

MINOR - PYL302: [Total marks: 40]

EXAM ETHICS: Open book, No cross talk, No discussion

[From Q 1 to 6, upload answers in pdf in the google sheet. Show detailed calculation and mathematical formulation]

Q1. A] A gamma ray of energy 4 MeV undergoes a pair creation process and in a He gas field ionization chamber of capacitance 10 pF, and one of the generated particle is detected. Calculate the pulse height in the output of an amplifier (gain = 1000), where $W_{\text{He}} = 42.6 \text{ eV}$.

B] Three radioactive gamma particle emitters (A,B,C) emit photons of same energy. Considering photon emission involves two energy levels (in all cases) with times 10 ns, 50 ns and 100 ns, distinguish A, B and C using a photon detection system **[3+2=5]**

Q2. A] Explosion of one H-bomb releases energy of typically 10^{30} MeV . A nuclear fusion reactor is designed to use water of a lake (area: 256, 000 km^2 , depth: 0.08km) as its fuel. If the abundance of D is 0.0156% and considering fusion reaction in Deuterium, plasma, estimate how many H-bomb explosion is required to produce equivalent energy of this reactor?

B] In a U-235 fission reactor 10^{11} fission events per second occur. Approximately how much power will be generated in the reactor? **[3 + 2 = 5]**

Q3. A] Draw activity curves (conceptual) for the following parent daughter relationships: (i) long lived parent, (ii) very long lived parent.

B] Calculate the age of the earth (approximately), given that the isotopic abundances of U-238 and U-235 today are 99.28% and 0.72% respectively. Assume that originally these isotopes were present in equal abundances and no isotopic separation has occurred by physical or chemical process. **[2+3=5]**

Q4. In a general NAA process consider the following nuclear reaction, $X(n,b)Y$. If N_x is the total number of target nucleus, what is the saturation activity of Y? **[5]**

Q5. A] A biological sample under MRI scanner containing 1/10 cc water is kept in a magnetic field of 0.1 Tesla, which is capable of aligning all spins in one orientation. Calculate (approximately) the energy involved if the spin orientation of all the protons are 'flipped' under a resonant oscillatory field.

B] 'BNCT is more effective in cancer therapy as compared to gamma therapy' do you agree? Give reason **[3+2 = 5]**

Q6. A] Compound nucleus does not remember its formation process --- why?

B] An even-odd nucleus ${}_Z^AX^A$, emits an alpha particle. What is the energy released in this reaction in the framework of LDM? **[2 + 3 = 5]**

[From Q7 to 16: 1 mark for correct answer, -1/2 for wrong attempt]

Q7. In a Tokamak confinement of plasma which are driven out by electric field created by charge separation, is done by

(i) a large current passing parallel to toroidal current, (ii) adding a weak magnetic field alongwith toroidal field (iii) Using a rf field to resonate plasma, (iv) None of these

Q8. In a fission reactor suddenly jumping to state of reproduction factor $\gg 1$, control operator will immediately

(i) add fuel in the core, (ii) add moderator to the core, (iii) insert control rods, (iv) take out control rods

Q9. In a nuclear reaction $X+a \rightarrow [C^*] \rightarrow Y+\gamma$, the mean life time of C was found to be 4.7×10^{-15} sec. The 'level width' of γ is 3.4×10^{-2} eV. If a solid state detector is used to detect Y (K.E. 10eV), its resolution should be better than,

(i) $\sim 0.1\%$, (ii) $\sim 0.3\%$, (iii) $\sim 0.5\%$ (iv) $\sim 0.8\%$, (v) none of these

Q10. In a star if H to He conversion by fusion stops,

(i) the star will die, (ii) star becomes a black hole, (iii) another fusion reaction will trigger in the star, (iv) none of these

Q11. In a biological specimen undergoing a physical phase due to exposure of high dose nuclear radiation

(i) DNA reacts with OH^- , (ii) Chromosome breaks, (iii) Onset of mitosis gets delayed, (iv) none of these

Q12. In NAA process for estimating trace element level

(i) neutrons are scattered, (ii) neutron spectra is used to get activity, (iii) gamma ray spectrum is recorded, (iv) none of these

Q13. Skin undergoes less damage than lung due to 5 MeV alpha, True/False

Q14. Na is bombarded by high energy alpha and Hydrogen forms in the reaction. The compound nucleus is Mg. Yes/No

Q15. R-C circuit in an amplifier can give an integrated output. True/False

Q16. The B.E. of a nucleus is proportional to its volume. Therefore B.E./A should be a constant quantity. Yes/No

[1 x 10 = 10]