

## Digital Image Quality

### Multiple Choice

Identify the choice that best completes the statement or answers the question.

- \_\_\_ 1. All of the following can be described as image quality parameters *except*:
- high-contrast spatial resolution.
  - low-contrast spatial resolution.
  - noise.
  - reconstruction parameters.
- \_\_\_ 2. Which of the following describes the system's ability to resolve closely placed objects that are significantly different in the background?
- Low-contrast resolution
  - High-contrast resolution
  - Accuracy
  - Noise
- \_\_\_ 3. What term is in-plane resolution measured?
- Line pairs/inch
  - Line pairs/meters
  - Line pairs/millimeter
  - Line pairs/foot
- \_\_\_ 4. All of the following factors directly affect spatial resolution *except*:
- focal spot size.
  - detector cell size.
  - sampling frequency.
  - mAs
- \_\_\_ 5. Pixel size is determined by:
- matrix size/field of view.
  - field of view/matrix size.
  - field of view  $\times$  matrix size.
  - field of view + matrix size.
- \_\_\_ 6. If the field of view is 30 cm with a matrix size of  $512 \times 512$ , what is the pixel size?
- 0.50 mm
  - 0.58 mm
  - 0.60 mm
  - 0.68 mm
- \_\_\_ 7. All of the following are operator-controlled factors that affect image noise *except*:
- inherent filtration.
  - kilovoltage.
  - detector cell size.
  - tube current.

- \_\_\_ 8. What is an indication of an x-ray system's ability to freeze motions of the exposed object?
- High-contrast resolution
  - Low-contrast resolution
  - Spatial resolution
  - Temporal resolution
- \_\_\_ 9. What is the most straightforward way to reduce or eliminate the motion of an object?
- Increase stime
  - Decrease time
  - Increase slice thickness
  - Decrease slice thickness
- \_\_\_ 10. Artifacts can have all of the following effects *except*:
- degrade image quality.
  - affect the perceptibility of detail.
  - lead to misdiagnosis.
  - reduce patient radiation dose.
- \_\_\_ 11. The ability of the system to differentiate between two small objects that have similar subject contrast refers to:
- contrast resolution.
  - spatial resolution.
  - geometric unsharpness.
  - distortion.
- \_\_\_ 12. Contrast is a \_\_\_ property of the radiographic image.
- photographic
  - geometric
  - detail
  - a and c
- \_\_\_ 13. Visibility of the recorded detail is accomplished by balancing:
- geometric properties
  - amount of density
  - level of contrast
  - B and C
- \_\_\_ 14. A radiograph with low radiographic contrast:
- has very few densities
  - has very similar densities
  - has short-scale contrast
  - none of the above
- \_\_\_ 15. To measure resolution, a \_\_\_\_\_ is necessary:
- sensitometer
  - densitometer
  - resolution test pattern
  - resolution camera

- \_\_\_ 16. A line pair is made up of:
- a line
  - two lines
  - a space
  - A and C
- \_\_\_ 17. The combination of rows and columns that make up the digital image is the:
- matrix
  - FOV
  - pixel
  - bit depth
- \_\_\_ 18. The smallest component of the digital image matrix is the:
- matrix
  - FOV
  - pixel
  - bit depth
- \_\_\_ 19. The anatomic area being imaged is the:
- matrix
  - FOV
  - pixel
  - bit depth
- \_\_\_ 20. The number of bits that determine the gray level that can be assigned to a pixel is the:
- matrix
  - FOV
  - pixel
  - bit depth
- \_\_\_ 21. Which of the following matrices results in a digital image with the best image quality?
- $200 \times 200$
  - $600 \times 600$
  - $1024 \times 1024$
  - $2048 \times 2048$
- \_\_\_ 22. The advantage of having a larger bit depth is that:
- a larger part can be imaged
  - more shades of gray can be assigned to the pixel
  - the image has improved contrast resolution
  - B and C
- \_\_\_ 23. The ability to distinguish between structures that attenuate the x-ray beam similarly is:
- brightness
  - contrast resolution
  - spatial resolution
  - noise
- \_\_\_ 24. The property that is similar to the geometric property of recorded detail is:

- a. brightness
  - b. contrast resolution
  - c. spatial resolution
  - d. noise
- \_\_\_\_\_ 25. Spatial resolution is improved with:
- a. increased pixel density and increased pixel pitch
  - b. increased pixel density and decreased pixel pitch
  - c. decreased pixel density and increased pixel pitch
  - d. decreased pixel density and decreased pixel pitch
- \_\_\_\_\_ 26. Quantum noise is a result of:
- a. too few x-ray photons reaching the image receptor
  - b. too many x-ray photons reaching the image receptor
  - c. x-rays with energy that is too high reaching the image receptor
  - d. A and C
- \_\_\_\_\_ 27. A digital image that is somewhat underexposed appears:
- a. too bright
  - b. too dark
  - c. with unacceptable brightness
  - d. none of the above
- \_\_\_\_\_ 28. A digital image that is somewhat overexposed appears:
- a. too bright
  - b. too dark
  - c. noisy as a result of quantum noise
  - d. none of the above
- \_\_\_\_\_ 29. An artifact:
- a. includes over- and underexposure of the image
  - b. is always due to items imaged that are not part of the anatomy (such as necklaces that were not removed)
  - c. is an unwanted image seen in a radiograph
  - d. none of the above
- \_\_\_\_\_ 30. Also known as *high-contrast resolution*, this quality determines the system's ability to distinguish between very different tissue types as they get closer together.
- a. noise
  - b. spatial resolution
  - c. contrast resolution
  - d. all of the above
- \_\_\_\_\_ 31. This quality determines the system's ability to distinguish between very similar tissues.
- a. noise
  - b. spatial resolution
  - c. contrast resolution
  - d. all of the above

- \_\_\_ 32. A change in any factor that has more x-ray photons reaching the detector will result in an image with decreased:
- noise
  - spatial resolution
  - contrast resolution
  - all of the above
- \_\_\_ 33. Using a lower mA increases:
- noise
  - spatial resolution
  - contrast resolution
  - all of the above
- \_\_\_ 34. The limiting factor for contrast resolution is:
- SID
  - selection of window level
  - noise
  - spatial resolution

**True/False**

*Indicate whether the statement is true or false.*

- \_\_\_ 1. Low-contrast resolution can be measured with phantoms that contain low-contrast objects of different sizes.
- \_\_\_ 2. With digital imaging, the intensity of radiation reaching the image receptor determines the brightness of the image.
- True
  - False
- \_\_\_ 3. Image contrast and contrast resolution are the same.
- True
  - False
- \_\_\_ 4. Because overexposure of the digital image receptor typically produces an image with appropriate brightness and no quantum noise, all studies should be done with a little more exposure than needed.
- True
  - False
- \_\_\_ 5. Scatter radiation is not a significant concern with digital imaging because the computer can adjust the image brightness and contrast.
- True
  - False
- \_\_\_ 6. Artifacts can make diagnosis of pathologic conditions difficult or impossible.
- True
  - False

## Digital Image Quality Answer Section

### MULTIPLE CHOICE

1. ANS: D

In general, image quality of a system can be described by several key performance parameters: high-contrast spatial resolution, low-contrast resolution, temporal resolution,

PTS: 1 REF: p. 175

2. ANS: B

High-contrast spatial resolution of a system describes the system's ability to resolve closely placed objects that are significantly different from their background.

PTS: 1 REF: p. 175

3. ANS: C

The in-plane resolution is specified in terms of line pairs per centimeter or line pairs per millimeter.

PTS: 1 REF: p. 175

4. ANS: D

Many factors affect spatial resolution. The most dominating factors are the X-ray focal spot size and shape, detector cell size, and sampling frequency.

PTS: 1 REF: p. 176 | p. 177

5. ANS: B

The pixel size is related to field of view by the following equation: Pixel size = Field of view/Matrix size.

PTS: 1 REF: p. 177

6. ANS: B

$30\text{ cm} \times 10 = 300\text{ mm}$ ,  $300/512 = 0.585$ .

PTS: 1 REF: p. 178

7. ANS: A

The parameters under operator control include X-ray tube voltage (in kilovolts), tube current (in milliamperes),

PTS: 1 REF: p. 182

8. ANS: D

Temporal resolution is an indication of an x-ray system's ability to freeze motions of the exposed object.

PTS: 1 REF: p. 183

9. ANS: B

The most straightforward way to reduce or eliminate the motion impact is to decrease time.

- PTS: 1                    REF: p. 183  
10. ANS: D  
Artifacts can degrade image quality, affect the perceptibility of detail, or even lead to misdiagnosis.
- PTS: 1                    REF: p. 189  
11. ANS: A  
Different from spatial resolution, contrast resolution is the system's ability to image structures that are very similar in terms of subject contrast.
- PTS: 1  
12. ANS: A  
Contrast is a photographic property, determining the visibility of recorded detail in the radiographic image.
- PTS: 1  
13. ANS: D  
Balancing density and contrast results in excellent visibility of the detail recorded in the image.
- PTS: 1                    OBJ: 4  
14. ANS: B  
A radiograph with low or long-scale contrast has densities that are very similar to each other.
- PTS: 1                    OBJ: 6  
15. ANS: C  
A resolution test pattern is needed to measure resolution.
- PTS: 1                    OBJ: 11  
16. ANS: D  
A line pair consists of a line and a space.
- PTS: 1                    OBJ: 11  
17. ANS: A  
The matrix is the combination of rows and columns that make up the digital image.
- PTS: 1                    OBJ: 13  
18. ANS: C  
The pixel, or picture element, is the smallest component of the image matrix.
- PTS: 1                    OBJ: 13  
19. ANS: B  
The field of view (FOV) is the anatomic area being imaged.
- PTS: 1                    OBJ: 13  
20. ANS: D  
The bit depth is the number of bits used to determine the gray level assigned to a pixel.
- PTS: 1                    OBJ: 15  
21. ANS: D

For a given FOV, the larger the matrix, the smaller the pixels resulting in the best image quality.

- PTS: 1                    OBJ: 13
22. ANS: D  
Larger bit depth results in more shades of gray being available to assign to a pixel, improving contrast resolution.
- PTS: 1                    OBJ: 15
23. ANS: B  
A system's ability to tell apart structures with similar attenuation characteristics is contrast resolution.
- PTS: 1                    OBJ: 16
24. ANS: C  
Spatial resolution is very similar to recorded detail.
- PTS: 1                    OBJ: 16
25. ANS: B  
Increased spatial resolution is the result of smaller pixels, either by including more (increased pixel density) or placing them closer together (decreased pixel pitch).
- PTS: 1                    OBJ: 16
26. ANS: A  
Quantum noise is the result of too few x-ray photons (no matter what their energy) reaching the IR.
- PTS: 1                    OBJ: 18
27. ANS: D  
Decreased exposure to the digital IR results in appropriate brightness (because the computer makes the adjustment), but with quantum noise.
- PTS: 1                    OBJ: 18
28. ANS: D  
Overexposure of the digital image results in an image with appropriate brightness (because the computer makes the adjustment), but without quantum noise because there are more than enough photons reaching the IR.
- PTS: 1                    OBJ: 18
29. ANS: C  
An artifact is an unwanted image seen on the radiograph. It includes items such as necklaces that should have been removed but it also includes many other issues.
- PTS: 1                    OBJ: 19
30. ANS: B  
Spatial resolution determines the system's ability to distinguish between very different tissue types as they get closer together.
- PTS: 1                    OBJ: 15
31. ANS: C

Contrast resolution, or low-contrast resolution, determines the system's ability to distinguish between very similar tissues.

PTS: 1                    OBJ: 15

32. ANS: A

Quantum noise is due to a low level of photons being detected, so any adjustment that increases the number of photons detected will reduce noise.

PTS: 1                    OBJ: 15

33. ANS: A

A lower mA reduces the number of photons reaching the detector, leading to increased noise.

PTS: 1                    OBJ: 15

34. ANS: C

Contrast resolution is limited by noise.

PTS: 1                    OBJ: 15

#### TRUE/FALSE

1. ANS: T

Low-contrast resolution can be measured with phantoms that contain low-contrast objects of different sizes.

PTS: 1                    REF: p. 181

2. ANS: F

With digital imaging, unlike film-screen, the intensity of radiation reaching the IR does not control image brightness.

PTS: 1                    OBJ: 16

3. ANS: F

Image contrast describes the appearance of the anatomy, whereas contrast resolution determines how well similar tissues can be distinguished.

PTS: 1                    OBJ: 16

4. ANS: F

Even though the overexposed digital image may appear to be of good quality, the patient has been unnecessarily exposed to excessive radiation, a serious infraction of the radiographer's code of ethics.

PTS: 1                    OBJ: 18

5. ANS: F

Even though the computer can adjust the image, scatter radiation is an important issue with digital imaging because these image receptors are much more sensitive to low-energy x-ray photons (such as scattered photons) than film-screen.

PTS: 1                    OBJ: 18

6. ANS: T

Artifacts can create significant problems when they interfere with imaging the anatomy of interest.

PTS: 1

OBJ: 19