2

Set – III

Answer Key

Q1	**A**	**Select the correct alternative.**	
	(i)	(a) 3R	
	(ii)	(c) A, Z+1	(2)
	(iii)	(c) approximately 1000V	(2)
	(iv)	(b) endoergic	(2)
	(v)	(d) all of the above	(2)
	(vi)	(b) pair production	(2)
Q1	**B**	**Answer in one sentence**	(2)
	(i)	It is very stable.	
	(ii)	The change in the total kinetic energy in a nuclear reaction is the Q value of a nuclear reaction	(1)
	(iii)	De Broglie waves produce dispersion Group velocity of de Broglie wave is equal to the velocity of particle	(1)
Q1	**C**	**Fill in the blanks**	(1)
	(i)	192 hours.	
	(ii)	$A^{1/3}$.	(1)
	(iii)	Positive or Greater than zero	(1)
	(iv)	Large or extremely large	(1)
	(v)	180° or π radian	(1)
Q 2	**A**	**Attempt ANY ONE**	(1)
	(i)	Explanation to law of successive disintegration (growth and decay), $\frac{dN_2}{dt} = \lambda_1 N_1 - \lambda_2 N_2 = \lambda_1[N_0 e^{-\lambda_1 t}] - \lambda_2 N_2$ --------- $N_2 e^{\lambda_2 t} = \frac{\lambda_1 N_0}{\lambda_2 - \lambda_1}[e^{(\lambda_2-\lambda_1)t} - 1]$ --------- $N_2 = \frac{\lambda_1 N_0}{\lambda_2 - \lambda_1}[e^{-\lambda_1 t} - e^{-\lambda_2 t}]$ ---------	(2) (2) (2) (2)
	(ii)	Explanation on experimental set up Size: momentum $\Delta P = F\,\Delta t$ $\therefore \Delta P = \frac{1}{4\pi\epsilon_0}\frac{2e.Ze}{b.v}$, $\theta \sim \frac{\Delta P}{P} = \frac{1}{4\pi\epsilon_0}\frac{2e.Ze}{b.v} \times \frac{1}{mv}$ $b = \frac{1}{4\pi\epsilon_0}\frac{2Ze^2}{mv^2}\frac{1}{\theta}$ $\therefore R = \frac{1}{4\pi\epsilon_0}\frac{2Ze^2}{mv^2}$	(2) (2) (2)
Q 2	**B**	**Attempt ANY ONE**	(2)
	(i)	Definition of mass defect and binding energy Graph of B. E. /nucleon Characteristics of graph	(2) (2)
	(ii)	Statement and explanation To get $N = N_0 e^{-\lambda t}$ --------- Definition of Half-life period --------- To get $T_{1/2} = \frac{0.693}{\lambda}$ ---------	(4) (2) (3) (1)
Q 2	**C**	**Attempt ANY ONE**	(2)
	(i)	$N = N_0 e^{-\lambda t}$	

		$\lambda = \frac{1}{10} 2.303 \log 5$ --------- $T = \frac{0.693}{\lambda} = 4.307\ hours$ ---------	(2)
	(ii)	Mass defect = $\Delta m = 0.002388\ amu$ Energy liberated = E = $\Delta m \times 931$ MeV ---------- E = 2.223 MeV ---------	(2) (1) (1)
Q 3	A	**Attempt ANY ONE** ---------	(2)
	(i)	Identifying that the Q equation is quadratic in E_y **:1 mark.** Rearranging the equation and solving to obtain $\sqrt{E_y} = v + \sqrt{v^2 + w}$ Where, $v = \frac{\sqrt{m_x E_x m_y}}{m_y + M_Y} cos\theta, w = \frac{M_Y Q + E_x(M_Y - m_x)}{M_Y + m_y}$	(1) (7)
	(ii)	Nuclear reaction definition: 2 marks Explaining different types of nuclear reactions: **3 marks each.**	(2) (6)
Q 3	B	**Attempt ANY ONE**	
	(i)	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)
	(ii)	Identifying that energy loss rate is inversely proportional to velocity $-\frac{dK}{dx} = \frac{c}{v}, c - constant$ Deriving $\frac{dK}{dx} = mv\frac{dv}{dx}$ Identification of the limits of the integration i.e. At $x = 0, v = v_0$ and at $x = R, v = 0$ where, R is range Proving $v_0^3 = cR$ using above	(2) (1) (2) (1) (2)
Q 3	C	**Attempt ANY ONE**	
	(i)	Quenching explanation Various mixtures used for quenching or electronic quenching explained Explaining how use of quenching mixture leads to extended life of GM tube	(1) (2) (1)
	(ii)	1 mole of Po^{239} (i.e.239 gm) contains 6.023×10^{23} nuclei Energy released = $6.023 \times 10^{23} \times 205 MeV = 1234.715 MeV$ **Formula : 1 mark** **Working : 2 marks** **Final answer with proper unit : 1 mark**	(1) (2) (1)
Q 4	A	**Attempt ANY ONE**	
	(i)	Diagram of Davisson-Germer Experiment Construction Polar graph explanation to get λ Finding λ using Bragg's law	(2) (2) (2) (2)
	(ii)	Considering the condition of a photon emitted by a star	(2)

		Finding the Potential energy Condition of photon reaching the earth Deriving the expression $\frac{\Delta\nu}{\nu} = \frac{GM}{c^2R}$	(2) (1) (3)
Q 4	**B**	**Attempt ANY ONE**	
	(i)	X-rays explanation Any six properties Any 2 applications with details	(2) (3) (3)
	(ii)	Understanding energy using HUP Explaining the uncertainty in time and energy Taking Uncertainty in position 10^{-14} m and finding uncertainty in momentum Calculating energy (124 MeV) and explaining its contradiction	(2) (2) (2) (2)
Q 4	**C**	**Attempt ANY ONE**	
	(i)	$\Delta x_{max} = a$ Using HUP, $\Delta p_{min} = \frac{h}{\Delta x}$ $\Delta p_{min} = h/a$ Minimum possible energy $E_{min} = \Delta p_{min}^2/2m = h^2/(2ma^2)$	(1) (2) (2)
	(ii)	Given: $\lambda_i = 0.3$ A° $\theta = 180°$ Compton shift $= \Delta\lambda = \lambda_s - \lambda_i = \frac{h}{m_0c}(1 - \cos\theta) = 0.0482$ A° $\lambda_s = 0.3482$ A°	 (2) (2)
Q 5		**Attempt ANY FOUR**	
	(i)	Applications of isotopes in Medicine, Food and agriculture, Industry and Archaeological field	(2) (1) (1) (1)
	(ii)	Natural radioactivity Artificial radioactivity	(2) (3)
	(iii)	Q value or nuclear disintegration energy defined as the change in the total kinetic energy of the nuclear reaction: 2 marks $Q = E_y + E_Y - E_x$: 1 mark Rest of the derivation resulting in $Q = [(m_x + M_X) - (m_y + M_Y)]c^2$: 2 marks	(2) (1) (2)
	(iv)	Definition Properties, examples or energy released etc.	(2) (3)
	(v)	Explanation of wave and particle phenomenon Wave showing particle nature Particles showing wave nature	(1) (2) (2)
	(vi)	When the voltage is increased, λ_{min} is shifted towards smaller values Duane and hunts showed that wavelength limit of contant spectrum varies inversely as the voltage applied. Obtaining expression $\lambda_{min} = \frac{1.24x10^{-6}}{V}$	 (2) (3)