1 SET – II

ANSWER KEY

Q 1	A	**Select the correct alternative**	
	(i)	(a) 1.66×10^{-27} kg	(2)
	(ii)	(b) 1/16	(2)
	(iii)	(a) $E_y + E_Y - E_x$	(2)
	(iv)	(c) tens of eV	(2)
	(v)	(b) potential difference	(2)
	(vi)	(d) frequency	(2)
Q 1	B	**Answer in one sentence.**	
	(i)	Isobars: Same mass number (A), different atomic number (Z)	(1)
	(ii)	The time for which the GM tube is rendered insensitive and is thus temporarily unable to detect the arrival of any new ionizing particle is called the dead time.	(1)
	(iii)	Body which absorbs all the incident radiation on it. a=1, r = t = 0	(1)
Q 1	C	**Fill in the blanks**	
	(i)	Carbon	(1)
	(ii)	Three-fourth	(1)
	(iii)	Q-value or nuclear disintegration energy.	(1)
	(iv)	Endoergic or Q<0	(1)
	(v)	Light i.e.3×10^8 m/s	(1)
Q 2	A	**Attempt ANY ONE**	
	(i)	Explanation Radius of nucleus $R = R_0A^{1/3}$ $R_0 \approx 1.27$ fermi ------- Charge on the nucleus ------- Nuclear density $=10^{17}$ kg/m^3 ------- $\frac{number\ of\ nucleons}{m^3} = \frac{density}{Mass\ of\ a\ nucleon} \approx 10^{44}\ nucleon/m^3$ -------	(2) (2) (2) (2)
	(ii)	Statement of law of successive disintegration ------- Secular equilibrium: Statement and explanation $T_1 >> T_2$ i.e. $\lambda_1 << \lambda_2$ ------- $N_2 = \frac{\lambda_1 N_0}{\lambda_2}[1 - e^{-\lambda_2 t}]$ ------- $N_2 = \frac{\lambda_1 N_0}{\lambda_2}$ ------- $\therefore \frac{N_{2C}}{N_1} = \frac{\lambda_1}{\lambda_2} = \frac{T_2}{T_1} = constant$ -------	(2) (1) (2) (1) (2)
Q. 2	B	**Attempt ANY ONE**	
	(i)	Statement and explanat To get $N = N_0 e^{-\lambda t}$ -------- To get $T_{1/2} = \frac{0.693}{\lambda}$ --------	(2) (3) (3)
	(ii)	Sketch of Segre chart with description Characteristics of stable and unstable nuclei	(3) (5)
Q. 2	C	**Attempt ANY ONE**	

2

	(i)	$\frac{R_1}{R_2} = \left(\frac{A_1}{A_2}\right)^{1/3}$ -------- R_{He} = 1.69 Fm --------	(2) (2)
	(ii)	$N = \frac{6.02\times10^{23}}{226} \times 1 = 2.66 \times 10^{21}$ A = Activity = $\frac{dN}{dt}$ = Nλ 1 Ci = 3.7×10^{10} dis/s $\therefore \lambda = \frac{A}{N} = \frac{3.7\times10^{10}}{2.66\times10^{21}} = 1.39 \times 10^{-11}\, s^{-1}$ -------- $T_{1/2} = \frac{0.693}{\lambda} = 4.98 \times 10^{10} s$ --------	(2) (2)
Q 3	A	**Attempt ANY ONE**	
	(i)	Use of momentum conservation laws or momentum triangle seen Diagram of momentum conservation or momentum triangle: Define $Q = E_y + E_Y - E_x$ Rest of the derivation leading to $Q = E_y\left(1 + \frac{m_y}{M_Y}\right) - E_x\left(1 - \frac{m_x}{M_Y}\right) - \frac{2}{M_Y}\sqrt{m_x m_y E_x E_y}\cos\theta$	(2) (2) (1) (3)
	(ii)	Identifying $m_y \cong m_x + M_X - M_Y$ Momentum conservation leading to $m_x v_x = M_c V_c$ Where M_c, V_c denote the mass and velocity of the compound nucleus respectively Defining $Q = \frac{1}{2} m_x v_x^2 - \frac{1}{2} M_c V_c^2$ Rest of the derivation leading to $E_{th} = \frac{1}{2} m_x v_x^2 = -Q\left(\frac{m_x + M_X}{M_X}\right)$	(1) (1) (1) (2) (3)
Q 3	B	**Attempt ANY ONE**	
	(i)	Nuclear reaction definition: **2 marks** Stating and explaining any 3 different types of nuclear reactions: **2 marks each.**	(2) (2)
	(ii)	Diagram: 2 marks Construction: 2 marks Working: 4 marks	(2) (2) (4)
Q 3	C	**Attempt ANY ONE**	
	(i)	$Q = [(m_x + M_X) - (m_y + M_Y)]c^2$: or if masses are expressed in amu $Q = [(m_x + M_X) - (m_y + M_Y)] \times 931.5 MeV$ Q=11.373615MeV **Formula : 1 mark** **Working: 2marks** **Final answer with correct unit : 1 mark**	(1) (2) (1)
	(ii)	$Q = [(m_x + M_X) - (m_y + M_Y)] \times 931.5 MeV$: **1mark** **Q= -1.15506 MeV : 1 mark** $E_{th} \cong -\frac{Q(M_X + m_x)}{M_X}$:1 mark $E_{th} = 1.485218 MeV$:1 mark	(1) (1) (1) (1)
Q 4	A	**Attempt ANY ONE**	
	(i)	Statement of de Broglie hypothesis	(2)

		Bohr's first hypothesis Proof using de Broglie hypothesis	(2) (4)
	(ii)	Laue's experimental setup diagram Explanation of Laue's experimental setup Observation from the experiment	(3) (2) (3)
Q 4	B	**Attempt ANY ONE**	
	(i)	Compton effect explanation Diagram of scattering of electron Applying law of conservation of momentum Simplifying equations Obtaining $\Delta\lambda = \frac{h}{m_0 c}(1 - \cos\Theta)$	(2) (1) (1) (2) (2)
	(ii)	Considering two waves and their resultant effect with diagram Simplifying the equation Taking the condition for node and solving Getting the result $\Delta x = \frac{h}{\Delta p}$	(2) (2) (2) (2)
Q 4	C	**Attempt ANY ONE**	
	(i)	$\Delta x_{max} = 0.2\ A^0 = 0.2\times10^{-10}$ m Using HUP, $\Delta p_{min} = \frac{h}{\Delta x}$ $\Delta p_{min} = 3.3\times10^{-23}$ kg m/s Minimum possible energy $E_{min} = \Delta p_{min}^2/2m = 5.98\times10^{-16}$ J	(2) (2)
	(ii)	$n = 2, \theta = 20^\circ$ $d = 1.4\ A^\circ = 1.4\times10^{-10}$ m From Bragg's law, $2d \sin\theta = 2\lambda$ $\lambda = 0.48\times10^{-10}$ m	(1) (1) (2)
Q 5		**Attempt ANY FOUR**	
	(i)	Carbon dating: Explanation ------ ${}^{14}_{7}N + {}^{1}_{0}n \rightarrow ({}^{15}_{7}N) \rightarrow {}^{14}_{6}C + {}^{1}_{1}H$ ${}^{14}_{6}C \rightarrow {}^{14}_{7}N + \beta^- + antineutrino$ ------ $X = X_0 e^{-\lambda_c t} \quad \therefore t = \frac{1}{\lambda_C} ln \frac{X_0}{X}$ --------	(1) (2) (2)
	(ii)	Definition of Binding energy Graph of B. E. /nucleon Characteristics of graph	(1) (1) (3)
	(iii)	Stating any two conservation laws Describing the two conservation laws mentioned above	(2) (3)
	(iv)	Quenching explanation Various mixtures used for quenching or electronic quenching explained Explaining how use of quenching mixture leads to extended life of GM tube	(2) (2) (1)
	(v)	Pair production: conversion radiation energy into matter explanation Production of electron and positron Minimum energy required calculation	(2) (1) (2)
	(vi)	$\lambda_i = 0.5\ A^\circ$, $\theta = 120^\circ$	

		Compton shift $=\Delta\lambda = \lambda_s - \lambda_i = \frac{h}{m_0 c}(1-\cos\theta) = 0.0363$ A°	(3)
		$\lambda_s = \Delta\lambda + \lambda_i = 0.5363$ A°	(2)