UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2013/2014

COURSE NAME	:	FUNDAMENTAL OF HEALTH PHYSIC
COURSE CODE	:	DAU 24102
PROGRAMME	:	2 DAU
EXAMINATION DATE	:	DECEMBER 2013/JANUARY 2014
DURATION	:	2 ½ HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS IN SECTION A AND **TWO (2)** QUESTIONS IN SECTION B

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

SECTION A

Q1 (a) The basic requirement of health physics instrument is it's detector interacts with the radiation in such a manner that the magnitude of the instrument's response is proportional to the radiation effect or radiation property being measured.

(i) List three (3) health physics instruments used in the gas detection of radiation.
(ii) Give four (4) applications of particle-counting instruments.
(iii) Sketch a basic circuit of a gas-filled particle counters.

(13 marks)

(b) An alpha particle that traverses the chamber produces about 10^5 ion pairs, which corresponds to 1.6×10^{-14} C. If the chamber capacitance is 10×10^{-12} F and if all the charges are collected. Determine the voltage pulse resulting from the passage of this alpha.

(4 marks)

(c) Criticality is a chain reaction in fissile materials (which include isotopes of thorium, uranium, and plutonium) in which the splitting, or fission, of a fissile nucleus leads to the fission of at least one more fissile nucleus. Give how to determine criticality.

(8 marks)

Q2 (a) External radiation originates in X-ray machines and other devices specifically designed to produce radiation.

(i) Define external radiation and internal radiation.
(ii) State the basic principles for protection against external radiation.
(iii) The exposure rate one foot from a source is 500 mR/hr. Calculate the exposure rate three feet from the source.

(11 marks)

(b) Internal radiation exposure occurs when radio nuclides from environmental contamination enter the body. Explain

(i) how the internal radiation entry into the body.
(ii) how to control the internal radiation.

(14 marks)

SECTION B

Q3 (a) State five (5) types of decay and show one examples for each type.

(5 marks)

(b) Explain the process of

(i) phtoelectric effect.
(ii) compton effect.
(iii) pair production.

(9 marks)

(c) A decay chain is the decay of a radioactive isotope into other radioisotope through a series alpha, beta or gamma emission. Write down a decay chain of Neptunium. Fill the blank beginning with alpha decay.

$^{237}_{93}Np$

__________ α

__________ β

__________ α

__________ α

__________ α

____

__________ α

__________ α

__________ β

__________ α

$^{209}_{83}Bi$

$^{214}_{84}Po$ α

(11 marks)

Q4 (a) A wooden object from an archeological site is subjected to radiocarbon dating. The activity of the sample that is due to ^{14}C is measured to be 11.6 disintegrations per second. The activity of a carbon sample of equal mass from fresh wood is 15.2 disintegrations per second. The half-life of ^{14}C is 5715 yr. Determine the

(i) rate constant, k
(ii) age of the archeological sample.

(8 marks)

(b) A laboratory has 1.49 μg of pure $^{13}_{7}Na$, which has a half-life of 10.0 min. Determine

(i) the number of nuclei are present initially, N_o
(ii) the decay constant, λ
(iii) the activity initially, A_o
(iv) the activity of the decay after 1 hour
(v) how long will the activity drop to less than one per second.
Given Avogadro number is 6.02 x 10^{-23} nuclei.

(17 marks)

Q5 (a) Consider two radiation fields of equal energy flux. In one case, we have a 0.1MeV photon flux of 2000 photons/cm^2/s. In the second case, the photon energy is 2MeV and the flux is 100 photons/cm^2/s. The energy absorption coefficients for muscle are:

μ (energy, 0.1 MeV) = 0.0252 cm^2/g and
μ (energy, 2.0 MeV) = 0.0257 cm^2/g

Calculate the dose rates for the two radiation fields.

(5 marks)

(b) A survey meter, whose time constant is 4 seconds reads 10 mR (100 μSv) per hour while measuring the radiation from a dental X-ray exposure of 0.08 second. Determine the

(i) actual exposure rate.
(ii) dose to the dental hygienist if she had been at the point of measurement.

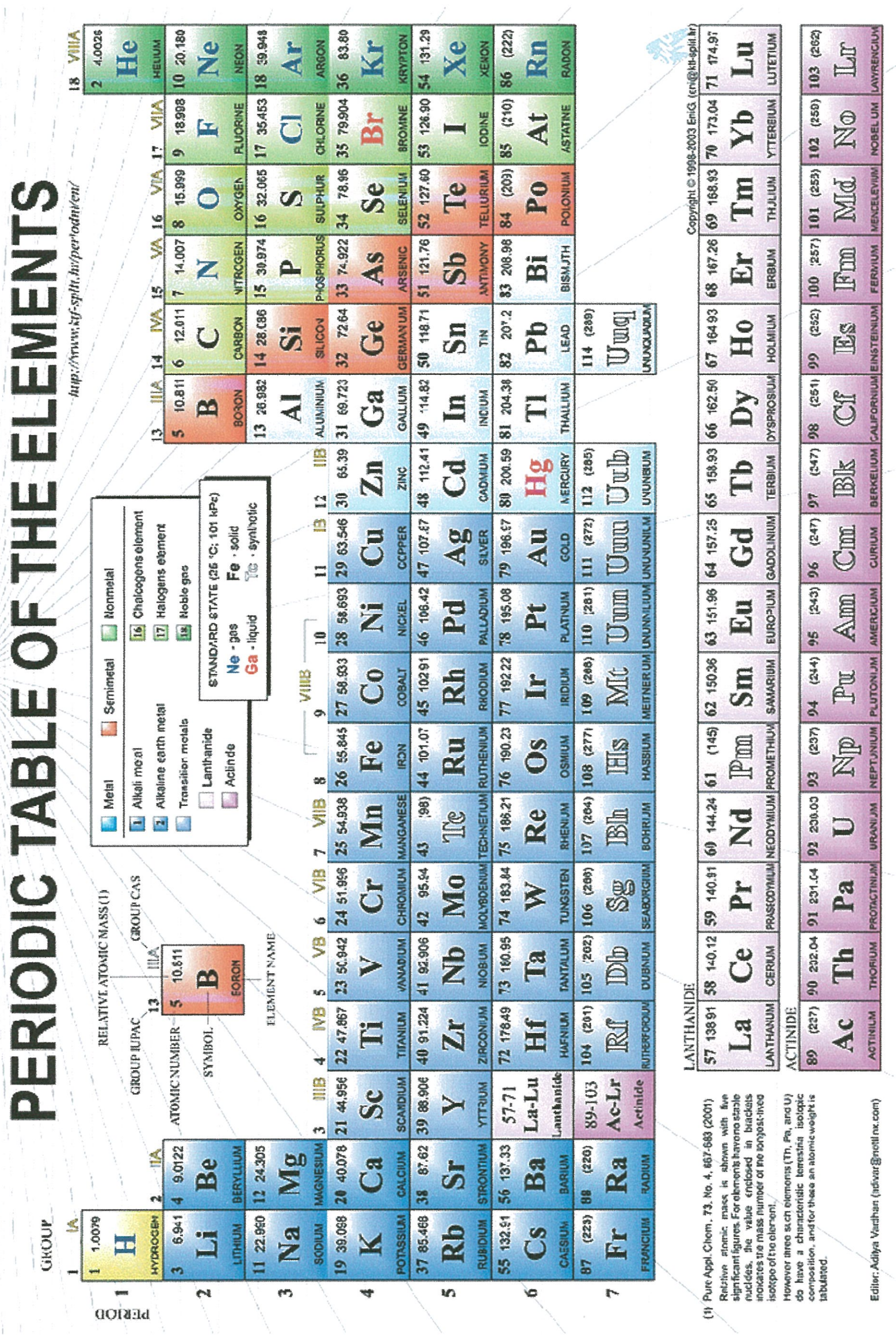
(5 marks)

(c) State the

(i) biological radiation effects due to the non-stochastic effect
(ii) biological radiation effects due to the stochastic effect.
(iii) ICRP basic radiation safety criteria dose limitation to prevent stochastic and non-stochastic effect.

(15 marks)

- END OF QUESTION -



PERIODIC TABLE OF THE ELEMENTS

FORMULA

SEMESTER / SESSION : SEM I / 2013/2014 PROGRAMME : 2 DAU
COURSE : FUNDAMENTAL OF HEALTH PHYSIC COURSE CODE : DAU 24102

$D = \frac{A_o}{\sqrt{2}} t_1$	$\frac{dN}{dt} = -\lambda N$
$E = \frac{hc}{\lambda}$	$V = \frac{Q}{C}$
$A = \frac{dN}{dt}$	$ln \frac{N}{N_o} = kt$
$k = \frac{\ln 2}{T_{\frac{1}{2}}}$	$\frac{I_1}{I_2} = \frac{{d_1}^2}{{d_2}^2}$
$V = \frac{Q}{C}$	$\boldsymbol{A = A_o e^{-\lambda t}}$
$T_{1/2} = \frac{\ln 2}{\lambda}$	$\boldsymbol{N = N_o e^{-\lambda t}}$
$\dot{D}_t = \frac{\dot{D}_i}{1 - e^{t/RC}}$:	$X = \frac{dQ}{dm}$
$N = \frac{-\frac{dN}{dt}}{\lambda}$	$D = \frac{E}{m}$
$D = D_o e^{-\mu x}$	$D_w = D_G$
$H(Sv) = D(Gy) Weight$ $H_T(Sv) = \sum_R W_R D$ $E(Sv) = \sum_T W_T H_T$ $H = H_1 + H_2$	$D_w = \frac{N_g E}{m}$

Avogadro's Number, $N_A = 6.023 \text{ X } 10^{23}$ atoms
Electron Charge, $e = 1.6 \text{ X } 10^{19}$ C
Electron Mass, $m_e = 9.109 \times 10^{-31}$ kg
Neutron Mass, $m_n = 1.675 \times 10^{-27}$ kg
Proton Mass, $m_p = 1.673 \times 10^{-27}$ kg
Atomic Mass Number, u = 1.6605×10^{-27} kg
Atomic Mass Number, u = 931.5 MeV
Plank's Constant, $h = 6.626 \times 10^{-34}$ J
Speed of light, $c = 3 \times 10^8$ ms^{-1}
1 Curie (Ci) = 3.7×10^{10} Becquerels (Bq)
1 Rad (Rad) = 10^{-2} Grays (Gy)
1 Rem (Rem) = 10^{-2} Sieverts (Sv)
1 Roentgen (R) = 2.58 x 10-4 Coulombs/kilogram (C/kg)
1 Gy = 100 rad = 1 Jkg^{-1}
1 R = 8.77×10^{-3} Grays (Gy)
Absorbed dose, D
Equivalent Dose, H
Effective Dose, E
Exposure, X
Radiation = R
Tissue = T
Charge, Q
Number of ionized, N_g
Dose to the wall, D_w = Dose to the gas, D_G

$$\dot{D} = \frac{\phi \frac{\text{photons}}{\text{cm}^2/\text{s}} \times E \frac{\text{MeV}}{\text{photon}} \times 1.6 \times 10^{-13} \frac{\text{J}}{\text{MeV}} \times \mu(\text{energy}) \frac{\text{cm}^2}{\text{g}}}{10^{-3} \frac{\text{J/g}}{\text{Gy}}}$$

$\dot{D} = \frac{\dot{\varphi} A(-dE/dx)\Delta x}{\rho A \Delta x} = \dot{\varphi}\left(-\frac{dE}{\rho dx}\right)$	$\dot{D}$ = dose rate $\dot{\varphi}$ = fluence rate ($cm^{-2} s^{-1}$) ρ = density A = area
$\dot{D} = \dot{\Psi} \frac{\mu_{en}}{\rho} = \frac{CE}{4\pi r^2} \frac{\mu_{en}}{\rho}$	$\dot{D}$ = Dose rate $\dot{\Psi}$ = energy fluence rate (MeV/cm^2 sec) C = activity (Bq) E = energy per decay (MeV) μ_{en}/ρ = mass energy-absorption coefficient of air ($cm^2 g^{-1}$) (~ same for photons between ~60keV and 2MeV)
$Dose = \frac{\left(\frac{\mu_{en}}{\rho}\right)(N)(E)(\rho x)(A)}{(A)(\rho x)} = \left(\frac{\mu_{en}}{\rho}\right)(N)(E)$	(μ_{en}/ρ) = mass energy absorption coefficient (cm^2/g) N = photon fluence (photons/cm^2) E = energy per photon ρ = density x = thickness A = area