

QP Code : 31001

(3 HRS)

[TOTAL MARKS 100]

- Note: 1) All questions are compulsory.  
 2) Use of non- programmable calculator is allowed.  
 3) Draw figures wherever necessary.  
 4) Symbols have their usual meanings unless mentioned.

Q.1 (A) Select the correct option

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- i) If half life of Au is 2.7days. Then its decay constant is \_\_\_\_  
 (a)  $2.73 \times 10^{-6} \text{ s}^{-1}$  (b)  $0.256 \text{ s}^{-1}$  (c)  $1.08 \times 10^{-6} \text{ s}^{-1}$  (d) None of these
- ii) As the number of nucleons in nuclei goes on increasing, the binding energy per nucleon  
 (a) first increases and then decreases (b) remains constant  
 (c) decreases continuously (d) increases continuously.
- iii) Radio isotopes have:  
 (a) same mass number but different atomic number  
 (b) same atomic number but different mass number  
 (c) same mass number and same atomic number  
 (d) same density but different atomic number.
- iv) The inverse of pair production processes is called  
 (a) Pair formation (b) Pair annihilation  
 (c) Both (a) and (b) (d) None of these
- v) The values of X and Y in the reaction  $^{16}_8\text{O} + ^2_1\text{H} \rightarrow ^X_8\text{O} + ^3_Y\text{H}$  are:  
 (a) X=16 ,Y= 1 (b) X=15 ,Y= 2  
 (c) X=15 ,Y= 1 (d) None of these
- vi) As the temperature of blackbody raised the maximum intensity of radiation emitted is displaced towards the.....side.  
 (a) higher wavelength (b) lower wavelength  
 (c) lower frequency (d) None of these.

(B) Answer in one sentence :

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- i) What is Binding Energy of a nucleus?  
 ii) State Bragg's law.  
 iii) What is Nuclear Fission?

(C) Fill in the blanks

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- i) One a.m.u. is equivalent to \_\_\_\_\_ MeV.  
 ii) If Q value of nuclear reaction is negative, the reaction is called \_\_\_\_\_.  
 iii) Laue pattern is obtained due to \_\_\_\_\_ of X-rays at lattice planes.  
 iv) For perfectly black body the coefficient of absorption is \_\_\_\_\_.  
 v) In Compton scattering the change in wave length is maximum if angle of scattering is \_\_\_\_\_

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- Q.2 (A) Attempt any one 08
- State law of radioactive disintegration and obtain a relation governing the radioactive decay, Define the terms decay constant, half life and mean life.
  - Define packing fraction .Draw the graph showing the variation of packing fraction with the mass number and state the inferences drawn from the graph.
- (B) Attempt any one 08
- State law of successive disintegration and derive the expression for the number of atoms in first two daughter elements.
  - Derive an expression to estimate the nuclear radius from Rutherford's  $\alpha$ -scattering experiment.
- (C) Attempt any one 04
- A charcoal sample from an ancient fire-pit showed a  $C^{14}$  activity of 11.3 counts per gm per min. The absolute activity of  $C^{14}$  in a living tree is around 15.3 counts per gm per min. Estimate the age of the charcoal sample. Half life of  $C^{14}$  is 5730 years.
  - Estimate the binding energy per nucleon of helium nucleus  ${}^4_2\text{He}$ .  
Given:  $M(\text{He}) = 4.002643 \text{ amu}$        $m_p = 1.007825 \text{ amu}$   
 $m_n = 1.008665 \text{ amu}$        $1 \text{ amu} = 931.5 \text{ MeV}$
- Q.3 (A) Attempt any one 08
- With the help of neat diagram, explain the construction and working of Geiger - Mueller counter.
  - Derive the equation of the Q-value of the nuclear reaction.
- (B) Attempt any one 08
- Explain the principle, construction and working of a Proportional counter with the help of neat diagram.
  - State and explain the conservation laws of nuclear reactions.
- (C) Attempt any one 04
- Determine the Q-value of the nuclear reaction  ${}^{14}_7\text{N}(\alpha, p){}^{17}_8\text{O}$ .  
Given :  $M({}^{14}_7\text{N}) = 14.00753 \text{ amu}$ ,  $M({}^{17}_8\text{O}) = 17.0045 \text{ amu}$ ,  
 $m_\alpha = 4.00387 \text{ amu}$ ,  $m_p = 1.00814 \text{ amu}$ ,  $1 \text{ amu} = 931.5 \text{ MeV}$
  - An  $\alpha$ -particle loses all of its energy in a gas and produces  $2.25 \times 10^5$  ion-pairs .If energy required to create one ion-pair is 32eV, What is the energy of an  $\alpha$ - particle.
- Q.4 (A) Attempt any one 08
- What is Compton effect? Derive an expression for Compton shift in wavelength of the photon.
  - Describe Davisson-Germer experiment to verify the dual nature of light.

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- (B) Attempt any one 08
- Discuss the distribution of energy in the spectrum of black body radiation.
  - Describe how X-rays are produced using Coolidge tube.
- (C) Attempt any one 04
- Calculate the wavelength of the matter waves associated with a ball of mass  $6.62 \times 10^{-2} \text{ kg}$  and moving with a velocity  $2 \text{ m/s}$ . Planck's constant  $h = 6.62 \times 10^{-34} \text{ J-s}$ .
  - Calculate the critical voltage required to stimulate the emission of characteristics lines of K-series in tungsten, if K absorption edge is  $1 \text{ AU}$ . Planck's constant  $h = 6.62 \times 10^{-34} \text{ J-s}$ .

- Q.5 Attempt any four 20
- Write short note on Carbon dating.
  - Discuss in brief the stability of nuclei.
  - Find the shortest wavelength of X rays emitted when electrons are accelerated through a potential difference of  $35 \text{ keV}$  in an X ray tube
  - Describe the construction & principle of working of gas-filled detector.
  - What do you understand by Gravitational Red shift?
  - State and explain De Broglie hypothesis. State properties of matter waves.

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