

Attempt all questions. Each question is 2 marks

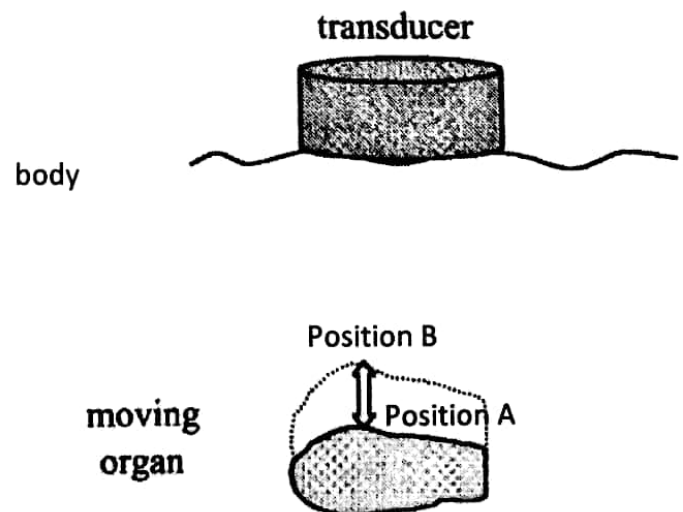
Q.1 List examples of medical image modalities based on (i) ionizing, and (ii) nonionizing radiation

Q.2 How to produce an MRI image data from the spinning phenomenon of the hydrogen proton?

Q.3 How functional MRI is acquired? List one application

Q.4 A Doppler shift ultrasound scanner transmit an ultrasound wave with a frequency of 1 MHz receives two echoes from two moving blood cells with frequencies 0.98MHz and 1.02MHz, respectively. If the ultrasound velocity is 1500 m/s. Compute the velocity of blood cells and determine whether it approaches or travel away from the transducer

Q.5 For the figure below, explain how m-mode ultrasound is performed to capture the movement of the periodically moving object. Sketch its output for position A and position B



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Q.1 List examples of medical image modalities based on (i) ionizing, and (ii) nonionizing radiation

- (i) X-ray, CT, PET, SPECT
- (ii) MRI, ultrasound

Q.2 How to produce an MRI image data from the spinning phenomenon of the hydrogen proton?

- 1- Main magnet produces a large magnetic field which align the spinning proton towards the direction of the main magnetic field in the longitudinal direction
- 2- Gradient coil localize the magnetic field at each location in the body
- 3- RF coil transmit a pulse with a short duration and with a certain frequency
- 4- Resonance: Only proton that spinning with the same frequency are excited and flip its spinning magnetic vector perpendicular to the main magnetic field (i.e., in the transverse plane)
- 5- Stop transmitter
- 6- RF coil received the relaxation signals (MRI signal) during the relaxation of the excited sinned protons.

Q.3 How functional MRI is acquired? List one application

- 1- Record two images one at rest and one during activating the brain with a certain stimulus
- 2- Record the difference between the two images

Application: Determine brain regions associated with brain discords

Q.4 A Doppler shift ultrasound scanner transmit an ultrasound wave with a frequency of 1 MHz receives two echoes from two moving blood cells with frequencies 0.98MHz and 1.02MHz, respectively. If the ultrasound velocity is 1500 m/s. Compute the velocity of blood cells and determine whether it approaches or travel away from the transducer

$$f_r = 0.98 \text{ MHz: } c + u = f_t c / f_r \rightarrow u = 30.6 \text{ m/s (away)}$$

$$f_r = 1.02 \text{ MHz: } c - u = f_t c / f_r \rightarrow u = 29.4 \text{ m/s (approaches)}$$

Q.5 For the figure below, explain how m-mode ultrasound is performed to capture the movement of the periodically moving object. Sketch its output for position A and position B

Performing continuous A-mode scan, echo amplitude is larger if the depth is small (e.g., at B)

