MODERN PHYSICS

1. A Hydrogen-like atom has atomic number Z. Photons emitted in the electronic transitions from level n = 4 to level n = 3 in these atoms are used to perform photoelectric effect experiment on a target metal. The maximum kinetic energy of the photoelectrons generated is 1.95 eV. If the photoelectric threshold wavelength for the target metal is 310 nm, the value of Z is _______.

[Given: hc = 1240 eV-nm and Rhc = 13.6 eV, where R is the Rydberg constant, h is the Planck's constant and c is the speed of light in vacuum] **[JEE(Advanced) 2023]**

2. List-I shows different radioactive decay processes and List-II provides possible emitted particles. Match each entry in List-I with an appropriate entry from List-II, and choose the correct option.

[JEE(Advanced) 2023]

	List-I		**List-II**
(P)	${}^{238}_{92}U \rightarrow {}^{234}_{91}Pa$	(1)	one α particle and one β^+ particle
(Q)	${}^{214}_{82}Pb \rightarrow {}^{210}_{82}Pb$	(2)	three β^- particles and one α particle
(R)	${}^{210}_{81}Tl \rightarrow {}^{206}_{82}Pb$	(3)	two β^- particles and one α particle
(S)	${}^{228}_{91}Pa \rightarrow {}^{224}_{88}Ra$	(4)	one α particle and one β^- particle
		(5)	one α particle and two β^+ particles

(A) $P \rightarrow 4, Q \rightarrow 3, R \rightarrow 2, S \rightarrow 1$
(B) $P \rightarrow 4, Q \rightarrow 1, R \rightarrow 2, S \rightarrow 5$
(C) $P \rightarrow 5, Q \rightarrow 3, R \rightarrow 1, S \rightarrow 4$
(D) $P \rightarrow 5, Q \rightarrow 1, R \rightarrow 3, S \rightarrow 2$

3. In a radioactive decay process, the activity is defined as $A = -\frac{dN}{dt}$, where N(t) is the number of radioactive nuclei at time t. Two radioactive sources, S_1 and S_2 have same activity at time t = 0. At a later time, the activities of S_1 and S_2 are A_1 and A_2, respectively. When S_1 and S_2 have just completed their 3^{rd} and 7^{th} half-lives, respectively, the ratio A_1/A_2 is __________. **[JEE(Advanced) 2023]**

4. The minimum kinetic energy needed by an alpha particle to cause the nuclear reaction ${}^{16}_{7}N + {}^{4}_{2}He \rightarrow {}^{1}_{1}H + {}^{19}_{8}O$ in a laboratory frame is *n* (in *MeV*). Assume that ${}^{16}_{7}N$ is at rest in the laboratory frame. The masses of ${}^{16}_{7}N$, ${}^{4}_{2}He$, ${}^{1}_{1}H$ and ${}^{19}_{8}O$ can be taken to be 16.006 *u*, 4.003 *u*, 1.008 *u* and 19.003 u, respectively, where 1 u = 930 $MeVc^{-2}$. The value of n is_________. **[JEE(Advanced) 2022]**

5. The binding energy of nucleons in a nucleus can be affected by the pairwise Coulomb repulsion. Assume that all nucleons are uniformly distributed inside the nucleus. Let the binding energy of a proton be E_b^p and the binding energy of a neutron be E_b^n in the nucleus. **[JEE(Advanced) 2022]**

Which of the following statement(s) is(are) correct?

(A) $E_b^p - E_b^n$ is proportional to Z(Z – 1) where Z is the atomic number of the nucleus.

(B) $E_b^p - E_b^n$ is proportional to $A^{-\frac{1}{3}}$ where *A* is the mass number of the nucleus.

(C) $E_b^p - E_b^n$ is positive.

(D) E_b^p increases if the nucleus undergoes a beta decay emitting a positron.

6. In a radioactive decay chain reaction, ${}^{230}_{90}\text{Th}$ nucleus decays into ${}^{214}_{84}\text{Po}$ nucleus. The ratio of the number of α to number of β^- particles emitted in this process is_________. **[JEE(Advanced) 2022]**

7. When light of a given wavelength is incident on a metallic surface, the minimum potential needed to stop the emitted photoelectrons is 6.0 *V*. This potential drops to 0.6 *V* if another source with wavelength four times that of the first one and intensity half of the first one is used. What are the wavelength of the first source and the work function of the metal, respectively? [Take $\frac{hc}{e} = 1.24 \times 10^{-6}$ Jm C^{-1}] **[JEE(Advanced) 2022]**

(A) 1.72×10^{-7} m, 1.20 eV

(B) 1.72×10^{-7} m, 5.60 eV

(C) 3.78×10^{-7} m, 5.60 eV

(D) 3.78×10^{-7} m, 1.20 eV

8. Which of the following statement(s) is(are) correct about the spectrum of hydrogen atom ? **[JEE(Advanced) 2021]**

(A) The ratio of the longest wavelength to the shortest wavelength in Balmer series is 9/5

(B) There is an overlap between the wavelength ranges of Balmer and Paschen series.

(C) The wavelengths of Lyman series are given by $\left(1+\frac{1}{m^2}\right)\lambda_0$, where λ_0 is the shortest wavelength of Lyman series and m is an integer

(D) The wavelength ranges of Lyman and Balmer series do not overlap

9. In a photoemission experiment, the maximum kinetic energies of photoelectrons from metals P, Q and R are E_P, E_Q and E_R, respectively, and they are related by $E_P = 2E_Q = 2E_R$. In this experiment, the same source of monochromatic light is used for metals P and Q while a different source of monochromatic light is used for the metal R. The work functions for metals P, Q and R are 4.0 eV, 4.5 eV and 5.5 eV, respectively. The energy of the incident photon used for metal R, in eV, is _________. **[JEE(Advanced) 2021]**

10. A heavy nucleus Q of half-life 20 minutes undergoes alpha-decay with probability of 60% and beta-decay with probability of 40%. Initially, the number of Q nuclei is 1000. The number of alpha-decays of Q in the first one hour is **[JEE(Advanced) 2021]**

(A) 50 (B) 75 (C) 350 (D) 525

11. A heavy nucleus N, at rest, undergoes fission N $\to$ P + Q, where P and Q are two lighter nuclei. Let $\delta = M_N - M_P - M_Q$, where M_P, M_Q and M_N are the masses of P, Q and N, respectively. E_P and E_Q are the kinetic energies of P and Q, respectively. The speed of P and Q are v_P and v_Q, respectively. If c is the speed of light, which of the following statement(s) is(are) correct ? **[JEE(Advanced) 2021]**

(A) $E_P + E_Q = c^2\delta$

(B) $E_P = \left(\frac{M_P}{M_P + M_Q}\right)c^2\delta$

(C) $\frac{v_P}{v_Q} = \frac{M_Q}{M_P}$

(D) The magnitude of momentum for P as well as Q is $c\sqrt{2\mu\delta}$, where $\mu = \frac{M_P M_Q}{(M_P + M_Q)}$

12. In an X-ray tube, electrons emitted from a filament (cathode) carrying current I hit a target (anode) at a distance d from the cathode. The target is kept at a potential V higher than the cathode resulting in emission of continuous and characteristic X-rays. If the filament current I is decreased to $\frac{I}{2}$, the potential difference V is increased to 2V, and the separation distance d is reduced to $\frac{d}{2}$, then

[JEE(Advanced) 2020]

(A) the cut-off wavelength will reduce to half, and the wavelengths of the characteristic X-rays will remain the same

(B) the cut-off wavelength as well as the wavelengths of the characteristic X-rays will remain the same

(C) the cut-off wavelength will reduce to half, and the intensities of all the X-rays will decrease

(D) the cut-off wavelength will become two times larger, and the intensity of all the X-rays will decrease

13. A particle of mass m moves in circular orbits with potential energy V(r) = Fr, where F is a positive constant and r is its distance from the origin. Its energies are calculated using the Bohr model. If the radius of the particle's orbit is denoted by R and its speed and energy are denoted by v and E, respectively, then for the n^{th} orbit (here h is the Planck's constant)- **[JEE(Advanced) 2020]**

(A) $R \propto n^{1/3}$ and $v \propto n^{2/3}$ (B) $R \propto n^{2/3}$ and $v \propto n^{1/3}$ (C) $E = \frac{3}{2}\left(\frac{n^2h^2F^2}{4\pi^2 m}\right)^{1/3}$ (D) $E = 2\left(\frac{n^2h^2F^2}{4\pi^2 m}\right)^{1/3}$

14. In a radioactive sample, ${}^{40}_{19}K$ nuclei either decay into stable ${}^{40}_{20}Ca$ nuclei with decay constant 4.5×10^{-10} per year or into stable ${}^{40}_{18}Ar$ nuclei with decay constant 0.5×10^{-10} per year. Given that in this sample all the stable ${}^{40}_{20}Ca$ and ${}^{40}_{18}Ar$ nuclei are produced by the ${}^{40}_{19}K$ nuclei only. In time $t \times 10^9$ years, if the ratio of the sum of stable ${}^{40}_{20}Ca$ and ${}^{40}_{18}Ar$ nuclei to the radioactive ${}^{40}_{19}K$ nuclei is 99, the value of t will be : [Given: ln 10 = 2.3] **[JEE(Advanced) 2019]**

(A) 9.2 (B) 1.15 (C) 4.6 (D) 2.3

15. A free hydrogen atom after absorbing a photon of wavelength λ_a gets excited from the state n = 1 to the state n = 4. Immediately after that the electron jumps to n = m state by emitting a photon of wavelength λ_e. Let the change in momentum of atom due to the absorption and the emission are Δp_a and Δp_e, respectively. If $\lambda_a/\lambda_e = \frac{1}{5}$. Which of the option(s) is/are correct? **[JEE(Advanced) 2019]**

[Use hc = 1242 eV nm; 1 nm = 10^{-9} m, h and c are Planck's constant and speed of light, respectively]

(A) $\lambda_e = 418$ nm

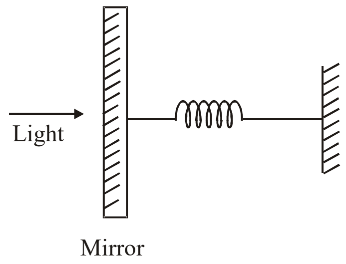
(B) The ratio of kinetic energy of the electron in the state n = m to the state n = 1 is $\frac{1}{4}$

(C) m = 2

(D) $\Delta p_a/\Delta p_e = \frac{1}{2}$

16. A perfectly reflecting mirror of mass M mounted on a spring constitutes a spring-mass system of angular frequency Ω such that $\frac{4\pi M\Omega}{h} = 10^{24} m^{-2}$ with h as Planck's constant. N photons of wavelength $\lambda = 8\pi \times 10^{-6}$ m strike the mirror simultaneously at normal incidence such that the mirror gets displaced by 1μm. If the value of N is $x \times 10^{12}$, then the value of x is_______.

[Consider the spring as massless] **[JEE(Advanced) 2019]**



17. Suppose a ${}^{226}_{88}Ra$ nucleus at rest and in ground state undergoes α-decay to a ${}^{222}_{86}Rn$ nucleus in its excited state. The kinetic energy of the emitted α particle is found to be 4.44 MeV. ${}^{222}_{86}Rn$ nucleus then goes to its ground state by γ-decay. The energy of the emitted γ-photon is _______ keV,

[Given: atomic mass of ${}^{226}_{88}Ra = 226.005u$, atomic mass of ${}^{222}_{86}Rn = 222.000u$, atomic mass of α particle = 4.000u, 1u = 931 MeV/c^2, c is speed of the light] **[JEE(Advanced) 2019]**

18. In a radioactive decay chain, ${}^{232}_{90}Th$ nucleus decays to ${}^{212}_{82}Pb$ nucleus. Let N_α and N_β be the number of α and β^- particles, respectively, emitted in this decay process. Which of the following statements is (are) true ? **[JEE(Advanced) 2018]**

(A) $N_\alpha = 5$ (B) $N_\alpha = 6$ (C) $N_\beta = 2$ (D) $N_\beta = 4$

19. In a photoelectric experiment a parallel beam of monochromatic light with power of 200 W is incident on a perfectly absorbing cathode of work function 6.25 eV. The frequency of light is just above the threshold frequency so that the photoelectrons are emitted with negligible kinetic energy. Assume that the photoelectron emission efficiency is 100% A potential difference of 500 V is applied between the cathode and the anode. All the emitted electrons are incident normally on the anode and are absorbed. The anode experiences a force $F = n \times 10^{-4}$ N due to the impact of the electrons. The value of n is _______ Mass of the electron $m_e = 9 \times 10^{-31}$ kg and 1.0 eV = 1.6×10^{-19} J ? **[JEE(Advanced) 2018]**

20. Consider a hydrogen-like ionized atom with atomic number Z with a single electron. In the emission spectrum of this atom, the photon emitted in the n = 2 to n = 1 transition has energy 74.8 eV higher than the photon emitted in the n = 3 to n = 2 transition. The ionization energy of the hydrogen atom is 13.6 eV. The value of Z is_______. **[JEE(Advanced) 2018]**

21. ^{131}I is an isotope of Iodine that β decays to an isotope of Xenon with a half-life of 8 days. A small amount of a serum labelled with ^{131}I is injected into the blood of a person. The activity of the amount of ^{131}I injected was 2.4×10^5 Becquerel (Bq). It is known that the injected serum will get distributed uniformly in the blood stream in less than half an hour. After 11.5 hours, 2.5 ml of blood is drawn from the person's body, and gives an activity of 115 Bq. The total volume of blood in the person's body, in liters is approximately (you may use $e^x \approx 1 + x$ for $|x| << 1$ and $\ln 2 \approx 0.7$). **[JEE(Advanced) 2017]**

22. An electron in a hydrogen atom undergoes a transition from an orbit with quantum number n_i to another with quantum number n_f. V_i and V_f are respectively the initial and final potential energies of the electron. If $\frac{V_i}{V_f} = 6.25$, then the smallest possible n_f is. **[JEE(Advanced) 2017]**

23. A photoelectric material having work-function ϕ_0 is illuminated with light of wavelength λ $\left(\lambda < \frac{hc}{\phi_0}\right)$.

The fastest photoelectron has a de-Broglie wavelength λ_d. A change in wavelength of the incident light by $\Delta\lambda$ results in a change $\Delta\lambda_d$ in λ_d. Then the ratio $\Delta\lambda_d/\Delta\lambda$ is proportional to

[JEE(Advanced) 2017]

(A) λ_d^3 / λ^2 (B) λ_d^3 / λ (C) λ_d^2 / λ^2 (D) λ_d/λ

24. In a historical experiment to determine Planck's constant, a metal surface was irradiated with light of different wavelengths. The emitted photoelectron energies were measured by applying a stopping potential. The relevant data for the wavelength (λ) of incident light and the corresponding stopping potential (V_0) are given below: **[JEE(Advanced) 2016]**

$\lambda(\mu m)$	V_0 (Volt)
0.3	2.0
0.4	1.0
0.5	0.4

Given that $c = 3 \times 10^8$ ms^{-1} and $e = 1.6 \times 10^{-19}$C, Planck's constant (in units of J s) found from such an experiment is :

(A) 6.0×10^{-34} (B) 6.4×10^{-34} (C) 6.6×10^{-34} (D) 6.8×10^{-34}

25. Highly excited states for hydrogen like atoms (also called Rydberg states) with nuclear charge Ze are defined by their principal quantum number n, where n >> 1. Which of the following statement(s) is (are) true? **[JEE(Advanced) 2016]**

(A) Relative change in the radii of two consecutive orbitals does not depend on Z

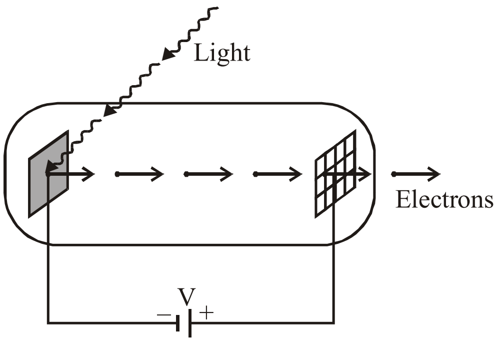
(B) Relative change in the radii of two consecutive oribitals varies as 1/n

(C) Relative change in the energy of two consecutive orbitals varies as $1/n^3$

(D) Relative change in the angular momenta of two consecutive orbitals varies as 1/n

26. A hydrogen atom in its ground state is irradiated by light of wavelength 970 Å. Taking $hc/e = 1.237 \times 10^{-6}$ eV m and the ground state energy of hydrogen atom as –13.6 eV, the number of lines present in the emission spectrum is **[JEE(Advanced) 2016]**

27. Light of wavelength λ_{ph} falls on a cathode plate inside a vacuum tube as shown in the figure. The work function of the cathode surface is ϕ and the anode is a wire mesh of conducting material kept at a distance d from the cathode. A potential difference V is maintained between the electrodes. If the minimum de-Broglie wavelength of the electrons passing through the anode is λ_e, which of the following statement(s) is(are) true ? **[JEE(Advanced) 2016]**



(A) For large potential difference ($V >> \phi/e$), λ_e is approximately halved if V is made four times

(B) λ_e increases at the same rate as λ_{ph} for $\lambda_{ph} < hc/\phi$

(C) λ_e is approximately halved, if d is doubled

(D) λ_e decreases with increase in ϕ and λ_{ph}

28. The isotope ${}_5^{12}B$ having a mass 12.014 u undergoes β-decay to ${}_6^{12}C$. ${}_6^{12}C$ has an excited state of the nucleus (${}_6^{12}C^*$) at 4.041 MeV above its ground state. If ${}_5^{12}B$ decays to ${}_6^{12}C^*$, the maximum kinetic energy of the β-particle in units of MeV is (1u = 931.5 MeV/c^2, where c is the speed of light in vacuum).

[JEE(Advanced) 2016]

29. The electrostatic energy of Z protons uniformly distributed throughout a spherical nucleus of radius R is given by $E = \frac{3}{5}\frac{Z(Z-1)e^2}{4\pi\varepsilon_0 R}$. The measured masses of the neutron, ${}_1^1H$, ${}_7^{15}N$ and ${}_8^{15}O$ are 1.008665 u, 1.007825 u, 15.000109 u and 15.003065 u respectively. Given that the radii of both the ${}_7^{15}N$ and ${}_8^{15}O$ nuclei are same, 1u = 931.5 MeV/c^2 (c is the speed of light) and $\frac{e^2}{(4\pi\varepsilon_0)}$ = 1.44 MeV fm. Assuming that the difference between the binding energies of ${}_7^{15}N$ and ${}_8^{15}O$ is purely due to the electrostatic energy, the radius of either of the nuclei is (1fm = 10^{-15}m) **[JEE(Advanced) 2016]**

(A) 2.85 fm (B) 3.03 fm (C) 3.42 fm (D) 3.80 fm

30. An accident in a nuclear laboratory resulted in deposition of a certain amount of radioactive material of half-life 18 days inside the laboratory. Tests revealed that the radiation was 64 times more than the permissible level required for safe operation of the laboratory. What is the minimum number of days after which the laboratory can be considered safe for use? **[JEE(Advanced) 2016]**

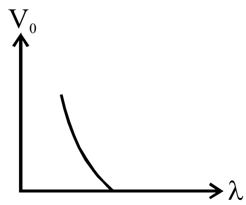
(A) 64 (B) 90 (C) 108 (D) 120

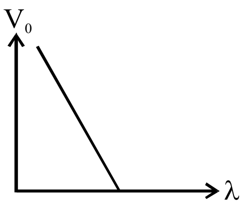
31. A nuclear power plant supplying electrical power to a village uses a radioactive material of half life T years as the fuel. The amount of fuel at the beginning is such that the total power requirement of the village is 12.5% of the electrical power available from the plant at that time. If the plant is able to meet the total power needs of the village for a maximum period of nT years, then the value of n is.

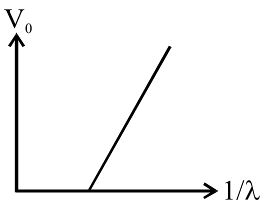
[JEE(Advanced) 2015]

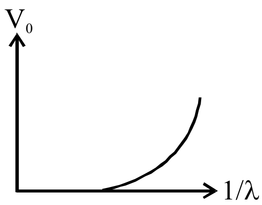
32. Consider a hydrogen atom with its electron in the n^{th} orbital. An electromagnetic radiation of wavelength 90 nm is used to ionize the atom. If the kinetic energy of the ejected electron is 10.4 eV, then the value of n is (hc = 1242 eV nm). **[JEE(Advanced) 2015]**

33. For photo-electric effect with incident photon wavelength λ, the stopping potential is V_0. Identify the correct variation(s) of V_0 with λ and 1/λ. **[JEE(Advanced) 2015]**

(A)


(B)


(C)


(D)


34. Match the nuclear processes given in column-I with the appropriate option(s) in column-II.

[JEE(Advanced) 2015]

	Column-I		**Column-II**
(A)	Nuclear fusion	(P)	Absorption of thermal neutrons by $^{235}_{92}U$
(B)	Fission in a nuclear reactor	(Q)	$^{60}_{27}Co$ nucleus
(C)	β-decay	(R)	Energy production in stars via hydrogen conversion to helium
(D)	γ-ray emission	(S)	Heavy water
		(T)	Neutrino emission

35. For a radioactive material, its activity A and rate of change of its activity R are defined as $A = -\frac{dN}{dt}$ and $R = -\frac{dA}{dt}$, where N(t) is the number of nuclei at time t. Two radioactive sources P (mean life τ) and Q (mean life 2τ) have the same activity at t = 0. Their rates of change of activities at t = 2τ are R_P and R_Q, respectively. If $\frac{R_P}{R_Q} = \frac{n}{e}$, then the value of n is : **[JEE(Advanced) 2015]**

36. An electron in an excited state of Li^{2+} ion has angular momentum $3h/2\pi$. The de Broglie wavelength of the electron in this state is $p\pi a_0$ (where a_0 is the Bohr radius). The value of p is **[JEE(Advanced) 2015]**

37. A fission reaction is given by ${}^{236}_{92}U \rightarrow {}^{140}_{54}Xe + {}^{94}_{38}Sr + x + y$, where x and y are two particles. Considering ${}^{236}_{92}U$ to be at rest, the kinetic energies of the products are denoted by $K_{Xe}, K_{sr}, K_x(2MeV)$ and $K_y(2MeV)$, respectively. Let the binding energies per nucleon of ${}^{236}_{92}U$, ${}^{140}_{54}Xe$ and ${}^{94}_{38}Sr$ be 7.5 MeV, 8.5 MeV and 8.5 MeV, respectively. Considering different conservation laws, the correct options(s) is (are) :- **[JEE(Advanced) 2015]**

(A) x = n, y = n, K_{sr} = 129 MeV, K_{xe} = 86 MeV

(B) x = p, y = e^-, K_{Sr} = 129 MeV, K_{xe} = 86 MeV

(C) x = p, y = n, K_{Sr} = 129 MeV, K_{xe} = 86 MeV

(D) x = n, y = n, K_{Sr} = 86 MeV, K_{xe} = 129 MeV

38. If λ_{Cu} is the wavelength of K_α X-ray line of copper (atomic number 29) and λ_{Mo} is the wavelength of the K_α X-ray line of molybdenum (atomic number 42), then the ratio $\frac{\lambda_{Cu}}{\lambda_{Mo}}$ is close to **[JEE(Advanced) 2014]**

(A) 1.99 (B) 2.14 (C) 0.50 (D) 0.48

39. A metal surface is illuminated by light of two different wavelength 248 nm and 310 nm. The maximum speeds of the photoelectrons corresponding to these wavelengths are u_1 and u_2, respectively. If the ratio $u_1 : u_2 = 2 : 1$ and hc = 1240 eV nm, the work function of the metal is nearly **[JEE(Advanced) 2014]**

(A) 3.7 eV (B) 3.2 eV (C) 2.8 eV (D) 2.5 eV

SOLUTIONS

1. Ans. (3)

Sol. n = 4   n = 3

$-1.51Z^2 eV$ $-0.85\ Z^2\ eV$

$E = E_4 - E_3 = 0.66\ Z^2\ eV$

$K_{max} = E - W$

$0.66\ Z^2\ \ 1.95 + 4 = 5.95$

$$W = 0.66Z^2 - 1.95 = \frac{hc}{\lambda} = \frac{1240}{310}$$

$\therefore Z = 3$

2. Ans. (A)

Sol. $_{Z_1}Z^{A_1} \rightarrow _{Z_2}Y^{A_2} + N_1\ _2He^4 + N_2\ _1e^0 + N_3\ _{-1}e^0$

Conservation of charge

$Z_1 = Z_2 + 2\ N_1 + N_2 - N_3$ ....(i)

Conservation of nucleons.

$A_1 = A_2 + 4N_1$

$$N_1 = \frac{A_1 - A_2}{4} \quad ....(ii)$$

From (i) and (ii)

$$N_2 - N_3 = Z_1 - Z_2 - \left(\frac{A_1 - A_2}{2}\right)$$

(P) $_{92}U^{238} \rightarrow _{91}Pa^{234}$

$$N_1 = \frac{238 - 234}{4} = 1 \rightarrow 1\alpha$$

$$N_2 - N_3 = (92 - 91) - \left(\frac{4}{2}\right) = -1 \rightarrow 1\beta^-$$

(Q) $_{82}Pb^{214} \rightarrow _{82}Pb^{210}$

$$N_1 = \frac{214 - 210}{4} = 1 \rightarrow 1\alpha$$

$$N_2 - N_3 = (82 - 82) - \left(\frac{4}{2}\right) = -2 \rightarrow 2\beta^-$$

(R) $_{81}T\ell^{210} \rightarrow _{82}Pb^{206}$

$$N_1 = \frac{210 - 206}{4} = 1 \rightarrow 1\alpha$$

$$N_2 - N_3 = (81 - 83) - \frac{4}{2} = -3 \rightarrow 3\beta^-$$

(S) $_{91}Pa^{228} \rightarrow _{88}Ra^{224}$

$$N_1 = \frac{228 - 224}{4} = 1\alpha$$

$$N_2 - N_3 = (91 - 88) - \frac{4}{2} = 1\beta^+$$

3. Ans. (16)

	S_1	S_2
Sol. t = 0	A_0	A_0
t = τ	A_1	A_2

$$\frac{A_1}{A_2} = \frac{A_0(0.5)^{t/(t_{1/2})_1}}{A_0(0.5)^{t/(t_{1/2})_2}} = \frac{(0.5)^3}{(0.5)^7} = 2^4 = 16$$

4. Ans. (2.30 - 2.35)

Sol. $^{16}_{7}N + ^{4}_{2}He \rightarrow ^{1}_{1}He + ^{19}_{8}O$

$^{16}_{7}N \quad + \quad ^{4}_{2}He \rightarrow \quad ^{1}_{1}He \quad + \quad ^{19}_{8}O$

16.006   4.003   1.008   19.003

$4v_0 = 1v_1 + 19v_2 = 20v_2$ (For max loss of KE)

$$v_0 = \frac{v_2}{5}$$

E required = (1.008 + 19.003 – 16.006 – 4.003) × 930 = 1.86

$$\frac{1}{2}4v_0^2 - \frac{1}{2}20v^2 = 1.86$$

$$\frac{1}{2}4v_0^2 - 10\frac{v_0^2}{25}20v^2 = 1.86$$

$$2v_0^2 - \frac{2}{5}v_0^2 = 1.86$$

$$\frac{8}{5}v_0^2 = 1.86$$

$$v_0^2 = \frac{1.86 \times 5}{8}$$

$$KE = \frac{1}{2}4v_0^2 = 2v_0^2 = \frac{18.6 \times 5}{4}$$

= 2.325

5. Ans. (A, B, D)

Sol. Binding energy of proton & neutron due to nuclear force is same. So difference in binding energy is only due to electrostatic P.E. and it is positive

$E_0^P - E_0^n$ = electrostatic P.E.

= Z × P.E. of one proton

$$= Z \times \frac{1}{4\pi\varepsilon_0}\frac{(Z-1)e^2}{R}$$

Where $R = R_0\ A^{1/3}$

$$= \frac{1}{4\pi\varepsilon_0}\frac{Z(Z-1)e^2}{R_0 A^{\frac{1}{3}}}$$

6. Ans. (2)

Sol. $Th_{90}^{230} \rightarrow Po_{84}^{214} + n\alpha_2^4 + m\beta_{-1}^0$

$230 = 214 + 4n$

$n = \frac{16}{4} = 4$

$90 = 84 + n \times 2 - m \times 1$

$90 = 84 + 4 \times 2 - m \times 1$

$m = 92 - 90 = 2$

Hence $\frac{n}{m} = \frac{4}{2} = 2$

7. Ans. (A)

Sol. $\frac{hc}{\lambda} = \phi + 6$ …(i)

$\frac{hc}{4\lambda} = \phi + 0.6$ …(ii)

$\frac{3hc}{4\lambda} = 5.4eV$ ($\therefore \phi = 1.2$ eV)

$\Rightarrow \frac{3}{4} \times \frac{6.63 \times 10^{-24} \times 3 \times 10^8}{5.4 \times 1.6 \times 10^{-19}} = \lambda = 1.72 \times 10^{-7} m$

8. Ans. (A, D)

Sol. For A

When the transition is from any level to n = 2, then photon emitted belong to Balmer series.

$\therefore$ For longest wavelength, transition occurs from n = 3 to n = 2.

$\therefore \frac{hc}{\lambda_{max}} = RCh\left[\frac{1}{2^2} - \frac{1}{3^2}\right]$ & for shortest wavelength transition occurs from n = ∞ to n = 2

$\therefore \frac{hc}{\lambda_{min}} = RCh\left[\frac{1}{2^2} - \frac{1}{\infty^2}\right]$

$\therefore \frac{\lambda_{longest}}{\lambda_{shorts}} = \frac{9}{5}$

For (B)

$\lambda_{longest}$ of Balmer $= \frac{36}{5R}$

$\lambda_{shortest}$ of Paschen $= \frac{9}{R}$

Hence these wavelength don't overlap.

For (C)

For Lyman series,

$\frac{1}{\lambda} = R\left[\frac{1}{1} - \frac{1}{m^2}\right]$

Also $\frac{1}{\lambda_0} = R$

$\therefore \frac{1}{\lambda} = \frac{1}{\lambda_0}\left[1 - \frac{1}{m^2}\right] \Rightarrow \lambda = \frac{\lambda_0}{1 - \frac{1}{m^2}}$

For (D)

$\lambda_{longest}$ of Lyman $= \frac{4}{3R}$,

$\lambda_{shortest}$ of Balmer $= \frac{4}{R}$

Hence that wavelength don't overlap.

9. Ans. (6)

Sol. For P & Q

$E_1 - 4 = E_P$

$E_1 - 4.5 = E_Q$

$E_P = 2\ E_Q$

$E_1 - 4 = 2\ (E_1 - 4.5)$

$E_1 = 5$ eV

$E_P = 1$ eV, $E_Q = E_R = 0.5$ eV

For $E_2 - 5.5 = 0.5$

$E_2 = 6$ eV

10. Ans. (D)

Sol. Out of 1000 nuclei of Q 60% may go α-decay

$\Rightarrow$ 600 nuclei may have α-decay

$\lambda = \frac{\ln 2}{t_{1/2}} = \frac{\ln 2}{20}$

t = 1 hour = 60 minutes

Using

$N = N_0 e^{-\lambda t}$

$= 600 \times e^{-\frac{\ln 2}{20} \times 60}$

N = 75

$\Rightarrow$ 75 Nuclei are left after one hour

So, No. of nuclei decayed

= 600 – 75 = 525

11. Ans. (A, C, D)

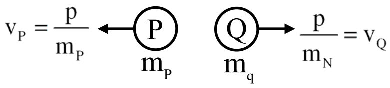
Sol. $N \longrightarrow P + Q$

Energy released = $(m_N - m_P - m_Q)c^2 = \delta c^2$

This will be distributed kinetic energy of P and Q

$\Rightarrow E_P + E_q = \delta c^2$ ....(i)

By conservation of momentum



So $\frac{v_P}{v_q} = \frac{M_q}{M_P}$ .....(ii)

Kinetic energy be written as $KE = \frac{p^2}{2m}$

Hence divided in inverse ratio of masses.

$E_P = \frac{M_q}{M_P + M_q} c^2 \delta$ ....(iii)

By equation (i) $\Rightarrow \frac{p^2}{2M_P} + \frac{p^2}{2M_q} = \delta c^2$

$\Rightarrow \frac{p^2}{2\mu} = \delta c^2 \Rightarrow p = c\sqrt{2\mu\delta}$

12. Ans. (A, C)

Sol. $\lambda_{min} = \frac{hc}{eV}$

$\Rightarrow \lambda_{min} \alpha \frac{1}{V} \Rightarrow (\lambda_{min})_{new} = \frac{\lambda_2}{2}$

$\because I = \frac{dN}{dt} \times \frac{hc}{\lambda}$

$\because \frac{dN}{dt}$ decreases

Hence I decreases

13. Ans. (B, C)

Sol. U = Fr

[Using U = Potential energy and v = velocity, to avoid confusion between their symbols]

$\Rightarrow$ Force = $\frac{-dU}{dr} = -F$

$\Rightarrow$ Magnitude of force = Constant = F

$\Rightarrow F = \frac{mv^2}{R}$ ....(1)

$\Rightarrow mvR = \frac{nh}{2\pi}$ ....(2)

$\Rightarrow F = \frac{m}{R} \times \frac{n^2h^2}{4\pi^2} \times \frac{1}{m^2R^2}$

$\Rightarrow R = \left(\frac{n^2h^2}{4\pi^2 mF}\right)^{1/3}$ ....(3)

$\Rightarrow v = \frac{nh}{2\pi mR}$

$\Rightarrow v = \frac{nh}{2\pi m}\left(\frac{4\pi^2 mF}{n^2h^2}\right)^{1/3}$

$\Rightarrow \boxed{v = \frac{n^{1/3}h^{1/3}F^{1/3}}{2^{1/3}\pi^{1/3}m^{2/3}}}$ ....(4)

(B) is correct

$\Rightarrow E = \frac{1}{2}mv^2 + U = \frac{1}{2}mv^2 + FR$

$\Rightarrow E = \frac{1}{2}m\left(\frac{n^{2/3}h^{2/3}F^{2/3}}{2^{2/3}\pi^{2/3}m^{4/3}}\right) + F \times \left(\frac{n^2h^2}{4\pi^2 mF}\right)^{1/3}$

$\Rightarrow E = \left(\frac{n^2h^2F^2}{4\pi^2 m}\right)^{1/3}\left[\frac{1}{2}+1\right]$

$= \frac{3}{2}\left(\frac{n^2h^2F^2}{4\pi^2 m}\right)^{1/3}$

14. Ans. (A)

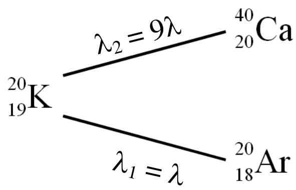
Sol. Parallel radioactive decay

$\lambda = \lambda_1 + \lambda_2 = 5 \times 10^{-10}$ per year

$N = N_0 e^{-\lambda t}$

$N_0 - N = N_{stable}$

$N = N_{radioactive}$



$\frac{N_0}{N} - 1 = 99$

$\frac{N_0}{N} = 100$

$\frac{N}{N_0} = e^{-\lambda t} = \frac{1}{100}$

$\Rightarrow \lambda t = 2\,\ell n10 = 4.6$

$t = 9.2 \times 10^9$ years

15. Ans. (B, C)

Sol. $\frac{hc}{\lambda_a} = 13.6\left[\frac{1}{1} - \frac{1}{4^2}\right]$ ...(i)

$\frac{hc}{\lambda_e} = 13.6\left[\frac{1}{m^2} - \frac{1}{4^2}\right]$ ...(ii)

(ii) / (i) , we get

$$\frac{\lambda_a}{\lambda_e} = \frac{\left[\frac{1}{m^2} - \frac{1}{16}\right]}{\left[1 - \frac{1}{16}\right]} = \frac{1}{5}$$

$\Rightarrow \frac{1}{m^2} - \frac{1}{16} = \frac{15}{16} \times \frac{1}{5}$

$\Rightarrow \frac{1}{m^2} - \frac{1}{16} = \frac{3}{16}$

$\Rightarrow \frac{1}{m^2} = \frac{3}{16} + \frac{1}{16}$

$\Rightarrow \boxed{m = 2}$

from (ii)

$\frac{hc}{\lambda_e} = 13.6\left[\frac{1}{2^2} - \frac{1}{4^2}\right] = 13.6 \times \frac{3}{16} ev$

$\Rightarrow \lambda_e = \frac{12400 \times 16}{13.6 \times 3} Å$

$\Rightarrow \lambda_e \approx 4862 Å$

we have $KE_n \propto \frac{z^2}{n^2}$

$\Rightarrow \frac{KE_2}{KE_1} = \frac{1}{4}$

$\Delta P_a = \frac{h}{\lambda_a}$

$\Delta P_e = \frac{h}{\lambda_e}$

$\Rightarrow \frac{\Delta P_a}{\Delta P_e} = \frac{\lambda_e}{\lambda_a}$

16. Ans. (1.00)

Sol. Let momentum of one photon is p and after reflection velocity of the mirror is v.

conservation of linear momentum

$Np\hat{i} = -Np\hat{i} + mv\hat{i}$

$mv\hat{i} = 2pN\hat{i}$

mv = 2Np ....(1)

since v is velocity of mirror (spring mass system) at mean position, v = AΩ

Where A is maximum deflection of mirror from mean position. (A = 1 μm) and Ω is angular frequency of mirror spring system,

momentum of 1 photon, $p = \frac{h}{\lambda}$

mv = 2Np .....(i)

$mA\Omega = 2N\frac{h}{\lambda}$

$N = \frac{m\Omega}{h} \times \frac{\lambda A}{2}$

given, $\frac{m\Omega}{h} = \frac{10^{24}}{4\pi} m^{-2}$

$\lambda = 8\pi \times 10^{-6}$ m

$N = \frac{10^{24}}{4\pi} \times \frac{8\pi \times 10^{-6} \times 10^{-6}}{2}$

$N = 10^{12} = x \times 10^{12}$

17. Ans. (130 to 140)

Sol. $Ra^{226} \longrightarrow Rn^{222} + \alpha$

Q = (226.005 – 222–4) 931 MeV

= 4.655 MeV

$K_\alpha = \frac{A-4}{A}(Q - E_\gamma)$

$4.44 \text{ MeV} = \frac{222}{226}(Q - E_\gamma)$

$Q - E_\gamma = (4.44)\left(\frac{226}{222}\right) \text{MeV}$

$E_\gamma = 4.655 - 4.520$

= .135 MeV

= 135 KeV

18. Ans. (A, C)

Sol. ${}^{232}_{90}Th$ is converting into ${}^{212}_{82}Pb$

Change in mass number (A) = 20

$\therefore$ no of α particle = $\frac{20}{4} = 5$

Due to 5 α particle, z will change by 10 unit.

Since given change is 8, therefore no. of β particle is 2

19. Ans. (24)

Sol. Power = nhν

n = number of photons per second

Since KE = 0, hν = ϕ

$200 = n[6.25 \times 1.6 \times 10^{-19} \text{ Joule}]$

$$n = \frac{200}{1.6\times10^{-19}\times6.25}$$

As photon is just above threshold frequency KE_{max} is zero and they are accelerated by potential difference of 500V.

$KE_f = q\Delta V$

$$\frac{P^2}{2m} = q\Delta V \Rightarrow P = \sqrt{2mq\Delta V}$$

Since efficiency is 100%, number of electrons = number of photons per second

As photon is completely absorbed force exerted = nmv

$$\frac{200}{6.25\times1.6\times10^{-19}}\times\sqrt{2\left(9\times10^{-31}\right)\times1.6\times10^{-19}\times500}$$

$$= \frac{3\times200\times10^{-25}\times\sqrt{1600}}{6.25\times1.6\times10^{-19}}$$

$$= \frac{2\times40}{6.25\times1.6}\times10^{-4}\times3 = 24$$

20. Ans. (3)

Sol. $$\Delta E_{2-1} = 13.6\times z^2\left[1-\frac{1}{4}\right] = 13.6\times z^2\left[\frac{3}{4}\right]$$

$$\Delta E_{3-2} = 13.6\times z^2\left[\frac{1}{4}-\frac{1}{9}\right] = 13.6\times z^2\left[\frac{5}{36}\right]$$

$\Delta E_{2-1} = \Delta E_{3-2} + 74.8$

$$13.6\times z^2\left[\frac{3}{4}\right] = 13.6\times z^2\left[\frac{5}{36}\right]+74.8$$

$$13.6\times z^2\left[\frac{3}{4}-\frac{5}{36}\right] = 74.8$$

$z^2 = 9$

$z = +3$

21. Ans. (5)

Sol. $t_{1/2} = 8$ days

$A = A_0e^{-\lambda t}$

$e^{\lambda t}(115) = A_0$

$$A_0 = 115(1+\lambda t) = 115\left(1+\frac{\ell n2}{t_{1/2}}\times11.5\right)$$

$A_0 = 115 \times 1.042 = 119.82$

$A_0 \cong 120$ Bq

120 Bq is the activity of 2.5 ml

∴ 2.4×10^5 Bq is the activity of

$$\frac{2.5\times10^{-3}}{120}\times2.4\times10^5$$

∴ Total volume of blood = 5 litres

22. Ans. (5)

Sol. $$U = -\frac{Z^2}{n^2}E_0$$

Z = 1

$$U = -\frac{E_0}{n^2}$$

$$\frac{U_i}{U_f} = \frac{n_f^2}{n_i^2} = 6.25$$

Taking $n_i = 2$

$n_f = 5$

23. Ans. (A)

Sol. According to photo electric effect equation :

$$KE_{max} = \frac{hc}{\lambda} - \phi_0$$

$$\frac{p^2}{2m} = \frac{hc}{\lambda} - \phi_0$$

$$\frac{\left(h/\lambda_d\right)^2}{2m} = \frac{hc}{\lambda} - \phi_0$$

Assuming small changes, differentiating both sides,

$$\frac{h^2}{2m}\left(-\frac{2d\lambda_d}{\lambda_d^3}\right) = -\frac{hc}{\lambda^2}d\lambda$$

$$\frac{d\lambda_d}{d\lambda} \propto \frac{\lambda_d^3}{\lambda^2}$$

24. Ans. (B)

Sol. $$KE_{max} = \frac{hc}{\lambda} - \phi$$

$$eV_s = \frac{hc}{\lambda} - \phi$$

$$1.6\times10^{-19}\times2 = \frac{h\times3\times10^8}{3000\times10^{-10}} - \phi \qquad ...(i)$$

$$1.6\times10^{-19}\times1=\frac{h\times3\times10^8}{4000\times10^{-10}}-\phi \qquad ...(ii)$$

From (ii) $\phi=\frac{h\times3\times10^8}{4000\times10^{-10}}-1.6\times10^{-19}$

$$1.6\times10^{-19}\times2=\frac{h\times3\times10^8}{3000\times10^{-10}}-\frac{h\times3\times10^8}{4000\times10^{-10}}+1.6\times10^{-19}$$

$$1.6\times10^{-19}=\frac{h\times3\times10^8}{10^{-7}}\left(\frac{1}{3}-\frac{1}{4}\right)=\frac{h\times3\times10^8}{10^{-7}}\left[\frac{4-3}{12}\right]$$

$$1.6\times10^{-19}=\frac{h\times3\times10^8}{10^{-7}}\times\frac{1}{12}$$

$$1.6\times4\times\frac{10^{-19}\times10^{-7}}{10^8}=h$$

6.4×10^{-34} Js = h

25. Ans. (A, B, D)

Sol. As radius $r\propto\frac{n^2}{z}$

$$\Rightarrow\frac{\Delta r}{r}=\frac{\left(\frac{n+1}{z}\right)^2-\left(\frac{n}{z}\right)^2}{\left(\frac{n}{z}\right)^2}=\frac{2n+1}{n^2}\approx\frac{2}{n}\propto\frac{1}{n}$$

as energy $E\propto\frac{z^2}{n^2}$

$$\Rightarrow\frac{\Delta E}{E}=\frac{\frac{z^2}{n^2}-\frac{z^2}{(n+1)^2}}{\frac{z^2}{(n+1)^2}}=\frac{(n+1)^2-n^2}{n^2.(n+1)^2}.(n+1)^2$$

$$\Rightarrow\frac{\Delta E}{E}=\frac{2n+1}{n^2}\simeq\frac{2n}{n^2}\propto\frac{1}{n}$$

as angular momentum $L=\frac{nh}{2\pi}$

$$\Rightarrow\frac{\Delta L}{L}=\frac{\frac{(n+1)h}{2\pi}-\frac{nh}{2\pi}}{\frac{nh}{2\pi}}=\frac{1}{n}\propto\frac{1}{n}$$

26. Ans. (6)

Sol. $\frac{hc}{\lambda}=\frac{12370}{970}$

$-13.6+12.7=-\frac{13.6}{n^2}$

$n^2=16$

$n=4$

Number of lines = ${}^nC_2=6$

27. Ans. (A)

Sol. $K_{max}=\frac{hc}{\lambda_{Ph}}-\phi$

kinetic energy of e^- reaching the anode will be

$K=\frac{hc}{\lambda_{Ph}}-\phi+eV$

Now

$$\lambda_e=\frac{h}{\sqrt{mK}}=\frac{h}{\sqrt{2m\left(\frac{hc}{\lambda_{Ph}}-\phi+eV\right)}}$$

If $eV>>\phi$

$$\lambda_e=\frac{h}{\sqrt{2m\left(\frac{hc}{\lambda_{Ph}}+eV\right)}}$$

If $V_f=4V_i$

$(\lambda_e)_f=\frac{(\lambda_e)_i}{2}$

28. Ans. (8 or 9)

Sol. ${}^{12}_{5}B\rightarrow{}^{12}_{6}C+{}^{0}_{-1}e+\overline{v}$

Mass defect = (12.014 – 12) u

$\therefore$ Released energy = 13.041 MeV

Energy used for excitation of ${}^{12}_{6}C$ = 4.041 MeV

$\therefore$ Energy converted to KE of electron

= 13.041 – 4.041 = 9 MeV

29. Ans. (C)

Sol. Electrostatic energy = BE_N-BE_O

$=[[7M_H+8M_n-M_N]-[8M_H+7M_n-M_O]]\times C^2$

$=[-M_H+M_n+M_O-M_N]C^2$

= [–1.007825 + 1.008665 + 15.003065 – 15.000109] × 931.5

= + 3.5359 MeV

$$\Delta E=\frac{3}{5}\times\frac{1.44\times8\times7}{R}-\frac{3}{5}\times\frac{1.44\times7\times6}{R}=3.5359$$

$$R=\frac{3\times1.44\times14}{5\times3.5359}=3.42\text{fm}$$

30. Ans. (C)

Sol. Let the permissible level have activity of $A_{permissible}$

Thus, initially

$A_0=64\,A_{permissible}$ [Given]

Let number of days required be t.

$$\therefore\frac{A_0}{2^{t/t_{1/2}}}=A_{permissible}$$

$$\Rightarrow\frac{64A_{permissible}}{2^{t/18}}=A_{permissible}$$

$\therefore$ t = 108 days

31. Ans. (3)

Sol. $12.5\% \rightarrow \left(\frac{1}{8}\right)^{th}$ of initial power

$\because$ After each T, P will be half

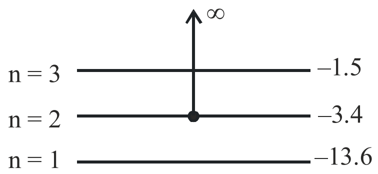
$$P \xrightarrow{T} \frac{P}{2} \xrightarrow{T} \frac{P}{4} \xrightarrow{T} \frac{P}{8}$$

$\therefore$ Total time = 3T

n = 3

32. Ans. (2)

Sol.



$$E_{Ph} = \frac{hc}{\lambda} = \frac{1242}{90} = 13.8\text{eV}$$

$E_{Ph} = \Delta E + (\text{K.E.})$

$13.8 = \Delta E + 10.4$

$\Delta E = 3.4$ eV

so electron initially was in n = 2

33. Ans. (A, C)

Sol. Stopping potential

$$eV_0 = \frac{hC}{\lambda} - \phi$$

hence V_0 v/s λ curve will be hyperbola and V_0 v/s $\frac{1}{\lambda}$ curve will be straight line with slope positive.

Hence (A, C)

34. Ans. (A)-R or R,T; (B)-P, S; (C)-Q,T; (D)-R

Sol. As per the information given in NCERT.

35. Ans. (2)

Sol. $N = N_0e^{-\lambda t}$

$A = \lambda N_0 e^{-\lambda t}$

$R = \lambda^2 N_0 e^{-\lambda t}$

$A_P = A_Q$ at t = 0

$\lambda_P N_P e^{-\lambda Pt} = \lambda_Q N_Q e^{-\lambda Qt}$ at t = 0

$\lambda_P N_P = \lambda_Q N_Q$ ... (i)

$$\frac{R_P}{R_Q} = \left(\frac{\lambda_P}{\lambda_Q}\right)^2 \left(\frac{N_P}{N_Q}\right) \frac{e^{-\lambda_P 2\tau}}{e^{-\lambda_Q 2\tau}}$$

$$\frac{R_P}{R_Q} = \left(\frac{\lambda_P}{\lambda_Q}\right)^2 \left(\frac{N_P}{N_Q}\right) \frac{1}{e} \quad \text{...(ii)}$$

$$\left[\lambda_P = \frac{1}{\text{mean life}}\right]$$

from equation (i) and equation (ii)

$$\frac{R_P}{R_Q} = \frac{2}{e}$$

36. Ans. (2)

Sol. From Bohr's law

$$mvr = \frac{nh}{2\pi} = \frac{3h}{2\pi} \text{ (from ques.)}$$

$\Rightarrow n = 3$

and momentum = $mv = \frac{3h}{2\pi r}$

Now, radius of n^{th} shell, $r = \left(\frac{n^2}{z}\right)a_0$

$$\Rightarrow r = \frac{(3)^2}{3} \cdot a_0 \qquad [\because Z_{Li} = 3]$$

$\Rightarrow r = 3a_0$

from De broglie law

$$\text{wavelength} = \frac{h}{\text{momentum}}$$

$$\Rightarrow \lambda = \frac{h}{mv} = \frac{h}{\frac{3h}{2\pi r}}$$

$$\Rightarrow \lambda = \frac{2\pi r}{3} = \frac{2\pi}{3} \times 3a_0$$

$\lambda = 2\pi a_0 = p\pi a_0$

$\Rightarrow P = 2$

37. Ans. (A)

Sol. U → Xe + Sr + x + y
2 2

$Q = 4 + K_{xe} + K_{sr}$ ... (i)

$-Q = E_B = 236 \times 7.5 - 140 \times 8.5 - 94 \times 8.5$

$\therefore$ Q = 219 ... (ii)

$\therefore K_{xe} + K_{sr} = 215$ MeV

Since, both x & y have same KE

$\therefore$ both particles should have same mass & lighter body will have higher KE.

38. Ans. (B)

Sol. $\sqrt{\frac{C}{\lambda}} = a(Z-b)$

b = 1

$$\sqrt{\frac{\lambda_{Cu}}{\lambda_{M_0}}} = \left(\frac{Z_{M_0}-1}{Z_{Cu}-1}\right)$$

$$\frac{\lambda_{Cu}}{\lambda_{M_0}} = \left(\frac{41}{28}\right)^2 = 2.14$$

39. Ans. (A)

Sol. $K_{max} = \frac{hc}{\lambda} - \phi$

$$\frac{1}{2}mu_1^2 = \frac{1240}{248} - \phi \quad ...(1)$$

$$\frac{1}{2}mu_2^2 = \frac{1240}{310} - \phi \quad ...(2)$$

Dividing, the two equations

$$\left(\frac{u_1}{u_2}\right)^2 = \frac{5-\phi}{4-\phi} \quad \& \quad \frac{u_1}{u_2} = \frac{2}{1} \text{ (given)}$$

$$4 = \frac{5-\phi}{4-\phi} \Rightarrow \phi = \frac{11}{3} = 3.7\,\text{eV}$$