SET – I (1)

ANSWER KEY

Q1	**A**	**Select the correct alternative**	
	(i)	(d) Stability	(2)
	(ii)	(c) binding energy	(2)
	(iii)	(a) is 1.00 MeV each	(2)
	(iv)	(a) $E_y + E_Y - E_x$	(2)
	(v)	(a) larger	(2)
	(vi)	(c) diffraction	(2)
Q1	**B**	**Answer in one sentence.**	
	(i)	Isotopes: - same atomic number (Z), different Mass number (A)	(1)
	(ii)	The energy loss rate $-\frac{dK}{dx}$ is called stopping power.(Give credit if the student uses $-\frac{1}{\rho}\frac{dK}{dx}$, ρ is density.)	(1)
	(iii)	As the temperature of black body is raised, the maximum intensity of radiation emitted is displaced towards the shorter wavelength side, $\lambda_m T$ = constant	(1)
Q1	**C**	**Fill in the blanks.**	
	(i)	less	(1)
	(ii)	$\frac{T_B}{T_A}$	(1)
	(iii)	Negative.	(1)
	(iv)	Fission or nuclear fission	(1)
	(v)	Zero	(1)
Q2	**A**	**Attempt ANY ONE.**	
	(i)	$\frac{dN_2}{dt} = \lambda_1 N_1 - \lambda_2 N_2 = \lambda_1\left[N_0 e^{-\lambda_1 t}\right] - \lambda_2 N_2$ --------- $N_2 e^{\lambda_2 t} = \frac{\lambda_1 N_0}{\lambda_2 - \lambda_1}\left[e^{(\lambda_2-\lambda_1)t} - 1\right]$ --------- $N_2 = \frac{\lambda_1 N_0}{\lambda_2 - \lambda_1}\left[e^{-\lambda_1 t} - e^{-\lambda_2 t}\right]$ --------- $\frac{dN_3}{dt} = \lambda_2 N_2 = \frac{\lambda_1\lambda_2 N_0}{\lambda_2-\lambda_1}\left[e^{-\lambda_1 t} - e^{-\lambda_2 t}\right]$ --------- $N_3 = \frac{\lambda_1\lambda_2 N_0}{\lambda_2-\lambda_1}\left[\frac{e^{-\lambda_2 t}}{\lambda_2} - \frac{e^{-\lambda_1 t}}{\lambda_1}\right] + N_0$ ---------	(1) (2) (2) (1) (2)
	(ii)	Definition of mass defect and binding energy --------- Graph of B. E. /nucleon --------- Characteristics of graph ---------	(2) (2) (4)
Q2	**B**	**Attempt ANY ONE.**	
	(i)	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) (2)

	(ii)	Statement of law of radioactive transformation ------- 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) (1) (2) (2) (2)
Q2	C	**Attempt ANY ONE.**	
	(i)	Mass defect = $\Delta m = [2 \times M_H + 2 \times M_N] - M_{He}$ $\Delta m = 0.030377$ amu B. E. = $\Delta m \times 931 = 28.28$ M eV.	(1) (2) (1)
	(ii)	$\lambda = \frac{0.693}{T_{1/2}} = 0.0315\ /year$ $\therefore t = \frac{1}{\lambda} ln\left(\frac{N_0}{N}\right) = 73.11\ years$	(1) (3)
Q3	A	**Attempt ANY ONE.**	
	(i)	Diagram Construction Working	(2) (2) (4)
	(ii)	General nuclear reaction expression $X(x,y)Y$ with projectile, ejectile, target and residual nucleus denoted properly Q value or nuclear disintegration energy defined as the change in the total kinetic energy of the nuclear reaction $Q = E_y + E_Y - E_x$ Rest of the derivation resulting in $Q = \left[(m_x + M_X) - (m_y + M_Y)\right]c^2$	(2) (2) (1) (3)
Q3	B	**Attempt ANY ONE.**	
	(i)	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)
	(ii)	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)

Q3	**C**	**Attempt ANY ONE.**	
	(i)	$E_{th} \cong -\frac{Q(M_X + m_x)}{M_X} = -\frac{-3.9(19+1)}{19} MeV = 4.1052 MeV$ **Formula : 1 mark** **Working : 2 marks** **Final answer with proper unit : 1 mark**	(1) (2) (1)
	(ii)	1 mole of U^{238} (i.e.238 gm) contains 6.023×10^{23} nuclei Energy released = $6.023 \times 10^{23} \times 200 MeV = 1204.6 MeV$ **Formula : 1 mark** **Working : 2 marks** **Final answer with proper unit : 1 mark**	(1) (2) (1)
Q4	**A**	**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)	Diagram of Davisson-Germer Experiment Construction Polar graph explanation to get λ Finding λ using Bragg's law	(2) (2) (2) (2)
Q4	**B**	**Attempt ANY ONE.**	
	(i)	Statement of HUP Explanation of HUP Finding the uncertainty of electron in nucleus Calculating the energy of electron and comparing with experimental value	(2) (2) (2) (2)
	(ii)	Diagram of X-ray tube Construction of X-ray tube Explanation of X-rays production	(2) (3) (3)
Q4	**C**	**Attempt ANY ONE.**	
	(i)	$T_1 = 90°C = 363$ K $\lambda_{m1} = 2 \times 10^{-5}$ m $T_2 = 200°C = 573$ K $\lambda_{m2} = ?$ From Wien's displacement law, $\lambda_m T$ = constant $\lambda_{m2} = (\lambda_{m1} T_1) / T_2 = 1.27 \times 10^{-5}$ m	(1) (1) (2)
	(ii)	Uncertainty in velocity $\Delta v = \frac{0.005 \times 340}{100} = 0.017$ Uncertainty in momentum $\Delta p = m_e \Delta v = 1.53 \times 10^{-32}$ Using Uncertainty Principle, $\Delta p . \Delta x = h$ $\Delta x = 0.043$ m	(1) (1) (1) (1)
Q5		**Attempt ANY FOUR**	
	(i)	Statement and explanation $T_1 >> T_2$ i.e. $\lambda_1 << \lambda_2$ --------	(1)

		$N_2 = \frac{\lambda_1 N_0}{\lambda_2}\left[1 - e^{-\lambda_2 t}\right]$ --------	(1)
		$N_2 = \frac{\lambda_1 N_0}{\lambda_2}$ --------	(1)
		$\therefore \frac{N_{2C}}{N_1} = \frac{\lambda_1}{\lambda_2} = \frac{T_2}{T_1} = constant$ --------	(2)
	(ii)	Definition of packing Fraction --------	(1)
		To get $p = \frac{M-A}{A}$ -------	(2)
		Graph --------	(1)
		Features --------	(1)
	(iii)	Definition	(2)
		Properties, examples or energy released etc.	(3)
	(iv)	Diagram	(2)
		Construction	(3)
	(v)	Given: $\lambda_i = 3$ A°	
		$\theta = 60°$	(1)
		Compton shift $= \Delta\lambda = \lambda_s - \lambda_i = \frac{h}{m_0 c}(1 - \cos\theta)$	(2)
		$\lambda_s = 3.0121$ A°	(2)
	(vi)	Explanation of matter waves	(3)
		Any four characteristics	(2)