SECTION : SR AZ

DUAL NATURE

PHYSICS

1. A Beam of cathode rays is subjected to crossed electric (E) and magnetic fields (B). The fields are adjusted such that the beam is not deflected. The specific charge of the cathode rays is given by
   1) $\frac{B^2}{2VE^2}$ 2) $\frac{2VB^2}{E^2}$ 3) $\frac{2VE^2}{B^2}$ 4) $\frac{E^2}{2VB^2}$
2. A source of light is placed at a distance of 50 cm from a photo cell and the stopping potential is found to be V_0. If the distance between the light source and photo cell is made 25 cm, The new stopping potential will be :
   1) $V_0/2$ 2) V_0 3) $4V_0$ 4) $2V_0$
3. In photoelectric emission process from a metal of work function 1.8 eV, The kinetic energy of most energetic electron is 0.5 eV. The corresponding stopping potential is
   1) 1.8 V 2) 1.3 V 3) 0.5 V 4) 2.3 V
4. When monochromatic radiation of intensity I falls on a metal surface, the number of photoelectrons and their maximum kinetic energy are N and T respectively. If the intensity of radiation is 2I,the number of emitted electrons and their maximum kinetic energy are respectively
   1) N and 2T 2) 2N and T 3) 2N and 2T 4) N and T
5. If velocity of a particle is 3 times of that of electron and ratio of degroglie wavelength of particle to that of electron is 1.84 x 10^{-4}. The particle will be
   1) Neutron 2) deuteron 3) alpha 4) tritium
6. A 5 watt source emits monochromatic light of wave length 5000 A. When placed 0.5 m away, it liberates photoelectrons from a photosensitive metallic surface. when the source is moved to a distance of 1.0 m, the number of photoelectrons liberated will be reduced by a factor of
   1) 8 2) 16 3) 2 4) 4
7. A photo-cell is illuminated by a source of light, which is placed at a distance d from the cell. If the distance become d/2, then number of electrons emitted per second will be
   1) remain same 2) four times 3) two times 4) one-fourth
8. As the intensity of incident light increases
   1) kinetic energy of emitted photoelectrons increases
   2) photo electric current decreases
   3) photoelectric current increases
   4) kinetic energy of emitted photoelectrons decreases.
9. The cathode of a photoelectric cell is changed such that the work function changes from W_1 and W_2 $(W_1 > W_2)$. If the current before and after changes are I_1 and I_2, all other conditions remaini ng unchanged, then (assuming $hv > w_2$)
   1) $I_1 = I_2$ 2) $I_1 < I_2$ 3) $I_1 > I_2$ 4) $I_1 < I_2 < 2I_1$
10. Light of frequency 1.5 times the threshold frequency is incident on a photosensitive material. What will be in the photoelectric current if the frequency is halved and intensity is doubled ?
    1) Doubled 2) Four times 3) one-fourth 4) zero
11. When two monochromatic light of frequency. v and $\frac{v}{2}$ are incident on a photoelectric metal, their stopping potential becomes $\frac{V_s}{2}$ and V_s ,respectively. The threshold frequency for this metal is

1) $2v$ 2) $3v$ 3) $\frac{2}{3}v$ 4) $\frac{3}{2}v$

12. When the light of frequency $2v_0$ (Where V_0 is threshold frequency), is incident on a metal plate, the maximum velocity of electrons emitted is V_1, when the frequency of the incident radiation is increased to $5v_0$, the maximum velocity of electrons emitted from the same plate is V_2, The ratio of V_1 to V_2 is
1) 1:2 2) 1:4 3) 4:1 4) 2:1

13. The photoelectric threshold wavelength of silver is $3250x10^{-10}m$. The velocity of the electron ejected from a silver surface by ultraviolet light of wavelength 2536 x $10^{-10}m$ is [Given h=4.14 x$10^{-15}eV$ s and c=0.3 x$10^8 ms^{-1}$]
1) $\approx 6 \times 10^6 ms^{-1}$ 2) $\approx 61x10^3 ms^{-1}$ 3) $\approx 0.3x10^6 ms^{-1}$ 4) $\approx 6x10^5 ms^{-1}$

14. Photons with energy 5 eV are incident on a cathode C in a photoelectric cell. The maximum energy of emitted 2 eV. When photons of energy 6 eV are incident on C, no photoelectrons will reach the anode A,if the stopping potential of A relative to C is
1) +3 V 2) +4 V 3) -1 V 4) -3 V

15. When a metallic surface is illuminated with radiation of wavelength λ, the stopping potential is V. If the same surface is illuminated with radiation of wavelength 2λ, the stopping potential is $\frac{V}{4}$. The threshold wavelength for the metallic surface is
1) $\frac{5}{2}\lambda$ 2) 3λ 3) 4λ 4) 5λ

16. When the energy of the incident radiation is increased by 20%, the kinetic energy of the photoelectrons emitted from a metal surface increased from 0.5 eV to 0.8 eV. The work function of the metal is
1) 0.65 eV 2) 1.0 eV 3) 1.3 eV 4) 1.5 eV

17. For photoelectric emission from certain metal the cut off frequency is v. if radiation of frequency $2v$ Impings on the metal plate, the maximum possible velocity of emitted electron will be (m is the electron mass)
1) $\sqrt{\frac{2hv}{m}}$ 2) $2\sqrt{\frac{hv}{m}}$ 3) $\sqrt{\frac{hv}{(2m)}}$ 4) $\sqrt{\frac{hv}{m}}$

18. The work functions for metals A, B and C are respectively 1.92 eV, 2.0 eV and 5 eV. According to Einstein's equation the metals which will emit photoelectrons for a radiation of wavelength 4100 A is/are
1) A only 2) A and B only
3) All the three metals 4) None

19. The ratio of de-broglie wavelengths of molecules of hydrogen and helium which are at temperature 27^0 C and 127^0C respectively is
1) $\frac{1}{2}$ ` 2) $\sqrt{\frac{3}{8}}$ 3) $\sqrt{\frac{8}{3}}$ 4) 1

20. In a photo-emissive cell. With exciting wavelength λ, the fastest electron has speed v. If the exciting wavelength is changed to $\frac{3\lambda}{4}$, the speed of the fastest emitted electron will be
1) less than $v(4/3)^{1/2}$ 2) $v(4/3)^{1/2}$
3) $v(3/4)^{1/2}$ 4) greater than $v(4/3)^{1/2}$

21. When light of wavelength 300 nm (nano meters) falls on a photoelectric emitter, photoelectrons are liberated. For another emitter, however, light of 600nm wavelength is sufficient for creating photoemission. What is the ratio of the work functions of two emitters ?
1) 1:2 2) 2:1 3) 4:1 4) 1:4

22. A 200 W sodium street lamp emits yellow light of wavelength 0.6 μm. Assuming it to be 25% efficient in converting electrical energy to light, the number of photons of yellow light it emits per second is
1) 1.5 x10^{20} 2) 6 x10^{18} 3) 62 x 10^{20} 4) 3 x 10^{19}

23. A source S_1 is producing, 10^{15} photons per second of wavelength 5000 A. Another source S_2 is producing 1.02×10^{15} photons per second of wavelength5100 A. Then,(power of S_2) (power of S_1) Is equal to

1) 1.00 2) 1.02 3) 1.04 4) 0.98

24. Monochromatic light of frequency 6.0×10^{14} HZ is produced by a laser. The power emitted is 2×10^{-3} W. The number of photons emitted, on the average, by the source per second is

1) 5×10^{16} 2) 5×10^{17} 3) 5×10^{14} 4) 5×10^{15}

25. An electromagnetic wave of wavelength 'λ' is incident on a photosensitive surface of negligible work function. If 'm' mass is of photoelectron emitted from the surface has de-Broglic wavelength λ_d then

1) $\lambda = \left(\frac{2h}{mc}\right)\lambda_d^2$ 2) $\lambda = \left(\frac{2m}{hc}\right)\lambda_d^2$

3) $\lambda_d = \left(\frac{2mc}{h}\right)\lambda^2$ 4) $\lambda_d = \left(\frac{2mc}{h}\right)\lambda_d^2$

26. An electron of mass m with an initially velocity $\vec{v} = v_0 i (v_0 > 0)$ enters an electric field $\vec{E} = -\vec{E}_0 i$ $(E_0 = cons\tan t > 0)$ at t = 0.If λ_0 is its de-broglie wavelength initially, then its de-broglie wavelength at time t is

1) $\frac{\lambda_0}{\left(1 + \frac{eE_0}{mv_0}t\right)}$ 2) $\lambda_0\left(1 + \frac{eE_0}{mv_0}t\right)$ 3) $\lambda_0 t$ 4) λ_0

27. Electrons of mass m with de-broglie wavelength λ fall on the target in an X-ray tube. The cut off wavelength (λ_0) of the emitted X-ray is

1) $\lambda_0 = \frac{2mc\lambda^2}{h}$ 2) $\lambda_0 = \frac{2h}{mc}$ 3) $\lambda_0 = \frac{2m^2c^2\lambda^3}{h^2}$ 4) $\lambda_0 = \lambda$

28. An electron of mass m and a photon have same energy E. The ratio of de-broglie wavelength associated with them is

1) $c(2mE)^{1/2}$ 2) $\frac{1}{c}\left(\frac{2m}{E}\right)^{1/2}$ 3) $\frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$ 4) $\left(\frac{E}{2m}\right)^{1/2}$

29. The wavelength λ_e of an electron and λ_p of a photon of same energy E are related by

1) $\lambda_p \alpha \sqrt{\lambda_e}$ 2) $\lambda_p \alpha \frac{1}{\sqrt{\lambda_e}}$ 3) $\lambda_p \alpha \lambda_e^2$ 4) $\lambda_p \alpha \lambda_e$

30. Electrons used in an electron microscope are accelerated by a voltage of 25 kv. If the voltage is increased to 100kv then the de-broglie wavelength associated with the electrons would

1) Increased by 2 times 2) decrease by 2 times

3) decrease by $\frac{1}{2}$ times 4) increase by $\frac{1}{2}$ times

KEY

Q.NO	1	2	3	4	5	6	7	8	9	10
1-10	4	2	3	2	1	4	2	3	1	4
11-20	4	1	4	4	2	2	1	2	3	4
21-30	2	1	1	4	4	1	1	3	3	3

HINT

1. (d): When a beam of cathode rays (or electrons) are subjected to crossed electric (E) and magnetic (B) fields, the beam is not deflected, if

Force on electron due to magnetic field = Force on electron due to electric field

$$Bev = eE \text{ or } v = \frac{E}{B}$$

If V is the potential difference between the anode and the cathode, then

$$\frac{1}{2}mv^2 = eV \text{ or } \frac{e}{m} = \frac{v^2}{2V}$$

Substituting the value of v from equation (ii), we get

$$\frac{e}{m} = \frac{E^2}{2VB^2}$$

Specific charge of the cathode rays $\frac{e}{m} = \frac{E^2}{2VB^2}$

2. (b): y changing the position of source of light from photo cell, there will be a change in the intensity of light falling on photo cell.

3. (c) The stopping potential V_s is related to the maximum kinetic energy of the emitted electrons $K_{\max}$ through the relation

$$K_{\max} = eV_s$$

$$0.5\ eV_s = eV_s \text{ or } V_s = 0.5 \text{ V}$$

4. (b) The number of photoelectrons ejected is directly proportional to the intensity of incident light. Maximum kinetic energy is independent of intensity of incident light but depends upon the frequency of light. Hence option (b) is correct

5. (a) : Given, $v_p = 3v_e$ $\quad \frac{\lambda_p}{\lambda_e} = 1.81x10^{-4}$

$$\lambda = \frac{h}{mv} = \lambda\alpha\frac{1}{mv}$$

$$\frac{\lambda_p}{\lambda_e} = \frac{m_e}{m_p}\frac{v_e}{v_p}$$

$$\frac{\lambda_p}{\lambda_e} = \frac{m_e}{3m_p}$$

$$1.814 \text{ x } 10^{-4} = \frac{9x10^{-31}}{3xm_p} \qquad m_p = 1.67 \text{ x} 10^{-27} kg$$

6. (d) : For a light source of power P watt, the intensity at a distance d is given by $I = \frac{p}{4\pi d^2}$

Where we assume light to spread out uniformly in all directions

i.e it is a spherical source.

$I\alpha \frac{1}{d^2}$ or $\frac{I_1}{I_2}=\frac{d_2^2}{d_1^2}$ or, $\frac{I_1}{I_2}=\left(\frac{1}{0.5}\right)^2$ or $\frac{I_1}{I_2}=4$ or $I_2=\frac{I_1}{4}$

In a photoelectric emission, the number of photoelectrons liberated per second from a photo sensitive metallic surface is proportional to the intensity of light. When a intensity of source reduced by a factor of four, the number of photoelectrons is also reduced by a factor of 4

7. (b)

8 . (c) : If the intensity of light of a given frequency is increased , then the number of photons strikes more electrons of metals and hence number of photons emitted through the surface increase and hence photoelectric current increases.

9. (a) : The work function has no effect on photoelectric current so long as hv> w_0 . The photoelectric current is proportional to the intensity of incident light. Since there is no change in the intensity of light, hence $I_1=I_2$

10. (d) : Initially, $v=1.5v_0$

If the frequency is halved, $v=\frac{v}{2}=\frac{1.5v_0}{2}<v_0$

Hence, no photoelectric emission will take place

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11. (d) : Let the threshold frequency is v_0.

By using the equation of photo electric effect, $E=hv_0+eV_0$

Case-I : $hv=hv_0+\frac{eV_s}{2}$

Case-II : $\frac{hv}{2}=hv_0+ev_s$

$\frac{hv}{2}=\frac{-eV_s}{2}$

$-hv=eV_s$ put in (i)

$hv=hv_0-\frac{hv}{2}$, so $v_0=\frac{3}{2}v$

12. $\frac{1}{4}=\frac{v_1^2}{v_2^2}$ or $\frac{v_1}{v_2}=\frac{1}{2}$

13. $v=6\text{ x }10^5 ms^{-1}=0.6\text{ x}10^6 ms^{-1}$

14. (b) : According to Einstein's photoelectric equation maximum kinetic energy of photoelectrons

$KE_{\max}=E_v-\phi$

$V_{cathode}-V_{anode}=3V=-V_{stopping}$

$V_{stopping}=-3v$

15. (b) : According to Einstein's photoelectric equations

$\frac{eV}{4}=\frac{hc}{\lambda}-\frac{hc}{\lambda_0}$

As per equation, $eV = \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$

$\frac{hc}{4\lambda} = \frac{3hc}{4\lambda_0}$ or $\lambda_0 = 3\lambda$

16. (b) : According to Einstein's photoelectric equation, the kinetic energy of emitted photoelectrons is

$K = hv - \phi_0$

$0.5eV = hv - \phi_0$

$0.8eV = 1.2hv - \phi_0$

Equation (i) and (ii)

$\phi_0 = 1.0eV$

17. (a) : Work function, $\phi_0 = hv$

According to Einstein's photoelectric equation,

$\frac{1}{2}mv_{max}^2 = h(2v) - hv$ or $\frac{1}{2}mv_{max}^2 = hv$

$v_{max} = \sqrt{\frac{2hv}{m}}$

18. (b)

19. (a) : The kinetic energy of an electron , $\frac{1}{2}$ x $mv^2 = eV$ or final velocity of electron $(v) = \sqrt{\frac{2eV}{m}}$

20. (d) : According to Einstein's photoelectric equation,

$\frac{1}{2}mv_1^2 = \frac{hc}{3\lambda/4} - W_0 = \frac{4}{3}\left(\frac{1}{2}mv^2 + W_0\right)$

$v_1^2 = \frac{4}{3}v^2 + \frac{2}{3}W_0$

So, v_1 is greater than $v(4/3)^{1/2}$

21. (b) : $W_0 = \frac{hc}{\lambda_0}$ or $W_0 \alpha \frac{1}{\lambda_0}$

$\frac{W_1}{W_2} = \frac{\lambda_2}{\lambda_1} = \frac{600}{300} = \frac{1}{2}$

22. (a) : 1.5 x 10^{20}

23. (a) : For a source S_1,

Wavelength, $\lambda_1 = 5000A$

Number of photons emitted per second, $N_1 = 10^{15}$

Energy of each photon, $E_1 = \frac{hc}{\lambda_1}$

Power of source S_1, $E_1 N_1 = \frac{N_1 hc}{\lambda_1}$

Power of source S_2, $P_2 = N_2 E_2 = \frac{N_2 hc}{\lambda_2}$

Dividing power of S_2 & S_1

$$\frac{S_2}{S_1} = 1$$

24. (d) : power $p = 2 \text{ x } 10^{-3} w$

Energy of one photon E=hv=6.63 x10^{-34} x 6 x 10^{14} j

Number of photons emitted per second,N=P/E

N= 5 x 10^{15}

25. (d) : As work function is negligible, therefore kinetic energy of emitted electron =Energy of incident photon

$$p = \sqrt{\frac{2mhc}{\lambda}}$$

De-broglie wavelength of emitted electron is

$$\lambda = \left(\frac{2mc}{h}\right)\lambda_d^2$$

26. (a) ; $\left(\lambda_0 = \frac{h}{mv_0}\right)$

27. (a) : Kinetic energy of electrons

$$K = \frac{p^2}{2m} = \frac{(h/\lambda)^2}{2m} = \frac{h^2}{2m\lambda^2}$$

So, maximum energy of photon 9X-ray) = K

$$\frac{hc}{\lambda_0} = \frac{h^2}{2m\lambda^2}$$

$$\lambda_0 = \frac{2mc\lambda^2}{h}$$

28. (c) : For electron of energy E,

De-broglie wavelength, $\lambda_e = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$

For photon of energy, E = hv=$\frac{hc}{\lambda_p} \Rightarrow \lambda_p = \frac{hc}{E}$

$$\frac{\lambda_e}{\lambda_p} = \frac{h}{\sqrt{2mE}} \times \frac{E}{hc} = \frac{1}{c}\left(\frac{E}{2m}\right)^{1/2}$$

29. (c) : Wavelength of an electron of energy E is

$$\lambda_e = \frac{h}{\sqrt{2m_e E}}$$

Wavelength of a photon of same energy E is

$$\lambda_p = \frac{hc}{E} \text{ or } E = \frac{hc}{\lambda_p}$$

Squaring on both sides of eq.(i), we get

$$\lambda_e^2 = \frac{h^2}{2m_e E} \text{ or } E = \frac{h^2}{2m_e \lambda_e^2}$$

Equating (ii) and (iii), we get

$$= \lambda_p \alpha \lambda_e^2$$

30. (c) : The de broglie wavelength λ associated with the electron is

$$\lambda = \frac{1.227}{\sqrt{V}} nm$$

Where V is the accelerating potential in volts.

$$\lambda \alpha \frac{1}{\sqrt{V}}$$

$$\frac{\lambda_1}{\lambda_2} = \sqrt{\frac{V_2}{V_1}} = \sqrt{\frac{100 \times 10^3}{25 \times 10^3}} = 2 \text{ or } \lambda_2 = \frac{\lambda_1}{2}$$

None of the given options is correct.