CHUKA UNIVERSITY

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE

CHEM 417: RADIATION AND NUCLEAR CHEMISTRY

STREAMS: **TIME: 2 HOURS**

DAY/DATE: MONDAY 20/09/2021 **11.30 A.M – 1.30 P.M**

INSTRUCTIONS

- **Answer question one and any other two questions**

QUESTION ONE (30 MARKS)

1.(a) (i) List nine stringent requirements set against radiation detectors for nuclear instruments. [4 marks]

(ii) Discuss the most extensively utilized effects for radioactive radiation detection. [2 marks]

(iii) Outline the principal advantages and drawbacks of semiconductor detectors. [6 marks]

(iv) State features of the scintillation detector which tends to be dependent on the working conditions contributing it to be highly disadvantageous in industry. [2½ marks]

(b) (i) Write short notes on ionization interactions of gamma radiation with matter. [5 marks]

(ii) Compare scintillation and HPGe detector systems for gamma spectrometry with respect to resolution, efficiency, cost and other factors and also explain why these systems cannot be used for the selection of beta particles. [4½ marks]

(iii) What type of radiotracer technique should be used for the following analyses/ processes?

(I) Qualitative analysis of cation in a mixture. [½ mark]

(II) Determination of total suspended particulates (ISP) [½ mark]

(III) Determination of Ba. [½ mark]

(iv) Blood volume in a patient. [½ mark]

(v) Explain why long lined radioisotopes are preferred for isotope dilution experiment and also what precautions you need to take when you have short lived isotope only in the laboratory. [1 mark]

(c) Describe the principle of radioimmuno assay. [3 marks]

QUESTION TWO (20 MARKS)

2. (a) (i) Discuss the main characteristics of the various types of radiation given off by radioactive elements. [8 marks]

(ii) Briefly explain the following:

(I) Group displacement law. [2 marks]

(II) Radioactive equilibrium. [2 marks]

(III) Radioactive series [5 marks]

(b) (i) Cobalt 60 decays by emission of a beta particle, predict the atomic number mass numbers and name of the isotope formed. [1½ marks]

(ii) How many α and β – particles are emitted for the transformation.

$^{232}_{90}Th \rightarrow {}^{208}_{82}pb$ [1½ marks]

QUESTION THREE (20 MARKS)

3. (a) Discuss the stability of nuclear under the following;

(i) Binding energy per nucleon [4 marks]

(ii) Neutro -proton ratio and odd – even rule. [6 marks]

(b) (i) Derive parent -daughter decay- growth relationships when the daughter nucleus is stable. [5 marks]

(ii) The half life of a certain radioactive element A (molar mass 108) is 2 -30 min.

(I) Calculate the decay constant. [1 mark]

(II) If the sample had activity of 3HC, calculate the number of atoms and grams of the radioactive element. [2 marks]

(iii) emits ∝ particles and its half life period is 3.825 days. How many milligram of will remain after 8.83 days from 0.020 mg sample? [2 marks]

QUESTION FOUR (20 MARKS)

4. a (i) Discuss principles of the isotope dilution procedure and its applications. [7 marks]

(ii) The strepromycin in 500g of a broth was determined by addition of 1.34 mg of the pure antibiotic containing 14_C. The specific activity of this preparation was found to be 223 cpm/mg for a 30 min count from the mixture, 0.112 mg of purified streptomycin was isolated which produced 634 counts in 60 min . Calculate the concentration in parts per million streptomycin in the sample. [3 marks]

(b) (i) Prove that

$$R = CN\varnothing\sigma\left[1-e^{-¿¿\frac{0.693t}{t_{½}}}\right]$$

Where ;

R = counting rate

S = the saturation factor

C = A constant called the absolute detection efficiency.

$\varnothing$ = Average flux density

N = The number of stable target atoms

σ = the capture cross section. [8 ½ marks]

(ii) Draw a well labelled diagram showing the effect of neutron flux density and time on the activity induced in a sample. [1½ marks]
