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THE OPEN UNIVERSITY OF SRI LANKA
BACHELOR OF SCIENCE DEGREE PROGRAMME – LEVEL 05
FINAL EXAMINATION 2016/2017
MEDICAL PHYSICS –PYU 3167/PYE 5167
Duration: TWO HOURS (2 hrs)

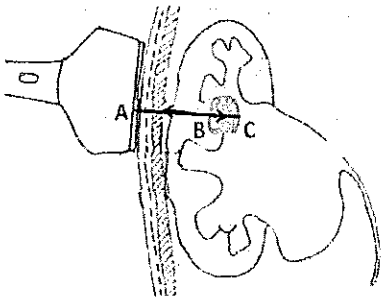
Date: 03rd January 2018 **Time 1.30 pm – 3.30 pm**

Answer Any Four (4) questions only
(Planck constant, $h = 6.6 \times 10–34$ J s; speed of light, $c = 3.0 \times 10^8$ m s^{-1}; charge on electron $q = 1.6 \times 10^{-19}$ C , Avogadro number $A = 6.02 \times 10^{23}$)

1. (a). Define piezoelectric effect and with a proper diagram, show how piezoelectric oscillator produces ultrasound waves . ***(10 marks)***

(b). Briefly explain the advantages of using ultrasound for prenatal scanning compared to other possible imaging modalities, such as X-rays or CT. ***(10 marks)***

(c). The presence of kidney stones in the renal calyces is deleted by Ultrasound imaging of a kidney as schematically shown in the following figure. Using the data in the table below and approximating the stone as uniform and spherical, if the stone is passed to the ureter, will it be able to be excreted in the urine stream if the average diameter of a normal ureter is 2 mm. Explain your answer with mathematical estimation. ***(15 marks)***



Location	Arrival time (μs)		Material	Speed (m/s)	Z (x 10^6 Kg/m^2s)
B → A	5.5		Muscle	1580	2.2
C → A	7		Kidney stone	4300	4.7

(d). In the above section (c), suppose that Ultrasound waves were incident on the upper surface of the kidney stone (labeled B) with an intensity I_o , what would be the reflected and transmitted intensities at point B. Express all your answers in terms of I_o ?

(15 marks)

(2). (a). X-rays are produced at the anode of the X-ray tube by two separate mechanisms. Name these two mechanisms and explain them briefly. *(15 marks)*

(b). Use a diagram to show the expected changes to the shape of the X-ray spectrum when (a) the mAs and (b) the kVp applied to the X- ray tube is increased. *(15 marks)*

(c). Estimate the minimum wavelength of the X-rays emitted when the X –ray tubes operates at a 30 kV. *(10 marks)*

(d). If a 2 mm thickness of a material transmits 25% of a monoenergetic beam of photons, calculate the attenuation coefficient (μ) and the half-value layer (HVL) of that material.. *(10 marks)*

3. (a). What is the difference between non-ionizing radiation and ionizing radiation? Give two examples for each type of radiation. *(5 marks)*

(b). Calculate the activity **in Ci** of 2.0 μg of ^{131}I ($T_{1/2}$ = 8 Days). If ^{131}I has a biological half-life of 24 days calculate the effective half-life of it. *(15 marks)*

(c). A certain amount of a radioactive isotope of S has an activity that is four times higher than the activity of a certain amount of a radioactive isotope of Ca. The half-life of the S-isotope is 87 days and half-life of the Ca-isotope is 162 days. After how many days is the activity of both substances become equal? *(15 marks)*

(d). Iodine-123, which is used for diagnostic imaging in the thyroid, has a half-life of 13 hours. If 50.0 mg of I-123 were prepared at 8:00 A.M. on Monday, what is the **activity** remain at 10:00 A.M. on the following day? *(15 marks)*

4. (a). Define the terms absorbed dose, equivalent dose and effective dose and indicate the SI units used to quantify them. *(10 marks)*

(b). A patient absorbed a total of 0.40 J of energy from a beam of X-rays. The volume of tissue affected was 1.350×10^{-3} m^{-3}. Assuming a mean tissue density of 10^3 kg m^{-3}, what is the absorbed dose averaged over that volume of tissue. *(10 marks)*

(c). If the tissue mentioned in part (a) is from lungs with a tissue weighing factor of 0.12. Calculate the effective dose to the lungs. ***(15 marks)***

(d). A hospital employee receives a whole body dose rate of 70 $\mu Sv\ hr^{-1}$ at a distance of 1 m when she handles a particular gamma source as a part of her profession. Calculate the distance at which she must stand from the source in order to reduce the effectivc dose rate to 6.0 $\mu Sv\ hr^{-1}$. ***(15 marks)***

5. (a). What is the intensity at 30 cm from a 100 mCi point source of Cs-137? ($\Gamma = 3.3\ R\text{-}cm^2$ /hr-mCi) ***(10 marks)***

(b). The intensity of an unshielded Cs-137 source is 1 R/hr. If the source is put into a lead shield of 5 cm thick, what would be the intensity on the outside of the shield? Assume your distance from the source has not changed. (Limnear attenuation coefiicent for lead , $\mu = 1.29\ cm^{-1}$). ***(15 marks)***

(c). How much lead shielding must be used to reduce the exposure rate from an I-131 source from 32 mR/hr to 2 mR/hr? HVL of lead for I-131 is 0.178 cm. ***(15 marks)***

(d). List three basic techniques used in nuclear medicine to control " **INTERNAL**" radiation hazards. ***(10 marks)***

6. (a). Modern radiation therapy treatments are given in daily fractions during an extended period. List five advantageous of dose fractionation. ***(15 marks)***

(b). The biologic effects on tissue from fractionated radiation therapy depend on the "four Rs" of radiation biology. List these "four Rs" ***(10 marks)***

(c). The effect of a dose of radiation on a biological entity can be influenced by three factors. Name these three factors. ***(10 marks)***

(d). List five biological factors that modify the radiation damage. ***(15 marks)***

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