UNIVERSITY OF ESWATINI

FACULTY OF HEALTH SCIENCES
DEPARTMENT OF ENVIRONMENTAL HEALTH
BSc DEGREE IN ENVIRONMENTAL HEALTH SCIENCE
MAIN EXAMINATION, DECEMBER, 2019

TITLE OF PAPER : **RADIATION AND RADIOACTIVITY**

COURSE CODE : **EHS 417**

TIME : **2HOURS**

TOTAL MARKS : **100**

INSTRUCTIONS:

- **QUESTION 1 IS COMPULSORY**
- **ANSWER ANY OTHER THREE QUESTIONS**
- **ALL QUESTIONS ARE WORTH 25 MARKS EACH**
- **FORMULAE AND PERIODIC TABLE ARE PROVIDED**
- **BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER.**

DO NO OPEN THIS EXAMINATION PAPER UNTIL PERMISSION HAS BEEN GRANTED BY THE INVIGILATOR.

QUESTION 1

I. Multiple Choices: Write True or False against each letter corresponding to the following statements as they apply to radiation and radioactivity

a) The formation of a nucleus from its nucleons is called nuclear fission.

b) The formation of just one nucleus of helium-4 releases 4.54×10^{-12}J.

c) The nuclear strong force is able to overcome the electrostatic force of repulsion between protons, and it binds the nucleons into a package.

d) To achieve less energy and thus more stability, radio-nuclides eject small nuclear fragments, and may simultaneously release high-energy electromagnetic radiation.

e) All non-ionizing radiation is not electromagnetic radiation.

f) Electric fields are produced by electric charges, while magnetic fields are produced by moving charges, or a current.

g) In radiation therapy, selected cells or tissues are to be destroyed with damage to nearby healthy tissues.

h) When a radioisotope is to be used for therapy, alpha as well as Beta and gamma emitters can be used.

i) A given isotope should not be able to concentrate in the desired area or preferably emit alpha or beta particles because they have limited penetration power and will not damage adjacent tissues.

j) Ultrasound frequencies are those above 20 000 Hz.

k) Uranium (235) can be split by a neutron into smaller pieces, such as strontium and xenon, accompanied by the release of more neutrons and a tremendous amount of energy.

(22 marks)

II.

Describe the health and safety importance of beta particles and how can they be distinguished among other particles.

(3 marks)

QUESTION 2

a) Describe the biological effects of radiation and how exposure can be prevented

(10 marks)

b) Describe the general uses of radioactivity

(15 marks)

QUESTION 3

i. Describe biological effects of radiation.

(12 marks)

ii. Describe a nuclear reaction.

(5 marks)

iii. Describe beta radiation.

(8 marks)

QUESTION 4

a) Describe the process of nuclear fission involving Uranium – 235 and also calculate the amount of energy that will be emitted.

(20 marks)

b) Write the two rules for writing nuclear reactions.

(2 marks)

c) What are the dangers of radiation to human beings?

(3 marks)

QUESTION 5

i. Describe the process of fission and how it goes in a nuclear reactor.

(8 marks)

ii. Describe the use of radioisotopes in medicine in general and specifically of Iodine 131, Technectium-99m and Cobalt-60.

(14 marks)

iii. Name three sources of radiation.

(3 marks)

FORMULAE- ACOUSTIC AND HEALTH/RADIOACTIVITY AND RADIATION

1. $W = \sum_{i=1}^{4} \frac{p\ rms(I)S}{\rho C}$ where $\rho C = 420$ RAYLS
2. $SPL = 10 \log (p_1/p_0)^2$
3. $NR = 10 \log_{10} = \frac{TA_2}{TA_1}$
4. $SPL_t = 10 \log_{10} [\Sigma\ 10^{SPL/10}]$
5. $SWL = 10 \log W/W_0$
6. $I = \frac{W}{A}$
7. $I = \frac{p^2_{rms}}{\rho C}$ or $p_{rms} = (I \rho C)^{1/2}$
8. $S.I.L = 10 \log_{10} (I/I_{ref})$
9. $R = \frac{S\bar{\alpha}}{1-\bar{\alpha}}$
10. $\bar{\alpha} = \frac{S_1\bar{\alpha}_1 + S_2\ \bar{\alpha}_2 + \ldots.}{S_1 + S_2}$
11. $SPL_t = SWL + 10 \log_{10} \{ \frac{Q}{4\pi r^2} + \frac{4}{R} \}$
12. $T = \frac{0.161\ V}{S\bar{\alpha}}$
13. $T = \frac{0.161\ V}{-S[\ln (1-\bar{\alpha})] + 4mV}$
14. $\tau = \frac{p_t^2/\rho C^2}{p_i^2/\rho C^2}$
15. $TL = 10 \log_{10} [\frac{1}{\tau}]$
16. $t = \frac{1}{1.21\ x\ 10^{-4}\ yr^{-1}} \ln(\frac{0.227}{s})$
17. Radiation Intensity $\propto \frac{1}{d^2}$

PERIODIC TABLE OF ELEMENTS

PERIODS	GROUPS 1 IA	2 IIA	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8	9	10 VIIIB	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 VIIIA
1	1.008 H 1																	4.003 He 2
2	6.941 Li 3	9.012 Be 4											10.811 B 5	12.011 C 6	14.007 N 7	15.999 O 8	18.998 F 9	20.180 Ne 10
3	22.990 Na 11	24.305 Mg 12											26.982 Al 13	28.086 Si 14	30.974 P 15	32.06 S 16	35.453 Cl 17	39.948 Ar 18
4	39.098 K 19	40.078 Ca 20	44.956 Sc 21	47.88 Ti 22	50.942 V 23	51.996 Cr 24	54.938 Mn 25	55.847 Fe 26	58.933 Co 27	58.69 Ni 28	63.546 Cu 29	65.39 Zn 30	69.723 Ga 31	72.61 Ge 32	74.922 As 33	78.96 Se 34	79.904 Br 35	83.80 Kr 36
5	85.468 Rb 37	87.62 Sr 38	88.906 Y 39	91.224 Zr 40	92.906 Nb 41	95.94 Mo 42	98.907 Tc 43	101.07 Ru 44	102.91 Rh 45	106.42 Pd 46	107.87 Ag 47	112.41 Cd 48	114.82 In 49	118.71 Sn 50	121.75 Sb 51	127.60 Te 52	126.90 I 53	131.29 Xe 54
6	132.91 Cs 55	137.33 Ba 56	138.91 *La 57	178.49 Hf 72	180.95 Ta 73	183.85 W 74	186.21 Re 75	190.2 Os 76	192.22 Ir 77	195.08 Pt 78	196.97 Au 79	200.59 Hg 80	204.38 Tl 81	207.2 Pb 82	208.98 Bi 83	(209) Po 84	(210) At 85	(222) Rn 86
7	223 Fr 87	226.03 Ra 88	(227) **Ac 89	(261) Rf 104	(262) Ha 105	(263) Unh 106	(262) Uns 107	(265) Uno 108	(266) Une 109	(267) Uun 110								

Atomic mass → 10.811
Symbol → B
Atomic No. → 5

TRANSITION ELEMENTS

*Lanthanide Series	140.12 Ce 58	140.91 Pr 59	144.24 Nd 60	(145) Pm 61	150.36 Sm 62	151.96 Eu 63	157.25 Gd 64	158.93 Tb 65	162.50 Dy 66	164.93 Ho 67	167.26 Er 68	168.93 Tm 69	173.04 Yb 70	174.97 Lu 71
**Actinide Series	232.04 Th 90	231.04 Pa 91	238.03 U 92	237.05 Np 93	(244) Pu 94	(243) Am 95	(247) Cm 96	(247) Bk 97	(251) Cf 98	(252) Es 99	(257) Fm 100	(258) Md 101	(259) No 102	(260) Lr 103