Assignment – 3

Course Instructor: Prof. Rajeev Gupta

M.Sc. Chemistry (Semester – IV)

Paper: 4104 Section: B (Nuclear & Radiation Chemistry)

Instructions: ***All questions are compulsory. Question No. 1 carries 11 marks while other two questions carry 12 marks each.***

(4 + 4 + 3 = 11)

Q1. Attempt all parts.

(a) Na (Z = 11) with mass numbers 22 and 23 have spins 3 and 3/2, respectively. Explain.

(b) How does a chain reaction sustained in a nuclear fission reactor and when the reactor becomes "critical"?

(c) The Electrical quadrupole moment of ^{175}Lu (Z = 71) is 5.9b. Calculate the deformation index (β) for this nucleus.

(4 x 3 = 12)

Q2. Attempt any three parts.

(a) A radiation source is to be calibrated using Fricke's dosimeter for which G(Fe^{3+}) is 15.6. If the change in extinction (at 305 nm) of the solution is 0.3, calculate the amount of radiation received. The molar extinction coefficient for Fe^{3+} species is 2174 $M^{-1}cm^{-1}$ and the density of the solution is 1024 kg/m^3. The cell used in the experiment has a path length of 1 cm. Is calibration of the dosimeter possible in presence of an organic impurity?

(b) What do you understand by the cross – section of a nuclear reaction? Calculate the number of ^{64}Cu atoms produced when a 40 mg piece of ^{65}Cu wire was exposed to a thermal neutron flux of 4 x 10^8 $cm^{-2}sec^{-1}$ for 5 minutes. The cross-section for the ^{65}Cu (n, 2n) ^{64}Cu nuclear reaction is 0.32b.

(c) What is plasma and how can it be confined? For deuterium – tritium fusion reaction, the value of Lawson criterion is 10^{14} sec/cm^3. What do you understand by this value?

(d) Discuss the various modes of interaction of γ - rays with matter by which it loses its energy.

(4 x 3 = 12)

Q3. Attempt any <u>three</u> parts.

(a) $^{65}Cu_{29}$ gives rise to (α, n), (α, 2n) and (α, 3n) nuclear reactions when bombarded with α particles of 28 MeV energy. Why does not the reaction stop at (α, n) reaction? Explain.

(b) Discuss the important features of the "Liquid Drop Model" and explain fission of a heavy nucleus using this model.

(c) After irradiation by neutrons, ^{127}I undergoes a nuclear reaction $^{127}I(n, \gamma)^{128}I$ by emitting γ - ray of energy 4.8 MeV. How is it that the hot I – atom causes the bond rupture in C_2H_5I and not in HI given the corresponding C_2H_5I and HI bond energies as 3.0 and 2.0 eV, respectively.

(d) Examine the following data and comment if it is possible to set up a <u>fast neutron</u> breeder reactor using $^{233}U_{92}$ or $^{235}U_{92}$ as the fuel:

Fuel	σ (n, fission)	σ (n, capture)	ν	η
$^{233}U_{92}$	2.20	0.15	2.59	2.43
$^{235}U_{92}$	1.44	0.22	2.52	2.19

Also explain the role of blanket in breeder reactor?

Values of some of the physical constants:

$N = 6.023 \times 10^{23}$

$1/4\pi\varepsilon_o = 9 \times 10^9$

1 amu = 931.478 MeV

$e = 1.6 \times 10^{-19}$ C

$1eV = 1.6 \times 10^{-19}$ J

$k = 1.3805 \times 10^{-23}$ J deg^{-1}

$R_o = 1.3 \times 10^{-15}$ m; $R = R_oA^{1/3}$