

CONFIDENTIAL



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

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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

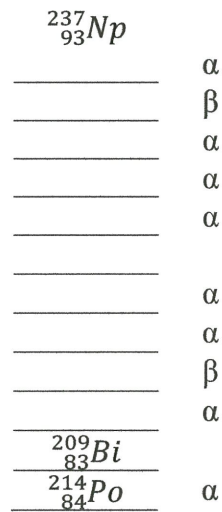
Q3 (a) State five (5) types of decay and show one examples for each type. (5 marks)

(b) Explain the process of

- (i) photoelectric 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.



(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}Na , which has a half-life of 10.0 min. Determine

- (i) the number of nuclei are present initially, N_0
- (ii) the decay constant, λ
- (iii) the activity initially, A_0
- (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 6.02×10^{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/cm²/s. In the second case, the photon energy is 2MeV and the flux is 100 photons/cm²/s. The energy absorption coefficients for muscle are:

$$\begin{aligned}\mu(\text{energy}, 0.1 \text{ MeV}) &= 0.0252 \text{ cm}^2/\text{g} \text{ and} \\ \mu(\text{energy}, 2.0 \text{ MeV}) &= 0.0257 \text{ cm}^2/\text{g}\end{aligned}$$

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 -

FINAL EXAMINATION

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PERIODIC TABLE OF THE ELEMENTS

<http://www.kj5pitt.hi/perodtbl.cfm>

PERIOD	GROUP	RELATIVE ATOMIC MASS (1)	GROUP IUPAC	GROUP CAS	ATOMIC NUMBER	SYMBOL	ELEMENT NAME
1	IA	1.0079	1A		1	H	HYDROGEN
2	IIA	6.941	2A		3	Li	LITHIUM
2	IIIA	9.0122	3A		4	Be	BERYLLIUM
3	IIIB	22.98976928	3B		11	Na	SODIUM
3	IIIB	24.304	4B		12	Mg	MAGNESIUM
4	IVB	40.078	4B		19	K	POTASSIUM
4	IVB	44.95591	5B		20	Ca	CALCIUM
4	IVB	47.88	6B		21	Sc	SCANDIUM
4	IVB	48.086	7B		22	Ti	TITANIUM
4	IVB	50.9415	8B		23	V	Vanadium
4	IVB	52.00	9B		24	Cr	Chromium
4	IVB	54.938044	10B		25	Mn	Manganese
4	IVB	55.845	11B		26	Fe	Iron
4	IVB	58.9326	12B		27	Co	Cobalt
4	IVB	58.9326	13B		28	Ni	Nickel
4	IVB	63.546	14B		29	Cu	Copper
4	IVB	65.39	15B		30	Zn	Zinc
5	VB	87.62	5B		37	Rb	RUBIDIUM
5	VB	88.906	6B		38	Sr	STRONTIUM
5	VB	91.224	7B		40	Zr	Zirconium
5	VB	92.906	8B		41	Nb	Niobium
5	VB	95.94	9B		42	Mo	Molybdenum
5	VB	101.07	10B		44	Ru	Ruthenium
5	VB	101.07	11B		45	Rh	Rhodium
5	VB	106.42	12B		46	Pd	Palladium
5	VB	106.42	13B		47	Ag	Silver
5	VB	107.8682	14B		48	Cd	Cadmium
5	VB	112.411	15B		49	In	Indium
5	VB	114.818	16B		50	Sn	Stannum
5	VB	127.40	17B		51	Sb	Antimony
5	VB	127.40	18B		52	Te	Tellurium
5	VB	127.60	19B		53	I	Iodine
5	VB	131.29	20B		54	Xe	Xenon
6	VIB	132.91	6B		55	Cs	Caesium
6	VIB	137.327	7B		56	Ba	Barium
6	VIB	178.49	8B		72	Hf	Hafnium
6	VIB	180.948	9B		73	Ta	Tantalum
6	VIB	183.84	10B		74	W	Tungsten
6	VIB	186.207	11B		75	Re	Rhenium
6	VIB	186.207	12B		76	Os	Osmium
6	VIB	193.224	13B		77	Ir	Iridium
6	VIB	195.084	14B		78	Pd	Palladium
6	VIB	196.966569	15B		80	Hg	Mercury
6	VIB	200.59	16B		81	Tl	Thallium
6	VIB	204.38	17B		82	Pb	Lead
6	VIB	208.980389	18B		83	Bi	Bismuth
6	VIB	208.980389	19B		84	Po	Polonium
6	VIB	209	20B		85	At	Astatine
6	VIB	210	21B		86	Rn	Radon
7	VIIA	151.964	7A		87	Fr	Francium
7	VIIA	162.60	8A		88	Ra	Radium
7	VIIA	175.077	9A		89	Ac	Actinium
7	VIIA	175.077	10A		89	La	Lanthanum
7	VIIA	175.077	11A		89	Ce	Cerium
7	VIIA	175.077	12A		89	Pr	Praseodymium
7	VIIA	175.077	13A		89	Nd	Niodymium
7	VIIA	175.077	14A		89	Pm	Promethium
7	VIIA	175.077	15A		89	Sm	Samarium
7	VIIA	175.077	16A		89	Eu	Europium
7	VIIA	175.077	17A		89	Gd	Gadolinium
7	VIIA	175.077	18A		89	Tb	Terbium
7	VIIA	175.077	19A		89	Dy	Dysprosium
7	VIIA	175.077	20A		89	Ho	Holmium
7	VIIA	175.077	21A		89	Er	Erbium
7	VIIA	175.077	22A		89	Tm	Thulium
7	VIIA	175.077	23A		89	Yb	Ytterbium
7	VIIA	175.077	24A		89	Lu	Lutetium
7	VIIA	175.077	25A		89	U	Uranium
7	VIIA	175.077	26A		89	Np	Neptunium
7	VIIA	175.077	27A		89	Pu	Plutonium
7	VIIA	175.077	28A		89	Am	Americium
7	VIIA	175.077	29A		89	Cm	Curium
7	VIIA	175.077	30A		89	Bk	Berkelium
7	VIIA	175.077	31A		89	Cf	Californium
7	VIIA	175.077	32A		89	Es	Einsteinium
7	VIIA	175.077	33A		89	Fm	Fermium
7	VIIA	175.077	34A		89	Md	Mendelevium
7	VIIA	175.077	35A		89	No	Nobelium
7	VIIA	175.077	36A		89	Lr	Lavrencium

(1) Pure Appl. Chem., 73, No. 4, 657-688 (2001)
 Relative atomic masses are based on the 12C isotope of carbon with the relative atomic mass of 12 exactly. For elements with stable nuclei, the value enclosed in brackets indicates the mass number of the longest-lived isotope of the element.
 Properties of each element (T_m, P_m, etc.) are given in the table. The values are based on the composition, and for these an atomic weight is tabulated.
 Editor: Aditya Vachhar (advach@nptel.com)

FORMULA

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$D = \frac{A_o}{\sqrt{2}} t_1$	$\frac{dN}{dt} = -\lambda N$	Avogadro's Number, $N_A = 6.023 \times 10^{23}$ atoms Electron Charge, $e = 1.6 \times 10^{19}$ 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, $u = 1.6605 \times 10^{-27}$ 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) = 2.58×10^{-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
$E = \frac{hc}{\lambda}$	$V = \frac{Q}{C}$	
$A = \frac{dN}{dt}$	$\ln \frac{N}{N_o} = kt$	
$k = \frac{\ln 2}{T_{1/2}}$	$\frac{I_1}{I_2} = \frac{d_1^2}{d_2^2}$	
$V = \frac{Q}{c}$	$A = A_o e^{-\lambda t}$	
$T_{1/2} = \frac{\ln 2}{\lambda}$	$N = N_o e^{-\lambda t}$	
$\dot{D}_t = \frac{\dot{D}_i}{1 - e^{-\lambda RC}}$	$X = \frac{dQ}{dm}$	
$N = \frac{-dN}{\lambda}$	$D = \frac{E}{m}$	
$D = D_o e^{-\mu x}$	$D_w = D_G$	
$H (Sv) = D(Gy) \text{Weight}$ $H_T (Sv) = \sum_R W_R D$ $E (Sv) = \sum_T W_T H_T$ $H = H_1 + H_2$	$D_w = \frac{N_g E}{m}$	
$\dot{D} = \frac{\phi \frac{\text{photons}}{\text{cm}^2/\text{s}} \times E \frac{\text{MeV}}{\text{photon}} \times 1.6 \times 10^{-13} \frac{\text{J}}{\text{MeV}} \times \mu (\text{energy}) \frac{\text{cm}^2}{\text{g}}}{10^{-3} \frac{\text{J/g}}{\text{Gy}}}$		
$\dot{D} = \frac{\dot{\phi} A (-dE/dx) \Delta x}{\rho A \Delta x} = \dot{\phi} \left(-\frac{dE}{\rho dx} \right)$		
$\dot{D} = \dot{\Psi} \frac{\mu_{en}}{\rho} = \frac{CE \mu_{en}}{4\pi^2 \rho}$		
$\text{Dose} = \frac{\left(\frac{\mu_{en}}{\rho} \right) (N)(E)(\rho x)(A)}{(A)(\rho x)} = \left(\frac{\mu_{en}}{\rho} \right) (N)(E)$		