



DEPARTMENT OF CHEMISTRY
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA

FIRST SEMESTER 2021/2022 EXAMINATION

COURSE CODE: CHM 412

COURSE TITLE: Radiation and Nuclear Chemistry 2 Units

INSTRUCTIONS: Answer any Three Questions

TIME ALLOWED: 2 Hours

- 1a) Compare and contrast the decay processes of electron capture and positron emission. **(6 marks)**
- b) If C-14 is constantly decaying, how is it that a living being has a constant amount of C-14 throughout its life time? **(4 marks)**
- (c) For each of the following groups of isotopes, which is likely to be the most stable? What decay modes are the unstable ones most likely to undergo, and what product(s) would be formed? **(10 marks)**
- (i) ^{19}Ne , ^{20}Ne , ^{23}Ne (ii) ^{58}Ni , ^{59}Ni , ^{66}Ni
- 2a) Define the following and state their units: **(4 marks)**
- i) absorbed dose
- ii) equivalent dose
- b) During an iodine bioassay of a person using I-125, the result of a 2 minute measurement was 1200 counts (or 600 cpm). The background for a 2 minute measurement performed immediately before was 950 counts (or 475 cpm). Knowing the detection efficiency of the instrument for I-125 to be 1.42 % for a person, determine the content of I-125 in the person's thyroid. **(16 marks)**
- 3a) Write nuclear equations for each of the following radioactive decay processes. **(8 marks)**
- i. positron emission of Cs-127
- ii. alpha decay of Bi-211
- iii. electron capture of the nucleus having 49 protons and 60 neutrons
- iv. beta decay of zirconium-97
-) Explain why a photon is emitted after an electron capture. **(4 marks)**
- i What is the relationship between a positron and an electron? **(2 marks)**

c) Iodine-131, used in diagnosis of thyroid disease, has a half-life of 8.04 days. How long will it take the 40.0 mg sample of I-131 to decay to 2.50 mg? **(6 marks)**

4a) Which radioactive emission(s) best fit(s) the following statements? Give a reason for each of the answers **(12 marks)**

- i. emissions are charged
- ii. emission is the most massive (heaviest)
- iii. emission is the most charged
- iv. emission is most dangerous outside the body
- v. emission is stopped by thin paper or a few centimeters of air
- vi. emission can travel through paper, but is stopped by aluminum
- vii. emission can travel through fairly thick lead

b) Explain why beta, rather than alpha or gamma radiation is used to check the correct thickness of paper being produced in a paper-making factory **(4 marks)**

ci) Why is U-234 unstable? **(2 marks)**

- ii. Give a reason why it is possible to use the decay of U-234 to Pb -206 to date geologic formations. **(2 marks)**