MACHAKOS UNIVERSITY

University Examinations 2019/2020Academic year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE)

SPH 451: RADIATION AND ENVIRONMENT

DATE: 10/12/2019 **TIME: 8.30-10.30 AM**

INSTRUCTIONS TO CANDIDATES

Answer question ONE and other TWO questions

YOU MAY USE

The following constants may be useful $Boltzman\ constant\ k_o = 8.99\ x\ 10^9 Nm^2C^{-2}, e = 1.67\ x\ 10^{-19}\ C,\ Z = 1\ for\ a\ proton, c - speed\ of\ light =\ 2.99792458x\ 10^8 \frac{m}{s},$ $N_A\ avogadro\ number\ =\ 6.02 \times 10^{23} ptcles, m_p mass\ of\ proton = 1.67\ x\ 10^{-27} kg,\ 1\ \text{eV}\ =\ 1.602\ \text{x}\ 10^{-19}\ J$

QUESTION ONE (30 MARKS)

a) Solar radiation reaches a point on the earth's surface when the sun angle is at 80^o and at another time when the sun angle is 30^o. Using a diagram explain at which angle is the radiation is most intense. (3 marks)

b) Explain what is meant by solar radiation spatial variation and temporal variation. Use a diagram or a graph whichever necessary. (4 marks)

c) The earth is tilted at an angle23.5^o. Explain what happens to this angle as it orbits the sun (2 marks)

d) Explain why during summer, temperatures are higher than during winter (4 marks)

e) Using a diagram explain what happens to solar radiation as it travels towards the earth surface. (3 marks)

f) Using a diagram define Air Mass (AM) (4 marks)

g) Explain what happens when radiation pass through matter (3 marks)

h) When a radiation particle travels through matter it sees a sea of electrons. Its success depends on two factors, name them? (2 marks)

i) i. Write down the Bethe formula (3 marks)

j) ii. Explain what the Bethe formula describes (2 marks)

QUESTION TWO (20 MARKS)

a) Name three sources of background radiation and explain how each result (6 marks)

b) Name two sources of man-made radiation and explain how each result (4 marks)

c) Define the following terms

i. Extraterrestrial radiation (2 marks)

ii. Solar constant (2 marks)

d) Calculate stopping power of water for protons, given that excitation energy ln *I* eV = 4.312 for water Z= 1 for protons, $F(\beta) = 7.69$ and $\beta^2 = 0.00213$. (6 marks)

QUESTION THREE (20 MARKS)

a) Using a diagram, compare the earth's and solar radiation spectra (4 marks)

b) Write down the inverse square law of spectra intensity (2 marks)

c) Compare the temperatures of a planet with and without an atmosphere due to solar radiation (2 marks)

d) Define radiation tolerance dose (2 marks)

e) A proton traverse through water with kinetic energy $T = 0.5$ MeV, Find

i. its rate of energy Loss. (6 marks)

ii. Also find its range. (4 marks)

(take stopping potential for water as 270 MeVcm^{-1})

QUESTION FOUR (20 MARKS)

a) Name two mechanisms that lead to loss of energy of a radiation particle when it interacts with matter. (2 marks)

b) Name an instrument that is used to measure spectral power distribution (1 mark)

c) Spectra distribution can be defined for every type of light source.

i. Explain the significance of this knowledge (2 marks)

ii. Explain why tomato has vivid red colour, using a graph. (2 marks)

d) As the earth orbits the sun, it follows an elliptical path, at some time it is near the sun and at some other time its further, what is the impact of this on the earth surface (3 marks)

e) Calculate the mean excitation (I) energy for water. You can use the information that follows. (10 marks)

$I \approx 19.0\ eV; \qquad Z = 1 \quad eg\ hydrogen$

$I \approx 11.2\ eV + (11.7)(Z)eV;\ \ 2 \leq Z \leq 13$

$I \approx 52.8eV + (8.71)(Z)eV;\ Z > 13$

QUESTION FIVE (20 MARKS)

a) The following equation describes stopping potential when a particle travels through water

$$\frac{dE}{dX} = \frac{4\pi\ n\ z^2}{m_e c^2 \beta^2} \cdot (\frac{e^2}{4\pi\epsilon_o})^2 \left[In\left(\frac{2m_e\ c^2\beta^2}{I.(1-\beta^2)}\right) - \beta^2\right]$$

Show that this equation for proton travelling through water is same as

$-\frac{dE}{dX} = \frac{0.170}{\beta^2}[F(\beta) - 4.31]\ meVcm^{-1}$ (7 marks)

b) Hence,

i. Compute β^2 and $F(\beta)$ for a proton with kinetic energy T = 15 MeV (7 marks)

ii. Stopping power for water (3 marks)

c) Explain the basis that governs detection of a radiation (3 marks)