

Part I. Answer these questions by marking the best answer among the choices given: [5 points each]

1. Basic idea of ultrasound imaging relies on ...
 - a. Echo ranging (*)
 - b. Mechanical resonance
 - c. Faster waves than sound
 - d. Longer waves than sound
2. Study of blood flow inside vessels is possible using ... ultrasound imaging.
 - a. A-mode
 - b. B-mode
 - c. M-mode
 - d. Doppler mode (*)
3. The fundamental approach to the safe use of diagnostic ultrasound is ...
 - a. To use the lowest output power
 - b. To use the shortest scan time
 - c. To acquire the required diagnostic information
 - d. All of the above (*)
4. If an ultrasound echo returns after $65 \mu\text{s}$ from its transmission, distance to reflection surface is ...
 - a. 1 cm
 - b. 5 cm (*)
 - c. 10 cm
 - d. 20 cm
5. Hydrogen nuclei (protons) are most widely used nuclei in MRI because of their ...
 - a. Natural abundance
 - b. Tissue abundance
 - c. Presence in all organic compounds
 - d. All of the above (*)
6. MRI image is a map for ...
 - a. The wave reflectors inside the body
 - b. The attenuation of tissues in the body
 - c. The distribution of the Hydrogen nuclei in the body (*)
 - d. The static magnetic field
7. Fluoroscopy is ...
 - a. X-ray imaging for blood vessels
 - b. Projection x-ray imaging
 - c. Digital subtraction x-ray imaging
 - d. Continuous x-ray imaging (*)
8. During pregnancy, only ... can be used safely.
 - a. X-ray imaging
 - b. Ultrasound imaging (*)
 - c. MRI
 - d. CT

9. The imaging application that has the highest x-ray exposure dose is ...
- Computed tomography (*)
 - Bone imaging
 - Mammography
 - Angiography
10. Digital (filmless) x-ray systems have the disadvantage of ... compared to analog (film-based) systems.
- Lower resolution (*)
 - Bad effect on environment
 - Processing problems
 - Lower contrast that cause problems in viewing

Part II. Mark the following statement as either True (T) or False (F): [3 points each]

11. Ultrasound imaging provide good images for body areas that contain bone or air. (F)
12. Ultrasound imaging systems always have a large size. (F)
13. Effects of MRI magnetic field are present in the same floor as the MRI system only. (F)
14. A patient with credit card in his wallet inside the magnet can affect MRI performance. (F)
15. We should never use ferromagnetic tools/accessories near the MRI magnet. (T)
16. MRI produces very loud noise during scan that could be harmful to human ears. (T)
17. The process of generating x-rays is called Bremsstrahlung. (T)
18. X-Ray image is just a map of x-ray reflection in different parts of the body. (F)
19. Film-based x-ray imaging systems allow better viewing of images than digital systems. (F)
20. Angiography is imaging of blood vessels. (T)
21. Surgical needles can be clearly seen in x-ray images. (T)
22. Ultrasound dose accumulates in the body with time. (F)
23. It is important for doctors to wear protective gear when they are exposed to x-rays. (T)

Part III. Answer the following question: [6 points each]

24. Compute the wavelength of ultrasound waves of frequency 7.5 MHz in tissues.

$$c = f \lambda$$

$$1540 \text{ (m/s)} = 7.5 \times 10^6 \text{ (Hz)} \times \lambda$$

$$\lambda = 2.05 \times 10^{-4} = 0.2 \text{ mm}$$

25. What is the resonance frequency of Hydrogen nuclei H^1 in a 3 Tesla MRI system?

$$\omega_0 = \gamma B_0 = 42.6 \text{ (MHz/T)} \times 3 \text{ (T)} = 127.8 \text{ MHz}$$