UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES
DEPARTMENT OF ENVIRONMENTAL HEALTH
BSc DEGREE IN ENVIRONMENTAL HEALTH SCIENCES
(RE-SIT EXAMINATION, JANUARY, 2019)

TITLE OF PAPER : **RADIOACTIVITY AND RADIATION**

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 THE ANSWER TO EACH QUESTION IN A SEPARATE SHEET OF PAPER.**

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QUESTION 1

I. **For the following statements as applied in radioactivity, radiation, health and safety write whether they are True or False.**

a) In the case of electromagnetic energy, the fields are composed of vector quantities.
b) A vector field is any physical quantity that takes on different values of magnitude and direction at different points in space.
c) The electric and magnetic fields are in time phase and space quadrature.
d) The radiometric system is used mainly for assessing optical radiation hazards.
e) The photometric system is used for specifying exposure limits for visible radiation and lighting requirements.
f) A nuclear reaction is when a particle penetrates and changes a nucleus.
g) If an object gains energy its mass decreases.
h) When an atom emits a beta particle, its mass number decreases by 2 and its atomic number decreases by 1.
i) The standard unit is the curie, the number of nuclear disintegrations occurring per second in 1 kg of uranium.
j) The nuclear strong force is able overcome the electrostatic force of repulsion between protons and it binds the nucleons into a package.

(20 marks)

II. Briefly describe ultrasonography.

(5 marks)

QUESTION 2

i. Describe measurement of radiation.

(7 marks)

ii. Cesium – 137, $^{137}_{55}Cs$ is one of the radioactive wastes from a nuclear power plant or an atomic bomb explosion, emits beta and gamma radiation. Write a nuclear equation for the decay of Cesium – 137,

(6 marks)

iii. Describe the arrangement of electrons in an atom and the importance attached to such an arrangement.

(6 marks)

iv. Strontium – 90, a beta emitter, is one of many radionuclides present in the wastes of operating nuclear power plants. Write a balanced nuclear equation for the decay.

(6 marks)

QUESTION 3

a) Describe radiation under the following headings:

i) Units of Activity [3]

ii) Units of Radiation Dose [3]

iii) Additive Units for Radiation Dose [5]

(11 marks)

b) Describe gamma radiation and their use in medicine.

(9 marks)

c) At 1.5 m from a small source, the radiation intensity is 40 units. What is the radiation intensity at 5,6 m ?

(5 marks)

QUESTION 4

a) Describe a nuclear reaction where a uranium atom - atomic number 92 and mass number 238 loses an alpha particle.

(10 marks)

b) Describe theprocess of fission and how it goes in a nuclear reactor

(8 marks)

c) Describe the use of radioisotopes Iodine-131 and iodine 123 in medicine

(7 marks)

QUESTION 5

a. Describe how a scan is produced.

(4 marks)

b. Briefly describe sources of radiation

(5 marks)

c. Briefly describe irradiation of food

(6 marks)

d. In the 1940s scrolls were found in the Dead Sea. Some were made up of copper and others were made of parchment, when one parchment scroll was analyzed by the carbon-14 dating method, its specific activity was found to be 0.175 Bqg^{-1}. Calculate the age of the scroll to two significant figures.

(5 marks)

e. Describe a Nuclear reaction.

(5 marks)

FORMULAE

1. $W = \sum_{i=1}^{4} \frac{p\ rms(I)S}{\rho C}$ where ρC = 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. $\bar{\alpha} = \frac{S_i\bar{\alpha}_i + S_2\,\bar{\alpha}_2 + \ldots}{S_i + S_2}$
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. $t = \frac{1}{1.21 \times 10^{-4}\ yr^{-1}} \ln(\frac{0.227}{s})$
17. Radiation Intensity $\propto \frac{1}{d^2}$

PERIODIC TABLE OF THE ELEMENTS

GROUPS

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
PERIODS	IA	IIA	IIIB	IVB	VB	VIB	VIIB	VIII			IB	IIB	IIIA	IVA	VA	VIA	VIIA	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	TRANSITION ELEMENTS										26.982 Al 13	28.0855 Si 14	30.9738 P 15	32.06 S 16	35.453 Cl 17	39.948 Ar 18
4	39.0983 K 19	40.078 Ca 20	44.956 Sc 21	47.88 Ti 22	50.9415 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	92.9064 Nb 41	95.94 Mo 42	98.907 Tc 43	101.07 Ru 44	102.906 Rh 45	106.42 Pd 46	107.868 Ag 47	112.41 Cd 48	114.82 In 49	118.71 Sn 50	121.75 Sb 51	127.60 Te 52	126.904 I 53	131.29 Xe 54
6	132.905 Cs 55	137.33 Ba 56	138.906 *La 57	178.49 Hf 72	180.948 Ta 73	183.85 W 74	186.207 Re 75	190.2 Os 76	192.22 Ir 77	195.08 Pt 78	196.967 Au 79	200.59 Hg 80	204.383 Tl 81	207.2 Pb 82	208.980 Bi 83	(209) Po 84	(210) At 85	(222) Rn 86
7	(223) Fr 87	226.025 Ra 88	(227) **Ac 89	(261) Rf 104	(262) Ha 105	(263) Unh 106	(262) Uns 107	(265) Uno 108	(266) Une 109									

* Lanthanide series	140.115 Ce 58	140.908 Pr 59	144.24 Nd 60	(145) Pm 61	150.36 Sm 62	151.96 Eu 63	157.25 Gd 64	158.925 Tb 65	162.50 Dy 66	164.930 Ho 67	167.26 Er 68	168.934 Tm 69	173.04 Yb 70	174.967 Lu 71
** Actinide series	232.038 Th 90	231.036 Pa 91	238.029 U 92	237.048 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

Numbers below the symbol of the element indicates the atomic numbers. Atomic masses, above the symbol of the element, are based on the assigned relative atomic mass of ^{12}C = exactly 12; ( ) indicates the mass number of the isotope with the longest half-life.

SOURCE: International Union of Pure and Applied Chemistry, I. Mills, ed., *Quantities, Units, and Symbols in Physical Chemistry*, Blackwell Scientific Publications, Boston, 1988, pp 86-98.