# UNIVERSITY OF ESWATINI

**FACULTY OF HEALTH SCIENCES**
**DEPARTMENT OF ENVIRONMENTAL HEALTH**
**BSc DEGREE IN ENVIRONMENTAL HEALTH SCIENCE**
**RE-SIT EXAMINATION, JANUARY, 202O**

**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) The uses of laser and radio-frequency radiation in industrial, scientific, military, consumer, and medical applications are examples of natural sources and application of non-ionization radiation.

b) Overexposure to non-ionizing radiation produces a number of serious health effects, but there are thresholds between safe exposures and over exposures

c) Electromagnetic radiation is the propagation, or transfer, of energy through space and matter by time-varying electric and magnetic fields.

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) Skin effects of importance from occupational exposure include; erythema, photosensitivity, ageing and cancer.

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.

k) The net effect of positron emission is to gain a neutron and lose a proton.

l) There are five different types of ionising radiation, namely alpha ($\alpha$), beta ($\beta$), neutrons (n), gamma ($\gamma$).

**(24 marks)**

II. Define One electron volt

**(1 mark)**

**QUESTION 2**

a) Describe the difference between a biological and a health effect.
**(4 marks)**

b) Describe the effects of exposure to Ultraviolet Radiation to the skin
**(10 marks)**

c) Describe the nuclear strong force.
**(4 marks)**

d) By means of a balanced equation, illustrate the alpha decay of uranium-238
**(7 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) Describe Radiological Protection
**(12 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. $\bar{\alpha} = \frac{S_i\bar{\alpha}_i + S_2\bar{\alpha}_2 + \ldots.}{S_i + S_2}$
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 $\propto \frac{1}{d^2}$