NeetPreparation

Atoms and Nuclei Important Questions With Answers

NEET Physics 2023

---

1. If the binding energy per nucleon in ${}_3\mathrm{Li}^7$ and ${}_2\mathrm{He}^4$ nuclei are respectively 5.60 MeV and 7.06 MeV, then the energy of proton in the reaction ${}_3\mathrm{Li}^7 + \mathrm{p}^{3/4} \rightarrow 2{}_2\mathrm{He}^4$ is ______________ .
   a) 19.6 MeV b) 2.4 MeV c) 8.4 MeV **d) 17.3 MeV**

   Solution : -
   Total BE of nucleons in ${}_3\mathrm{Li}^7$
   $= 7 \times 5.60 = 39.20\mathrm{MeV}$
   Total BE of nucleons in $2\left({}_2\mathrm{He}^4\right)$
   $= (4 \times 7.06) \times 2 = 56.48\mathrm{MeV}.$
   Therefore, energy of protons in the reaction
   = difference of BE's
   = 56.48-39.20=17.3 MeV

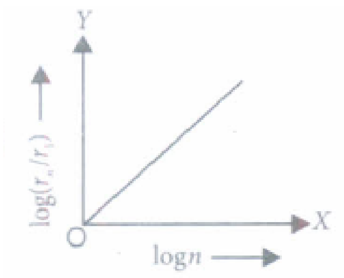
2. A nucleus ${}_nX'''$ emits one α-particle and two β particles. The resulting nucleus is :
   a) ${}_{n\_4}Z^{m-6}$ b) ${}_nZ^{m-6}$ **c) ${}_nX^{m-4}$** d) ${}_{n\_2}Y^{m-4}$

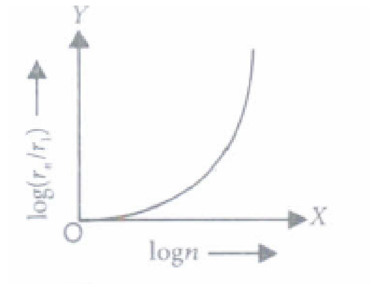
   Solution : -
   α-particle is ${}_2He^4$
   In β emission, the neutron gets converted to proton and electron
   ${}_nX^m \xrightarrow{1\alpha}{}_{n-2} Y^{m-4} \xrightarrow{2\beta}{}_n Z^{m-4}$
   So, new nucleus results as ${}_nX^{m-4}$

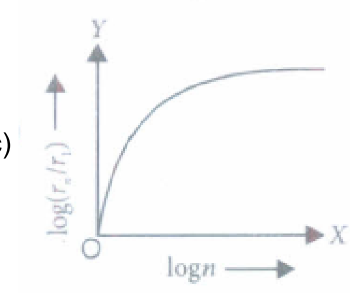
3. If E is the energy of n^{th} orbit of hydrogen atom the energy of n^{th} orbit of He atom will be
   a) E b) 2E c) 3E **d) 4E**

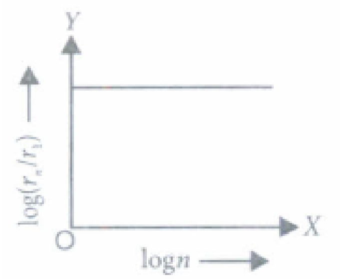
   Solution : -
   Since Bohr's formula for energy in n^{th} orbit is
   $E_n = -\frac{me^4 Z^2}{8\varepsilon_0^2 n^2 h^2} \Rightarrow E_n \infty Z^2$
   Now for hydrogen (${}_1H^2$), Z_H = 1, and E_H = E and for helium (${}_2He^4$), Z_{He} = 2.
   $\therefore \frac{E_H}{E_{He}} = \frac{(Z_H)^2}{(Z_{He})^2} \Rightarrow E_{He} = \left(\frac{Z_{He}}{Z_H}\right)^2 E_H = (2)^2 E = 4E$

4. In a hydrogen atom, the radius of n^{th} Bohr orbit is r_n, The graph between log(rn/rl) and logn will be

a) 

b) 

c) 

d) 

Solution : -

We know that $r_n \propto n^2$ or $(r_n/r_l) = n^2$ So, $\log(r_n/r_1) = 2\log n$ Hence, the graph between $\log(r_n/r_1)$ and logn will be a straight line passing through origin. The positive slope is given by $\tan\theta = 2$.

5. The fission properties of $^{239}_{94}Pu$ are very similar to those of $^{235}_{92}U$. The average energy released per fission is 180 MeV If all the atoms in 1 kg of pure $^{239}_{94}Pu$ undergo fission, then the total energy released in MeV is

a) 4.53 x 10^{26}MeV b) 2.21 x 10^{14}MeV c) 1 x 10^{13}MeV d) 6.33 x 10^{24}MeV

Solution : -

Number of atoms in 1 kg of pure ^{239}pu

$= \frac{6.023\times10^{23}}{239} \times 1000 = 2.52 \times 10^{24}$

As average energy released per fission is 180 MeV

$\therefore$ Total energy released = 2.52 x 10^{24} x 180 MeV

= 4.53 x 10^{26}MeV

6. **Assertion:** Large angle of scattering of alpha particles led to the discovery of atomic nucleus.

Reason : Entire positive charge of atom is concentrated in the central core.

a) If both assertion and reason are true and reason is the correct explanation of assertion.

b) If both assertionand reason are true but reason is not the correct explanationof assertion.

c) If assertion is true but reason is false. d) If both assertion and reason are false.

Solution : -

Alpha particle is positively charged, so is the nucleus, so the large angle of scattering of alpha particle shows that the nucleus is positively charged and concentrated in the central core.

7. In the question number 63, the frequency of emitted photon due to the given transition is (h = 6.64 $\times$ 10^{-34} J s, 1 eV = 1.6 $\times$ 10^{-19} J)

a) 2.46 $\times$ 10^{10} Hz b) 2.46 $\times$ 10^{12} Hz **c) 2.46 $\times$ 10^{15} Hz** d) 2.46 $\times$ 10^{18} Hz

Solution : -

From Bohr's third postulate of atomic theory the frequency of emitted photon

$hv = E_2 - E_1$ = 10.2eV $\therefore v = \frac{10.2}{h} eV$

Here, 10.2eV = 10.2 $\times$ 1.6 $\times$ 10^{-19} J, h = 6.64 $\times$ 10^{-34} J s

$\therefore v = \frac{10.2\times1.6\times10^{-19}}{6.64\times10^{-34}} = 2.46 \times 10^{15} Hz$

8. **Assertion:** Most of the mass of the atom is concentrated in its nucleus.

Reason: All alpha particles striking a gold sheet are scattered in different directions.

a) If both assertion and reason are true and reason is the correct explanation of assertion.

b) If both assertionand reason are true but reason is not the correct explanationof assertion.

c) If assertion is true but reason is false. d) If both assertion and reason are false.

Solution : -

The results of α-particle scattering experiment showed that most of the mass of the atom is concentrated in its nucleus. Not all but only high energy α-particles are scattered when they strike an extremely thin foil of metal and passing through nucleus

9. The acronym LASER stands for

a) Light Amplification by Stimulated Emission of Radiation

b) Light Amplitude by Stimulated Emission of Radiation

c) Light Amplification by Strong Emission of Radiation

d) Light Amplification by Stimulated Emission of Radiowave

10. The shortest wavelength in the Balmer series is (R = 1.097 $\times$ 10^7 m^{-1})

a) 200 nm b) 256.8 nm c) 300 nm **d) 364.6 nm**

Solution : -

Wavelength for Balmer series is

$\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n^2}\right)$

at n=∞ , the limit of the series observed.

$\therefore \frac{1}{\lambda} = R\left(\frac{1}{4} - \frac{1}{\infty^2}\right) \Rightarrow \frac{1}{\lambda} = \frac{R}{4} or \lambda = \frac{4}{R}$

Here, Ryberg's constant R = 1.097 $\times$ 10^7 m^{-1}

$\therefore \lambda = \frac{4}{1.097 \times 10^7}$ =364.6 $\times$ 10^{-9} m = 364.6 nm.

11. The binding energy per nucleon is maximum in case of ______________ .

a) ${}_2\mathrm{He}^4$ **b)** ${}_{26}\mathrm{Fe}^{56}$ c) ${}_{56}\mathrm{Ba}^{141}$ d) ${}_{92}\mathrm{U}^{235}$

Solution : -

The binding energy curve has a broad maximum in the range A=30 to A=120 corresponding to average binding energy per nucleon =8 MeV. The peak value of the maximum is 8.8 MeV / N for ${}_{26}\mathrm{Fe}^{56}$.

12. Assertion: When a nucleus is in an excited state, it can make a transition to a lower energy state by the emission of gamma rays.

Reason: There are energy levels for a nucleus just like there are energy levels in atoms.

a) If both assertion and reason are true and reason is the correct explanation of assertion.

b) If both assertion and reason are true but reason is not the correct explanation of assertion.

c) If assertion is true but reason is false. d) If both assertion and reason are false.

13. The number of beta particles emitted by a radioactive substance is twice the number of alpha particles emitted by it. The resulting daughter is an:

a) Isotope of parent b) Isobar of parent c) Isomer of parent d) Isotone of parent

Solution : -

From an equation shown :

${}_nX^m \xrightarrow{1\alpha}{}_{n-2}Y^{A-4} \xrightarrow{2\beta}{}_Z P^{A-4}$

As the resulting daughter and parent nucleus has similar atomic number, so they are isotope.

14. If n is the orbit number of the electron in a hydrogen atom, the correct statement among the following is

a) electron energy increases as n increases.

b) hydrogen emits infrared rays for the electron transition from n = ∞ to n = 1.

c) electron energy is zero for n = 1.   d) electron energy varies as n^2.

Solution : -

In a hydrogen atom, the energy of electron in n^{th} orbit is

$E_n = -\frac{13.6}{n^2} eV$

15. Wavelength of spectral line emitted is inversely proportional to :

a) Radius   **b) Energy**   c) Velocity   d) Quantum number

Solution : -

$E = \frac{12375}{\lambda} eV$

Wavelength of spectral line emitted is inversely proportional to energy $\lambda \propto 1/E$

16. A nucleus represented by the symbol $_Z^AX$ has ____________ .

a) A protons and (Z-A) neutrons   b) Z neutrons and (A-Z) protons   **c) Z protons and (A-Z) neutrons**

d) Z protons and A neutrons

Solution : -

$_Z^AX \text{ has } Z \text{ protons and } (A-Z) \text{ neutrons}$

17. An electron in the ground state of hydrogen atom is revolving in anticlockwise direction in circular orbit of radius R. The orbital magnetic dipole moment of the electron will be

a) $\frac{eh}{4\pi m}$ b) $\frac{eh}{2\pi m}$ c) $\frac{eh^2}{4\pi m}$ d) $\frac{e^2h}{4\pi m}$

Solution : -

According to Bohr's theory,

$mvr = n\frac{h}{2\pi} = \frac{h}{2\pi} \quad (\because n = 1)$

$\therefore v = \frac{h}{2\pi mr}$

We know that rate of flow of charge is current.

$\therefore I = e\left(\frac{v}{2\pi r}\right) = \frac{ev}{2\pi r} = \frac{e}{2\pi r} \times \frac{h}{2\pi mr} = \frac{eh}{4\pi^2 mr^2}$

Magnetic dipole moment = IA

$\therefore \quad M = \frac{eh}{4\pi^2 mr^2} \times \pi r^2 = \frac{eh}{4\pi m}$

18. What is the ratio of the shortest wavelength of the Balmer series to the shortest wavelength of the Lyman series?

a) 4 : 1   b) 4 : 3   c) 4 : 9   d) 5 : 9

Solution : -

For a Balmer series

$\frac{1}{\lambda_B} = R\left[\frac{1}{2^2} - \frac{1}{n^2}\right]$ ....(i)

where n = 3, 4, ...

By putting n = ∞ in equation (i), we obtain the series limit of the Balmer series. This is the shortest wavelength of the Balmer series.

or $\lambda_B = \frac{4}{R}$ ....(ii)

For a Lyman series

$\frac{1}{\lambda_L} = R\left[\frac{1}{1^2} - \frac{1}{n^2}\right]$ ....(iii)

where n = 2, 3, 4, ...

By putting n = ∞ in equation (iii), we obtain the series limit of the Lyman series. This is the shortest wavelength of the Lyman series.

or $\lambda_L = \frac{1}{R}$ ....(iv)

Dividing (ii) by (iv), we get

$\frac{\lambda_B}{\lambda_L} = \frac{4}{1}$

19. An electron emitted in beta radiation originates from:
a) inner orbits of atom b) free electrons existing in the nuclei **c) decay of a neutron in a nuclei**
d) photon escaping from the nucleus

Solution : -

In β-emission, a neutron of nucleus decays into a proton, a β-particle and an anti-neutrino
$n \rightarrow p + e^{-} + \bar{v}$

20. A radioactive sample with a half-life of 1 month has the label: Activity =2 microcurie on 1-8-1991. What would be its activity two months earlier?
a) 1.0 microcurie b) 0.5 microcurie c) 4 microcurie **d) 8 microcurie**

Solution : -

The activity of a radioactive substance is defined as the rate at which the nuclei of its atoms in the sample disititegrate. In two half-lives, the activity becomes onefourth. Two months is 2 half-life period. The activity, two months earlier was
2 x 2^2=8 microcurie.

Note

The activity of a radioactive sample is called one curie, if it undergoes 3.7×10^{10} disintegrations per second.

21. If an electron in a hydrogen atom jumps from the 3rd orbit to the 2nd orbit, it emits a photon of wavelength λ. When it jumps from the 4th orbit to the 3rd orbit, the corresponding wavelength of the photon will be :
a) (16/25)λ b) (9/16)λ **c) (20/7)λ** d) (20/13)λ

Solution : -

We know that de Broglie wavelength is $\lambda = 1/R$
$\left[1/n_L^2 - 1/n_H^2\right]$
Using the equation data,$\lambda = 1/R\left[1/n^2 - 1/3^2\right] = \frac{36}{5R}$
On jumping from 4th orbit to 3rd orbit,
$\lambda' = 1/R\left[1/3^2 - 1/4^2\right] = \frac{16\times 9}{7R}$
Now corresponding wavelength of photon is
$\lambda' = \lambda \times \frac{16\times 9}{5R} \quad or \quad \lambda' = \frac{20\lambda}{7}$

22. A deuteron strikes $_8O^{16}$ nucleus with subsequent emission of an alpha particle. Identify the nucleus so produced:
a) $_3Li^7$ b) $_5B^{10}$ c) $_7N^{13}$ **d) $_7N^{14}$**

Solution : -

When a deuteron strikes $_8O^{16}$ nucleus with subsequent emission of alpha particle, then we have a reaction: $_8O^{16}$ + $_1H^2 \longrightarrow {}_2He^4 + {}_7N^{14}$

23. A certain mass of Hydrogen is changed to Helium by the process of fusion. The mass defect in fusion reaction is 0.02866 a.m.u. The energy liberated per a.m.u. is:
(Given: 1a.m.u = 931 MeV)
a) 26.7 MeV **b) 6.675 MeV** c) 13.35 MeV d) 2.67 MeV

Solution : -

Mass defect D m=0.02866 a.m.u.
Energy $= 0.02866 \times 931 = 26.7\text{MeV}$
As ${}_1\text{H}^2 + {}_1\text{H}^2 \rightarrow {}_2\text{He}^4$
Energy liberated per a.m.u.
$= 13.35/2\text{MeV}$
$= 6.65\text{MeV}$

24. **Assertion:** Atoms of each element are stable and emit characteristic spectrum.
Reason: The spectrum provides useful information about the atomic structure.

a) If both assertion and reason are true and reason is the correct explanation of assertion.

b) If both assertionand reason are true but reason is not the correct explanationof assertion

c) If assertion is true but reason is false   d) If both assertion and reason are false.

Solution : -

Atoms of each element are stable and emit characteristic spectrum. The spectrum consists of a set of isolated parallel lines termed as line spectrum. It provides useful information about the atomic structure.

25. The binding energy per nucleon of deuterium and helium nuclei are 1.1 MeV and 7.0 MeV respectively. When two deuterium nuclei fuse to form a helium nucleus the energy released in the fusion is

a) 23.6 MeV   b) 2.2 MeV   c) 28.0 MeV   d) 30.2 MeV

Solution : -

${}_1H^2 +_1 H^2 \Rightarrow_2 He^4 + \triangle E$

The binding energy per nucleon of a deuterium =1.1MeV

∴Total binding energy = 2 x 1.1 = 2.2 MeV

The binding energy per nucleon of a helium nuclei =7MeV

∴Total binding energy = 4 x 7 = 28 MeV

Hence, energy released

$\triangle E$= (28 - 2 x 2.2) = 23.6 MeV

26. Light energy emitted by star is due to

a) breaking of nuclei   **b) joining of nuclei**   c) burning of nuclei   d) reflection of solar light

Solution : -

Light energy emitted by stars is due to fusion of light nuclei.

27. In which of the following systems will the radius of the first orbit (n =1) be minimum?

a) Hydrogen atom   **b) Doubly ionized lithium**   c) Singly ionized helium   d) Deuterium atom

Solution : -

$r \propto \frac{1}{Z}; Z(=3)$ is maximum for Li^{2+}.

28. In the Bohr model of the hydrogen atom, the lowest orbit corresponds to

a) infinite energy   b) maximum energy   **c) minimum energy**   d) zero energy

Solution : -

In hydrogen atom, the lowest orbit corresponds to minimum energy.

29. If 200 MeV energy is released in the fission of a single nucleus of ${}^{235}_{92}U$,the fissions which are required to produce a power of 1 kW is

a) 3.125 x 10^{13}   b) 1.52 x 10^{6} c) 3.125 X 10^{12} d) 3.125 x 10^{14}

Solution : -

Let the number of fissions per second be n. Energy released per second

= n x 200 MeV = n x 200 x 1.6 X 10^{-13} J

Energy required per second = power x time

= 1 kW x 1 s = 1000 J

∴ n x 200 x 1.6 X 10^{-13} = 1000

or $n = \frac{1000}{3.2\times10^{-11}} = \frac{10}{3.2} \times 10^{13} = 3.125 \times 10^{13}$

30. In a Geiger-Marsden experiment. Find the distance of closest approach to the nucleus of a 7.7 MeV a-particle before it comes momentarily to rest and reverses its direction. (Z for gold nucleus = 79)

a) 10 fm   b) 20 fm   **c) 30 fm**   d) 40 fm

Solution : -

Let d be the distance of closest approach then by the conservation of energy.
Initial kinetic energy of incoming α-particle K = Final electric potential energy U of the system

As $K=\frac{1}{4\pi\varepsilon_0}\times\frac{(2e)(Ze)}{d}\therefore d=\frac{1}{4\pi\varepsilon_0}\frac{2Ze^2}{K}$ .....(i)

Here,

$\frac{1}{4\pi\varepsilon_0}=9\times10^9 Nm^2C^{-2}, Z=79, e=1.6\times10^{-19}C$

K=7.7 MeV = $7.7\times10^6\times1.6\times10^{-19}$ J=1.2×10^{-12} J

Substituting these values in (i)

$d=\frac{2\times9\times10^9\times(1.6\times10^{-19})^2\times79}{1.2\times10^{-12}}$

d = 3×10^{-14} m = 30 fm ($\because$ 1 fm = 10^{-15} m)

31. The half-life of a radioactive substance is 30 minutes. The time (in minutes) taken between 40% decay and 85% decay of the same radioactive substance is :

a) 15 b) 30 c) 45 **d) 60**

Solution : -

We know that:

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

Half-life = $t_{1/2}$ = In $2/\lambda$

From the question we see that if number of active nuclei falls from 60% to 15%, then sample becomes, 1/4th, 1/2th

Hence number of half-lives is 2, so the time needed is:

t = 2 x 30 = 60 mints

32. If $M(A;Z), M_p$ and M_n denote the masses of the nucleus ${}_Z^AX$, proton and neutron respectively in units of u(1 u = 931.5 MeV / C^2) and BE represents its bonding energy in MeV, then ___________ .

a) $M(A,Z)=ZM_p+(A-Z)M_n-BE/c^2$ b) $M(A,Z)=ZM_p+(A-Z)M_n+BE$

c) $M(A,Z)=ZM_p+(A-Z)M_n-BE$ d) $M(A,Z)=ZM_p+(A-Z)M_n+BE/c^2$

Solution : -

Mass defect $=ZM_p+(A-Z)M_n-M(A,Z)$

or, $\frac{B\cdot E.}{c^2}=ZM_p+(A-Z)M_n-M(A,Z)$

$\therefore M(A,Z)=ZM_p+(A-Z)M_n-\frac{B\cdot E}{c^2}$

33. If muonic hydrogen atom is an atom in which a negatively charged muon (μ) of mass about 207 m_e revolves around a proton, then first Bohr radius of this atom is (r_e = 0.53×10^{-10} m)

a) 2.56×10^{-10} m b) 2.56×10^{-11} m c) 2.56×10^{-12} m **d) 2.56×10^{-13} m**

Solution : -

According to Bohr's atomic model,

$r\infty\frac{1}{m}\Rightarrow\frac{r_\mu}{r_e}=\frac{m_e}{m_\mu}$ .....(i)

Here, r_e = 0.53×10^{-10} m; m_μ = 207 m_e

$\therefore r_\mu=\frac{m_e}{207m_e}\times0.53\times10^{-10}$ (using (i))

= 2.56×10^{-13} m.

34. The stable nucleus that has a radius half that of Fe^{56} is:

a) Li^7 b) Na^{21} c) S^{16} d) Ca^{40}

Solution : -

Nuclear radius = R = $R_0A^{1/3}$

It shows that $R\propto A^{1/3}$

$R^3\propto A$

Further $A\propto R^3$

Now, $A_2/A_1 = (R_2/R_1)^3 = [(R_1/2)/R_1]^3 = 1/8$
Now $A_2 = A_1/8 = 56/8 = 7$
Hence, stable nucleus having radius half of Fe^{56} is Li^7.

35. Carbon dating is best suited for determining the age of fossils, if their age in years is of the order of
a) 10^3 **b) 10^4** c) 10^5 d) 10^6

Solution : -
Carbon dating is best suited for determining the age of fossils, if their age is of the order of 10^4 years.

36. If speed of electron in ground state energy level is 2.2×10^6 m s^{-1}, then its speed in fourth excited state will be
a) 6.8×10^6 m s^{-1} b) 8.8×10^5 m s^{-1} **c) 5.5×10^5 m s^{-1}** d) 5.5×10^6m s^{-1}

Solution : -
According to Bohr's model
$v = \frac{2Ke^2Z}{nh} or \quad v \propto \frac{1}{n} \quad \therefore \frac{v_A}{v_B} = \frac{n_B}{n_A}$
Here, $v_A = 2.2 \times 10^6$ ms^{-1}; $n_A = 1$, $n_B = 4$
$\therefore v_B = v_A \times \frac{n_A}{n_B} = 2.2 \times 10^6 \times \frac{1}{4} = 0.55 \times 10^6$
$= 5.5 \times 10^5$ ms^{-1}

37. The first use of quantum theory to explain the structure of atom was made by
a) Heisenberg **b) Bohr** c) Planck d) Einstein

Solution : -
Bohr initially use quantum theory to explain the structure of atom and proposed that energy of electron in an atom is quantized.

38. In a hydrogen atom the total energy of electron is
a) $\frac{e^2}{4\pi\varepsilon_0 r}$ b) $\frac{-e^2}{4\pi\varepsilon_0 r}$ **c)** $\frac{-e^2}{8\pi\varepsilon_0 r}$ d) $\frac{e^2}{8\pi\varepsilon_0 r}$

Solution : -
The kinetic energy of the electron in hydrogen atom are
$$K = \frac{1}{2}mv^2 = \frac{e^2}{8\pi\varepsilon_0 r} \quad \left[\because v^2 = \frac{e^2}{4\pi\varepsilon_0 mr}\right]$$
Electrostatic potential energy,
$$U = \frac{-e^2}{4\pi\varepsilon_0 r}$$
The total energy E of the electron in a hydrogen atom is
$$E = K + U, E = \frac{e^2}{8\pi\varepsilon_0 r} + \left(\frac{-e^2}{4\pi\varepsilon_0 r}\right) = -\frac{e^2}{8\pi\varepsilon_0 r}$$
here negative sign ahows that electron is bound to the nucleus.

39. In the question number 79, what would be the angular momentum of H_γ photon if the angular momentum of the system is conserved
a) h b) 2 h **c) 3 h** d) 4 h

Solution : -
According to Bohr's atomic model, angular momentum L_n=nh.
If the angular momentum of system is conserved then angular momentum of emitted photon = change in angular momentum of electron corresponding to the transition from n = 5 to n = 2
$\therefore L = L_5 - L_2 = 5h - 2h = 3h$

40. Two radioactive substances A and B have decay constants 5λ and λ respectively. At t = 0, they have the same number of nuclei. The ratio of number of nuclei of A to those of B will be $(1/e)^2$ after a time interval
a) 4λ b) 2λ **c)** $1/2\lambda$ d) $1/4\lambda$

Solution : -

Given:$\lambda_A = 5\lambda, \lambda_B = \lambda$
At t = 0, $(N_0)A = (N_0)B$
At time t,$\frac{N_A}{N_B} = (\frac{1}{e})^2$
According to radioactive decay,$\frac{N}{N_0} = e^{-\lambda t}$
$\therefore \frac{N_A}{(N_o)_A} = e^{-\lambda A^t}$ ....(i)
and $\frac{N_B}{(N_o)_B} = e^{-\lambda B^t}$.....(ii)
Divide (i) by (ii), we get
$\frac{N_A}{N_B} = e^{-(\lambda_A-\lambda_B)t}$ or $\frac{N_A}{N_B} = e^{-(5\lambda-\lambda)t}$
or $(\frac{1}{e})^2 = e^{-4\lambda t}$ $or(\frac{1}{e})^2 = (\frac{1}{e})^{4\lambda t}$
$\Rightarrow 4\lambda t = 2$ or $t = \frac{2}{4\lambda} = \frac{1}{2\lambda}$

41. Which of the following spectral series falls within the visible range of electromagnetic radiation?
a) Lyman series **b) Balmer series** c) Paschen series d) Pfund series

42. A nucleus $_nX^m$ emits one a and two b-particles. The resulting nucleus is:
a) $_nX^{m-4}$ b) $_{n-2}X^{m-4}$ c) $_{n-4}Z^{m-4}$ d) None of these
Solution : -
The reaction can be shown as
$_{n^0}X^m \overset{\alpha\left(_2\text{He}^4\right)}{\longrightarrow} \longrightarrow_{n-2}\text{Y}^{m-4}$
Thus, the resulting nucleus is the isotope of parent nucleus and is $_nX^{m-4}$.

43. The ionisation energy of hydrogen atom is 13.6 eV the ionisation energy of helium atom would be:
a) 13.6 eV b) 27.2 eV c) 6.8 eV **d) 54.4 eV**
Solution : -
Ionisation energy is defined as the energy required to knock an electron completely out of an isolated gaseous atom. When electron is raised to the orbit n = ¥, it will be completely out of the atom.
Ionisation energy of helium,
$E = \frac{2\pi^2 mZ^2k^2e^4}{h^2}\left[\frac{1}{1^2} - \frac{1}{\infty}\right]$
$= \frac{2\pi^2 m(2)^2k^2e^4}{h^2}\left[\frac{1}{1^2} - \frac{1}{\infty}\right]$
Ionisation energy for hydrogen atom
$= 13.6\text{eV} = \frac{2\pi^2 mk^2e^2}{h^2} \times 4 \times \left[\frac{1}{1^2} - \frac{1}{\infty^2}\right]$
$\Rightarrow \quad = 4 \times 13.6 = 54.4\text{eV}$

44. The total energy of an electron in the first excited state of hydrogen atom is about -3.4 eV. Its kinetic energy in this state is ______________ .
a) 3.4 eV b) 6.8 eV c) -3.4 eV d) -6.8 eV
Solution : -
$K.E. \frac{Z^2}{n^2}(13, 6\text{cV})$
Mechanical energy $= \frac{-Z^2}{n^2}(13.6\text{eV})$
K.E. in 2nd orbital for hydrogen =- Mechanical energy
$= -\frac{(1)^2}{(2)^2}(13.6) = +3.4\text{eV}$

45. In a radioactive decay process, the negatively charged emitted β-particles are _____________ .
a) The electrons produced as a result of the decay of neutrons inside the nucleus
b) The electrons produced as a result of collisions between atoms

c) The electronics orbiting around the nucleus d) The electrons present inside the nucleus

Solution : -

Under beta minus decay (β^-), a neutron is transformed into a proton, and an electron is emitted with the nucleus with an antineutrino.

$n \rightarrow p + e^- + V$

Where V is the antineutrino.

46. Two stable isotopes ${}_3^6Li$ and ${}_3^7Li$ have respective abundances of 7.5% and 92.5%. These isotopes have masses 6.01512 u and 7.01600 u respectively. The atomic weight of lithium is

a) 6.941 u b) 3.321 u c) 2.561 u d) 0.621 u

Solution : -

Atomic weight = average weight of the isotopes

$= \frac{6.01512 \times 7.5 + 7.01600 \times 92.5}{(7.5+92.5)} = \frac{45.1134+648.98}{100}$

= 6.941 u

47. J.J. Thomson's cathode-ray tube experiment demonstrated that.

a) The e/m ratio of the cathode-ray particles changes when a different gas is placed in the discharge tube

b) Cathode rays are streams of negatively charged ions

c) All the mass of an atom is essentially in the nucleus.

d) The e/m of electrons is much greater than the e/m of protons

Solution : -

Cathode rays are streams of negatively charged ions.

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

a) x = n, y = n, K_{sr} = 129 MeV, K_{Xe}= 86 MeV b) x = p,y =$\overline{e}$, 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

Solution : -

${}_{92}^{236}U \rightarrow {}_{54}^{140}\ Xe + {}_{38}^{94}\ Sr + x + y$

K_x = 2 MeV, K_y = 2 MeV, K_{Xe} = ?, K_{Sr} =?

By conservation of charge number and mass number,

x $\equiv$y$\equiv$ n

B.E. per nucleon of ${}_{92}^{236}U = 7.35MeV$

B.E. per nucleon of ${}_{54}^{140}Xe\ or\ {}_{38}^{94}Sr = 8.5MeV$

Q value of reaction,

Q=Net kinetic energy gained in the process

= K_{Xe} + K_{Sr} + 2 + 2 - 0 = K_{Xe} + K_{Sr} + 4 ....(i)

As number of nucleons is conserved in a reaction, so

Q = Difference of binding energies of the nuclei

= 140 x 8.5 + 94 x 8.5 - 236 x 7.5 = 219 MeV ......(ii)

From eqns. (i) and (ii)

K_{Xe} + K_{Sr} = 219 - 4 = 215 MeV

Xe and Sr have momentum of same magnitude but in opposite directions.

Hence, lighter body has larger kinetic energy.

So, from options,

K_{Sr} = 129 MeV, and K_{Xe} = 86 MeV

49. M_n and M**p**, represent mass of neutron and proton respectively. If an element having atomic mass M has N neutron and Z-proton, then the correct relation will be _______________ .

a) $M < [NM_n + ZM_p]$ b) $M > [NM_n + ZM_p]$ c) $M = [NM_n + ZM_p]$ d) $M = N[M_n + M_p]$

Solution : -

We have, Mass of neutron =M_n

Mass of proton =M_p; Atomic mass of the element =M;

Number of neutrons in the element =N and number of protons in the element =Z. For stability of nucleus the atomic mass (M) of any nucleus is always less than the sum of the masses of the constituent particles.

Hence, $M < [NM_n + ZM_p]$.

50. **Assertion :** Bohr's third postulate states that the stationary orbits are those for which the angular momentum is some integral multiple of h2πh2π.

Reason : Linear momentum of the electron in the atom is quantised.

a) If both assertion and reason are true and reason is the correct explanation of assertion.

b) If both assertionand reason are true but reason is not the correct explanationof assertion.

c) If assertion is true but reason is false. **d) If both assertion and reason are false.**

Solution : -

Bohr's second postulate states that the stationary orbits are those for which the angular momentum is some integral multiple of $\frac{h}{2\pi} i.e. L = n\frac{h}{2\pi}$ where n is an integer called a quantum number. But linear momentum is not quantised.