



PHYSICS

BOOKS - CP SINGH PHYSICS (HINGLISH)

X-Rays



1. (a) Find the maximum frequency of the X-rays emitted by an X-ray tube operating at

30kV.

(b) An X-ray tube operates at 20kV. 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.

(c) An X-ray tube is operated at 20kV and the current through the tube is 0.5mA. Find (i) the number of electrons hitting the target per second,

(ii) the energy falling on the target per secondas the kinetic anergy of the electrons and

(iii) the cut-off wavelength of the X-rays

emitted.



2. The short-wavelength limit shifts by 26 pm when the operating voltage in an X-ray tube is increased to 1.5 times the original value. What was the original value of the operating voltage?



3. The wavelength of the characteristic X - ray

 k_{lpha} line emitted by a hydrogens like element is

 0.32λ . The wavelength of the K_eta line emitted

by the same element will be



4. The *Ka* X-ray of molybdenum has wavelength 71 pm. If the energy of a molybdenum atom with a K electron knocked out is 23:32 keV, what will be the energy of this atom when an L electron is knocked out?

5. The wavelength of K_{α} X-ray of tungsten is 21.3 pm. It takes 11.3 keV to knock out an electron from the L shell of a tungsten atom. What shoulb be the minimum accelerating voltage across an X-ray tube having trungsten target which allows production of K_{α} X-ray?



6. The energy of a silver atom with a vacancy in K shell is 25.31 keV, in L shell is 3.56 keV and in M shell is 0.530 keV higher than the energy of the atom with no vacancy. Find the frequency of K_{α} , K_{β} and L_{α} X-rays of silver.

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7. The k_{α} X-rays of aluminium (Z = 13) and zinc (Z = 30) have wavelengths 887 pm and 146 pm respectively. Use Moseley\'s law $\sqrt{v} = a(Z-b)$ to find the wavelength of the

 K_{α} X-ray of iron (Z = 26).





Which of the following is correct regarding
 X-rays

(i) X-rays are electromagnetic radiation (photon) of short wavelength. X-rays move in straight lines in vacuum at a speed equal to that of light

(ii) Since X-rays are charge-less particles and therefore not deflected by electric or magnetic fields

(iii) X-rays are diffracted by crystals in accordance with Bragg's law. The Bragg's law states $2d\sin\theta = n\lambda$, where n is integer. θ is the angle at which X-ray is incident on the plane of atoms, d: distance between the parallel planes of atom (iv) X-rays affect a photographic plate more strongly than visible light

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

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

C. (i),(ii),(iv)

D. all

Answer: D

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2. Which of the following is correct regarding

X-rays

A. When incident on certain materials such as barium platocyanide, X-rays cause fluorescence (light is emitted from the material) B. When passed through a gas, X-rays ionize the molecules of the gas C. When X-ray passes through a material of thickness x, its final and initial intansity (I and I_0) are related as $I = I_0 e^{-\mu x}, \mu$: attenuation coefficient

D. All option are correct

Answer: D

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3. Which of the following is correct regarding Moseley's law

A. The elements in periodic table must be arranged according to atomic number and not by atomic weight



4. Consider a photon of continuous X-ray coming from a Coolidge tube. Its energy comes from

A. the K.E. of the striking electron

B. the K.E. of the free electrons of the

target

C. the K.E. of the ions of the target

D. an atomic transition in the target

Answer: A

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5. If the potential difference applied to tube is doubled and the separation between the filament and the target is also doubled, the cutoff wavelength

A. remain same

B. doubled

C. halved

D. become four times





6. If the current in the circuit for heating the filament is increased, the cutoff wavelength

A. will increase

B. will decrease

C. same

D. none



cartain maximum wavelength

D. has all wavelength lying between a

minimum and a maximum wavelength

Answer: C



8. The potential difference applied to an X-ray tube is increased. As a result, in the emitted

radiation,

A. (i),(ii)

B. (ii),(iii)

C. (iii),(iv)

D. (i),(iv)

Answer: C

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9. When an electron strikes the target in a

Coolidge tube, its entire kinetic energy

A. (i),(ii)

B. (ii),(iii)

C. (iii),(iv)

D. (ii),(iv)

Answer: D

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10. X-ray incident on a material

- (i) exerts a force on it
- (ii) transfers energy to it

(iii) transfers momentum to it

(iv) transfer impulse to it

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

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

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

D. all

Answer: D



11. 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

Answer: A

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12. In an X - rays tube , the intensity of the emitted X - rays beam is increased by

A. increasing the filament current

B. decreasing the filament current

C. increasing the target potential

D. decreasing the target potential

Answer: A

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13. Cutoff wavelength of X-rays coming from a

Coolidge tube depends on the

A. target material

B. accelerating voltage

C. filament current

D. none

Answer: B

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14. X- rays are produced in an X- rays tube operating at a given accelerating voltage . The

wavelength of the continuous X- rays has

values from

A. O to ∞

B. $\lambda_{\min}
ightarrow \infty$ where $\lambda_{\min}
ightarrow 0$

C. O to $\lambda_{
m max}$ where $\lambda_{
m max} > \infty$

D. λ_{\min} to λ_{\max} where $0 < \lambda_{\min} < \infty$

Answer: B

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15. The potential difference applied to an X-ray tube is 5k V and the current through it is 3.2 mA. Then, the number of electrons striking the target per second is. (a) 2×10^{16} (b) 5×10^{6} (c) 1×10^{17} (d) 4×10^{15} .

A. $2 imes 10^{16}$

 $\text{B.}\,5\times10^{16}$

 ${\rm C.1}\times10^{17}$

 $\text{D.}\,4\times10^{15}$

Answer: A

16. The potential different across the Coolidge tube is 20kV and 10mA current flows through the voltage supply. Only 0.5% of the energy carried by the electrons striking the largest is converted into X-ray. The power carried by the X-ray beam is p. Then

A. 0.1W

 $\mathsf{B.}\,1W$

 $\mathsf{C.}\,2W$

D. 10W

Answer: B

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17. Characteristic X-rays are produced due to

A. transfer of momentum in collision of

electrons with target atoms

B. transition of electrons from higher to

lower electronic orbits in an atom

C. heating of the target

D. transfer of energy in collision of

electrons with atoms in the target

Answer: B

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18. If the potential difference applied across a

Coolidge tube is increased , then

A. the wavelength of the K_{lpha} line will increase B. the wavelength of the K_{eta} line will decrease

C. the difference in wavelength between

the K_{lpha} and K_{eta} lines will decrease

D. none of the above

Answer: D

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19. Electrons with energy 80keV are incident on the tungsten target of an X - rays tube , kshell electrons of tungsten have 72.5keVenergy X- rays emitted by the tube contain only

A. a continous X-ray spectrum
(Bremsstrahlung) with a minimum
wavelength of ~0.155Å
B. a continous X-ray spectrum
(Bremsstrahlung) with all wavelengths

| C. the | characteristic | X-ray | spectrum | of |
|-------------------------------|----------------|---------|----------|-----|
| tungsten | | | | |
| D. a | continous | X-ray | spectr | um |
| (Bre | msstrahlung) | with | a minim | um |
| wave | elength of | ~0.155Å | and | the |
| characteristic X-ray spectrum | | | | of |
| tung | gsten | | | |

Answer: D

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20. 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) $\lambda_k - \lambda_c$ decreases (c) λ_k increases (d) λ_k decreases A. $(\lambda_k - \lambda_c)$ increases

- B. $(\lambda_k \lambda_c)$ decreases
- C. λ_k increases
- D. λ_k decreases

Answer: A



21. The binding energy of the innermost electron in tungsten is 40keV. To produce characteristic X - rays using a tungsten target

in an X - rays tube the potential difference V between the cathode and the anti - cathode should be

- A. V < 40 kV
- B. $V \leq 40 kV$
- ${\rm C.}\,V>40kV$
- D. V>~/~<40kV

Answer: C

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22. Electrons with de- Broglie wavelength λ fall on the target in an X- rays tube . The cut off wavelength of the emitted X- rays is

A.
$$\lambda_0=rac{2mc\lambda^2}{h}$$

B. $\lambda_0=rac{2h}{mc}$
C. $\lambda_0=rac{2m^2c^2\lambda^3}{h^2}$

D.
$$\lambda_0=\lambda$$

Answer: A



23. For the structural analysis of crystals, X-rays are used because

A. X-rays are have wavelength of the order

of interatomic spacing

B. X-rays are highly penetrating radiations

C. Wavelength of X-rays is of the order of

nuclear size

D. X-rays are coherent radiation





24. The K_{α} X-ray emission line of lungsten accurs at $\lambda = 0.021 nm$. What is the energy difference between K and L levels in the atom?

A. 0.51 MeV

 ${\rm B.}\,1.2 MeV$

 ${\rm C.}\,59 keV$

D. 13.6 eV

Answer: C



25. Which one of the following statement is *WRONG* in the context of X- rays generated from X- rays tube ?

A. Wavelength of characteristic X-rays

decreases when the atomic number of

the target increases

B. Cut-off wavelength of the continuous Xrays depends on the atomic number of the target C. Intensity of the characteristic X-ray depends on the electrical power given to the X-ray tube D. Cut-off wavelength of the continuous Xray depends on the energy of the electrons in the X-ray tube

Answer: B



26. Which of the following is accompanied by

the characteristic X - ray emission ?

A. α -particle emission

B. electron emission

C. positron emission

D. K-electron capture

Answer: D



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

A. (i),(ii)

B. (ii),(iii)

C. (i), (iii)

D. (i),(iv)

Answer: C



28. 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_{eta} for the other tube. Then,



A. $V_A > V_B, Z_A > Z_B$

 $\mathsf{B.}\, V_A > V_B, \, Z_A < Z_B$

 $\mathsf{C}.\,V_A < V_B,\,Z_A > Z_B$

D. $V_A < V_B, \, Z_A < Z_B$

Answer: B

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29. 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.

A. a

B.b

С. с

D. d

Answer: D



30. Moseley's law for characteristic X-rays is $\sqrt{v} = a(Z-b).$ In this,

A. both a and b are independent of the material

B. a is independent but b depends on the material

C. b is independent but a depends on the

material

D. both a and b depend on the material

Answer: A

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31. The largest distance between the interatomic planes of crystal is $10^{-7}cm$. The upper limit for the wavelength of X - rays

which can be usefully studied with this crystal

is

A. 1Å

B. 5Å

C. 10Å

D. 20\AA

Answer: D

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32. Consider a photon of continuous X-ray and a photon of characteristic X-ray of the same wavelength. Which of the following is/are different for the two photons?

A. frequency

B. energy

C. penetrating power

D. method of creation

Answer: D



- **33.** For harder X-rays,
- (i) the wavelength is higher
- (ii) the intensity is higher
- (iii) the frequency is higher
- (iv) the photon energy is higher
 - A. (i),(ii)
 - B. (ii),(iii)
 - C. (iii),(iv)
 - D. (i),(iv)

Answer: C



- **34.** Which of the following pairs constitute very similar rediations?
- (i) Hard ultraviolet rays and soft X-rays
- (ii) Soft ultraviolet rays and hard X-rays
- (iii) Very hard X-rays and low-frequency γ -rays
- (iv) Soft X-rays and γ -rays

A. (i),(ii)

B. (ii),(iii)

C. (i), (iii)

D. (i),(iv)

Answer: C

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