**Q.P. Code :02228**

**[Time: $2\frac{1}{2}$Hours]** **[ Marks:75]**

Please check whether you have got the right question paper.

N.B: 1. All questions are compulsory.
2. Figures to the right indicate full marks.
3. Draw neat diagrams wherever necessary.
4. Symbols have usual meaning unless otherwise stated.
5. Use of log table and non-programmable calculator allowed.

**Q. 1 (a)** Attempt **any one:-**

**i)** Write Q value equation for nuclear reaction in the standard form and obtain its solution in terms of energy of the product particle. Discuss the solution when the energy of the bombarding particle is very low. **10**

**ii)** Explain, how velocity and energy of $\alpha$ particles can be determined using magnetic spectrograph. What is the range of $\alpha$ particles? On what factors does it depend? **10**

**(b)** Attempt **any one:-**

**i)** Discuss alpha decay paradox. **05**

**ii)** Define threshold energy of a nuclear reaction. Obtain an equation for the same. **05**

**Q. 2 (a)** Attempt **any one:-**

**i)** Explain the salient features of the beta ray spectrum. What were the difficulties encountered in understanding beta decay? How were these difficulties overcome? **10**

**ii)** What is Mossbauer effect? Explain the experiment to study this effect. **10**

**(b)** Attempt **any one:-**

**i)** What are different types of beta decay? Discuss energetics of any one of them. **05**

**ii)** What is nuclear isomerism? Explain with suitable example. **05**

**Q. 3 (a)** Attempt **any one:-**

**i)** With the help of a schematic diagrams, explain the working of cloud chamber. What are its advantages and disadvantages? **10**

**ii)** Write Weizsacker's semi empirical mass formula for the nucleus. Rewrite it appropriately in the form of the equation of a parabola. For odd values of A, derive expressions for charge and mass of the most stable isobar. **10**

**(b)** Attempt **any one:-**

**i)** Show diagrammatically the variation of ionization current (pulse height) with applied voltage when a particle passes through a cylindrical ionization chamber. Mark and name the regions of interest for different types of radiation detector/ counter. **05**

**ii)** State the success and limitation of the liquid drop model of the nucleus. **05**

**[P.T.O]**

**Q. 4 (a)** Attempt **any one:-**

**i)** What is the Nuclear Reactor? Explain essential features which are used to classify the nuclear reactor. **10**

**ii)** Explain in detail, elementary particles. Discuss properties of neutrons and antineutrons. **10**

**(b)** Attempt **any one:-**

**i)** Explain natural fusion and energy produced in the stars. **05**

**ii)** What is a 'Breeder Reactor'? **05**

**Q. 5 (a)** Attempt **any one:-**

**i)** Complete the following nuclear reaction and find mass of X if Q value of the reaction is 2.38 MeV.

$^{23}_{11}Na + {}^{1}_{1}H \rightarrow {}^{20}_{10}Ne$ + X

Given: M ($^{23}_{11}Na$) = 22.989770 u, M($^{1}_{1}H$ ) = 1.0007825 u

M($^{20}_{10}Ne$) = 19.992440 u, 1 u = 931.5 MeV **04**

**ii)** Find the height of the potential barrier for $\alpha$ penetration through $^{238}_{92}U$ nucleus. The radius of the nucleus is 8.75 x $10^{-13}$cm.
Given: $\varepsilon_{\circ}$ = 8.85 x $10^{-12}$ f/m, $e$ = 1.6 x $10^{-19}$ C. **04**

**(b)** Attempt **any one:-**

**i)** In a beta decay, the parent emits four groups of conversion electrons with kinetic energies in keV of 266.3, 264.3, 263.6 and 193.3. To what shell of the daughter atom, K, $L_I$, $L_{II}$, $L_{III}$ does each group correspond? The electron binding energies (in keV) in the shells are 87.7, 15.4, 14.8 and 12.7 respectively. Calculate the energies of gamma-quanta concurrent with this decay. **04**

**ii)** The atomic masses of $^{7}_{3}Li$ and $^{7}_{4}Be$ are 7.016005 u and 7.016929 u respectively. Which of them shows beta activity and of what type? Determine Q-value.
Given: $m_e$ = 0.000548 u, 1u = 931.5 MeV. **04**

**(c)** Attempt **any one:-**

**i)** When a particle of energy 0.5 MeV passes through an ionization chamber, how many ion pairs are produced, if energy required per ion pair is 25 eV. What is the pulse height if the capacitance of the ionization chamber is 20pF? Given: e = 1.6 x $10^{-19}$C. **04**

**ii)** For an isobaric family A = 79. Estimate the nuclear charge $Z_0$ for the most stable isobar. Given $a_a$ = 19 MeV, $a_c$ = 0.60 MeV, $m_p$ = 1.007825u, $m_n$ = 1.008665u. 1u = 931. 5MeV. **04**

(**d)** Attempt **any one:-**

**i)** Calculate an amount of energy released by 5g of $^{235}_{92}U$ when it is completely fissioned if energy released per fission of $^{235}_{92}U$ is 200.6 MeV. Given: Avogadro's number = 6.023 x $10^{23}$ / mole. **03**

**ii)** If a fission process starts with 5000 neutrons, calculate the number of neutrons present in tenth generation. Given : multiplication factor k = 1.05 **03**

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