RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (General) Degree in Applied Sciences
Third Year – Semester II Examination – April / May 2016

PHY 3212 –MEDICAL PHYSICS II

Answer **all** questions Time allowed: **2 hours**

Instructions:

Use of a non-programmable calculator is permitted .

Values of constants

speed of light in a vacuum	$c = 3.00 \times 10^{8}\ \mathrm{ms}^{-1}$
electron charge	$e = 1.60 \times 10^{-19}\ \mathrm{C}$
the Planck constant	$h = 6.63 \times 10^{-34}\ \mathrm{J\,s}$
mass of electron	$\mathrm{m}_e = 9.11 \times 10^{-31}\ \mathrm{kg}$
mass of proton	$\mathrm{m}_p = 1.67 \times 10^{-27}\ \mathrm{kg}$
acceleration of free fall on the Earth's surface	$\mathrm{g} = 9.81\ \mathrm{m\,s}^{-1}$
electron volt	$1\ \mathrm{eV} = 1.60 \times 10^{-19}\ \mathrm{J}$
Rydberg constant	$R_H = 1.097 \times 10^{7}\ \mathrm{m}^{-1}$
Atomic mass unit	$1\ \mathrm{u} = 931.6\ \mathrm{MeV}$
Angstrom	$1\text{Å} = 1 \times 10^{-10}\ \mathrm{m}$

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1. Sound waves are incident on the ear canal of a normal human ear.

(a) Describe the physical processes involved in the transmission of the energy from the air through to the inner ear. [3]

(b) Describe how the sound energy received by the outer ear is transmitted to the inner ear. [3]

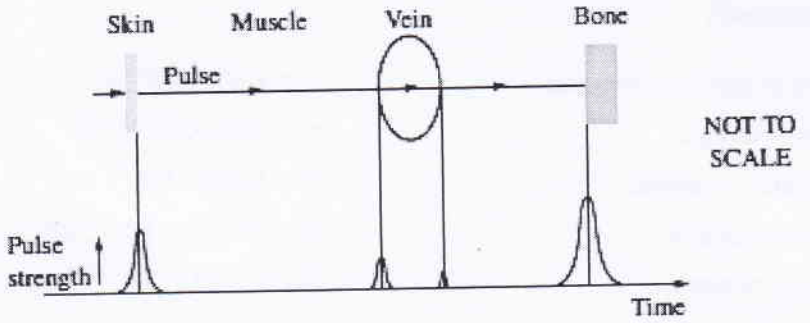
(c) Explain how the pressure changes due to the sound waves are amplified by the ear. [3]

(d) Define *intensity* of sound [2]

(e) A human ear has a threshold of hearing of 54 dB at a given frequency. Calculate the intensity of sound incident on the ear at this frequency. ($I_0 = 1.0\times10^{-12}\text{Wm}^{-2}$). [3]

(f) An intensity meter, set to the dB scale, measures the intensity level of a sound as 46 dB. Calculate the intensity of the sound at the meter. [3]

2. (a) The diagram shows part of a lower leg cross-section and its corresponding ultrasound scan image from a single transducer.



Explain how this type of scan can be used to construct a **two-dimensional image** of internal body structures. [4]

(b) Describe how the Doppler effect is used in ultrasound imaging and outline information that a Doppler ultrasound scan can provide about **blood flow** in the heart. [6]

(c) (i) Define *acoustic impedance* [2]

(ii) Ultrasound can pass from blood into a variety of materials. What happens to the incident pulse when it passes into materials of increasing acoustic impedance? [3]

(f) The acoustic impedance of air is $400\ \text{ms}^{-1}$.

Tissue	*Density* ($kg\ m^{-3}$)	*Velocity of sound* ($m\ s^{-1}$)
Muscle	1076	1580
Bone	1912	4080
Brain	1025	1540

Calculate the intensity of the reflected ultrasound at the interface between chest muscle and air as a proportion of the incident intensity. [3]

3. (a) Why is hydrogen the most commonly targeted element in the magnetic resonance imaging process? [2]

(b) Describe how properties of protons in nuclei are used in the production of magnetic resonance imaging (MRI) [3]

(c) How is the **orientation** of the magnetic axis of a hydrogen nucleus affected by the application of a strong magnetic field during an MRI scan? [3]

(d) Explain why MRI is an effective tool for diagnosing brain tumours rather than a CT scan [4]

(e) Describe the sequence of events and associated processes of physics by which an image is produced using magnetic resonance imaging [5]

4. An endoscope contains two bundles of optic fibres.

(a) Name the two bundles. For each bundle state clearly the arrangement of the fibres and explain its purpose in the operation of the endoscope. [4]

(b) Explain how an endoscope can be used to obtain images of internal organs. [4]