

Date : 23.11.2019

Time : (3 Hours)

Total Marks: 100

- N.B. (1) All questions are compulsory.
 (2) Figures to the right indicate marks for respective sub questions.
 (3) Use of **Non-programmable** calculators is **allowed**.
 (4) Draw **neat labeled diagrams** wherever **necessary**.
 (5) Symbols used have their usual meaning

Q.1) [A] Choose correct alternative in each of the following. (12)

- (i) In the graph of binding energy per nucleon v/s mass numbers, small peaks indicate that the corresponding element are -----
 (a) radioactive (b) Less stable
 (c) Comparably more stable (d) More abundant
- (ii) When a radioactive substance emits one alpha particle, _____
 (a) A decreases by 4, Z increases by 2 (b) A increased by 4, Z decreases by 2
 (c) A decreases by 2 (d) None of these.
- (iii) The average energy lost by the incident particle in creation one γ -pair which lies between -----
 (a) 5 to 15 eV (b) 35 to 45 eV
 (c) 25 to 35 eV (d) 15 to 25 eV
- (iv) When fast moving particle passes through a gas filled tube, the energy loss per unit length is inversely to its -----
 (a) Velocity (b) Charge
 (c) mass (d) density
- (v) X- rays shows _____ phenomenon.
 (a) interference (b) diffraction
 (c) polarization (d) all of the above.
- (vi) The gain in energy of a photon that falls in gravitational field is manifested as increase in _____
 (a) wavelength (b) velocity
 (c) mass (d) frequency

[B] Answer in One Sentence (3)

- (i) Define one curie.
 (ii) Write the principle of GM counter.
 (iii) What is gravitational red shifts?

[C] Fill in the blanks (5)

- (i) In ${}^{226}_{88}\text{Ra}$ nucleus, there are _____ neutrons and _____ protons.
 (ii) β radiations are simply -----.
 (iii) Complete the following nuclear reaction
 ${}^7\text{N}^{14} + {}^2\text{He}^4 \rightarrow {}^8\text{O}^{17} + \text{-----}$
 (iv) When charged particle passes through the matter which removes an electron from atom. The process is called as _____
 (v) _____ production is conversion of radiant energy into matter.

- Q.2) [A] Attempt **any ONE** of the following. (8)
- Derive an expression to estimate the nuclear radius from Rutherford's alpha scattering experiment.
 - What are radioactive isotopes? Explain the process of carbon dating. How the age of a geological sample is determined.
- [B] Attempt **any ONE** of the following. (8)
- State and prove the exponential law of radioactive decay. Explain the terms: decay constant, mean life and half life.
 - Explain the term mass defect. With the help of Segre chart, explain the stability in various nuclides.
- [C] Attempt **any ONE** of the following. (4)
- A piece of wood weighs 50 gm. and shows C^{14} activity of 320 dis/min. Estimate the time which has elapsed since piece of wood was part of living tree, assuming that living plants show an activity of 12 dis/min/gm and $T_{1/2} = 5730$ years.
 - Calculate the binding energy nucleon for ${}^{98}_{42}\text{Mo}$?. (Given: mass of ${}^{98}_{42}\text{Mo} = 97.905409$ amu; mass of proton = 1.007825 amu; mass of neutron = 1.008665 amu.)
- Q.3) [A] Attempt **any ONE** of the following. (8)
- Explain the principle, construction and working of an ionization chamber.
 - What is nuclear reaction? Explain different types of nuclear reaction.
- [B] Attempt **any ONE** of the following. (8)
- Explain the construction and working of proportional counter.
 - Define Q-value of a nuclear reaction & obtain an expression for it.
- [C] Attempt **any ONE** of the following. (4)
- A sample of radio-active element 3.54 MeV α particles is placed near the ionization chamber filled with air ($W = 30$ eV). Assume that 800 α particles enter in the chamber per second. Calculate the current produced.
 - Find the Q-value for the following reaction: $N^{14}(\alpha, p)O^{17}$. The masses of the nuclei are given as mass of nitrogen = 14.00753 amu, Mass of oxygen 17.045 amu, mass of α particle 4.00387 amu and mass of proton is 1.00814 amu. Given 1 amu = 931.5 Mev.
- Q.4) [A] Attempt **any ONE** of the following. (8)
- Describe the Coolidge tube for X-ray production. Enlist some properties of X-rays.
 - What is De Broglie hypothesis? With the help of Davisson Germer's experiment show the confirmation of the de Broglie hypothesis of matter waves.

- [B] Attempt **any ONE** of the following. (8)
- Derive an expression for shift in wavelength in Compton effect.
 - What is black body ? Discuss the distribution of energy in the spectrum of black body radiation.

- [C] Attempt **any ONE** of the following. (4)
- An electron has a speed of 300 m/s accurate to 0.01% within what range can we best locate the position of the electron.
($h = 6.63 \times 10^{-34} \text{ J.s}$, $m_e = 9.1 \times 10^{-31} \text{ Kg}$)
 - Compute the potential difference of accelerated electron of de Broglie wavelength $2.55 \times 10^{-10} \text{ m}$.

- Q.5) Attempt **any FOUR** of the following. (20)
- Define isotopes, isotones and isobars. Group the following six nuclides into three pairs isotones, isotopes and isobars.
 ${}_6\text{C}^{12}$, ${}_2\text{He}^3$, ${}_{80}\text{Hg}^{198}$, ${}_1\text{H}^3$, ${}_{79}\text{Au}^{197}$, ${}_6\text{C}^{14}$
 - Explain the properties of α and β radiation.
 - Explain in brief the interaction between particle and matter.
 - What is nuclear fission ? How is the energy released in nuclear fission?
 - Explain pair annihilation.
 - Give Bragg explanation for the production of Laue pattern.
