UNIVERSITY OF SWAZILAND

FACULTY OF HEALTH SCIENCES

DEPARTMENT OF ENVIRONMENTAL HEALTH

BSc DEGREE IN ENVIRONMENTAL HEALTH SCIENCES

SUPPLEMENTARY EXAMINATION, JULY, 2017

TITLE OF PAPER	**: RADIOACTIVITY AND RADIATION**
COURSE CODE	**: EHM 417**
TIME	**: 2HOURS**
TOTAL MARKS	**: 100**

INSTRUCTIONS:

1. **QUESTION 1 IS COMPULSORY**
2. **ANSWER ANY OTHER THREE QUESTIONS**
3. **ALL QUESTIONS ARE WORTH 25 MARKS EACH**
4. **FORMULAE AND PERIODIC TABLE ARE PROVIDED**
5. **BEGIN THE ANSWER TO EACH QUESTION IN A SEPARATE SHEET OF PAPER.**

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QUESTION 1

I. Multiple choices: for the following statements as applied in radioactivity, radiation, health and safety write whether they are True or False.

a) Ultrasound frequencies are those above 20 Hertz.
b) When a transducer is connected to a computer it can produce images of internal organs.
c) One advantage of ultrasonography is that it uses radiation.
d) Kidney stones are broken up by means of ultrasonic waves that are produced by a lithotripter.
e) An atom is made primarily of three fundamental particles; protons, electrons and neutrons.
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 alpha 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 [3]
iv) Radiation Sickness [3]
v) Radiation-Produced Free Radicals [3]
vi) Background Radiation [3]

(18 marks)

b) What is the health and safety importance of gamma rays and how can they be distinguished among other particles?

(4 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 ?

(3 marks)

QUESTION 4

i. Describe nuclear waste and how it can be safely dealt with to safeguard public health.

(15 marks)

ii. Describe applications of radioactivity under the following heading;

a. Radioactive tracers [5]
b. Radiological dating [5]

(10 marks)

QUESTION 5

a. Describe how a scan is produced.

(4 marks)

b. Describe carbon-14 dating

(8 marks)

c. Briefly describe sources of radiation

(6 marks)

d. Briefly describe irradiation of food

(3 marks)

e. 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.

(4 marks)

FORMULAE- ACOUSTIC AND HEALTH

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. $\bar{\alpha} = \frac{S_i\bar{\alpha}_i + S_2\bar{\alpha}_2 + \ldots}{S_i + S_2}$
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 $\propto \frac{1}{d^2}$

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Atomic #
Symbol
Name
Weight

6	2 4
C	
Carbon	
12.011	

Nonmetals: Metalloids | Other nonmetals | Halogens | Noble gases

Metals: Alkali metals | Alkaline earth metals | Lanthanoids | Actinoids | Transition metals | Post-transition metals

	2	3	4											5	16	17	18
gen																	2 He Helium 4.002602
m	4 Be Beryllium 9.0121...											5 B Boron 10.81	6 C Carbon 12.011	7 N Nitrogen 14.007	8 O Oxygen 15.999	9 F Fluorine 18.998...	10 Ne Neon 20.1797
m 9...	12 Mg Magnesium 24.305											13 Al Aluminium 26.981...	14 Si Silicon 28.085	15 P Phosphorus 30.973...	16 S Sulfur 32.06	17 Cl Chlorine 35.45	18 Ar Argon 39.948
ium 33	20 Ca Calcium 40.078	21 Sc Scandium 44.955...	22 Ti Titanium 47.867	23 V Vanadium 50.9415	24 Cr Chromium 51.9961	25 Mn Manganese 54.938...	26 Fe Iron 55.845	27 Co Cobalt 58.933...	28 Ni Nickel 58.6934	29 Cu Copper 63.546	30 Zn Zinc 65.38	31 Ga Gallium 69.723	32 Ge Germanium 72.63	33 As Arsenic 74.921...	34 Se Selenium 78.971	35 Br Bromine 79.904	36 Kr Krypton 83.798
ium 78	38 Sr Strontium 87.62	39 Y Yttrium 88.90584	40 Zr Zirconium 91.224	41 Nb Niobium 92.90637	42 Mo Molybdenum 95.95	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.90...	46 Pd Palladium 106.42	47 Ag Silver 107.8682	48 Cd Cadmium 112.414	49 In Indium 114.818	50 Sn Tin 118.710	51 Sb Antimony 121.760	52 Te Tellurium 127.60	53 I Iodine 126.90...	54 Xe Xenon 131.293
ium 0...	56 Ba Barium 137.327	57–71	72 Hf Hafnium 178.49	73 Ta Tantalum 180.94...	74 W Tungsten 183.84	75 Re Rhenium 186.207	76 Os Osmium 190.23	77 Ir Iridium 192.217	78 Pt Platinum 195.084	79 Au Gold 196.96...	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.2	83 Bi Bismuth 208.98...	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
cium	88 Ra Radium (226)	89–103	104 Rf Rutherfordium (267)	105 Db Dubnium (268)	106 Sg Seaborgium (271)	107 Bh Bohrium (272)	108 Hs Hassium (270)	109 Mt Meitnerium (276)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (280)	112 Cn Copernicium (285)	113 Nh Nihonium (284)	114 Fl Flerovium (289)	115 Mc Moscovium (288)	116 Lv Livermorium (293)	117 Ts Tennessine (294)	118 Og Oganesson (294)

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

57 La Lanthanum 138.90...	58 Ce Cerium 140.116	59 Pr Praseodymium 140.90...	60 Nd Neodymium 144.242	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.964	64 Gd Gadolinium 157.25	65 Tb Terbium 158.92...	66 Dy Dysprosium 162.500	67 Ho Holmium 164.93...	68 Er Erbium 167.259	69 Tm Thulium 168.93...	70 Yb Ytterbium 173.054	71 Lu Lutetium 174.9668
89 Ac Actinium (227)	90 Th Thorium 232.0377	91 Pa Protactinium 231.03...	92 U Uranium 238.02...	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)	103 Lr Lawrencium (262)