

36



KIBABII UNIVERSITY

**UNIVERSITY EXAMINATIONS
2022/2023 ACADEMIC YEAR**

**THIRD YEAR SECOND SEMESTER
MAIN EXAMINATIONS**

FOR THE DEGREE OF BSC (CHEMISTRY) AND B.EE

COURSE CODE: SCH 322

COURSE TITLE: RADIATION AND NUCLEAR CHEMISTRY

DATE: 19/04/2023

TIME: 2:00-4:00PM

INSTRUCTIONS TO CANDIDATES:

TIME: 2 HOURS

ANSWER QUESTION ONE AND ANY TWO OF THE REMAINING

THIS PAPER CONSISTS OF 3 PRINTED PAGES

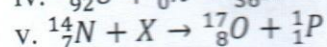
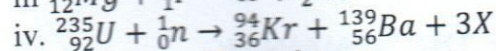
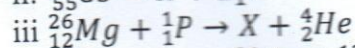
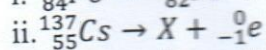
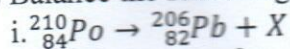
KIBU OBSERVES ZERO TOLERANCE TO examination

QUESTION ONE (30 MARKS)**(5 marks)****(a)** Define the following terms

- (i) Nuclear chemistry
- (ii) Radiations
- (iii) Nucleons
- (iv) Radioisotopes
- (v) Film badges

(b) Distinguish between fusion reaction and fission reaction **(2 marks)****(c)** Alpha (α), beta (β) and gamma (γ) rays differ from each other in nature and properties. State the three chief properties **(3 marks)****(d)** Radioisotope ${}_{15}\text{P}^{32}$ has a half-life of 15 days. Calculate the time in which the radioactivity of its 1.0 mg quantity will fall to 10% of the initial value **(4 marks)****(e)** Determine the decay constant for carbon 14, if it has a half-life of 5730 years **(2 marks)****(f)** State the Group Displacement Law' **(2 marks)****(g)** Explain the meaning of radioactive disintegration series **(1 mark)****(h)** State the three radioactive disintegration series **(3 marks)****(i)** Calculate the half-life of radium-226 if 1 g of it emits 3.7×10^{10} alpha particles per second ($L = 6.023 \times 10^{23}$) **(4 marks)****(j)** Discuss some of the practical application of nuclear chemistry in **(4 marks)**

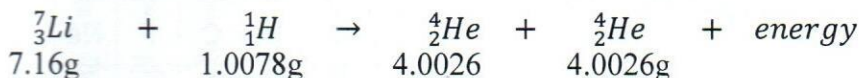
- i. Analytical applications
- ii. Industrial exploration of leaks

QUESTION TWO (20 MARKS)**(a)** Distinguish between isobars and isotones by giving an example for each **(4 marks)****(b)** What is meant by bremsstrahlung radiation **(2 marks)****(c)** Briefly explain how bremsstrahlung radiation occurs **(5 marks)****(d)** Balance the following nuclear equations and identify X **(5 marks)****(e)** Differentiate between the following mean life and half-life **(2 marks)****(f)** How many α and β particles are emitted in passing down from ${}_{90}^{230}\text{Th}$ to ${}_{82}^{206}\text{Pb}$ **(2 marks)****QUESTION THREE (20 MARKS)****(a)** Briefly describe the scintillation method of measuring radiations **(5 marks)****(b)** Discuss the stability of nucleus in terms of neutron-proton ratio **(4 marks)****(c)** Briefly describe the discovery of radioactivity **(4 marks)****(d)** Explain terrestrial radiation as a natural source of radioactive radiations **(5 marks)****(e)** State two artificial sources of radioactive radiation **(2 marks)**

QUESTION FOUR (20 MARKS)

(a) A sample of 2 g ${}^{209}_{83}\text{Bi}$ with a half-life 2.7×10^7 years decays into stable isotope of thallium by emitting alpha particle. What would be the activity of the sample after 2 years? (3 marks)

(b) Using Einstein equation; $E = MC^2$, determine the energy released in the following reaction in kcal (4 marks)



(c) (i) Define binding energy (2 marks)

ii) What is the binding energy for ${}^{11}_5\text{B}$ nucleus if its mass defect is 0.08181 amu? (4 marks)

(d) Tritium (${}^3\text{H}$) decays by beta emission to (${}^3\text{He}$) with a half-life of 12.26 years. A sample of a tritiated compound has an initial activity of 0.833Bq. Calculate the decay constant K and activity after 2.50 years. (4 marks)

(e) Based on the spin pairing, predict which one you would expect to be radioactive in each of the following pairs: (3 Marks)

- (i) Cl-35 or Cl-36
- (ii) Ne-20 or Ne-17
- (iii) Ca-40 or Ca-45

QUESTION FIVE (20 MARKS)

(a) Explain Film badges as a method of detection and measurement of radioactivity. (10 marks)

(b) Show that $t_{1/2} = \frac{0.693}{\lambda}$ (5 marks)

(c) 0.01 mg of Pu- 239 units has decay constant of 1.4×10^7 particles/ minute. What is its half-life (5 marks)

30

1 hydrogen 1 H 1.0079	2 helium 2 He 4.0026	3 lithium 3 Li 6.941	4 beryllium 4 Be 9.0122	5 boron 5 B 10.811	6 carbon 6 C 12.011	7 nitrogen 7 N 14.007	8 oxygen 8 O 15.999	9 fluorine 9 F 18.998	10 neon 10 Ne 20.180	11 sodium 11 Na 22.990	12 magnesium 12 Mg 24.305	13 aluminum 13 Al 26.982	14 silicon 14 Si 28.086	15 phosphorus 15 P 30.974	16 sulfur 16 S 32.065	17 chlorine 17 Cl 35.453	18 argon 18 Ar 39.948	
19 potassium 19 K 39.098	20 calcium 20 Ca 40.078	21 scandium 21 Sc 44.956	22 titanium 22 Ti 47.887	23 vanadium 23 V 50.942	24 chromium 24 Cr 51.996	25 manganese 25 Mn 54.938	26 iron 26 Fe 55.845	27 cobalt 27 Co 58.933	28 nickel 28 Ni 58.693	29 copper 29 Cu 63.546	30 zinc 30 Zn 65.38	31 gallium 31 Ga 69.723	32 germanium 32 Ge 72.61	33 arsenic 33 As 74.922	34 selenium 34 Se 78.96	35 bromine 35 Br 79.904	36 krypton 36 Kr 83.80	
37 rubidium 37 Rb 85.468	38 strontium 38 Sr 87.62	39 yttrium 39 Y 88.906	40 zirconium 40 Zr 91.224	41 niobium 41 Nb 92.906	42 molybdenum 42 Mo 95.96	43 technetium 43 Tc [98]	44 ruthenium 44 Ru 101.07	45 rhodium 45 Rh 102.91	46 palladium 46 Pd 106.42	47 silver 47 Ag 107.87	48 cadmium 48 Cd 112.41	49 indium 49 In 114.82	50 tin 50 Sn 118.71	51 antimony 51 Sb 121.76	52 tellurium 52 Te 127.60	53 iodine 53 I 126.90	54 xenon 54 Xe 131.29	
55 caesium 55 Cs 132.91	56 barium 56 Ba 137.33	57-70 lanthanoids * La 138.91	71 lutetium 71 Lu 174.97	72 hafnium 72 Hf 178.49	73 tantalum 73 Ta 180.95	74 tungsten 74 W 183.84	75 rhenium 75 Re 186.21	76 osmium 76 Os 190.23	77 iridium 77 Ir 192.22	78 platinum 78 Pt 195.08	79 gold 79 Au 196.97	80 mercury 80 Hg 200.59	81 thallium 81 Tl 204.38	82 lead 82 Pb 207.2	83 bismuth 83 Bi 208.98	84 polonium 84 Po [209]	85 astatine 85 At [210]	86 radon 86 Rn [222]
87 francium 87 Fr [223]	88 radium 88 Ra [226]	89-102 actinoids ** Lr [262]	103 lawrencium 103 Lr [262]	104 rutherfordium 104 Rf [261]	105 dubnium 105 Db [268]	106 seaborgium 106 Sg [271]	107 bohrium 107 Bh [272]	108 hassium 108 Hs [270]	109 meitnerium 109 Mt [278]	110 darmstadtium 110 Ds [285]	111 roentgenium 111 Rg [288]	112 unubium 112 Uub [285]	113 ununium 113 Uut [284]	114 ununquadium 114 Uuq [289]	115 ununpentium 115 Uup [288]	116 ununhexium 116 Uuh [293]	117 ununseptium 117 Uus [294]	118 ununoctium 118 Uuo [294]

Key:
 element name
 atomic number
 symbol
 atomic weight (mean relative mass)

*lanthanoids

**actinoids

lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dyprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.05
actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]