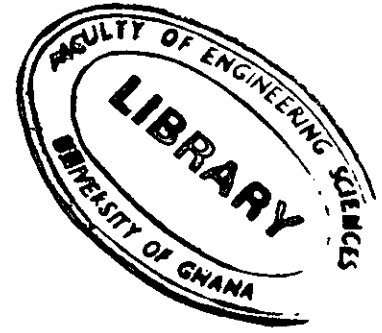




**UNIVERSITY OF GHANA**

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**BSC. ENGINEERING  
SECOND SEMESTER EXAMINATIONS: 2015/2016**

**DEPARTMENT OF BIOMEDICAL ENGINEERING  
BMEN 412: MEDICAL PHYSICS (2 CREDITS)**

**INSTRUCTIONS:**

***ATTEMPT ALL QUESTIONS***

***CALCULATIONS SHOULD BE DETAILED AND SYSTEMATIC. MARKS ARE ALLOCATED TO STEPS.***

**TIME ALLOWED: TWO (2) HOURS**

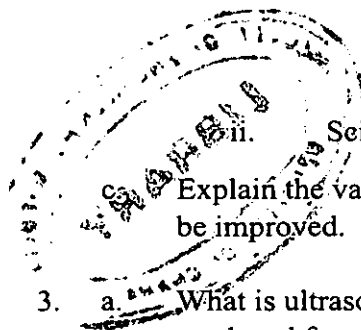
1. a. Explain Compton absorption and using the particle 4 – momentum;

$$P^2 \equiv E^2 - Pc \cdot Pc = E^2 - (Pc)^2 = (mc^2)^2$$

where  $P^2$ , is the Lorentz invariant and all the other symbols have their usual meanings. Show that the energy of the scattered photon is given by

$$E = h\nu_i \frac{1}{1 + \alpha(1 - \cos \theta)} \quad \text{where } \alpha = \frac{h\nu_i}{mc^2} \quad (15 \text{ marks})$$

- b. Explain pair production and demonstrate with an illustration how Bremsstrahlung x- rays are produced. Give two distinctions between characteristic x-rays and Bremsstrahlung x-rays. (10 marks)
2. a. Differentiate between Absorbed dose and Dose equivalent. (4 marks)
- b. Explain with the help of illustrations, the construction and the working principle of the following:
- i. Geiger-Müller counter



- ii. Scintillation counter (16 marks)
- Explain the various ways by which the efficiency of the above devices in (b) could be improved. (8 marks)

3. a. What is ultrasound transducer? Describe how ultrasound pressure waves are produced from ultrasound transducers. (8 marks)
- b. Ultrasound pressure waves incident on a boundary between two media of different acoustic impedance give rise to reflected and transmitted pressure waves. The pressure amplitudes and the intensities of the reflected and transmitted waves depends on the characteristic acoustic impedance and angle of incidence. Assuming that the boundary is planar and large compare to the wavelength of the ultrasound pressure waves and the boundary is between two fluids, show that

$$Z_2 = Z_1 \frac{P_i + P_r}{P_i - P_r}$$

where  $Z_1$  and  $Z_2$  are the acoustic impedances of medium 1 and medium 2, respectively.  $P_i$  and  $P_r$  are the incident and reflected ultrasound pressure waves, respectively.

(15 marks)

- c. Explain why the above assumption in (b) will not be true for soft tissue interaction. (4 marks)
4. a. What is a radioisotope? Explain why man-made radioisotopes are used in medicine for therapeutic purposes. (8 marks)
- b. Explain how radioisotopes are produced for medical therapeutics. (8 marks)
- c. A radioactive sample contains  $N$  atoms of a radioisotope. In 1 second,  $M$  atoms undergo decay. What is the half-life of this radioisotope? (4 marks)