UNIVERSITY OF ESWATINI

FACULTY OF HEALTH SCIENCES
DEPARTMENT OF ENVIRONMENTAL HEALTH
BSc DEGREE IN ENVIRONMENTAL HEALTH SCIENCE
RE-SIT EXAMINATION, 2021

TITLE OF PAPER : **RADIATION AND RADIOACTIVITY**

COURSE CODE : **EHS 417**

TIME : **2 HOURS**

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. **Write True or False against each letter corresponding to the following statements as they apply to radiation and radioactivity**

a) According to the electromagnetic theory, the speed of light is 2.9979×10^8 m/s in free space.

b) Light is an electromagnetic wave that requires medium for its propagation.

c) The equation, $E_R = mc^2$ indirectly implies that the mass of a particles may be completely convertible to energy.

d) Photons with energies less than 12.4 eV are considered to have sufficient energy to ionize matter, and are non-ionizing in nature.

e) A hot object has slightly more mass and is slightly more difficult to accelerate than an identical cold object because it has less thermal energy.

f) There are three skin cancers of concern; squamous cell carcinomas, basal cell carcinomas, and cutaneous malignant melanoma.

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

h) Electron capture does not change an atom's mass number, only its atomic number

i) Positrons are particles with the mass of an electron but have a positive instead of a negative charge.

j) Beta decay causes a nucleus to lose a neutron and gain a proton and thus decrease the neutron/proton ratio.

(20 marks)

II. Define One electron volt

(1 mark)

QUESTION 2

a) An electron moves with a speed, v = 0.850 c. Find its total energy and kinetic energy in mega electron volts.

$$E = \frac{m_c c^2}{\sqrt{1 - v^2//c^2}}$$

$= 9.11 \times 10^{-13} \times (3.0 \times 10^8 m/s)^2 \div \sqrt{1 - 0.850^2}/c^2$

$= 1.56 \times 10^{-13} J$

$= 1.56 \times 10^{-13} J \div 1.6 \times 10^{-19}$

$= 975000\ eV$

$= \underline{\boldsymbol{0.975\ MeV}}$

$KE = E - m_e c^2 = 0.975MeV - 0.511\ MeV = 0.464\ MeV$

$KE_i = \frac{1}{2} mv^2 = \frac{1}{2} (9.11 \times 10^{-13}\ kg)\ (0{,}850 \times 3 \times 10^8)^2$

$= 29618.89 \div 1.6 \times 10^{-19}$

$= \underline{\textbf{0.185 MeV}}$

(11 marks)

b) Describe the effects of exposure to Ultraviolet Radiation to the skin

(10 marks)

c) Describe the nuclear strong force.

(4 marks)

QUESTION 3

a. Describe alpha radiation

(8 marks)

b. Describe beta radiation

(6 marks)

c. The rest mass of one helium-3 nucleus is known to be 3.0011295 u. Calculate the sum of the rest masses of its three separated nucleons. The rest mass of a proton is 1.00727252 u, and that of a neutron 1.008665 u.
Using Einstein's equation, calculate the nuclear binding energy of the nucleus from the nuclear reaction and the energy per nucleon.

(11 marks)

QUESTION 4

i. Describe radioactive decay.

(5 marks)

ii. Cobalt -54 is a positron emitter. Write a balanced nuclear equation for its decay and also describe how a positron is made.

(12 marks)

iii. Briefly describe electron capture in the case of Vanadium – 50 nuclei.

(8 marks)

QUESTION 5

a) Distinguish between external and internal radiation.

(7 marks)

b) Describe uses of radiation in industry and medicine

(6 marks)

c) Calculate the binding force of $^{3}_{2}He$

(12 marks)

FORMULAE- ACOUSTIC AND HEALTH/RADIOACTIVITY AND RADIATION

1. $W = \sum_{i=1}^{4} \frac{\text{p rms(I)S}}{\rho C}$ 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 $\propto \frac{1}{d^2}$