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)

(a) Define the following terms **(5 marks)**

(i) Nuclear chemistry

(ii) Radiations

(iii) Nucleons

(iv) Radioisotopes

(v) Film budges

(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 **(3marks)**

(d) Radioisotope $_{15}P^{32}$ 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 ($L = 6.023 \times 10^{23}$) **(4marks)**

(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)**

i. $^{210}_{84}Po \rightarrow {}^{206}_{82}Pb + X$

ii. $^{137}_{55}Cs \rightarrow X + {}^{0}_{-1}e$

iii $^{26}_{12}Mg + {}^{1}_{1}P \rightarrow X + {}^{4}_{2}He$

iv. $^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{94}_{36}Kr + {}^{139}_{56}Ba + 3X$

v. $^{14}_{7}N + X \rightarrow {}^{17}_{8}O + {}^{1}_{1}P$

(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 $^{230}_{90}Th$ *to* $^{206}_{82}Pb$ **(2marks)**

QUESTION THREE (20 MARKS)

(a) Briefly describe the scintillation method of measuring radiations **(5marks)**

(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 $^{209}_{83}Bi$ 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)**

$$^{7}_{3}Li \quad + \quad ^{1}_{1}H \quad \rightarrow \quad ^{4}_{2}He \quad + \quad ^{4}_{2}He \quad + \quad energy$$

7.16g 1.0078g 4.0026 4.0026g

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

ii) What is the binding energy for $^{11}_{5}B$ nucleus if its mass defect is 0.08181 amu? **(4 marks)**

(d) Tritium (3H) decays by beta emission to (3He) 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

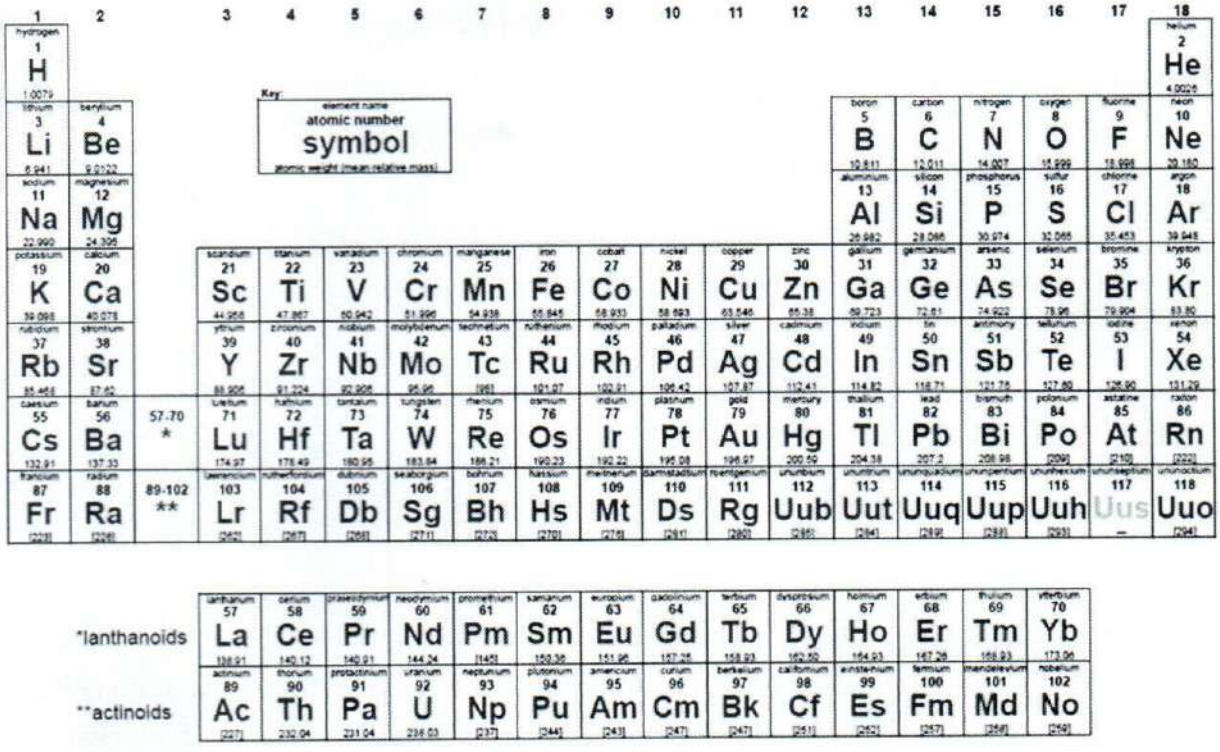
(iii) Ca-40 or Ca-45

QUESTION FIVE (20 MARKS)

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

(b) Show that $t_{½}=\frac{0.693}{\lambda}$ **(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**


Key
element name
atomic number
symbol
atomic weight (mean relative mass)
1 hydrogen 1 H 1.0079
2 helium 2 He 4.0026
3 lithium Li 6.941
4 beryllium Be 9.0122
5 boron B 10.811
6 carbon C 12.011
7 nitrogen N 14.007
8 oxygen O 15.999
9 fluorine F 18.998
10 neon Ne 20.180
11 sodium Na 22.990
12 magnesium Mg 24.305
13 aluminium Al 26.982
14 silicon Si 28.086
15 phosphorus P 30.974
16 sulfur S 32.065
17 chlorine Cl 35.453
18 argon Ar 39.948
19 potassium K 39.098
20 calcium Ca 40.078
21 scandium Sc 44.956
22 titanium Ti 47.867
23 vanadium V 50.942
24 chromium Cr 51.996
25 manganese Mn 54.938
26 iron Fe 55.845
27 cobalt Co 58.933
28 nickel Ni 58.693
29 copper Cu 63.546
30 zinc Zn 65.38
31 gallium Ga 69.723
32 germanium Ge 72.61
33 arsenic As 74.922
34 selenium Se 78.96
35 bromine Br 79.904
36 krypton Kr 83.80
37 rubidium Rb 85.468
38 strontium Sr 87.62
39 yttrium Y 88.906
40 zirconium Zr 91.224
41 niobium Nb 92.906
42 molybdenum Mo 95.96
43 technetium Tc [98]
44 ruthenium Ru 101.07
45 rhodium Rh 102.91
46 palladium Pd 106.42
47 silver Ag 107.87
48 cadmium Cd 112.41
49 indium In 114.82
50 tin Sn 118.71
51 antimony Sb 121.76
52 tellurium Te 127.60
53 iodine I 126.90
54 xenon Xe 131.29
55 caesium Cs 132.91
56 barium Ba 137.33
57-70 *
71 lutetium Lu 174.97
72 hafnium Hf 178.49
73 tantalum Ta 180.95
74 tungsten W 183.84
75 rhenium Re 186.21
76 osmium Os 190.23
77 iridium Ir 192.22
78 platinum Pt 195.08
79 gold Au 196.97
80 mercury Hg 200.59
81 thallium Tl 204.38
82 lead Pb 207.2
83 bismuth Bi 208.98
84 polonium Po [209]
85 astatine At [210]
86 radon Rn [222]
87 francium Fr [223]
88 radium Ra [226]
89-102 **
103 lawrencium Lr [262]
104 rutherfordium Rf [267]
105 dubnium Db [268]
106 seaborgium Sg [271]
107 bohrium Bh [272]
108 hassium Hs [270]
109 meitnerium Mt [276]
110 darmstadtium Ds [281]
111 roentgenium Rg [280]
112 ununbium Uub [285]
113 ununtrium Uut [284]
114 ununquadium Uuq [289]
115 ununpentium Uup [288]
116 ununhexium Uuh [293]
117 ununseptium Uus –
118 ununoctium Uuo [294]
*lanthanoids
57 lanthanum La 138.91
58 cerium Ce 140.12
59 praseodymium Pr 140.91
60 neodymium Nd 144.24
61 promethium Pm [145]
62 samarium Sm 150.36
63 europium Eu 151.96
64 gadolinium Gd 157.25
65 terbium Tb 158.93
66 dysprosium Dy 162.50
67 holmium Ho 164.93
68 erbium Er 167.26
69 thulium Tm 168.93
70 ytterbium Yb 173.04
**actinoids
89 actinium Ac [227]
90 thorium Th 232.04
91 protactinium Pa 231.04
92 uranium U 238.03
93 neptunium Np [237]
94 plutonium Pu [244]
95 americium Am [243]
96 curium Cm [247]
97 berkelium Bk [247]
98 californium Cf [251]
99 einsteinium Es [252]
100 fermium Fm [257]
101 mendelevium Md [258]
102 nobelium No [259]