



(University of Choice)

**MASINDE MULIRO UNIVERSITY OF
SCIENCE AND TECHNOLOGY**

(MMUST)

Main campus

UNIVERSITY MAIN EXAMINATIONS

2021/2022 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER EXAMINATIONS

FOR THE DEGREE

OF

BACHELOR OF SCIENCE AND EDUCATION (SCIENCE)

COURSE CODE: SCH 312

COURSE TITLE: RADIATION AND NUCLEAR CHEMISTRY

DATE: 20th April, 2022

TIME: 8 a.m-10a.m

INSTRUCTIONS TO CANDIDATES

- Answer all the Questions
- Attached find periodic table

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 4 Printed Pages. Please Turn Over. ▶

QUESTION ONE (18 MARKS)

- a) Define the following terms and give examples where applicable:
- Positron production (2 marks)
 - Gamma-ray production (2 marks)
 - Electron capture (2 marks)
 - Stable light nuclides have about equal numbers of neutrons and protons. What happens to the neutron-to-proton ratio for stable nuclides as the number of protons increases? (1 mark)
 - Nuclides that are not already in the zone of stability undergo radioactive processes to get to the zone of stability. If a nuclide has too many neutrons, which process(es) can the nuclide undergo to become more stable? Answer the same question for a nuclide having too many protons. (2 marks)
- b) Complete the following nuclear equations.(3 marks)
- ${}^{14}_7\text{N} + {}^4_2\text{He} \rightarrow ? + {}^1_1\text{H}$
 - ${}^{238}_{92}\text{U} + ? \rightarrow {}^{247}_{99}\text{Es} + 5{}^1_0\text{n}$
 - $? + {}^2_1\text{H} \rightarrow {}^{239}_{93}\text{Np} + {}^1_0\text{n}$
- c) Write nuclear equations for:
- Alpha emission by plutonium-239, one of the substances formed in nuclear power plants. (2 marks)
 - Beta emission by sodium-24, used to detect blood clots. (2 marks)
 - What is nuclear transformation? (1 mark)
 - Give an example of nuclear transformation. (1 mark)

QUESTION TWO (18 MARKS)

- a. The table shows the steady increase in the neutron-to-proton ratios of the most abundant isotopes of the elements in group 15 on the periodic table; complete it by filling the missing protons, neutrons and neutron to proton ratios (3 Marks)

Element	Number of neutrons	Number of protons	Neutron to proton ratio
Nitrogen, N			1 to 1
Phosphorus, P	16	15	
Arsenic, As	42		1.27to 1
Antimony, Sb	70	51	
Bismuth, Bi	126		1.52 to 1

- b. Describe the contribution of the following scientists in the discovery of radioactivity:
- H. Becquerel. (2 marks)-
 - Marie Curie and Pierre Curie. (2 marks)
- c. All radioactive decay processes follow first-order kinetics. What does this mean? (1 mark)
- What happens to the rate of radioactive decay as the number of nuclides is halved? (1 mark)

- ii. Write the first-order rate law and the integrated first-order rate law. Define the terms in each equation. (4 marks).
- iii. What is half-life? (1 mark)
- iv. Give the mathematical expression for half-life in radioactive decay. Define the terms in the equation. (2 marks)
- v. A certain active substance (which has no radioactive parent) has a half-life of 8.0 days. What fraction of the initial amount will be left after 16 days? (2 marks)

QUESTION THREE (19 MARKS)

- a. Radiotracers are used in the medical sciences to learn about metabolic pathways. What are radiotracers? Give examples (4 marks)
- b.
 - i. Nuclear fusion and nuclear fission are two exothermic nuclear processes. Differentiate between the two. (2 marks)
 - ii. How does the energy associated with fission or fusion processes compare to the energy changes associated with chemical reactions?(2 marks)
- c.
 - i. How does a nuclear power plant produce electricity? (3 marks)
 - ii. Discuss the Chernobyl disaster of 1986 (4 marks)
- iii. Explain what has been happening at the Chernobyl power plant since Russian invasion of Ukraine on 24th February, 2022 and how the war is affecting our economy.(4 marks)

QUESTION FOUR (15 MARKS)

- a. Give the other names for the following series, and discuss the steps in the thorium series (9 marks)
 - i. Uranium series
 - ii. Thorium series
 - iii. Actinium series
- b. The biological effects of a particular source of radiation depend on several factors. Explain. (4 marks)
- c. Write balanced equations for each of the following processes.
 - i. ${}^{11}_{6}\text{C}$ produces a positron. (1 mark)
 - ii. ${}^{214}_{83}\text{Bi}$ produces a β -particle. (1 mark)

Periodic Table of the Elements

MAIN-GROUP ELEMENTS		TRANSITION ELEMENTS																MAIN-GROUP ELEMENTS						
1A (1)		3B (3) 4B (4) 5B (5) 6B (6) 7B (7) 8B (8) (9) (10)										1B (11) 2B (12)		3A (13) 4A (14) 5A (15) 6A (16) 7A (17) 8A (18)										
1	1 H 1.008																	2 He 4.003						
2	3 Li 6.941																	10 Ne 20.18						
3	11 Na 22.99	12 Mg 24.31																	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80						
5	37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3						
6	55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)						
7	87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 (269)	111 (272)	112 (277)	As of mid-1999, elements 110 through 112 have not yet been named.											
		INNER TRANSITION ELEMENTS																						
6	Lanthanides	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0									
7	Actinides	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np (237)	94 Pu (242)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (260)									