Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2017/2018

COURSE NAME	:	RADIATION BIOPHYSICS
COURSE CODE	:	BWC 31703
PROGRAMME CODE	:	BWC
EXAMINATION DATE	:	JUNE/JULY 2018
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) An electron in an atom is completely described by four quantum numbers: principle quantum number n, angular momentum quantum number l, magnetic quantum number m_l and spin quantum number s. Describe the physical meaning of each of these quantum numbers.

(4 marks)

(b) Analyze the total permitted number of electrons for principle quantum number n =4.

(3 marks)

(c) The binding energies for electrons in the K, L, and M shells of an element are 8979 eV, 951 eV, and 74 eV, respectively. Predict the wavelength of the K_α and K_β characteristic X-rays emitted by this element.

(4 marks)

(d) One of the possible reactions that occurs when oxygen is bombarded by energetic neutrons is

$$^{16}O+n\rightarrow {}^{y}X+{}^{1}H$$

Identify the product nuclide X and its mass number y.

(3 marks)

(e) The nuclear binding energy for $^{235}_{92}U$ that corresponds to its mass defect is 1782.9042 MeV. Determine the rest mass of $^{235}_{92}U$ in atomic mass unit, u.

(6 marks)

Q2 (a) Disintegration of unstable radionuclide results in more stable nuclei and emission of ionizing radiation. Differentiate alpha decay, beta decay (electron and positron emission), electron capture and internal conversion processes

(8 marks)

(b) Serial radioactive decay occurs if one radionuclide produces one or more radioactive offspring in a chain. Analyze the activity of the parent and the daughter nuclei in the case of;

(i) Secular equilibrium, and
(ii) Transient equilibrium

In the case of no equilibrium conditions occurs, the activity of the parent and the daughter nuclei are as shown in **Figure Q2(b)** (denoted as A_1 and A_2, respectively)

(4 marks)

(c) Measurement on a radioactive nuclei sample shows that its activity decreases by a factor of 5 during 2 hour interval. Determine

(i) The decay constant of the radioactive nucleus, λ
(ii) The value of the half-life for this isotope, $T_{1/2}$

(5 marks)

(d) List the sources of natural background radiation

(3 marks)

Q3 (a) Justify why the advancement in science and technology has lead to the increase of average radiation exposure to the human being.

(3 marks)

(b) Differentiate the definition of energy transfer (also known as energy imparted), energy absorbed and energy lost that are occurring when radiation beam passes through tissue or tissue equivalent material.

(6 marks)

(c) Explain the meaning of coherent scattering process during the interaction of photon with matter and provide an example.

(3 marks)

(d) Compton scattering, pair production and photoelectric effect are the **THREE (3)** main incoherent scattering processes during the interaction of photon with matter. Summarize the interaction mechanism involved in each process.

(8 marks)

Q4 (a) Identify the characteristic of Compton scattering process in tissue equivalent material that render the process as the prominent energy absorption contributor.

(2 marks)

(b) Every photon scattering process will result in an energetic electron. Analyze **THREE (3)** principle processes by which energy is transferred from this energetic electron to biological molecules.

(6 marks)

(c) (i) Outline the difference between the term "Radiation Absorbed Dose (RAD)" and "Roentgen Equivalent Man (REM).

(ii) Determine a radiation dose of 10 micro Sievert (μSv) in unit millirem (mrem). Show the method of calculation in your answer.

(4 marks)

(d) A nuclear reactor operator has received the dose rate at 50 millirem per hour. The dose limit inside this reactor is 100 millirem. Calculate

(i) The radiation dose he will received after ½ hour
(ii) His stay time inside this reactor

(8 marks)

Q5 (a) Differentiate between elastic and inelastic neutron scattering processes.

(6 marks)

(b) Explain the term of "neutron capture".

(4 marks)

(c) Provide the explanation for "radiation carcinogenesis".

(4 marks)

(d) Differentiate between stochastic and non stochastic effect.

(6 marks)

-END OF THE QUESTIONS-

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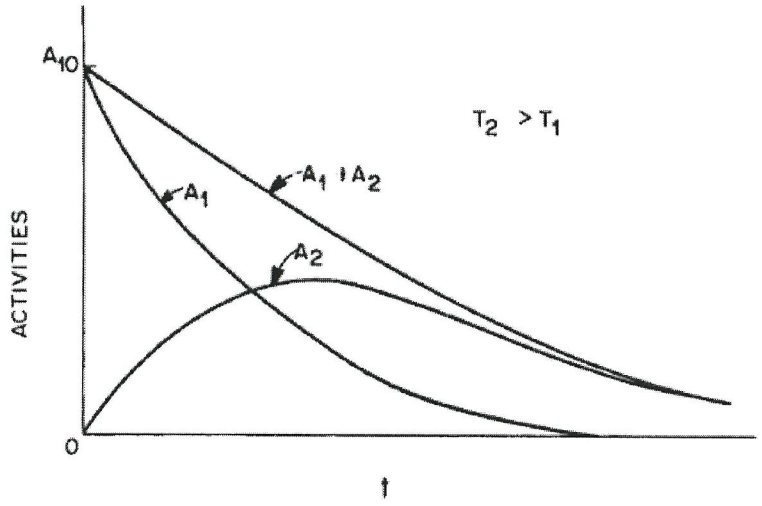

Figure Q2(b)

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List of constants :

Planck's constant $h = 6.6256\times10^{-34}$ Js
Velocity of light $c = 2.9979\times10^{8}$ m/s
Equivalent 1 $eV = 1.6021\times10^{-19}$ J
Atomic mass unit, $1u = 1.6605\text{x}10^{-27}$ kg = 931.494 MeV/c^2
Rest mass of a proton= $1.6726\text{x}10^{-27}$ kg
Rest mass of a neutron=$1.6749\text{x}10^{-27}$ kg
Rest mass of an electron= $9.109\text{x}10^{-31}$ kg

List of formula:

Photon energy, $E=hv=hc/\lambda$