TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES
DEPARTMENT OF MATHEMATICS AND PHYSICS

UNIVERSITY EXAMINATIONS 2017/2018
APS 4440: RADIATION AND ENVIRONMENT

SERIES: FEBRUARY 2018 TIME: 2 HOURS

Instructions to candidates:
You should have the following for this examination
Answer booklet, Examination paper, Examination Pass and Student ID.
1. This examination paper contains Five Questions:
   Question **ONE** carries **30 marks** while the rest of the questions carry **20 marks** each.
2. Answer question **ONE** and any **TWO** of the other questions.

You may use the following constants:
i). Speed of light in a vacuum: $c = 3.0 \times 10^8$ m/s.
ii). Planck's constant: $h = 6.63\times10^{-34}$ Js. $= 4.14\times10^{-15}$ eV.
iii). Avogadro's Constant = 6.02×10^{23} particles.
iv). Charge on an electron = 1.6×10^{-19} C.

QUESTION ONE (30 MKS)

a). Name two beneficial uses of ionizing radiation where X-rays and Gamma rays are used.

(2marks)

b). Give two methods of reducing radon exposure during the construction of a house?

(2marks)

c). Is there a safe dose of radiation? Explain.

(2marks)

d). How is background radiation measured?

(2marks)

e). (i) What is an a.m.u.?

(2marks)

(ii) How much energy, in eV is equivalent to one a.m.u?

(3marks)

f). By giving one example in each case, differentiate between an ionizing particle and ionizing radiation.

(4marks)

g). By working out the energy in a single photon of each type of radiation, find out which of the two rays have a higher ionizing potential. Given that Gamma rays have a frequency of 300 $x10^{18}$ Hz. while UV rays have a wavelength of $100x10^{-9}$ m.

(3marks)

h) (i).What is an electron-volt?

(1mark)

(ii). Find the energy, in Joules, equivalent to 1 eV.

(2marks)

i).(i) What is activity of a radioactive substance and what are the SI units of radioactive activity?

(2marks)

(ii) .How many particles will Radium 226 emit per minute if one gram has an activity of 37×10^3 MBq?

(2marks)

j). Describe a radiation dosimeter then give two examples.

(3marks)

QUESTION TWO (20 MKS)

a). Name the sources of background radiation in the environment.

(2marks)

b). Describe how the concentration of ionizing radiation varies with altitude in the atmosphere.

(4marks)

c).What is the difference between natural and artificial natural background radiation in the environment?

(2marks)

d). (i). In Radium series: $^{238}_{92}U \rightarrow {}^{234}_{90}Th \rightarrow {}^{234}_{91}Pa \rightarrow {}^{234}_{92}U \rightarrow {}^{230}_{90}Th$ name the particles emitted in each transition.

(2marks)

ii) What is absorbed dose as used in radiation exposure? Give its measurement unit.

(2marks)

e). Describe Radon and explain its source.

(2marks)

f).How is the distribution of cosmic radiation affected by latitude?

(3marks)

g). Explain the term "activity" of radioactive material stating its units of measurement.

(3marks)

QUESTION THREE. (20MKS)

a). Describe effective dose of radioactive exposture.

(2marks)

b). The weighting factors for the body tissues are: Lung 0.12, Liver 0.05, Bone surface and 0.01. A radionuclide causes exposure of the lung, the liver, and the surfaces of the bones. If the equivalent doses to the tissues are, respectively, 100, 70, and 300 mSv. Find the effective dose.

(3marks)

c). The number at the beginning of a radioactivity was $1x10^{24}$ atoms. Find the half-life of radioactive element whose activity is $2.7x10^{5}$ in the first second.

.

(5marks)

d). Name and describe two methods of minimizing dosage during X-Ray therapy.

(4marks)

e). How do UV, X-ray and Gamma rays interact with matter?

(6maks)

QUESTION FOUR. (20MKS)

a) (i) Assuming the world human population is 6×10^9 find the annual collective effective dose if the effective dose from all sources of radiation is, on average, 2.8 mSv per person in a year.

(2mks)

(ii) Explain the meaning of "internal dosimetry".

(2mks)

b). Explain two routes taken by radionuclides into the human body.

(4mks)

c). (i) What is committed dose of a radiation exposture?

(2mks)

d). Describe the characteristics of a high level radioactive waste material which are to be considered in radioactive material disposal.

(3mks)

e).(i) Show the significant parts of a Geiger-Muller tube on a simple diagram.

(4mks)

(ii) Explain why it is necessary to connect a GM tube to a source of DC voltage.

(3mks).

QUESTION FIVE (20MKS)

a). Give the hierarchy of dose quantities stating the unit of measurement of each dose category.

(8marks)

b). Name three major sources of risks encountered when handling artificial radiation sources.

(3marks)

c). A radioactive material contains $1x10^{12}$ atoms and has a half-life is 30 days.
(i) What is the material's activity in the first second?

(4marks)

(ii) What is the time taken when 10000 atoms have remained?

(3marks)

iii) Find the count rate when 10000 atoms have remained.

(2marks)