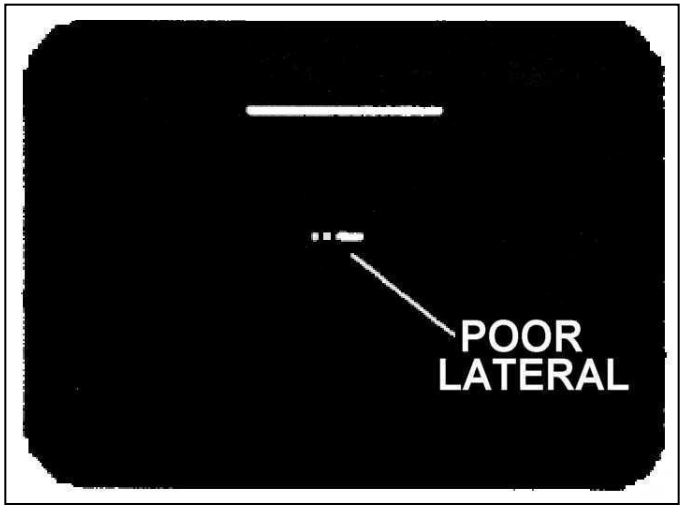


SPATIAL PULSE LENGTH	AXIAL RESOLUTION
4 mm	2 mm
3 mm	1.5 mm
2 mm	1 mm

LATERAL RESOLUTION



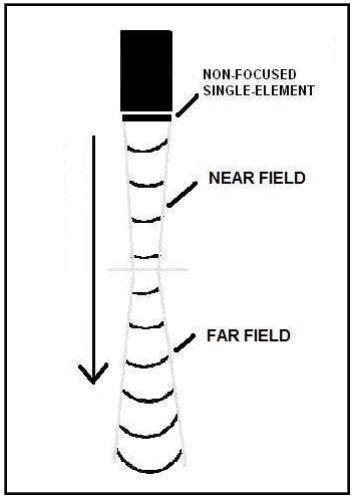
SCANNED STRUCTURE



DISPLAYED IMAGE

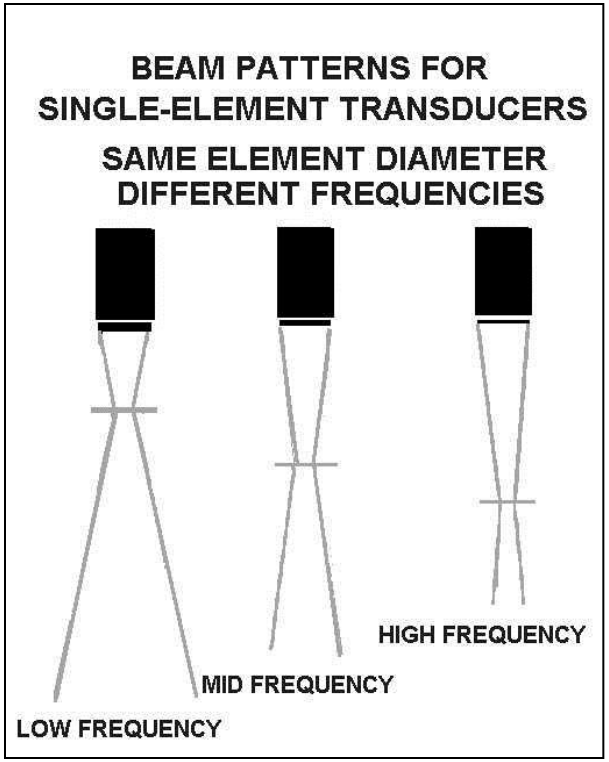
LATERAL RESOLUTION

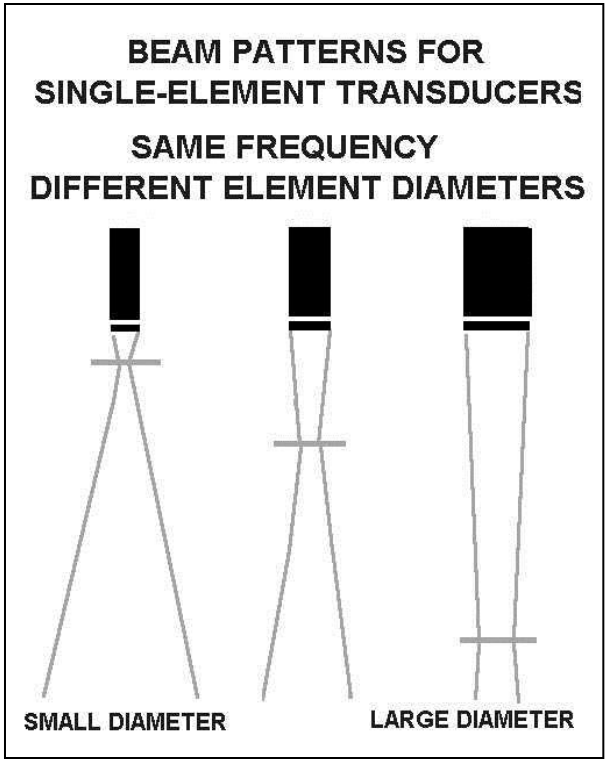
BEAM-WIDTH



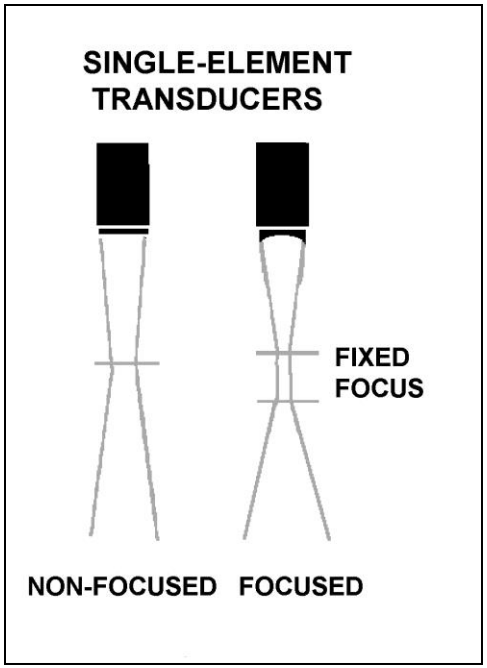
BEAM-WIDTH	LATERAL RESOLUTION
4 mm	4 mm
3 mm	3 mm
2 mm	2 mm

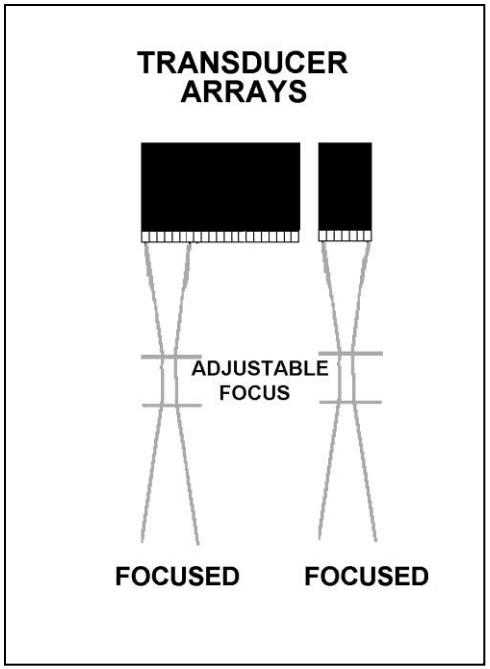
LATERAL RESOLUTION





LATERAL RESOLUTION





RESOLUTION vs. PENETRATION

HIGH-FREQUENCY TRANSDUCERS

BETTER RESOLUTION

GREATER ATTENUATION

POORER PENETRATION

LOW-FREQUENCY TRANSDUCERS

POORER RESOLUTION

LESS ATTENUATION

BETTER PENETRATION

ATTENUATION COEFFICIENT

(in tissue)

α = - 0.5 dB per cm per MHz

HALF INTENSITY DEPTH

(in tissue)

H.I.D. = 6 divided by frequency

TRANSDUCER FREQUENCY	ATTENUATION	PENETRATION	HALF INTENSITY DEPTH
Increase	Increase	Decrease	Decrease
Decrease	Decrease	Increase	Increase

ATTENUATION COEFFICIENTS IN TISSUE

(based on - 0.5 dB per cm per MHz)

Frequency	-dB per cm	Half-Intensity-Depth
2 MHz	1	3 cm
2.25 MHz	1.125	2.67 cm
2.5 MHz	1.25	2.4 cm
3 MHz	1.5	2 cm
3.5 MHz	1.75	1.71 cm
4 MHz	2	1.5 cm
5 MHz	2.5	1.2 cm
7 MHz	3.5	0.86 cm
7.5 MHz	3.75	0.8 cm
10 MHz	5	0.6 cm
15 MHz	7.5	0.4 cm

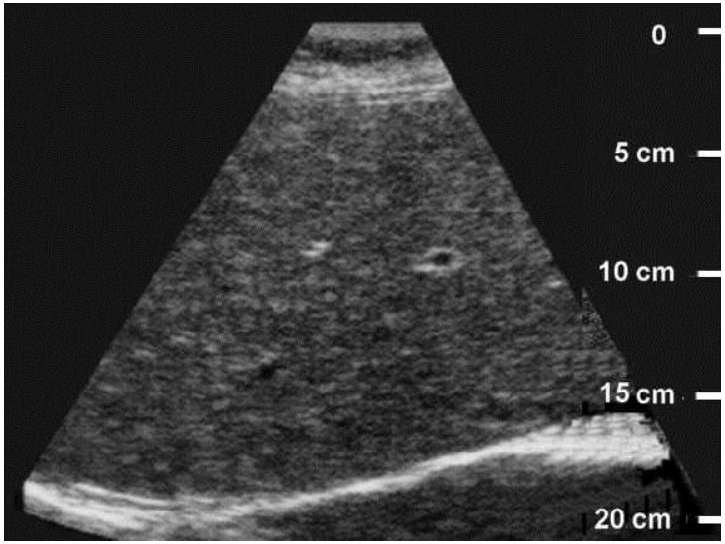
TRANSDUCER FREQUENCIES

2 MHz	2.25 MHz	2.5 MHz

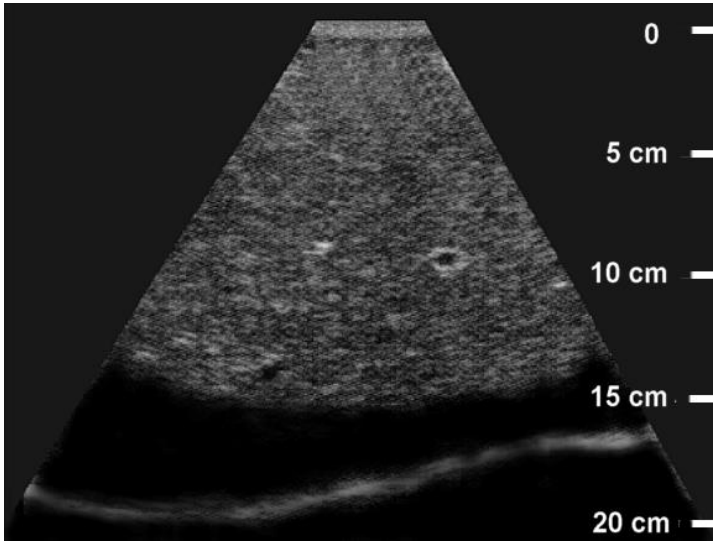
3 MHz	3.5 MHz	4 MHz

5 MHz	7 MHz	7.5 MHz
10 MHz	12 MHz	15 MHz

ADULT LIVER

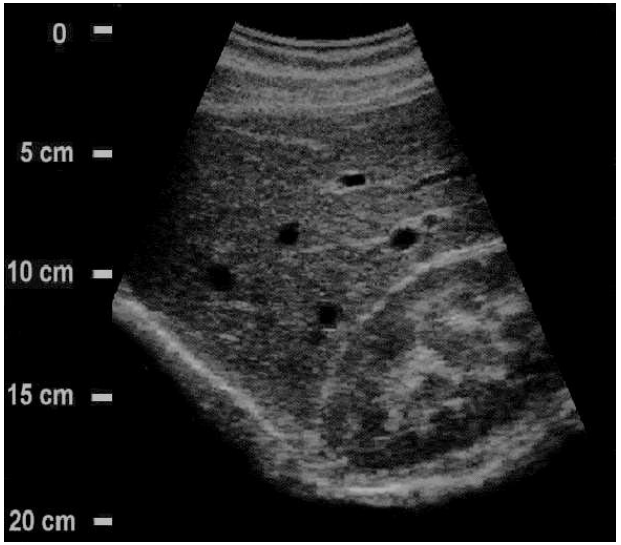


2.5 MHz

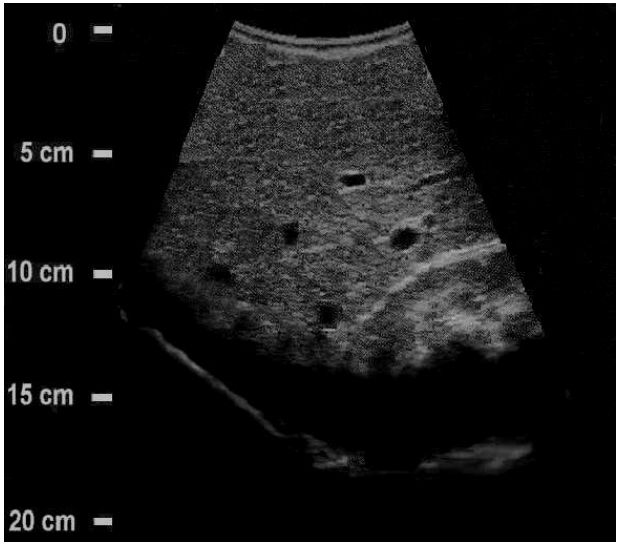


4 MHz

ADULT LIVER AND RIGHT KIDNEY

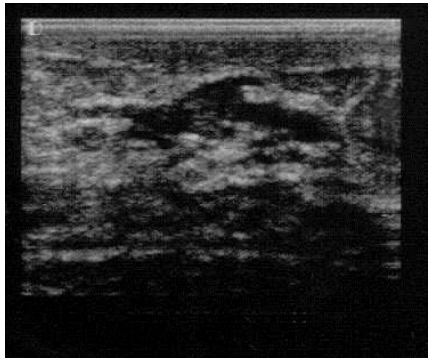
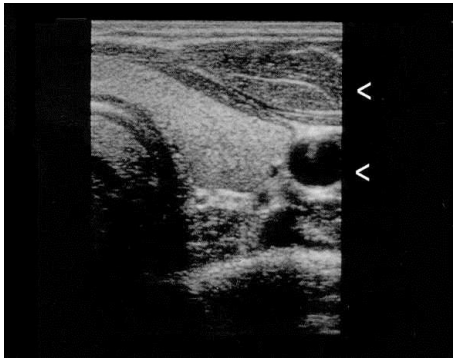
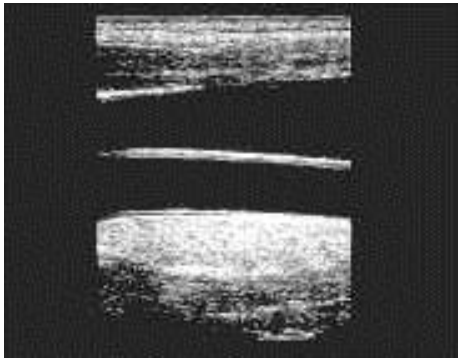
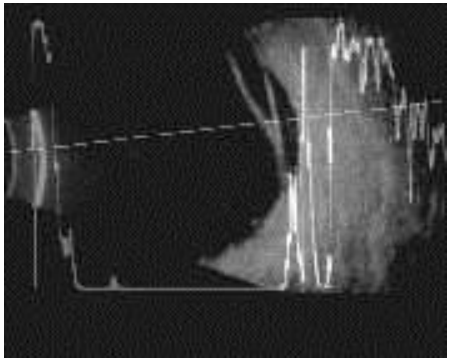


3.5 MHz

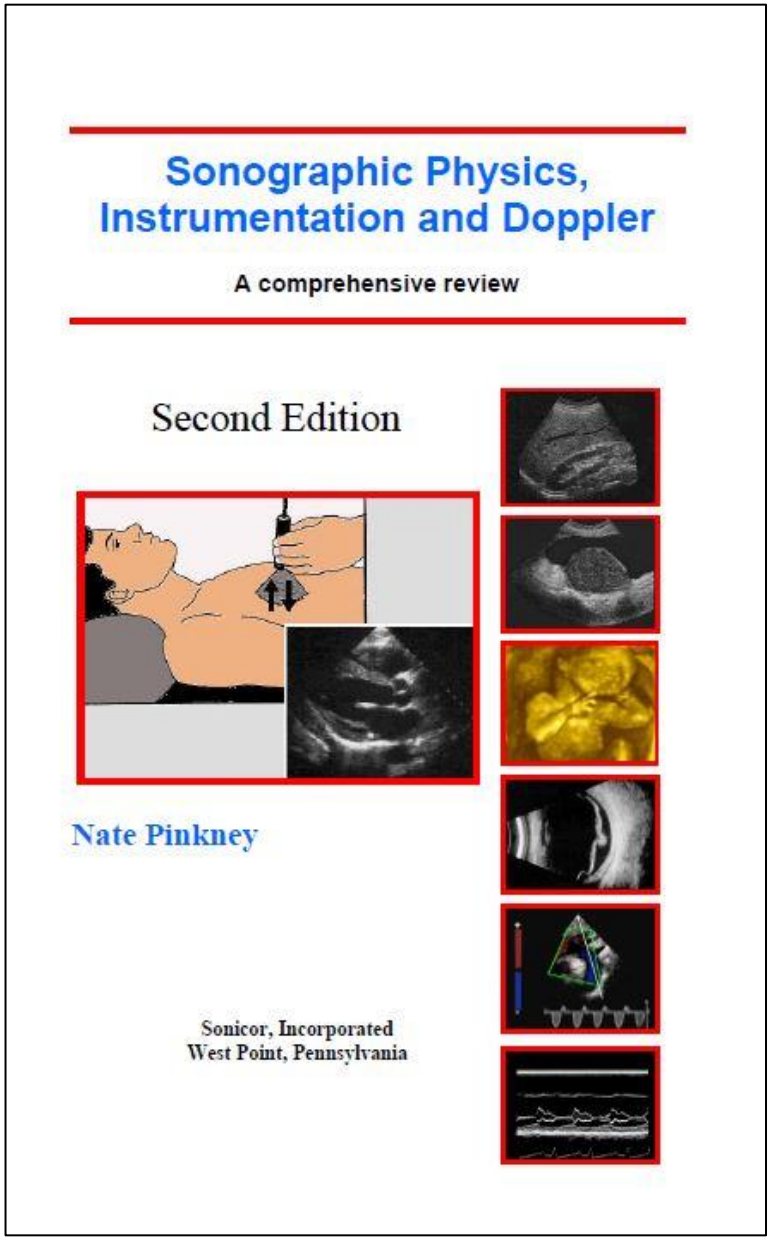


5 MHz

SMALL PARTS

BREAST	THYROID	VASCULAR	OPHTHALMIC
			
7 MHz	7.5 MHz	10 MHz	12 MHz

Answers to the following EIGHTEEN practice questions were derived from material in the textbook:



Question 1

What is the minimum reflector separation required to produce separate echoes?

- the spatial resolution of the ultrasound system
- the dynamic range
- the attenuation coefficient
- the reflection coefficient

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Question 2

What affects lateral resolution?

- damping
- spatial pulse length
- intensity
- focusing

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- damping
- spatial pulse length
- intensity
- focusing

Question 3

What can be done to reduce the far field beam diameter on a single-element transducer?

- use adjustable focusing
- use a transducer with a smaller aperture
- select a higher frequency transducer
- select a lower frequency transducer

Pages 17 and 18

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Pages 17 and 18

Question 4

What is the area between the face of an unfocused single-element transducer and the point where the beam starts to diverge?

- fraunhofer zone
- focal plane
- far zone
- near field

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- fraunhofer zone
- focal plane
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Question 5

Assuming a fixed frequency, what occurs when the diameter of an unfocused transducer is increased?

- far field divergence increases
- penetration decreases
- length of the near field increases
- length of the near field decreases

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Question 6

What is the fresnel zone?

- the focal zone of a focused transducer
- the far field of a transducer
- the distance from the face of a non-focused transducer to the beginning of the far field
- the fraunhofer zone

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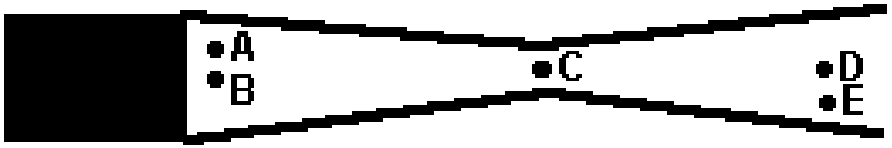
What is the fresnel zone?

- the focal zone of a focused transducer
- the far field of a transducer
- the distance from the face of a non-focused transducer to the beginning of the far field
- the fraunhofer zone

Question 7

Assuming no losses due to attenuation, which reflector provides the strongest echo?

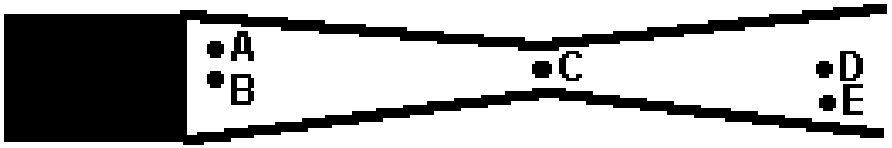
- A
- B
- C
- D
- E



Question 7

Assuming no losses due to attenuation, which reflector provides the strongest echo?

A
B
C
D
E



Question 8

What is a characteristic of a focused, curved, single piezoelectric element?

- it can be used for CW Doppler
- it can be dynamically focused
- it produces a beam pattern that is determined during manufacturing
- it can be electronically focused

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Question 9

What affects axial resolution?

- focusing
- beam width
- element diameter
- spatial pulse length

Pages 16 and 17

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- beam width
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Pages 16 and 17

Question 10

What is produced with higher frequency transducers?

- improved lateral resolution
- improved axial resolution and reduced attenuation
- increased penetration
- poor axial resolution

Pages 15 and 19

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- improved lateral resolution
- improved axial resolution and reduced attenuation
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Pages 15 and 19

Question 11

Which of the following does not contribute to attenuation?

- beam divergence
- scattering
- absorption
- constructive interference

Pages 4 and 19

Question 11

Which of the following does not contribute to attenuation?

- beam divergence
- scattering
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Pages 4 and 19

Question 12

What occurs as the frequency of sound increases?

- the amount of scatter decreases
- attenuation decreases
- penetration increases
- the number of specular reflectors increases

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Question 13

Which of the following transducers provides the maximum penetration?

- 10.0 MHz
- 7.5 MHz
- 2.25 MHz
- 3.5 MHz

Pages 19 and 20

Question 13

Which of the following transducers provides the maximum penetration?

- 10.0 MHz
- 7.5 MHz
- 2.25 MHz
- 3.5 MHz

Pages 19 and 20

Question 14

Which transducer would likely be used to image superficial structures?

- 2 MHz
- 2.5 MHz
- 3 MHz
- 10 MHz

Question 14

Which transducer would likely be used to image superficial structures?

- 2 MHz
- 2.5 MHz
- 3 MHz
- 10 MHz

Question 15

What is the average attenuation of ultrasound energy in the patient?

- 10.0 dB per cm per MHz
- 20.0 dB per cm per MHz
- 5.0 dB per cm per MHz
- 0.5 dB per cm per MHz

Question 15

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- 10.0 dB per cm per MHz
- 20.0 dB per cm per MHz
- 5.0 dB per cm per MHz
- 0.5 dB per cm per MHz

Question 16

What is the amount of attenuation of sound from a 5 MHz transducer after traveling through 1 cm of tissue?

- 1 dB
- 2 dB
- 2.5 dB
- 3 dB

Question 16

What is the amount of attenuation of sound from a 5 MHz transducer after traveling through 1 cm of tissue?

- 1 dB
- 2 dB
- 2.5 dB
- 3 dB

Question 17

What is the half-intensity-depth?

- the depth where the intensity is 50% of the originally transmitted intensity
- the depth where the frequency is 50% of the originally transmitted frequency
- the thickness of the matching layer in an array
- the range of frequencies contained in an ultrasound pulse

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- the depth where the frequency is 50% of the originally transmitted frequency
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Question 18

What mainly determines lateral resolution?

- beam diameter
- pulse duration
- bandwidth
- spatial pulse length

Question 18

What mainly determines lateral resolution?

- beam diameter
- pulse duration
- bandwidth
- spatial pulse length

END OF LESSON 04

For information on the accompanying textbook, visit the Website:

www.Sonicorinc.com