NEET REVISION SERIES

ATOMIC PHYSICS

Revise Most Important Questions to Crack NEET 2020

Q-1 - 19037947

In rutherford's experiment, the mumber of alpha-particles scattered through an angle of 90 is 28 per minute. Then,the number of particles scattered through an angle of 60per minute by the same nucleus is

(A) 28 per minute

(B) 112 per minute

(C) 12.5 per minute

(D) 7 per minute

CORRECT ANSWER: B

SOLUTION:

According to Rutherford's scattering formula,if the α-particle scattered at angle θ is directly proportional to

$$\frac{1}{\sin^4(\theta/2)}$$

Then,$N_0 = \frac{K}{\sin^4(\theta/2)}$

$\theta = 90, N\theta = 28 \min^{-1}$

Rightarrow

$$28 = \frac{K}{\sin(45)} = 4K$$

$$\Rightarrow K = 7$$

Thus,$N_\theta = \frac{7}{\sin^4(\theta/2)}$

Hence,the number of α-particles scattered at an angle of 60 per minute is

$$N_0 = \frac{7}{\sin^4 30}$$

$$= \frac{7}{(1/2)}$$

$= 7 \times 16 = 112$

Q-2 - 15217506

An α- particle accelerated through V volt is fired towards a nucleus. It distance of closest approach is r. If a proton accelerated through the same potential is fired towards the same nucleus, the distance of closest approach of the proton will be :

(A) r

(B) 2r

(C) $\frac{r}{2}$

(D) $\frac{r}{4}$

CORRECT ANSWER: 1

SOLUTION:

$$a_{\alpha} = +2e$$

$$2eV = \frac{K \times (2e)(Ze)}{r}$$

$$eV = \frac{K \times (e)(Ze)}{x}$$

x=r

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Q-3 - 14155451

Ratio of difference of spacing between the energy levels with $n = 3$ and $n = 4$ and the spacing between the energy levels with $n = 8$ and $n = 9$ for a hydrogen like atom or ion is

(A) 0.71

(B) 0.41

(C) 2.43

(D) 14.82

CORRECT ANSWER: B

SOLUTION:

$$\frac{r_4 - r_3}{r_9 - r_8} = \frac{4^2 - 3^2}{9^2 - 8^2}$$
$$= 0.41$$

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Q-4 - 11312830

Statement I : The energy of a He^+ ion for a given n is almost exactly four times that of H atom for the same n.

Statement II : Photon emitted during transition between corresponds pair of levels in He^+ and H have the same energy E and the same wavelength $\lambda = hc / E$.

(A) Statement I is True , Statement II is True , Statement

II is a correct explanation for Statement I.

(B) Statement I is True , Statement II is True , Statement II is NOT a correct explanation for Statement I.

(C) Statement I is True , Statement II is False.

(D) Statement I is False , Statement II is True.

CORRECT ANSWER: A

SOLUTION:

A h atom that drops from $n = 2$ level to $n = 1$ level emits a photon of energy $10.2eV$ and wavelength $122nm. A$He^(+)

$io \ne mitsapho$

$\rightarrow nofthesamee$

$\ne rgy \text{ and } wave \le n$

$> hwhenitdropsom$

n = 4 $\le vel \rightarrow$ n = 2` level.

Any radiation in the ultraviolet region of hydrogen spectrum is able to eject photoelectrons from a metal. What should be the maximum value of threshold frequency for the metal?

(A) $3.288 \times 10^{15} Hz$

(B) $2.466 \times 10^{15} Hz$

(C) $4.594 \times 10^{14} Hz$

(D) $8.220 \times 10^{14} Hz$

CORRECT ANSWER: B

SOLUTION:

For minimum frequency in Lyman series of H -atom, transition n=2to n=1 takes place.

Now , hv=$\Delta E = E_2 - E_1$

or hv=

$$\left[\left(-\frac{13.6}{2^2}\right)-\left(-\frac{13.6}{1^2}\right)\right]eV$$

$$v=\frac{10.2\times1.6\times10^{-19}}{6.63\times10^{-34}}$$

$$\therefore v=2.466\times10^{15}Hz$$

If the threshold frequency of metal is v or less,

photoelectron will come out.

Q-6 - 14939563

The ionization potential of H-atom is 13.6 V. The H-atoms in ground state are excited by mono chromatic radiations of photon energy 12.09 ev. Then the number of spectral lines emitted by the excited atoms, will be

(A) 1

(B) 2

(C) 3

(D) 4

CORRECT ANSWER: C

Q-7 - 14157313

If the total energy of an electron is $-1.51 eV$ in hydrogen atom then find out $K.E$, $P.E.$, orbit radius and velocity of the electron in that orbit.

SOLUTION:

Given, (i) $E = -1.5eV$

$(i)E = -KE$
$K.E = -E\{\because Z$
$= 1\}$

$1.51eV$

(ii) $PE = -2 \times 1.51$

$= -3.02eV$

(iii) Orbit $= 3^{rd}$
$\because E = -13.6$
$\times \frac{Z^2}{n^2}eV \Rightarrow -1.51$
$= -13.6 \times \frac{1^2}{n^2}$

$n^2 = \frac{-13.6}{-1.51} = 9$

$n = 3$

(iv)

$$r = 0.529 \times \frac{3 \times 3}{1}$$

$$= 0.529 \times 9 = 4.761$$

$$v = 2.188 \times 10^8$$

$$\times \frac{1}{3} cm / \sec$$

$$= \frac{2.188 \times 10^8}{3}$$

$$= 0.729 \times 10^8 cm / \sec$$

Q-8 - 19037989

In hydrogen atom, an electron jumps from bigger orbit to smaller orbit, so that radius of smaller orbit is one-fourth of radius of bigger orbit. If speed of electron in bigger orbit was v,then speed in smaller orbit is

(A) $\frac{v}{4}$

(B) $\frac{v}{2}$

(C) v

(D) $2v$

CORRECT ANSWER: D

SOLUTION:

Radius of nth orbit,$r_n \propto n^2$

$$\frac{r_{\text{n big}}}{r_{\text{n small}}}=\frac{n^2 big}{n^2 small}$$

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

(given)

Rightarrow$\frac{n_{big}}{n_{small}}=2$

Rightarrow$\frac{n_{small}}{n_{big}}=\frac{1}{2}$

Velocity of electron in nth orbit

$$v_n \propto \frac{1}{n}$$

$$\frac{v_{(\text{n big})}}{v_{(\text{n small})}}=\frac{n_{small}}{n_{big}}$$

$$=\frac{1}{2}$$

Rightarrow

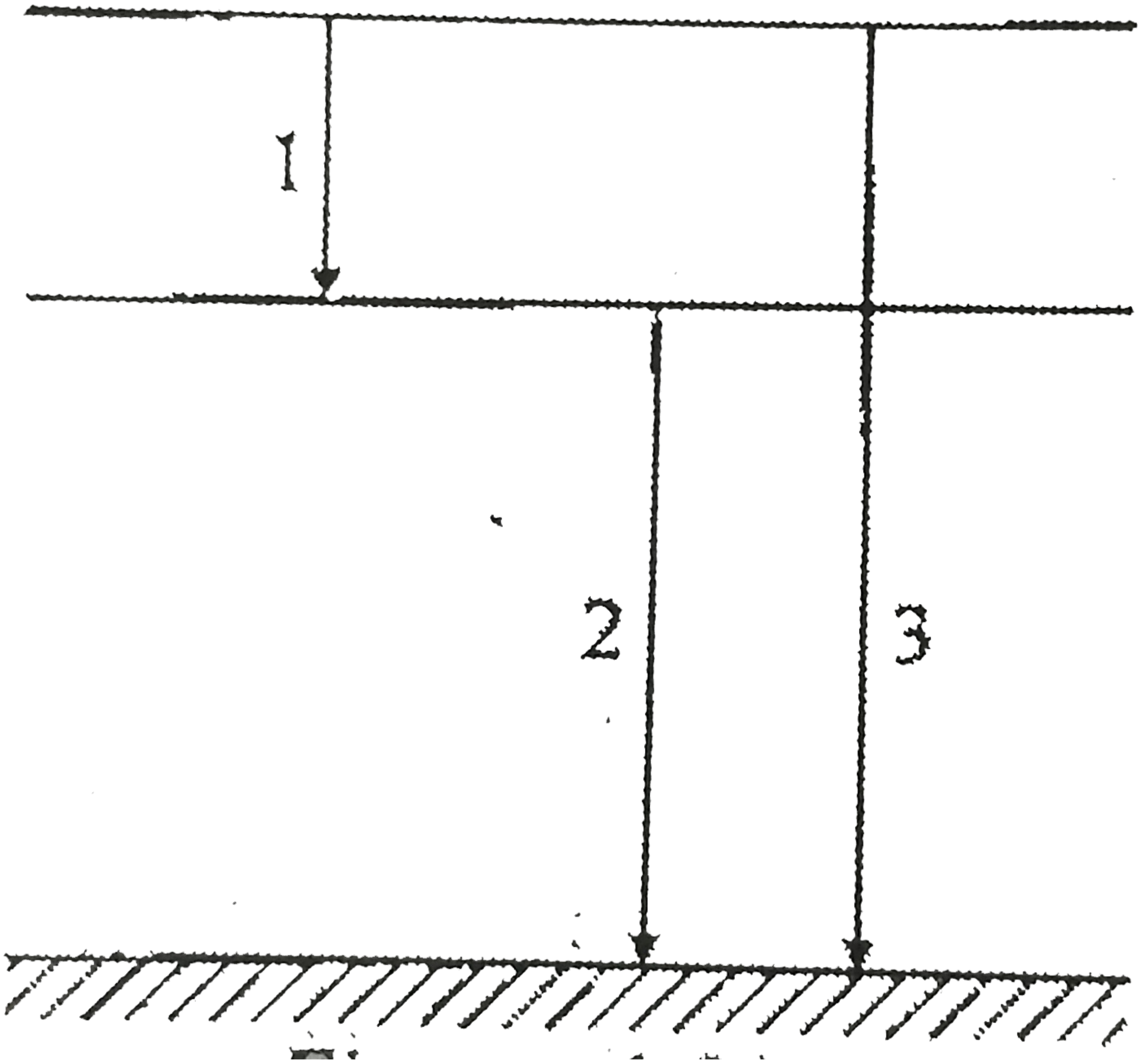
$$V_{\text{n small}}=2\left(v_{\text{n big}}\right)$$

$$=2v$$

Q-9 - 18250868

The wavelengths and frequencies of photons in transition 1,2 and 3 for hydrogen like atom are $\lambda_1, \lambda_2, \lambda_3, v_1, v_2$ and v_3 respectively.

Then:



(A) $v_3 = v_1 + v_2$

(B) $v_3 + \frac{v_1 v_2}{v_1 + v_2}$

(C) $\lambda_3 = \lambda_1 + \lambda_2$

(D) $\lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

Q-10 - 17937238

Cut off potential for a metal in photoclectric effect for light of wavelength λ_1, λ_2 and λ_3 is found to be V_1, V_2 and V_3 volts , If V_1, V_2 and V_3 are in Arithmetic progression then λ_1, λ_2 and λ_3 will be in

(A) Arithmetic progression

(B) Geometric progression

(C) Harmonic progression

(D) None of these

CORRECT ANSWER: C

Q-11 - 19037990

In hydrogen atom, if $\lambda_1, \lambda_2, \lambda_3$ are shortest wavelengths in Lyman, Balmer and Paschen series respectively, then $\lambda_1 : \lambda_2 : \lambda_3$equals

(A) $1:4:9$

(B) $9:4:1$

(C) $1:2:3$

(D) $3:2:1$

CORRECT ANSWER: A

SOLUTION:

For hydrogen atom,

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right),$$

$n_2 > n_1$

For Lyman series,$n_1 = 1, n_2 = \infty$

Rightarrow$\frac{1}{\lambda_1} = R$

For Balmer series, $n_1 = 2, n_2 = \infty$

Rightarrow$\frac{1}{\lambda_2} = \frac{R}{4}$

For Paschen series,$n_1 = 3, n_2 = \infty$

Rightarrow$\frac{1}{\lambda_3} = \frac{R}{9}$

So,

$\lambda_1 = \frac{1}{R}, \lambda_2 = \frac{4}{R}, \lambda_3$
$= \frac{9}{R}$

$\lambda_1 : \lambda_2 : \lambda_3 = 1:4:9$

Q-12 - 11312534

Consider a hydrogen-like atom whose energy in nth excited state is given by

$E_n = \frac{13.6Z^2}{n^2}$

When this excited makes a transition from excited state to ground state , most energetic photons have energy $E_{\max} = 52.224eV$. and least energetic photons have energy $E_{\max} = 1.224eV$

Find the atomic number of atom and the intial state or excitation.

SOLUTION:

Maximum energy is liberated for transition $E_n \rightarrow 1$ and minimum energy for $E_n \rightarrow E_{n-1}$ Hence,

$$\frac{E_1}{n^2} - E_1 = 52.224eV$$

$$\frac{E_1}{n^2} - \frac{E_1}{(n-1)^2} = 1.224eV$$

Solving the above equation simultaneously, we get

$E_1 = -54.4eV$ and $n = 5$

$$E_1 = \frac{13.6Z^2}{l^2} = -54.4eV$$

Hence ,$Z = 2$ i.e. ,

the gas is helium, originally excited to

$n = 5$ energy state.

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Q-13 - 14948571

A hydrogen like atom (atomic number z) is in a higher excited state of quantum number n. This excited atom can make a transition to the first excited state by successively emitting two photons of energies $10.2eV$ and $17.0eV$ respectively. Alternatively the atom from the same excited state can make a transition to the second excited state by successively emitting 2 photons of energy $4.25eV$ and$5.95eV$ respectively. Determine the value of $(n + z)$

CORRECT ANSWER: 9

SOLUTION:

$$27.2 \times 1.602 \times 10^{-12} = R_H z^2 hc\left[\frac{1}{2^2} - \frac{1}{n^2}\right]$$

..(1)

$$10.2 \times 1.602 \times 10^{-12} = R_H z^2 hc\left[\frac{1}{3^2} - \frac{1}{n^2}\right]$$

.(2)

After solving (1) and (2)

$$n = 6, z = 3$$

$$n + z = 9$$

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Q-14 - 17937296

Positron is the antiparticle of an electron .It has the same mass as an electron but the opposite charge An electron and a positron moving towards each other with equal and opposite velocities.

(A) can annihilate into one photon. Conserving both energy and momentum

(B) cannot annihilate into one photon because energy cannot be conserved

(C) cannot annihilate into one photon because momentum cannot be conserved

(D) cannot annihilate into one photon because charge cannot be conserved

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CORRECT ANSWER: C

In a Coolidge tube, the potential difference used to accelerate the electrons is increased from $12.4kV$ to $24.8kV$. As a result, the difference between the wavelengths of K_α-line and minimum wavelength becomes thrice. The wavelength of the K_α line is $0.25 \times KA$. Find the value of K. $\frac{hc}{e} = (12.4KVA)$

SOLUTION:

According to question

$$3\left(\lambda_{K_\alpha} - \frac{12.4}{12.4}\right)$$

$$= \lambda_{K_\alpha} - \frac{12.4}{12.4}$$

$$\Rightarrow \lambda_{K_{\alpha = 1.25A}}$$

Consider Bohr's theory for hydrogen atom . The magnitude of orbit angular momentum orbit radius and velocity of the electron in nth energy state in a hydrogen atom are l , r and v respectively. Find out the value of 'x' if product of v, r and l (vrl) is directly proportional to n^x.

CORRECT ANSWER: 2

Q-17 - 18250787

In the Bohr model of a hydrogen atom, the centripetal force is furnished by the coulomb attraction between the proton and the electron. If a_0 is the radius of the ground state orbit, m is the mass and e is the chargeon the electron and ε_0 is the vacuum permittivity,the speed of the electron is

(A) 0

(B) $\dfrac{e}{\sqrt{\varepsilon_0 a_0 m}}$

(C) $\dfrac{e}{\sqrt{4\pi\varepsilon_0 a_0 m}}$

(D) $\dfrac{\sqrt{4\pi\varepsilon_0 a_0 m}}{e}$

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Q-18 - 16016824

The radial wave function for 1 s electron in H-atom is $R = \dfrac{2}{a_0^{3/2}} e^{-r/a_0}$ where a_0=radius of 1^{st} orbit of H-atom . The ratio of probablitiy of 1^{st} electron in hyrogen atom at distance a_0 from nucleus to that at distance $\dfrac{a_0}{2}$ from nucleus.

(A) equal

(B) $\dfrac{1}{e} time$

(C) $\frac{4}{e} time$

(D) $\frac{e}{4} time$

CORRECT ANSWER: C

SOLUTION:

probability of finding and electron at a particular

distance=$4\pi_2 R^2$

$$P_1 = 4\pi r^2 R^2 = 4\pi r^2$$

$$\times \frac{4}{a_0^3} e^{-2r/a_0}$$

$$at \quad a_0 \quad p_1 = 4\pi a_0^2$$

$$\times \frac{4}{a_0^3} e^{-2a_0/a_0}$$

$$at \quad a_{0/2} \quad p_2 = 4\pi \frac{a_0^2}{4}$$

$$\times \frac{4}{a_0^3} e^{\frac{-2a_0}{2a_0}}$$

$$at \quad a_{0/2} \quad \frac{p_2}{p_2}$$

$$= \frac{4\pi a_0^2 \times \frac{4}{a_0^3} e^{\frac{-2a_0}{2a_0}}}{4\pi \frac{a_0^2}{4} \times \frac{4}{a_0^3} e^{\frac{-2a_0}{2a_0}}}$$

$$\frac{p_1}{p_2} = \frac{e^{-}}{\frac{1}{4}e^{-1}} = \frac{4}{e}$$

Q-19 - 11034342

a.The schrodinger wave equation for hydrogen atom is

$$\psi_{2s} = \frac{1}{4\sqrt{2\pi}}\left(\frac{1}{a_0}\right)^{\frac{3}{2}}\left(2 - \frac{r_0}{a_0}\right)e^{\left(-\frac{r}{a}\right)}$$

When a_0 is Bohr's radius Let the radial node in $2s$ be n at Then find r_0 in terms of a_0

b. A base ball having mass $100g$ moves with velocity $100ms^{-1}$

.Find the value of teh wavelength of teh base ball

CORRECT ANSWER: A::B::C

SOLUTION:

b. $\lambda = \frac{h}{mv}$("de Broglie's equation")= (6.626 xx 10^(-34))/(100 xx 10^(-3) xx 100) = 6.626 xx 10^(-35) m `

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Q-20 - 16016871

The wave function for 1s orbital of hydrogen atom is given by:

$$\Psi_{1s} = \frac{\pi}{\sqrt{2}} e^{-r/a_0}$$

Where, a_0= Radius of first Bohar orbit

r= Distance from the nucleus (Probability of finding the ekectron varies with respect to it)

What will be the ratio of probability of finding rhe electron at the nucleus to first Bohr's orbit a_0?

(A) e

(B) e^2

(C) $1/e^2$

(D) Zero

CORRECT ANSWER: D

SOLUTION:

For 1 s orbital , porabability of finding thr electron at the nucleus is zero.

Q-21 - 17937359

In a hypothetical atom, potential energy between electron and proton at distance r is given by $\left(\frac{-ke^2}{4r^2}\right)$ where k is a constant Suppose Bohr theory of atomic structrures is valid and n is principle quantum number, then total energy E is proportional to

(A) n^5

(B) n^2

(C) n^6

(D) n^4

CORRECT ANSWER: C

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Q-22 - 19037984

A H-atom moving with speed v makes a head on collision with a H-atom in rest. Both atoms are in ground state. Find the minimum value of velocity v for which one of atom may excite.

(A) $6.25 \times 10^4 m/s$

(B) $8 \times 10^4 m/s$

(C) $7.25 \times 10^4 m/s$

(D) $13.6 \times 10^4 m/s$

CORRECT ANSWER: A

SOLUTION:

For $v_{\min}$ 'collision should be completely

inelastic.According to energy conservation principle,

$$\frac{1}{2}mv^2_{\min} = \frac{1}{2}mv^2$$
$$+ \frac{1}{2}mv^2 + \Delta E......(i)$$

According to momentum conservation principle,

$$mv_{\min} = mv + mv$$

$$v = \frac{v_{\min}}{2}$$ ..(ii)

After solving Eqs.(i),we get

$$\left(\frac{1}{2}\right)mv^2_{\min} = 2\Delta E$$

$$\therefore v_{\min} = \sqrt{\left(\frac{4\Delta E}{m}\right)}$$

Here, $\Delta E =$ minimum excitation energy=$10.2eV$

$$m = 1.67 \times 10^{-27} kg$$

$$\therefore v_{\min}$$

$$= \sqrt{\left(\frac{4 \times 10.2 \times 1.6 \times 10^{-19}}{1.67 \times 10^{-27}}\right)}$$

$$= 6.25 \times 10^4 m/s$$

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Q-23 - 11312549

A cobalt target $(Z = 27)$ is bomberded with electron and the wavelength of its characteristic spectrum are measured . A second , fainter characcteristic spectrum is also found because of an impurity in the target. The wevelength of the K_{α} lines are 178.9 pm (cobalt) and $143.5 \pm$ (impurity). What is the impurity?

SOLUTION:

Using Moseley's law and putting c/λ for v (and assuming $b = 1$), we obtain

$$\frac{\sqrt{c}}{\lambda_{Co}} = aZ_{Co} = a \text{ and}$$

$$\frac{\sqrt{c}}{\lambda_x = aZ_x - a}$$

Driving yields $\frac{\sqrt{\lambda_{Co}}}{\lambda_x} = \frac{Z_x - 1}{Z_{Co} - 1}$

Solving for the unknown , we find $Z_x = 30.0$, the impurty is zine.

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Q-24 - 11034045

A natural atom of an element has $2K, 8L, 9M$ and $2N$ electrons

.The atomic number of element is :

The total number of s electons are

(A) 8

(B) 6

(C) 4

(D) 10

CORRECT ANSWER: B

SOLUTION:

$2K\,,8L\,,9M\,,$ and $\,,$
$2N$
$1s^2\,, 2s^2p^6\,, 3s^2 3p^6 3d^1\,,$
$4s^2$

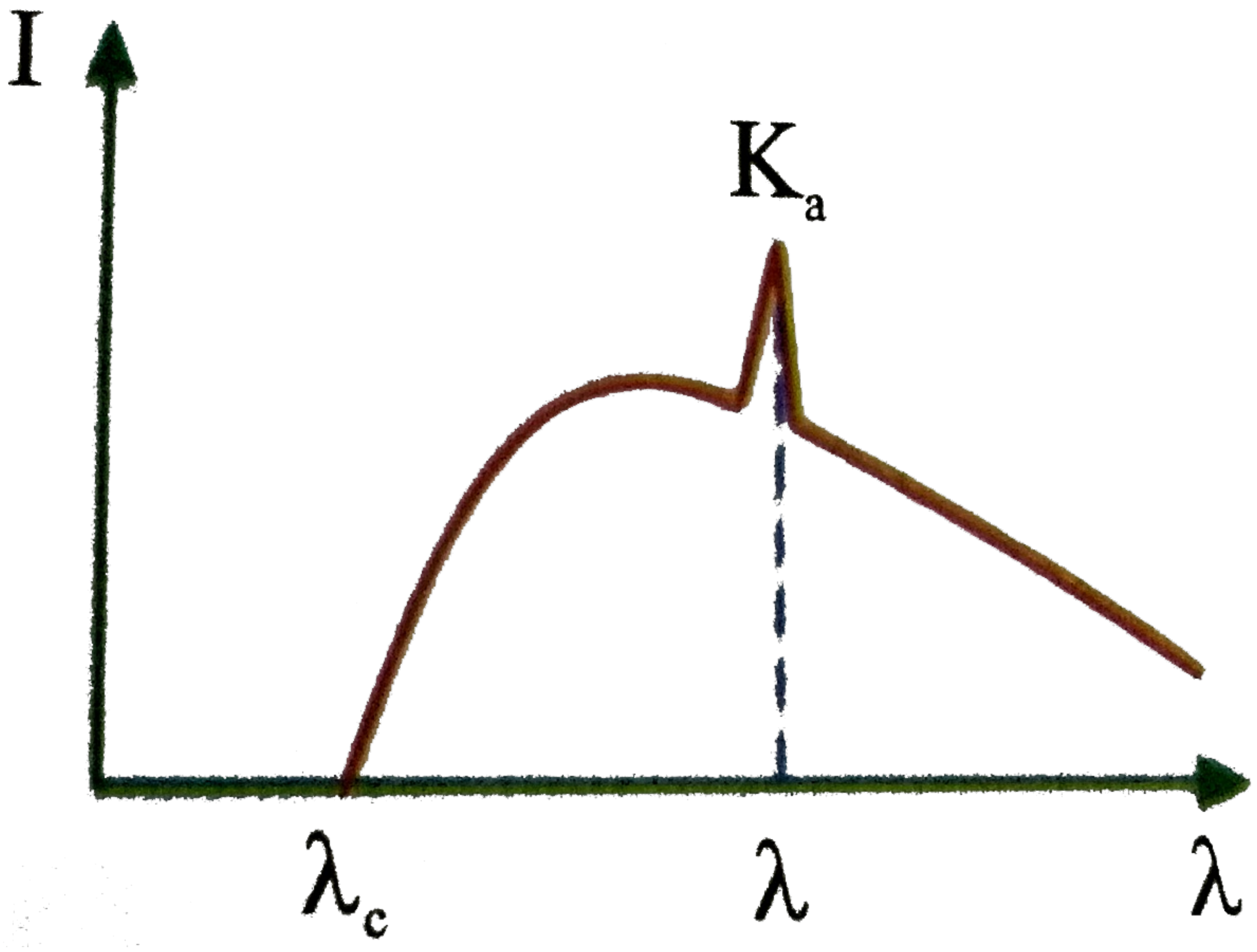
$$\begin{pmatrix} K means n = 1 & l means n = 2 \\ M means n = 3 & N means n = 4 \end{pmatrix}$$

Structure is3d^(1),4s^(2)$A \rightarrow micνmber211$s^(2) +

2s^(2) + 3s^(2) + 4s^(2) = 8`

Q-25 - 14155025

Given X-ray spectrum is for a coolidge tube having accelerating potential V. If accelerating potential is decreased to $V/4$, then $\Delta\lambda = \lambda - \lambda_c$ becomes four times with change in anode element . If Z is the atomic number of the original element, them the atomoc number of new element is (neglect screening effect)



(A) Z

(B) $Z/2$

(C) $2Z$

(D) $Z/3$

CORRECT ANSWER: B

SOLUTION:

In the first case :

$$\Delta\lambda = \frac{4}{3RZ^2}\frac{hc}{eV}\Bigg($$

$$\therefore \frac{1}{\lambda_{ka}} = RZ^2\left(\frac{1}{1}\right.$$

$$\left. - \frac{1}{4}\right)\Bigg)$$

in the second case

$$4\Delta = \frac{4}{3RZ_2^2} - \frac{4hc}{eV}$$

$$\Rightarrow Z_2 = \frac{Z}{2}$$

Q-26 - 11312530

A moving hydrogen atom makes a head-on collision with a stationary hydrogen atom. Before collision, both atoms are in ground state and after collision they move together . What is the minimum atom , such that one of the atoms reaches one of the excitation state.

SOLUTION:

Let K be the kinetic energy of the moving hydrogen atom K' the kinetic energy of combined mass after collision.

From conservation of liner momentum .

$p = p' \Rightarrow \sqrt{2Km}$

$= \sqrt{2K'(2m)}$

or $K = 2K'$

From conservation of energy

$K = K' + \Delta E$

Solving Eqs. (i) and (ii), we get $\Delta E = \frac{K}{2}$

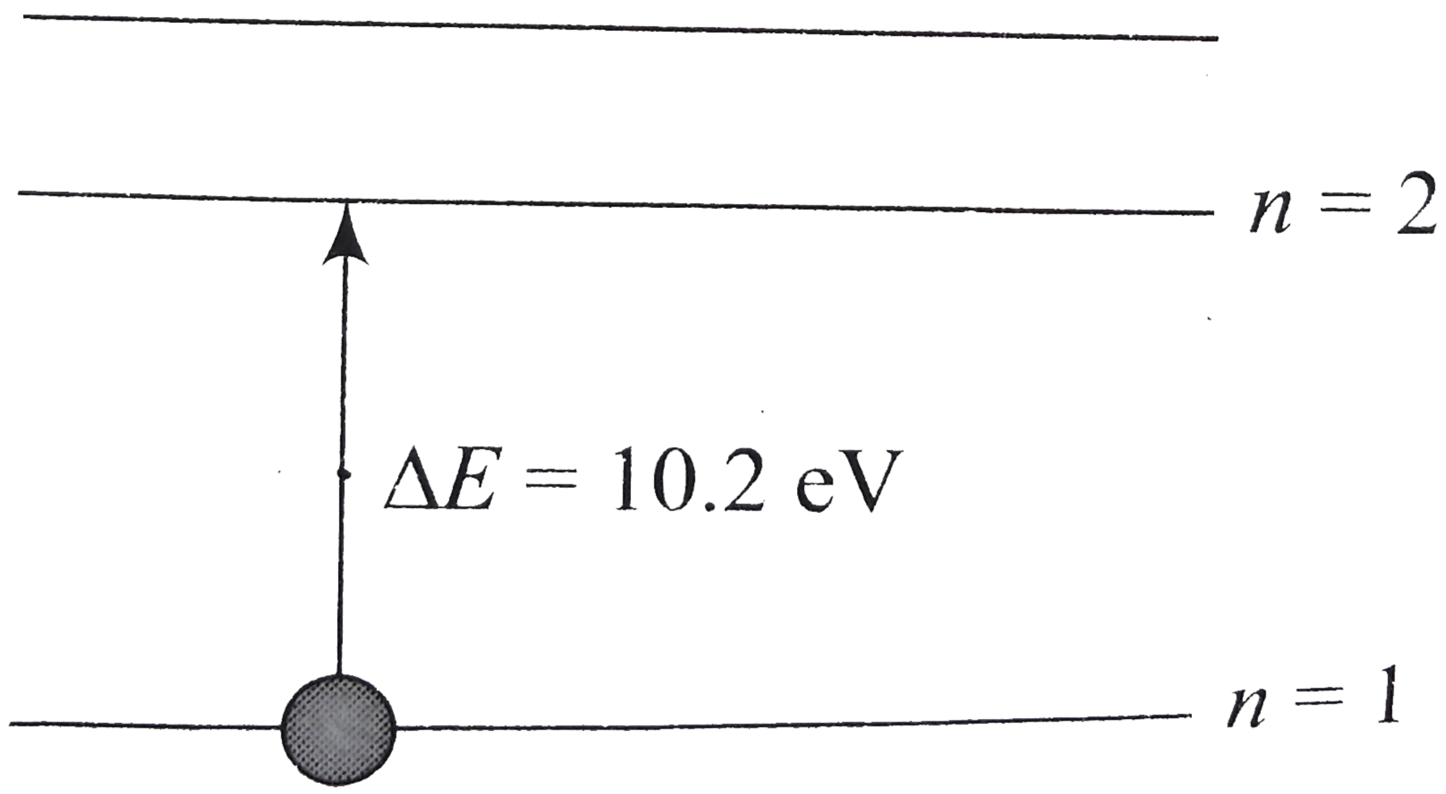
Now, minimum value of ΔE for hydrogen atom is

$10.2 eV$.

or $\Delta E \geq 10.2 eV$

$\therefore \frac{K}{2} \geq 10.2 eV$

$\therefore K \geq 20.4 eV$



Therefore, the minimum kinetic energy of moving hydrogen is $20.4eV$

Q-27 - 11970100

An α-particle with a kinetic energy of $2.1eV$ makes a head on collision with a hydrogen atom moving towards it with a kinetic energy of $8.4eV$. The collision

(A) must be perfectly elastic

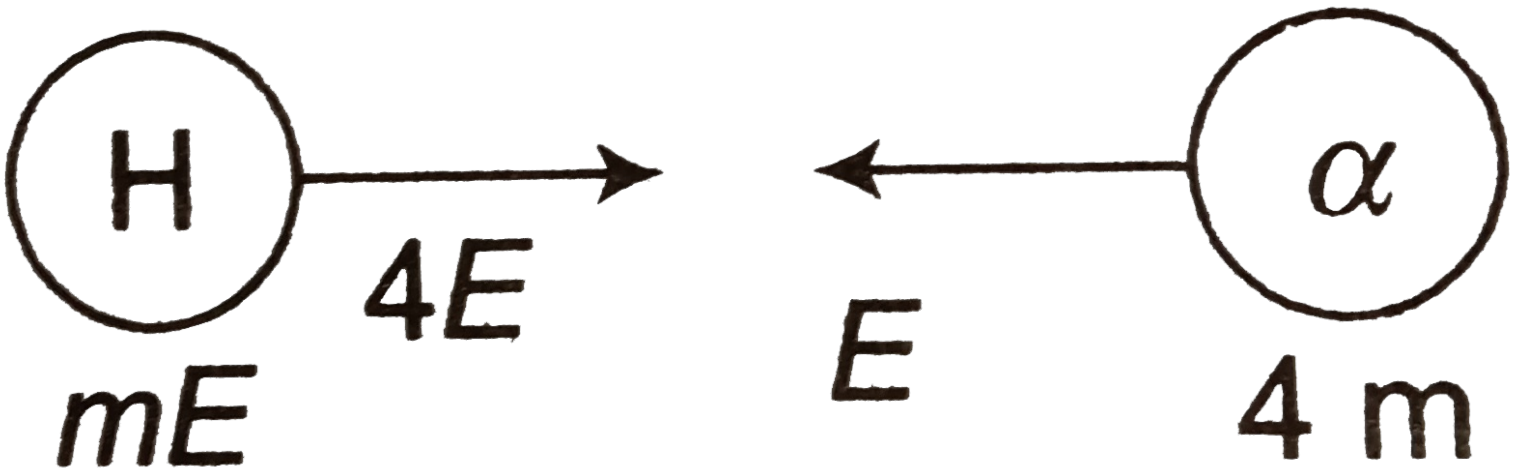
(B) may be perfectly inelastic

(C) may be inelastic

(D) must be perfectly inelastic

CORRECT ANSWER: C

SOLUTION:



$$P_i = \sqrt{m.4.\,E}$$
$$-\sqrt{4mE} = 0$$

For completely inelastic collision both cone to rest after collision and net energy of $4E + E = 10.5eV$ is lost. But electron in ground state of H-atom can accept only an energy of $10.2eV$. hence the collision may be inelastic but it can never be perfectly inelastic.

Q-28 - 10060401

A photon collides with a stationary hydrogen atom in ground state inolestically . Energy of the order of inicro second another photon collicles with same hydrogen atom indastisically with an energy of $15eV$ what will be observad by the detanctor?

(A) One photon of energy $10.2eV$ and an electronof energy $1.4eV$

(B) 2 photon of energy of $1:4eV$

(C) 2 photon of energy of $10.2eV$

(D) One photon of energy $10.2eV$ and another photon of $1.4eV$

CORRECT ANSWER: A

SOLUTION:

Initially a photon of energy $10.2eV$ colllides ineltastically with a hydrogen atom in ground state for hydrogen atom, $E_1 = -13.6eV, E_2 = -\frac{13.6}{4}eV = -4eV$

$$\therefore E_2 - E_1 = 10.2eV$$

The electron of hydrogen atom will jump to recound arbit after absurbing the photo of energy $10.2eV$. The electronic jumps back to its original state its less then microseco and release a photon of energy $10.2ev$. Another photon of energy $15eV$ strikes the hydrogen atom inelastically . This energy is ionisation energy is $13.6eV$. The remain energy of `14eV in left with electron is its kinetic energy

Q-29 - 11970176

Hydrogen atom in ground state is excited by a monochromatic radiation of $\lambda = 975$. Number of spectral lines in the resulting spectrum emitted will be

(A) 3

(B) 2

(C) 6

(D) 10

CORRECT ANSWER: C

SOLUTION:

For the $\lambda = 975$

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

where R is the Rydberg constant

Solving we get

$n_2 = n = 4$ ($\because n_1 = 1$ ground state)

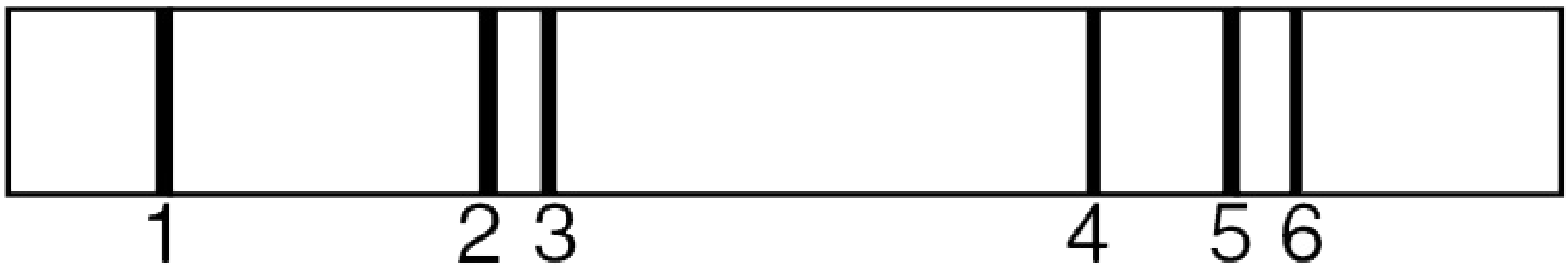
Therefore number of spectral lines

$$= \frac{n(n-1)}{2}$$

$$= \frac{4(4-1)}{2} = 6$$

Q-30 - 15160215

A tube contains a sample of hydrogen atoms which are all in their third excited state. The atoms de-excite and a spectrum of the radiation emitted is obtained. The spectrum is shown in the given figure.



(a) Which of the lines $(1, 2, 3, 4, 5$ or $6)$ represent a transition from quantum state $n = 3$ to $n = 2$.

(b) Which of the lines represent the one with second smallest wavelength?

CORRECT ANSWER: (A) 2 , (B) 5

Q-31 - 15879839

Consider an electron in the n^{th} orbit of a hydrogen atom in the Bohr model . The circumference of the orbit can be expressed in terms of the de Broglie wavelength λ of the electron as :

(A) $(0.529)n\lambda$

(B) $\sqrt{n}\lambda$

(C) $(13.6)\lambda$

(D) $n\lambda$

CORRECT ANSWER: D

Q-32 - 12973150

An electron is moving in Bohr's fourth orbit. Its de Broglie wavelength is λ. What is the circumference of the fourth orbit?

(A) $2/\lambda$

(B) 2λ

(C) 4λ

(D) $3/\lambda$

CORRECT ANSWER: C

SOLUTION:

According to Bohr's quantum mechanicla postulate,

$$mvr = h.\frac{h}{2\pi}$$

or $2\pi r = n.\frac{h}{mv} = n.\lambda$

For the fourth Bohr's orbit, $n = 4$. Thus,

$$2\pi r = 4.\lambda$$

Q-33 - 14273916

A beam of ultraviolet light of all wavelength passes through hydrogen gas at room temperature, in the x-direction. Assume that all photons emitted due to electron transitions inside the gas emerge in the y-direction. Let A and B denote the lights emerging from the gas in the x-and y-directions respectively.

(i) Some of the incident wavelengths will be absent in A

(ii) Only those wavelengths will be present in B which are absent in A

(iii) B will contain some visible light

(iv) B will contain some infrared light

(A) (i),(ii)

(B) (ii), (iii)

(C) (i),(iii),(iv)

(D) (ii),(iii),(iv)

CORRECT ANSWER: C

Q-34 - 11969924

If in nature they may not be an element for which the principle quantum number $n > 4$, then the total possible number of elements will be

(A) 60

(B) 32

(C) 4

(D) 64

CORRECT ANSWER: A

SOLUTION:

For $n=1$, maximum number of state $=2n^2=2$ and for $n=2, 3, 4,$ maximum number of states would be $8, 18, 32$ respectively, Hence number of possible elements

$$=2+8+18+32$$
$$=60$$

Q-35 - 11312806

A hydrogen atom having kinetic energy E collides with a stationary hydrogen atom. Assume all motions are taking place along the line of motion of the moving hydrogen atom. For this situation, mark out the correct statement (s).

(A) For $E \geq 20.4 eV$ only, collision would be elastic.

(B) For $E \geq 20.4 eV$ only, collision would be inelastic.

(C) For $E = 2.4 eV$ only, collision would be perfectly inelastic.

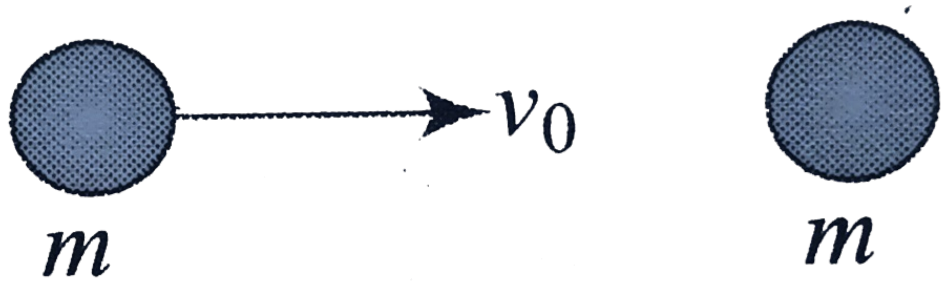
(D) For $E = 18 eV$ the KE of initially moving hydrogen atom after collisition is zero.

CORRECT ANSWER: B::C::D

SOLUTION:

Let collisition between two atoms be an elastic one .

From momentum conservation, $mv_0 = mv_1 + mv_2$



Before collision

After collision

from

energy conservation,

$$\frac{mv_1^2}{2}+\frac{mv_2^2}{2}-\frac{mv_0^2}{2} = -\Delta E$$

where ΔE is the energy absorbed by the initally

stationary atom to changes its state.

Solving above equation, we get

$$(v_1 - v_2)^2 = v_0^2 = -\frac{4\Delta E}{m}$$

For collision to be inelastic collisition, $(v_1 = v_2)^2$ ge 0: a real quantity [equal to sign for perfect inelastic collision.]

The minimum value of $\Delta E is 10.2 eV$, so for collision inelastic $E \geq 20.2 eV$

For perfectly inelastic collision $v_1 = v_2$ and hence $E = 20.4 eV$ for $E = 18 eV$, the collisition is elastic one and as masses are the same , velocity would be interchanged during collision.

Q-36 - 14155256

The relation between $\lambda_1 =$ wavelength of series limit of Lyman series ,$\lambda_2 =$ the wavelength of the series limit of Balmer sereis & $\lambda_3 =$ the wavelength of first line of Lyman series:

(A) $\lambda_1 = \lambda_2 + \lambda_3$

(B) $\lambda_3 = \lambda_1 + \lambda_2$

(C) $\lambda_2 = \lambda_3 - \lambda_1$

(D) none of these

CORRECT ANSWER: D

SOLUTION:

$$\frac{K}{\lambda_1} = E^{\infty}$$

$$- E_1 \text{and} \frac{K}{\lambda_2} = E_{\infty}$$

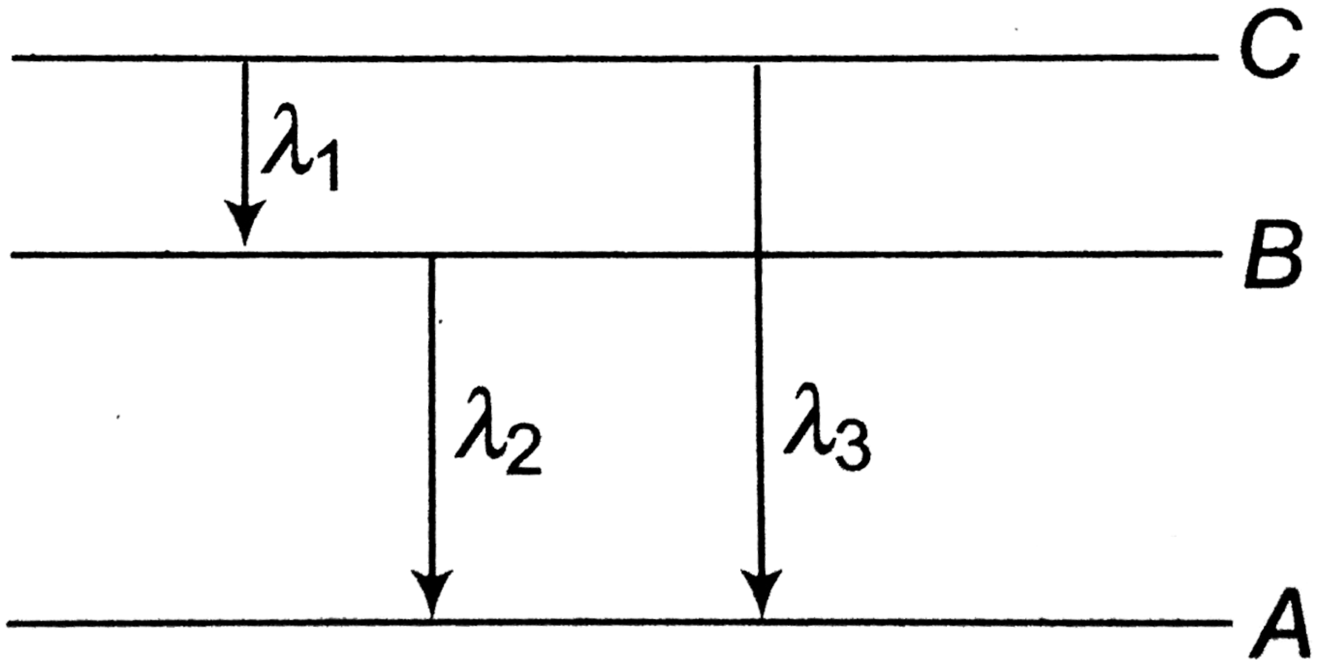
$$- E_2$$

$$\frac{k}{\lambda_3} = E_2 - E_1 \Rightarrow \frac{1}{\lambda_1}$$

$$- \frac{1}{\lambda_2} = \frac{1}{\lambda_3}$$

Q-37 - 11970034

Energy levels A, B, C of a certain atom corresponding to increasing values of energy i.e., $E_A < E_B < E_C$. If λ_1, λ_2, λ_3 are the wavelengths of radiations correspnding to the transitions C to B, B to A and C to A respectively, which o fthe following statements is correct?



(A) $\lambda_3 = \lambda_1 + \lambda_2$

(B) $\lambda_3 = \dfrac{\lambda_1\lambda_2}{\lambda_1 + \lambda_2}$

(C) $\lambda_1 + \lambda_2 + \lambda_3 = 0$

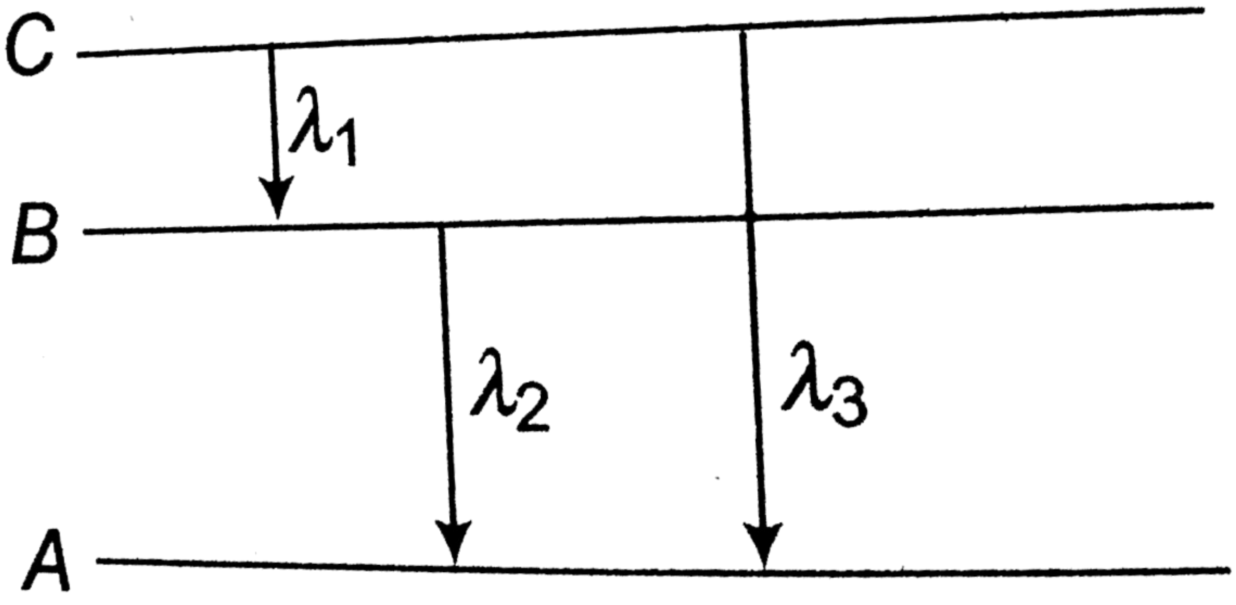
(D) $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

CORRECT ANSWER: B

SOLUTION:

Let the energy in A, B and C state be E_A. E_B and E_C

then from the figure



$$(E_C - E_B) + (E_B - E_A) = (E_C - E_A)$$

or $\frac{hc}{\lambda_1} + \frac{hc}{\lambda_2} = \frac{hc}{\lambda_3}$

$$\Rightarrow \lambda_3 = \frac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$$

Q-38 - 11312534

Consider a hydrogen-like atom whose energy in nth excited state is

given by

$$E_n = \frac{13.6Z^2}{n^2}$$

When this excited makes a transition from excited state to ground state , most energetic photons have energy

$E_{\max} = 52.224eV$. and least energetic photons have energy

$E_{\max} = 1.224eV$

Find the atomic number of atom and the intial state or excitation.

SOLUTION:

Maximum energy is liberated for transition $E_n \rightarrow 1$ and minimum energy for $E_n \rightarrow E_{n-1}$ Hence,

$$\frac{E_1}{n^2} - E_1 = 52.224eV$$

$$\frac{E_1}{n^2} - \frac{E_1}{(n-1)^2} = 1.224eV$$

Solving the above equation simultaneously, we get

$E_1 = -54.4eV$ and $n = 5$

$$E_1 = \frac{13.6Z^2}{l^2} = -54.4eV$$

Hence ,$Z = 2$ i.e. ,
the gas is helium, originally excited to
$n = 5$ energy state.

Q-39 - 11970214

In a hypotherical Bohr hydrogen, the mass of the electron is doubled. The energy E_0 and the radius r_0 of the first orbit will be (a_0 is the Bohr radius)

(A)
$E_0 = -27.2eV, r_0 = a_0 / 2$

(B)

$E_0 = -27.2eV, r_0 = a_0$

(C) $E_0 = -13.6eV, r_0 = a_0/2$

(D) $E_0 = -13.6eV, r_0 = a_0$

CORRECT ANSWER: A

SOLUTION:

Here radius of electron orbit $r \propto 1/m$ and energy $E \propto m$, where m is the mass of the electron.

Hence energy of hypothetical atom

$$E_0 = 2 \times (-13.6eV) = -27.2eV$$

and radius $r_0 = \dfrac{a_0}{2}$

Q-40 - 10968829

As an electron makes a transition from an excited state to the ground state of a hydrogen like atom/ion

(a) kinetic energy, potential energy and total energy decrease

(b) kinetic energy decreases, potential energy increases but total energy remains same

(c) kinetic energy and total energy decrease but potential energy increases

(d) its kinetic energy increases but potential energy and total energy decrease

---

CORRECT ANSWER: D

SOLUTION:

The expressions of kinetic energy, potential energy and total energy are

$$K_n = \frac{me^4}{8\varepsilon_0^2 n^2 h^2} \Rightarrow K_n \propto \frac{1}{n^2}$$

$U_n = \frac{-me^4}{4\varepsilon_0^2 n^2 h^2} \Rightarrow$ U_n prop - (1)/(n^2) and E_n = (-me^4)/(8epsilon_0^2n^2h^2) rArr E_n prop -(1)/(n^2)`

in the transition from some excited state to ground state, the value of n decreases, therefore kinetic energy increases, but potential and total energy decrease.

Q-41 - 18250817

Ionisatiori energy for hydrogen atom in the ground state is E.What is the ionisation energy of Li^{++} atom in the 2^{nd} excited state?

(A) E

(B) 3 E

(C) 6 E

(D) 9 E

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Q-42 - 12016703

An electron in hydrogen atom first jumps form second excited state to first excited state and then form first excited state to ground state. Let the ratio of wavelength, momentum and energy of photons emitted in these two cases be a, b and c respectively, Then

(A) $a = \frac{9}{4}$

(B) $b = \frac{5}{27}$

(C) $c = \frac{5}{27}$

(D) $c = \frac{1}{a}$

CORRECT ANSWER: B::C::D

SOLUTION:

First transition is form n=3 to n=2. Second transition is form n=2 to n=1.

$$\therefore \frac{E_1}{E_2} = c$$

$$= \frac{1/2^2 - 1/3^2}{1/1^2 - 1/2^2}$$

$$= \frac{5/36}{3/4} = \frac{5}{36} \times \frac{4}{3}$$

$$= \frac{5}{27}$$

As $p = \frac{E}{c}$, therefore, $\frac{p_1}{p_2} = b = \frac{E_1}{E_2} = c$

i.e,. $B = c = \frac{5}{27}$

As $E = \frac{hc}{\lambda} \therefore \lambda \propto \frac{1}{E}$

or

$$a = \frac{\lambda_1}{\lambda_2} = \frac{E_2}{E_1} = \frac{27}{5}$$

$$= \frac{1}{c} \text{ or } c = \frac{1}{a}$$

Q-43 - 11970062

The wavelength of radiation emitted is λ_0 when an electron jumps from the third to the second orbit of hydrogen atom. For the electron jump from the fourth to the second orbit of hydrogen atom, the wavelength of radiation emitted will be

(A) $\frac{16}{25}\lambda_0$

(B) $\frac{20}{27}\lambda_0$

(C) $\frac{27}{20}\lambda_0$

(D) $\frac{25}{16}\lambda_0$

CORRECT ANSWER: B

SOLUTION:

$$\frac{1}{\lambda}=R\left[\frac{1}{n_1^2}-\frac{1}{n_2^2}\right]$$

$$\Rightarrow \frac{1}{\lambda_{3\to2}}=R\left[\frac{1}{(2)^2}-\frac{1}{(3)^2}\right]=\frac{5R}{36}$$

and

$$\frac{1}{\lambda_{4\to2}}=R\left[\frac{1}{(2)^2}-\frac{1}{(4)^2}\right]=\frac{3R}{16}$$

$$\therefore \frac{\lambda_{4\to2}}{\lambda_{3\to2}}=\frac{20}{27}$$

$$\Rightarrow \lambda_{4\to2}=\frac{20}{27}\lambda_0$$

When an electron moving at a high speed strikes a metal surface, which of the following are possible?

(i) The entire energy of the electron may be converted into an X-ray photon

(ii) Any fraction of energy of the electron may be converted into an X-ray photon

(iii) The entire energy of the electron may get converted to heat

(iv) The electron may undergo elastic collision with the metal surface

(A) (i),(ii),(iii)

(B) (ii),(iii),(iv)

(C) (i),(iii),(iv)

(D) all

CORRECT ANSWER: A

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Q-45 - 14531024

Statement-1

If the accelerating potential in an X-ray tube is increased, the wavelength of the characterstic X-rays do not change.

because

Statement-2

When an electron beam strikes the target in an X-ray tube, part of the kinetic energy is converted into X-ray energy.

(A) Statement-1 is True, Statement-2 is True, Statement-2 is a correct explanation for Statement-1

(B) Statement-1 is True, Statement-2 is True, Statement-2 is NOT a correct explanation for Statement -1

(C) Statement-1 is True, Statement-2 is Flase

(D) Statement -1 is False, Statement-2 is True

CORRECT ANSWER: B

SOLUTION:

Both statements are correct but statement (2) is not correct explaination of statement (1) Energy of characterstics x-ray depends on the different in energy levels.

Q-46 - 9729335

An X-ray tube operates at 20 kV. A particular electron loses 5% of its kinetic energy to emit an X-ray photon at the first collision. Find the wavelength corresponding to this photon.

SOLUTION:

Kinetic energy acquired by the electron is

$$K = eV = 20$$

$$\times \left(10^3\right) eV. Thee$$

$$\ne rgyofthepho \rightarrow n$$

= 0.05 xx 20 xx (10^3) eV = (10 ^3) eV.

Thus, $\dfrac{hc}{\lambda} = \left(10^3\right) eV$

or, $\lambda = \dfrac{hc}{10^3 eV}$

$$= \frac{\left(4.14 \times 10^{-15} eVs\right) \times \left(3 \times 10^8 ms^{-1}\right)}{10^3 eV}$$

=

$$\frac{1242 eVnm}{10^3 eV} = 1$$

$$\cdot 24 nm$$

.

Q-47 - 10060384

Electrons with energy $80keV$ are incdent on the tungsten target of an X - rays tube , k- shell electrons of tangsten have $72.5keV$ energy X- rays emitted by the tube constain only

(A) a contimuous X - rays spectrum (Bremasstrablung) with a miximum wavelength of 0.155 �

(B) a contimuous X - rays spectrum (Bremasstrablung) with all wavelength

(C) the characteristic X - rays spectrum of tungsten`

(D) a contimuous X - rays spectrum (Bremasstrablung) with a miximum wavelength of 0.155 � and the characteristic X - rays spectrum of tungsten.

CORRECT ANSWER: D

SOLUTION:

KEY CONCEPT :

$$\lambda_{\min} = \frac{he}{E}$$

$$\therefore \lambda_{\min} = \frac{12400}{80 \times 10^3}$$

$$= 0.155$$

Energy of incident electrons is greater than the ionization energy of electron in $K - shell$, the $K - shell$ electrons will be knocked off . Hence, characteristic X - ray spectrum will be obtained

Q-48 - 16178144

An electron beam in an X-ray tube is acclerated through a potential difference of 50000 volts. These are then made to fall on a tungsten target The shortest wavelength of the X-ray emitted by the tube is

(A) 2.0 �

(B) 0.25 mm

(C) 0.25 cm

(D) 0.025 nm

CORRECT ANSWER: D

Q-49 - 16178163

Consider the following two statements A and B and identify the correct choice in the given answer

A : The characteristic X-ray spectrum depends on the nature of the material of the target

B : The short wavelength limit of continuous X-ray spectrum varies inversely with the potential difference applied to the X-rays tube

(A) A is true and B is false

(B) A is false and B is true

(C) Both A and B are true

(D) Both A and B are false

CORRECT ANSWER: C

Q-50 - 11312575

An X-ray tube operated at $40kV$ emits a continous X-ray spectrum with a short wavelength limit $\lambda_{\min} = 0.310$. Calculate Plank's constant.

SOLUTION:

We have ,

$$\lambda_{\min} = \frac{hc}{eV} \text{ or } h$$

$$= \frac{eV\lambda_{\min}}{c}$$

Here,

$e = 1.6$

$\times 10^{-19} co\underline{o}mb, V$

$= 40kV = 40 \times 10^{3}V$

(i)

$\lambda_{\min} = 0.310 = 0.310$

$\times 10^{-10}m$

$c = 3 \times 10^{8}ms^{-1}$

$\therefore h$

$$= \frac{\left(1.6 \times 10^{-19}\right) \times \left(40 \times 10^{3}\right) \times 0.310 \times 10^{-10}}{3 \times 10^{8}}$$

(ii) $= 6.61 \times 10^{-34}J - s$

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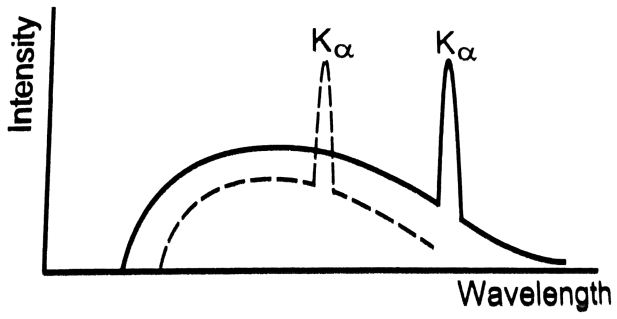
Q-51 - 9729364

Figure shows the intensity-wavelength relations of X-rays coming from two different Coolidge tube. The solid curve represents the relation for the tube A in which the potential difference between the target and the filament is V_A and the atomic number of the target material is Z_A. These quantities are V_β and Z_β for the other tube. Then,



(A) $V_A > V_B, Z_A > Z_B$

(B) $V_A > V_B, Z_A < Z_B$

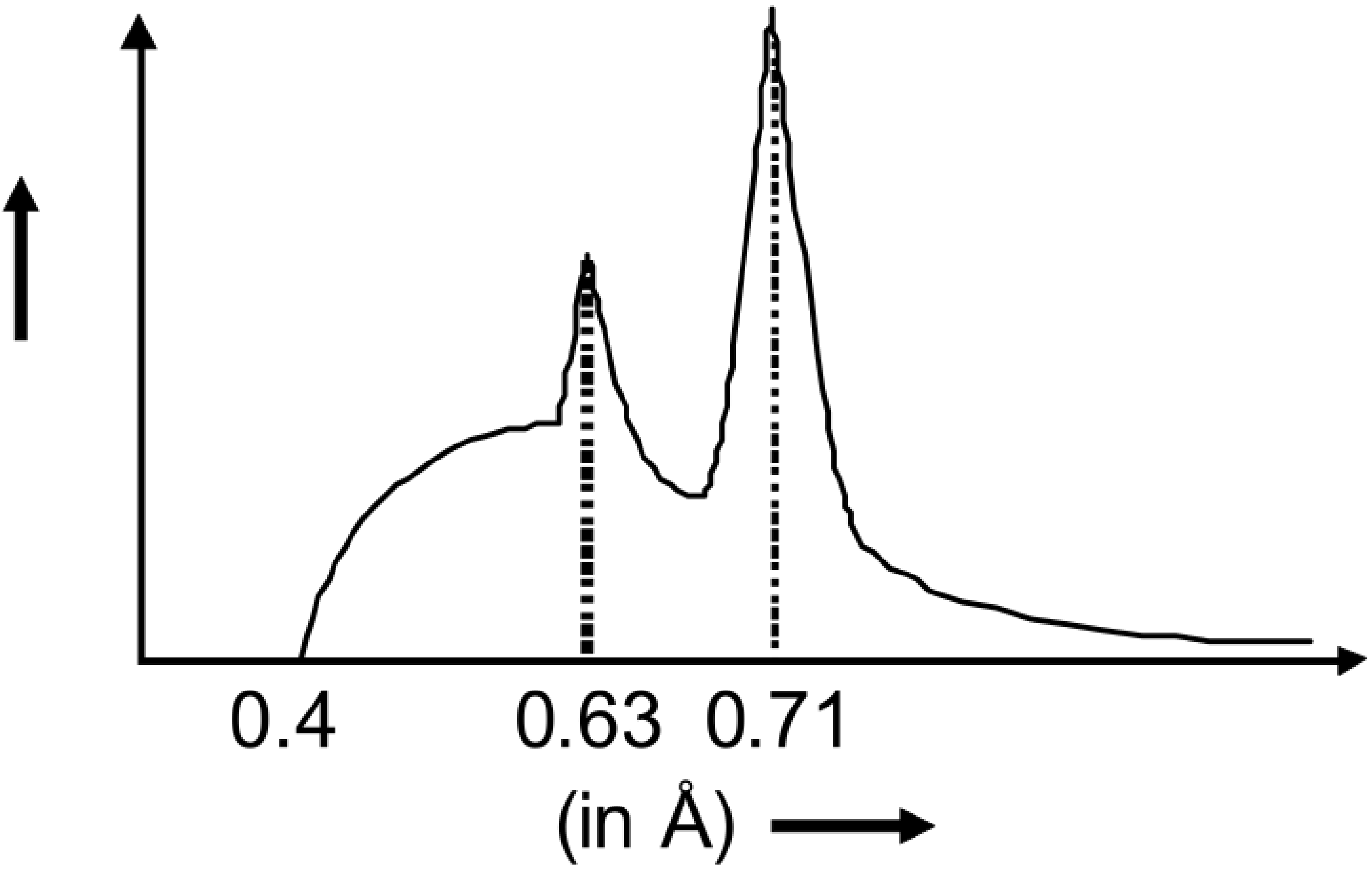
(C) $V_A < V_B, Z_A > Z_B$

(D) $V_A < V_B, Z_A < Z_B$

CORRECT ANSWER: B

Q-52 - 11804876

Figure shows intensity versus wavelength graph of X-rays coming from coolidge-tube with molybdenum as target element :



The two peaks shown in graph correspond to K_{α} and K_{β} X-rays

Voltage applied across Coolidge tube is (approximatly)

(A) 20 kV

(B) 16 kV

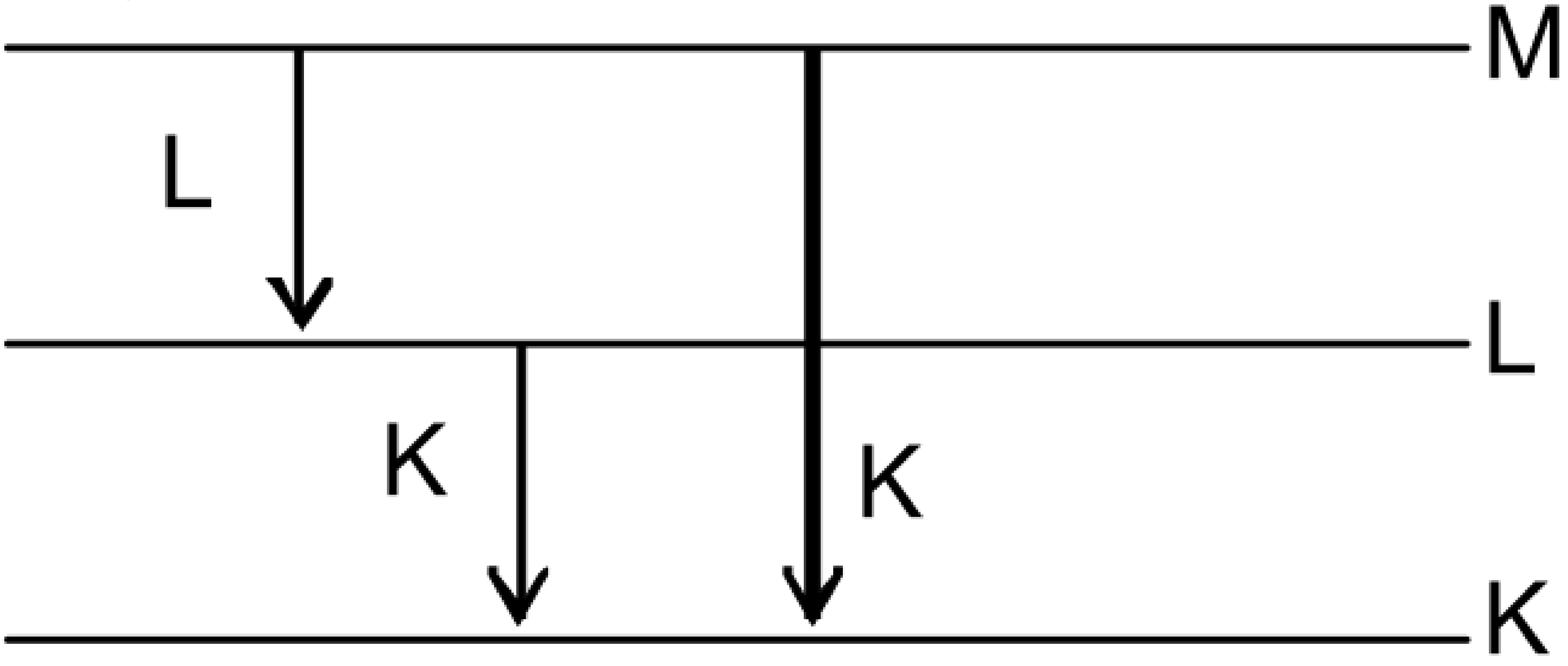
(C) 31 kV

(D) 18 kV

SOLUTION:

$$\frac{1}{\lambda_{Kb}} = \frac{1}{\lambda_{K\alpha}} + \frac{1}{\lambda_{L\alpha}}$$

$$\frac{1}{\lambda_{L\alpha}} = 5.6$$



$$eV = \frac{hc}{\lambda}$$

$$V = \frac{hc}{e\lambda} = 31 \times 10^3 \text{ volts}$$

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Q-53 - 11312823

X-ray from a tube with a target A of atomic number Z shows strong K lines for target A and weak$K$ lines for impurities. The wavelength og K_α lines is λ_z for target A and λ_1 and λ_2 for two impurities.

$$\frac{\lambda_z}{\lambda_1}=4 \text{ and } \frac{\lambda_z}{\lambda_2}=\frac{1}{4}$$

Assuming the screeining contant of K_α lines to be unity select the correct statement(s).

(A) The atomic number of first impurity is $2z-1$.

(B) The atomic number of first impurity is $2z+1$.

(C) The atomic number of second impurity is $\frac{(z+1)}{2}$.

(D) The atomic number of second impurity is $\frac{z}{2}+1$.

CORRECT ANSWER: A::C

SOLUTION:

Moseloey's law:

$$\lambda \propto \frac{1}{(z-1)}2 : \frac{\lambda_z}{\lambda_1}$$

$$= \frac{(z_1-1)^2}{(z-1)^2}$$

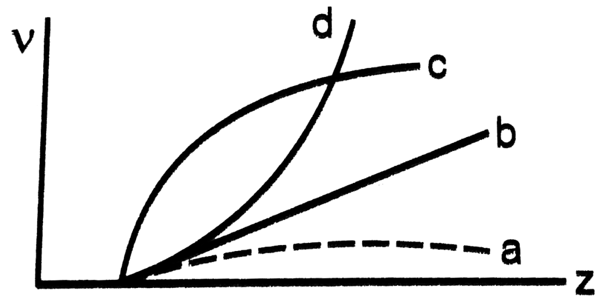
$$z_1 - 1 = (z-1)2 :$$

$$z_1 = 2z - 1 : \frac{\lambda_z}{\lambda_2} = \frac{1}{4}$$

$$= \left(\frac{z_2-1}{z-1}\right)^2$$

Q-54 - 9729360

Frequencies of K_α X-rays of different materials are measured. Which one of the graphs in figure (44-Q1) may represent the relation between the frequency v and the atomic number Z.



CORRECT ANSWER: D

Q-55 - 11969652

X-rays are produced by accelerating electrons by voltage V and let they strike a metal of atomic number Z . The highest frequency of $X - rays$ produced is proportional to

(A) V

(B) Z

(C) $(Z - 1)$

(D) $(Z - 1)^2$

CORRECT ANSWER: D

SOLUTION:

According to Mosley's law $v \propto (Z - b)^2$

For k_α line, $b = 1$, and it has maximum frequency so

$v_{\max} \propto (Z - 1)^2$

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Q-56 - 11312756

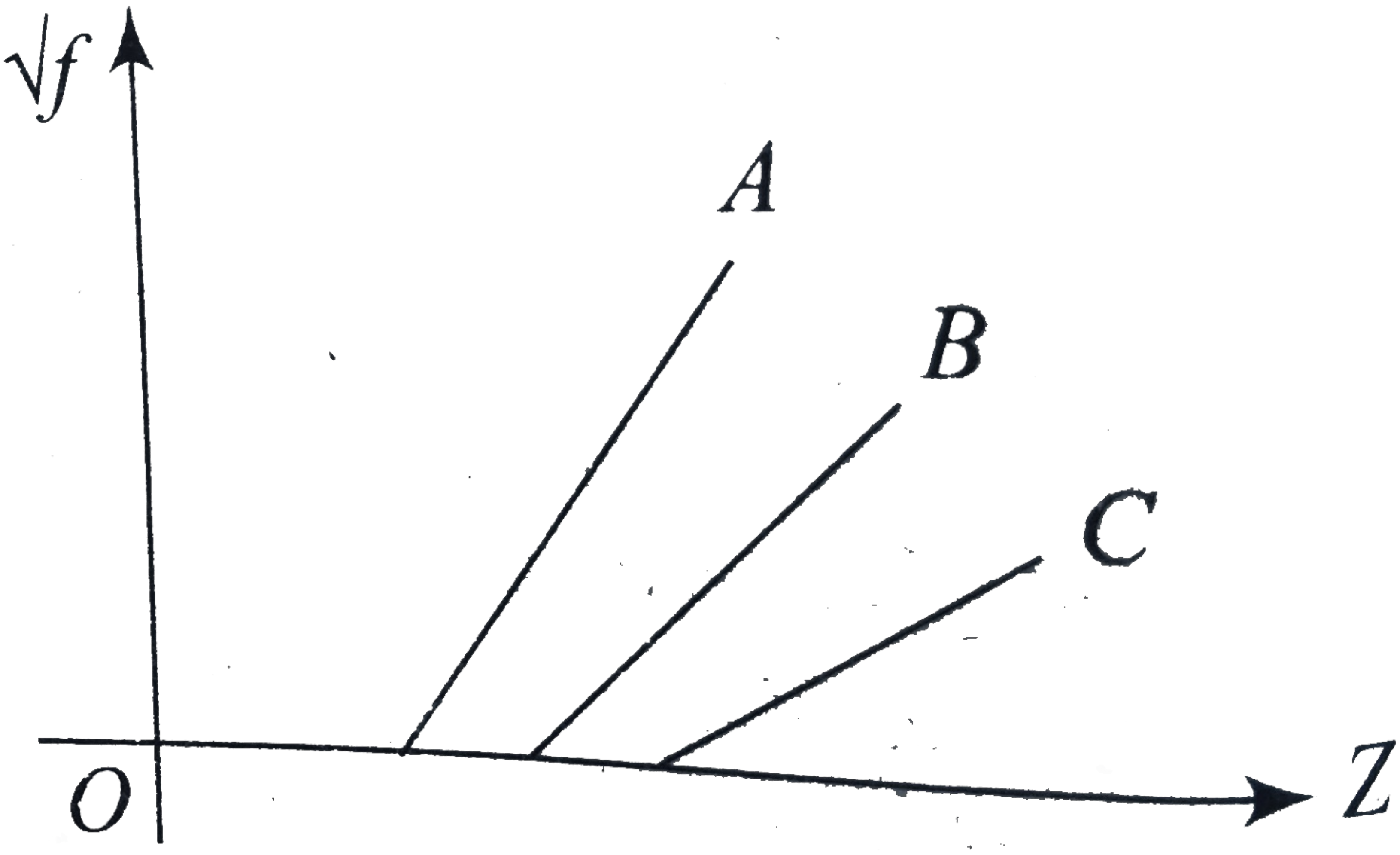
Figure shown Moseley's plot between $\sqrt{f}$ and Z where f

$isthe\mathfrak{r}quency$ and Z

$isthea \rightarrow mic\nu mber. Threel$

$\in esA, B,$ and C

always in the graph may repersent



(A) $K_{papha}, K_{\beta}, \text{ and } K_{\gamma}$ lines, respectively

(B) $K_{\gamma}, K_{\beta}, \text{ and } K_{\alpha}$ lines, respectively

(C) $K_{\sigma}, L_{\sigma}, \text{ and } K_{\alpha}$ lines, respectively

(D) Nothing

CORRECT ANSWER: D

SOLUTION:

The $K, L \text{ and } M$ lines have different intercepts. The intercept of K is more than that of L,which in turn is more than that of M.

Q-57 - 11312814

Let $\lambda_{\alpha'}, \lambda_{\beta}, \text{ and } \lambda'_{\alpha}$ denote the wavelength of the X-ray of the $K_{\alpha}, K_{\beta}, \text{ and } L_{\alpha}$ lines in the characteristic X-rays for a metal.

Then.

(A) $\lambda_\alpha > \lambda_\alpha > \lambda_\beta$

(B) $\lambda_\alpha > \lambda_\beta > \lambda_\alpha$

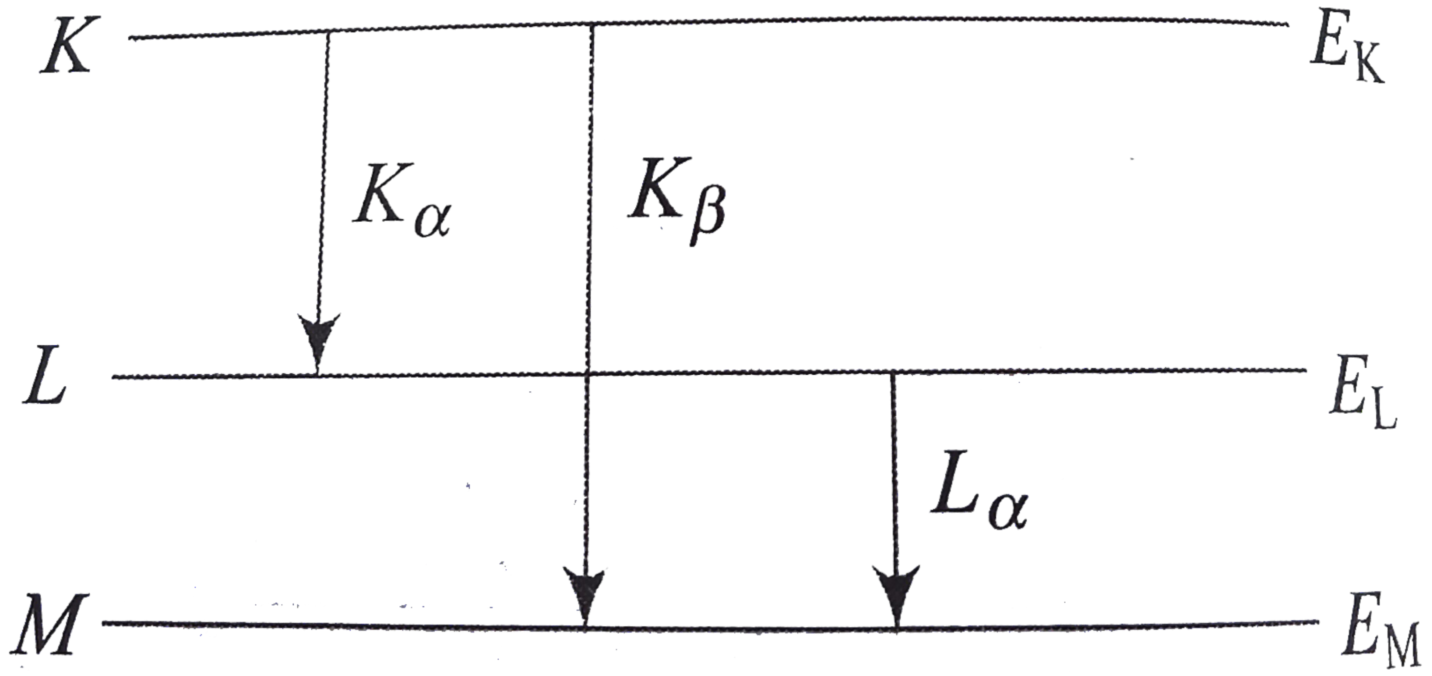
(C) $\frac{1}{\lambda_\beta} = \frac{1}{\lambda_\alpha} + \frac{1}{\lambda'_\alpha}$

(D) $\frac{1}{\lambda_\alpha} = \frac{1}{\lambda_\beta} + \frac{1}{\lambda_\alpha}$

CORRECT ANSWER: A::C

SOLUTION:

$$E_K - E_L = \frac{hc}{\lambda_\alpha} \text{ (i)}$$



$$E_K - E_M = \frac{hc}{\lambda_\beta} \text{ (ii)}$$

$$E_L - E_M = \frac{hc}{\lambda'_\alpha} \text{ (iii)}$$

(ii) - (i)

$$\Rightarrow E_L - E_M = \frac{hc}{\lambda'_\alpha}$$

$$= \frac{hc}{\lambda_\beta} - \frac{hc}{\lambda_\alpha}$$

$$\frac{1}{\lambda_\beta} = \frac{1}{\lambda_\alpha} + \frac{1}{\lambda'_\alpha}$$

Also,

$$(E_K) - E_M)$$

$$> (E_K - E_L)$$

$$> (E_L - E_M)$$

$$\frac{hc}{\lambda_\beta} > \frac{hc}{\lambda_\alpha} > \frac{hc}{\lambda'_\alpha}$$

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Q-58 - 13157018

λ_e, λ_p and λ_α are the de-Broglie wavelength of electron, proton and

α particle. If all the accelerated by same potential, then

(A) $\lambda_e < \lambda_p < \lambda_\alpha$

(B) $\lambda_e < \lambda_p > \lambda_\alpha$

(C) $\lambda_e > \lambda_p > \lambda_\alpha$

(D) $\lambda_e = \lambda_p > \lambda_\alpha$

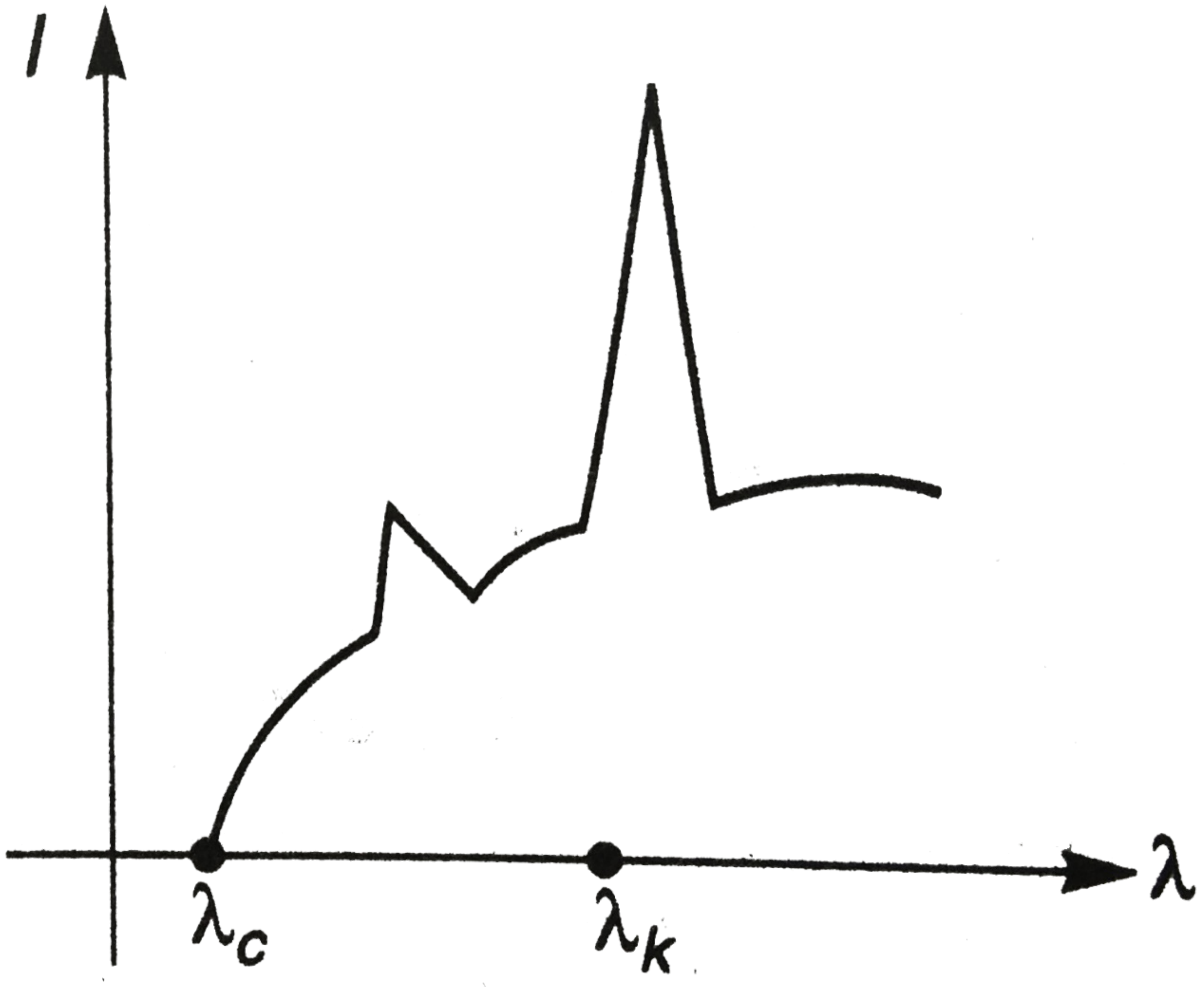
CORRECT ANSWER: C

SOLUTION:

NA

Q-59 - 10968843

The intensity of X-rays form a coolidge tube is plotted against wavelength λ as shown in the figure. The minimum wavelength found is λ_c and the wavelength of the K_α line is λ_k. As the accelerating voltage is increased



(a) $\lambda_k - \lambda_c$ increases (b) $\lambda_k - \lambda_c$ decrases

(c) λ_k increases (d) λ_k decreases

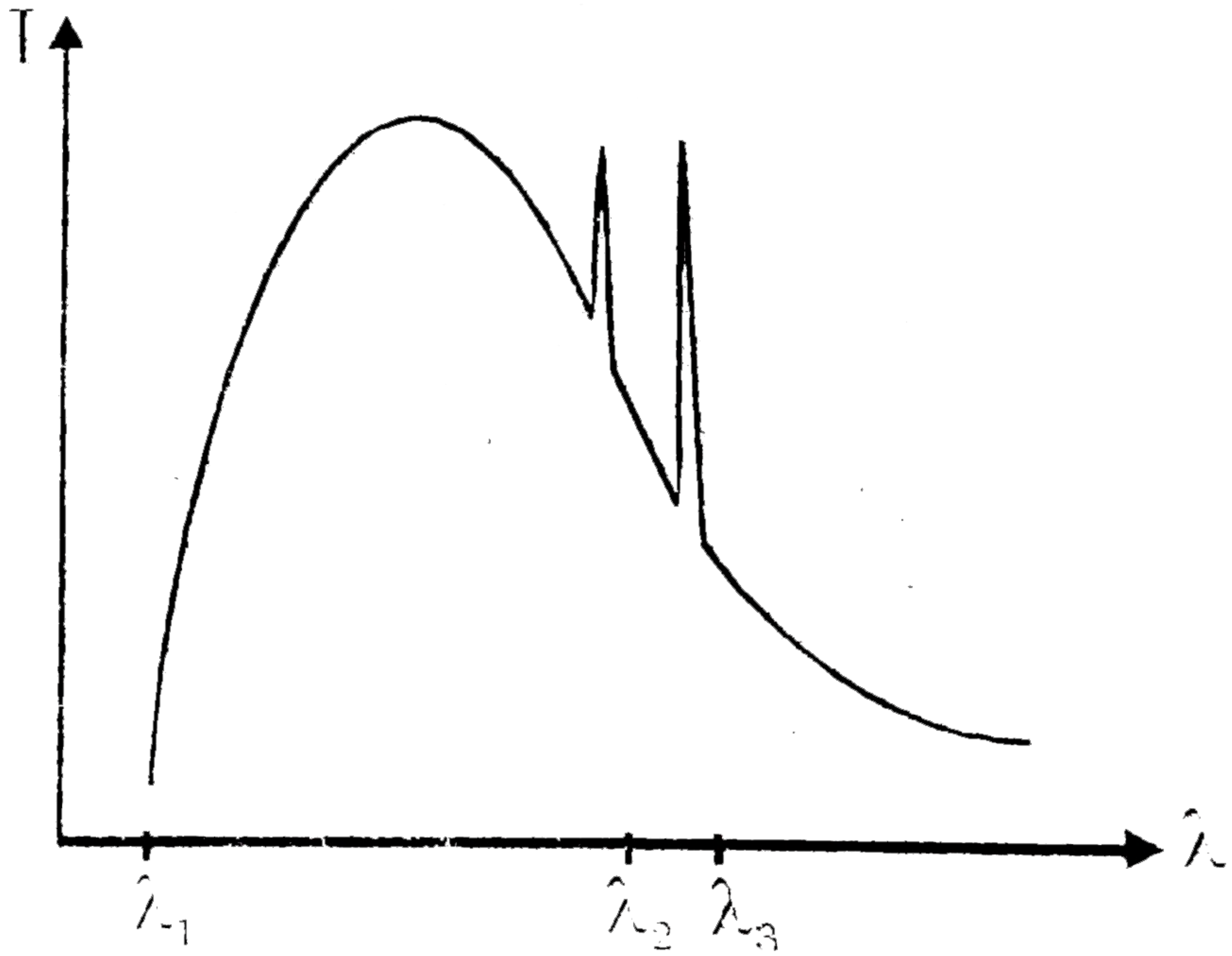
CORRECT ANSWER: A

SOLUTION:

Wevelength λ_k is independent of the accelerating voltage (V), while the minimum wavelength λ_c is inversely proportional to V. Therefore, as V is increased λ_k remains unchanged whereas λ_c decreases or $\lambda_k - \lambda_c$ will increase.

Q-60 - 14949497

Intensity of x-rays coming from an x-ray tube is plotted against wavelength as shown:-



(A) If accelerating potential is changed keeping target same, then sharp peaks $(\lambda_2 \& \lambda_3)$ will shift to new position.

(B) If accelerating potential is changed keeping the target same, then minimum wavelength of spectrum (λ_1) will shift to new location

(C) In the radiation coming out of the tube photons corresponding to wavelength λ_3 will have more energy than those corresponding to λ_2

(D) In the radiation coming out of the tube number of photons corresponding to wavelength λ_3 will be more in number than number of photons corresponding to λ_2

CORRECT ANSWER: B::D

SOLUTION:

Spectrum peaks are due to characterstic X-rays, which depend on target, where as $\lambda_{\min}$ is a property of accelerating voltage.