DPP

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/46

Video Solution on YouTube:- https://youtu.be/veQ1_ryXN94

Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/19

Q 1. The wavelength of X - rays decreases, when
(a) Temperature of target is increased
(b) Intensity of electron beam is increased
(c) K.E. of electrons striking the target is increased
(d) K.E. of electrons striking the target is decreased

Q 2. The minimum wavelength of X-rays produced in an X-ray tube is λ when the operating voltage is V. What is the minimum wavelength of the X-rays when the operating voltage is V/2?
(a) $\frac{\lambda}{2}$ (b) λ
(c) 2λ (d) 4λ

Q 3. X-rays are being produced in a tube operating at 10^5 V. The velocity of X-rays produced in vacuum tube is
(a) 3×10^8 m/s (b) 2.8×10^8 m/s
(c) 3.1×10^8 m/s (d) 3×10^{10} m/s

Q 4. The X-rays produced in a Coolidge tube of potential difference 40 V have minimum wavelength of
(a) 3.09×10^{-8}m (b) 5.09×10^{8}m
(c) 4.09×10^{-8}m (d) 1.09×10^{8}m

Q 5. A metal block is exposed to beams of X-ray of different wavelength. X-rays of which wavelength penetrate most
(a) 2 Å (b) 4 Å
(c) 6 Å (d) 8 Å

Q.6 When a beam of accelerated electrons hits a target, a continuous X - ray spectrum is emitted from the target. Which of the following wavelength is absent in X - ray spectrum, if the X - ray tube is operating at 40,000volts?
(a) 0.25 Å (b) 0.5 Å
(c) 1.5 Å (d) 1.0 Å

Q 7. Which of the following wavelength falls in X - ray region?
(a) 10000 Å (b) 1000 Å
(c) 1 Å (d) 10^{-2} Å

Q 8. In X-ray tube, when the accelerating voltage V is doubled, the difference between the wavelength of K_α line and minimum wavelength of continuous X-ray spectrum

(a) Remains constant (b) becomes half

(c) Becomes more than two times (d) Becomes less than two times

Q 9. Mosley measured the frequency (f) of the characteristic X-ray from many metals of different atomic number (Z) and represented his results by a relation known as Moseley's law. This law is (a, b are constant)

(a) $f = a(Z - b)^2$ (b) $Z = a(f - b)^2$

(c) $f^2 = a(Z - b)$ (d) $f = a(Z - b)^{1/2}$

Q 10. If the frequency of K_α X-rays emitted from the element with atomic number 31 is v, then the frequency of K_α X-rays emitted from the element with atomic number 51 would be

(a) $\frac{3}{5}$v (b) $\frac{51}{31}$v

(c) $\frac{25}{9}$v (d) $\frac{9}{25}$v

Q 11. The X– ray wavelength of L_α line of Platinum (Z=78) is 1.30 Å. The X– ray wavelength of L_α line of Molybdenum (Z = 42) is (constant b = 7.4)

(a) 5.41 Å (b) 4.20 Å

(c) 2.70 Å (d) 1.35 Å

Q 12. An X-ray tube operates at 40 kV. Suppose the electron converts 70% of its energy into a photon at each collision. Find the 2nd lowest wavelengths emitted from the tube. Neglect the energy imparted to the atom with which the electron collides

(a) 44.28 pm (b) 147.61 pm

(c) 493 pm (d) 122.43 pm

Q 13. The wavelength of kα X- rays produced by an X - rays tube is 0.76Å. The atomic number of the anode material of the tube is

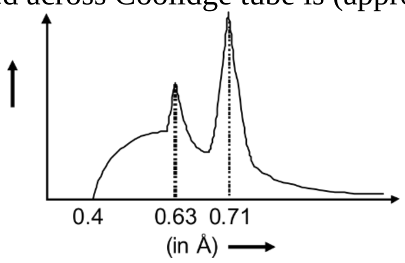
(Considering that Bohr's model is applicable)

(a) 57 (b) 39

(c) 34 (d) 41

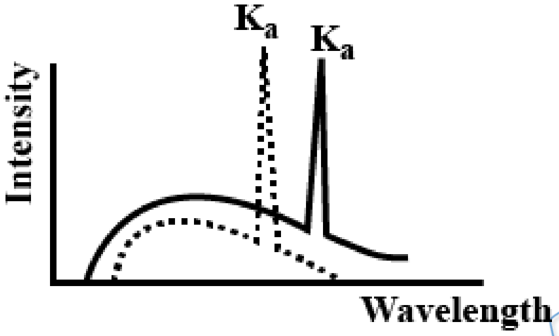
Q 14. Figure shows intensity versus wavelength graph of X-rays coming from Coolidge-tube with molybdenum as target element. The two peaks shown in graph correspond to K_α and K_β X- rays.

Wavelength of L_α X- rays from Coolidge tube will be (approximately) and Voltage applied across Coolidge tube is (approximately)



(a) 1.2 Å, 20 kV (b) 2100 Å, 16 kV
(c) 5.6 Å, 31 kV (d) 12.3 Å, 18 kV

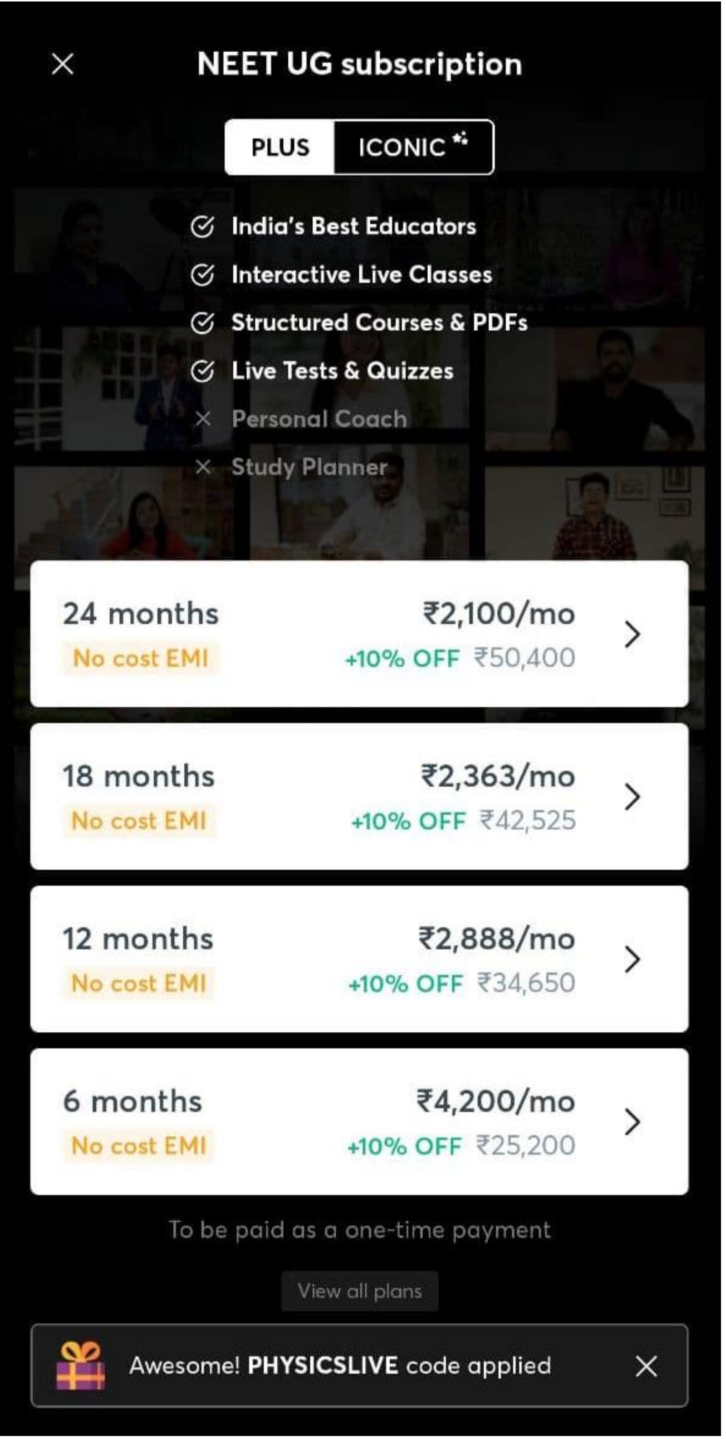
Q 15. Given curve shows the intensity wavelength relation of X−rays coming from two different Coolidge tubes A and B. The dark curve represents the relation for the tube A in which potential difference between the target and the filament is V_A and the atomic number of the target material is Z_A. Similarly dotted curve is for tube B. Respective quantities are V_B and Z_B for the tube B. 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) $V_A < V_B, Z_A < Z_B$

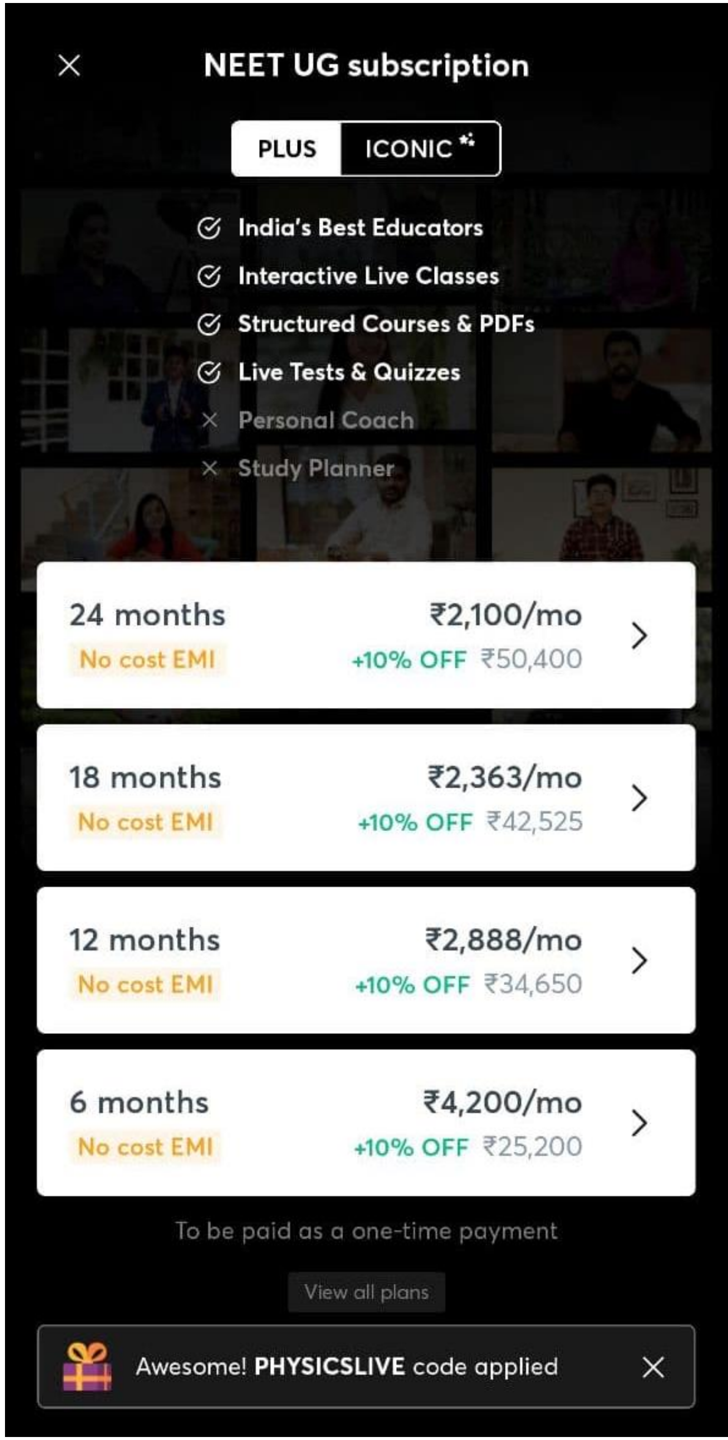
Answer Key

Q.1 c	**Q.2 c**	**Q.3 a**	**Q.4 a**	**Q.5 a**
Q.6 a	**Q.7 c**	**Q.8 d**	**Q.9 a**	**Q.10 c**
Q.11 a	**Q.12 b**	**Q.13 d**	**Q.14 c**	**Q.15 b**



PHYSICSLIVE

Use code PHYSICSLIVE to get 10% OFF on Unacademy PLUS and learn from India's Top Faculties.



Written Solutions

DPP- Modern Physics: X- Rays

By Physicsaholics Team

Solution: 1

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

$$\therefore \lambda_{min} \propto \frac{1}{KE}$$

So; when $KE \uparrow \Rightarrow \lambda_{min} \downarrow$

Ans. c

Solution: 2

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

$$\lambda \propto \frac{1}{V}$$

$$\frac{\lambda_1}{\lambda_2} = \frac{V_2}{V_1}$$

$$\frac{\lambda}{\lambda_2} = \frac{V/2}{V}$$

$$\frac{\lambda}{\lambda_2} = \frac{1}{2}$$

$$\boxed{\lambda_2 = 2\lambda}$$ Ans

Ans. c

Solution: 3

The X- Ray is nothing but an electromagnetic wave, and as know, electromagnetic waves travel with the speed of light in vacuum.

$c = 3 \times 10^8$ m/s

Ans. a

Solution: 4

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

$$\lambda_{min} = \frac{12400}{40} A^{o}$$

$$= 310\ A^{o}$$

$$= 310 \times 10^{-10}\ m$$

$$\boxed{\lambda_{min} = 3.1 \times 10^{-8}\ m}\ Ans$$

Ans. a

Solution: 5

Penetrating power is greater for lower wavelength.

Ans. a

Solution: 6

$$\because \lambda_{min} = \frac{hc}{eV}$$

$$= \frac{12400}{40,000}$$

$$\boxed{\lambda_{min} = 0.31\ A^{\circ}}$$

Hence; wavelengths less than $0.31\ A^{\circ}$ is not possible.

Ans

Ans. a

Solution: 7

wavelengths of x-Rays ranges from 0.1 A° to 100 A°

So; 1 A° falls in X-Ray

Ans. c

Solution: 8

$$\Delta d = d_{K\alpha} - d_{min}$$

$\because$ $V \rightarrow 2V$

& $d_{min} \propto \frac{1}{V}$

$$\Rightarrow d_{min} \rightarrow \frac{d_{min}}{2}$$

But $d_{K\alpha}$ = remains same

then; $\Delta d' = d_{K\alpha} - \frac{d_{min}}{2}$

$$\Delta d' = d_{K\alpha} - d_{min} + \frac{d_{min}}{2}$$

$$\Delta d' = (\Delta d) + \frac{d_{min}}{2}$$

means; $\Delta d' > \Delta d$

but as we know $d_{min} < d_{K\alpha}$.

so; $\boxed{\Delta d' < 2\Delta d}$ Ans

Ans. d

Solution: 9

Mosley's Law :-

$$\sqrt{f} \propto (z-b)$$

$$\sqrt{f} = k(z-b)$$

$$f = k^2(z-b)$$

$$k^2 = a$$

$$\boxed{f = a(z-b)^2}$$ Ans

Ans. a

Solution: 10

from Moseley's Law:

$$\sqrt{\nu} = a(Z-1)$$

$$\nu = a^2(Z-1)^2$$

$$\nu \propto (Z-1)^2$$

$$\frac{\nu}{\nu'} = \left(\frac{31-1}{51-1}\right)^2$$

$$\frac{\nu}{\nu'} = \left(\frac{30}{50}\right)^2 = \frac{9}{25}$$

$$\boxed{\nu' = \frac{25}{9}\nu}$$ Ans

Ans. c

Solution: 11

$\because \sqrt{\nu} \propto (z-b)$

or $\nu \propto (z-b)^2$; ($b = 7.4$ given)

and $\nu \propto \frac{1}{d}$

so; $d \propto \left(\frac{1}{z-b}\right)^2$

so; $\frac{d_1}{d_2} = \frac{(z_2-b)^2}{(z_1-b)^2}$

$\frac{1.3\,A^\circ}{d_2} = \frac{(42-7.4)^2}{(78-7.4)^2}$

$d_2 = \frac{4984.36}{1197.16} \times 1.3\,A^\circ$

$d_2 = 5.41\ A^\circ$ Ans

Ans. a

Solution: 12

operating voltage = 40kV

Energy of e^- = 40 keV
= 40,000 eV

Energy utilized = 70% of 40,000 eV
$= \frac{70}{100} \times 40,000$ eV

Energy utilized = 28,000 eV
↳ Energy of photon

so; wavelength of first photon

$$\lambda_1 (\text{in } A^0) = \frac{12400}{E(eV)}$$

$$\lambda_1 = \frac{12400}{28,000}$$

$\lambda = 0.4428\ A^0$

$\boxed{\lambda_1 = 44.28 \text{ pm}}$

so; after 2^{nd} collision

E = 70% of (remaining energy)

= 70% [30% of initial energy]

$$= \frac{70}{100}\left[\frac{30}{100} \times 40,000\right]$$

E = 8400 eV

$$\lambda_2 = \frac{12400}{8400} = 1.4761\ A^0$$

$\boxed{\lambda_2 = 147.61 \text{ pm}}$ Ans

Ans. b

Solution: 13

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

∵ for K_α; $b = 1$ and $n_1 = 1$, $n_2 = 2$

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

$$\frac{1}{\lambda} = \frac{3}{4}R(Z-1)^2$$

$$\frac{1}{0.76\times10^{-10}} = \frac{3}{4}\times1.097\times10^{7}\times(Z-1)^2$$

$$\frac{10^{10}}{0.76} = \frac{3}{4}\times1.097\times10^{7}\times(Z-1)^2$$

$$\frac{1000}{0.76} = \frac{3}{4}\times1.097\,(Z-1)^2$$

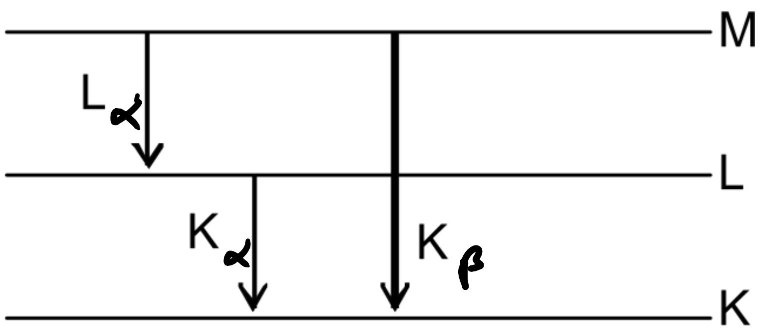
$$(Z-1)^2 = 1599.25$$

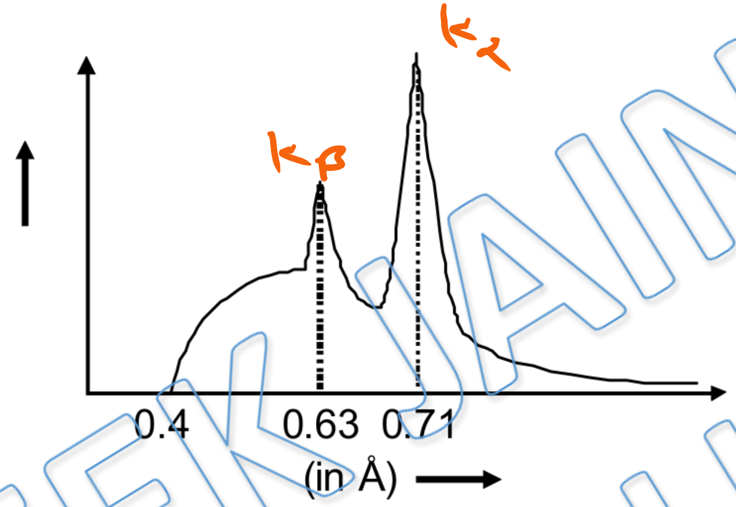
$$(Z-1) = 40$$

$$\boxed{Z = 41}$$ Ans.

Ans. d

Solution: 14





$$E_{MK} = E_{ML} + E_{LK}$$

$$\frac{hc}{\lambda_{K\beta}} = \frac{hc}{\lambda_{L\alpha}} + \frac{hc}{\lambda_{K\alpha}}$$

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

$$\frac{1}{\lambda_{L\alpha}} = \frac{1}{\lambda_{K\beta}} - \frac{1}{\lambda_{K\alpha}}$$

$$\lambda_{L\alpha} = \frac{\lambda_{K\beta}\lambda_{K\alpha}}{\lambda_{K\alpha} - \lambda_{K\beta}}$$

$$\lambda_{L\alpha} = \frac{(0.63)(0.71)}{(0.71 - 0.63)}$$

$$\boxed{\lambda_{L\alpha} = 5.59\ A^{\circ}}$$ Ans

$\lambda_{min} = 0.4\ A^{\circ}$ [from graph]

so; $E(eV) = \frac{hc}{\lambda(A^{\circ})}$

$$E = \frac{12400}{0.4}$$

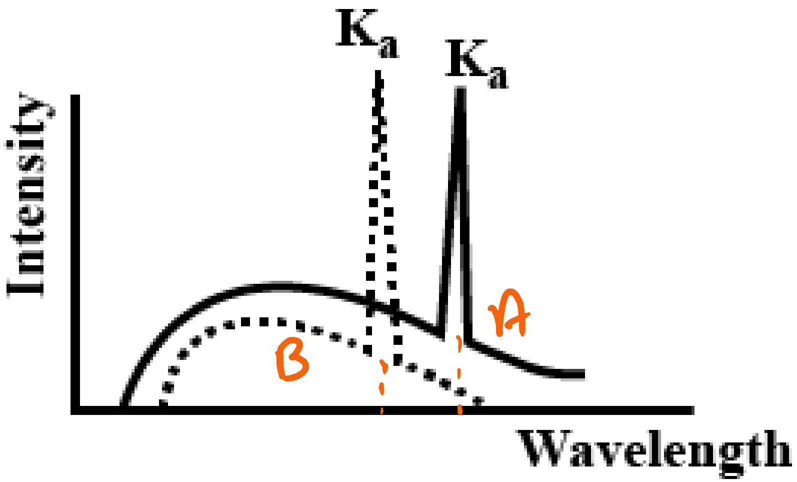
$$E = 31000\ eV$$

$$E = 31 \times 10^3\ eV$$

$$\boxed{\Delta V = 31 \times 10^3\ Volt}$$ Ans

Ans. c

Solution: 15



∵ for characteristic wavelengths

$\nu \propto (Z-b)^2$

$\lambda \propto \frac{1}{(Z-b)^2}$

when $Z \uparrow \Rightarrow \lambda \downarrow$

so; as $(\lambda_{K\alpha})_A > (\lambda_{K\alpha})_B$

so; $\boxed{Z_A < Z_B}$

as; $(\lambda_{min})_A < (\lambda_{min})_B$

$E \propto \frac{1}{\lambda}$

or $V \propto \frac{1}{\lambda}$

$\Rightarrow \boxed{V_A > V_B}$ Ans.

Ans. b

For Video Solution of this DPP, Click on below link

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/46

Video Solution on YouTube:- https://youtu.be/veQ1_ryXN94

Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/19

Chalo Niklo