DPP - Daily Practice Problems

Chapter-wise Sheets

Date : | Start Time : | End Time :

PHYSICS

CP25

SYLLABUS : Dual Nature of Radiation and Matter

Max. Marks : 180 **Marking Scheme :** (+4) for correct & (–1) for incorrect answer **Time : 60 min.**

INSTRUCTIONS : This Daily Practice Problem Sheet contains 45 MCQs. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.

1. A particle of mass 1 mg has the same wavelength as an electron moving with a velocity of 3×10^6 ms^{-1}. The velocity of the particle is:

(a) $2.7\times10^{-18}\ ms^{-1}$ (b) $9\times10^{-2}\ ms^{-1}$

(c) $3\times10^{-31}\ ms^{-1}$ (d) $2.7\times10^{-21}\ ms^{-1}$

2. An electron of mass m and a photon have same energy E. The ratio of de-Broglie wavelengths associated with them is :

(a) $\frac{1}{c}\left(\frac{E}{2m}\right)^{\frac{1}{2}}$ (b) $\left(\frac{E}{2m}\right)^{\frac{1}{2}}$

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

3. All electrons ejected from a surface by incident light of wavelength 200nm can be stopped before travelling 1m in the direction of uniform electric field of 4N/C. The work function of the surface is

(a) 4 eV (b) 6.2 eV (c) 2 eV (d) 2.2 eV

4. The maximum kinetic energy of the electrons hitting a target so as to produce X-ray of wavelength 1 Å is

(a) 1.24 keV (b) 12.4 keV

(c) 124 keV (d) None of these

5. An X-ray tube is operated at 15 kV. Calculate the upper limit of the speed of the electrons striking the target.

(a) 7.26×10^7 m/s (b) 7.62×10^9 m/s

(c) 7.62×10^7 cm/s (d) 7.26×10^9 m/s

6. A and B are two metals with threshold frequencies 1.8×10^{14} Hz and 2.2×10^{14} Hz. Two identical photons of energy 0.825 eV each are incident on them. Then photoelectrons are emitted in (Take $h = 6.6\times10^{-34}$ Js)

(a) B alone (b) A alone

(c) neither A nor B (d) both A and B.

7. If E_1, E_2, E_3 are the respective kinetic energies of an electron, an alpha-particle and a proton, each having the same de-Broglie wavelength, then

(a) $E_1 > E_3 > E_2$ (b) $E_2 > E_3 > E_1$

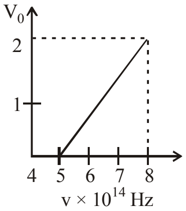
(c) $E_1 > E_2 > E_3$ (d) $E_1 = E_2 = E_3$

RESPONSE GRID					
	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ			

Space for Rough Work

8. Which of the following when falls on a metal will emit photoelectrons ?
(a) UV radiations (b) Infrared radiation
(c) Radio waves (d) Microwaves

9. The stopping potential (V_0) versus frequency (v) plot of a substance is shown in figure, the threshold wavelength is



(a) 5×10^{14}m
(b) 6000 Å
(c) 5000 Å
(d) Cannot be estimated from given data

10. A material particle with a rest mass m_0 is moving with speed of light c. The de-Broglie wavelength associated is given by
(a) $\frac{h}{m_0 c}$ (b) $\frac{m_0 c}{h}$ (c) zero (d) ∞

11. 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
(a) 1.5×10^{20} (b) 6×10^{18}
(c) 62×10^{20} (d) 3×10^{19}

12. A proton has kinetic energy E = 100 keV which is equal to that of a photon. The wavelength of photon is λ_2 and that of proton is λ_1. The ratio of λ_2/λ_1 is proportional to
(a) E^2 (b) $E^{1/2}$ (c) E^{-1} (d) $E^{-1/2}$

13. In photoelectric effect the work function of a metal is 3.5 eV. The emitted electrons can be stopped by applying a potential of –1.2 V. Then
(a) the energy of the incident photon is 4.7 eV
(b) the energy of the incident photon is 2.3 eV
(c) if higher frequency photon be used, the photoelectric current will rise
(d) when the energy of photon is 3.5 eV, the photoelectric current will be maximum

14. The threshold frequency for a metallic surface corresponds to an energy of 6.2 eV and the stopping potential for a radiation incident on this surface is 5 V. The incident radiation lies in
(a) ultra-violet region (b) infra-red region
(c) visible region (d) X-ray region

15. When photons of energy hν fall on an aluminium plate (of work function E_0), photoelectrons of maximum kinetic energy K are ejected. If the frequency of the radiation is doubled, the maximum kinetic energy of the ejected photoelectrons will be
(a) 2K (b) K (c) K + hν (d) $K + E_0$

16. Which metal will be suitable for a photoelectric cell using light of wavelength 4000Å. The work functions of sodium and copper are respectively 2.0 eV and 4.0 eV.
(a) Sodium (b) Copper
(c) Both (d) None of these

17. The maximum velocity of an electron emitted by light of wavelength λ incident on the surface of a metal of work-function ϕ is
(a) $\sqrt{\frac{2(hc + \lambda\phi)}{m\lambda}}$ (b) $\frac{2(hc + \lambda\phi)}{m\lambda}$
(c) $\sqrt{\frac{2(hc - \lambda\phi)}{m\lambda}}$ (d) $\sqrt{\frac{2(h\lambda - \phi)}{m}}$

18. If the kinetic energy of a free electron doubles, it's deBroglie wavelength changes by the factor
(a) 2 (b) $\frac{1}{2}$ (c) $\sqrt{2}$ (d) $\frac{1}{\sqrt{2}}$

19. Radiations of two photon's energy, twice and ten times the work function of metal are incident on the metal surface successsively. The ratio of maximum velocities of photoelectrons emitted in two cases is
(a) 1 : 2 (b) 1 : 3 (c) 1 : 4 (d) 1 : 1

20. The cathode of a photoelectric cell is changed such that the work function changes from W_1 to W_2 ($W_2 > W_1$). If the current before and after changes are I_1 and I_2, all other conditions remaining unchanged, then (assuming hν > W_2)
(a) $I_1 = I_2$ (b) $I_1 < I_2$
(c) $I_1 > I_2$ (d) $I_1 < I_2 < 2 I_1$

21. Monochromatic radiation emitted when electron on hydrogen atom jumps from first excited to the ground state irradiates a photosensitive material. The stopping potential is measured to be 3.57 V. The threshold frequency of the materials is :
(a) 4×10^{15} Hz (b) 5×10^{15} Hz
(c) 1.6×10^{15} Hz (d) 2.5×10^{15} Hz

22. Photoelectric work function of a metal is 1eV. Light of wavelength λ = 3000 Å falls on it. The photo electrons come out with velocity
(a) 10 metres/sec (b) 10^2 metres/sec
(c) 10^4 metres/sec (d) 10^6 metres/sec

23. When the energy of the incident radiation is incredased 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 :
(a) 0.65 eV (b) 1.0 eV (c) 1.3 eV (d) 1.5 eV

24. The maximum distance between interatomic lattice planes is 15 Å. The maximum wavelength of X-rays which are diffracted by this crystal will be
(a) 15 Å (b) 20 Å (c) 30 Å (d) 45 Å

RESPONSE GRID					
	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ
	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ
	18. ⓐⓑⓒⓓ	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ
	23. ⓐⓑⓒⓓ	24. ⓐⓑⓒⓓ			

25. In photoelectric effect, stopping potential for a light of frequency n_1 is V_1. If light is replaced by another having a frequency n_2 then its stopping potential will be

(a) $V_1 - \frac{h}{e}(n_2 - n_1)$ (b) $V_1 + \frac{h}{e}(n_2 + n_1)$

(c) $V_1 + \frac{h}{e}(n_2 - 2n_1)$ (d) $V_1 + \frac{h}{e}(n_2 - n_1)$

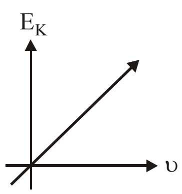
26. The maximum kinetic energy of the photoelectrons ejected from a photocathode when it is irradiated with light of wavelength 440nm is 1eV. If the threshold energy of the surface is 1.9eV, then which of the following statement is/are incorrect?

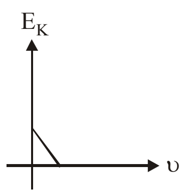
(a) The threshold frequency for photo sensitive metal is 4.6×10^{14}Hz
(b) The minimum wavelength of incident light required for photoemission is 6513 Å.
(c) The maximum wavelength of incident light required for photoemission is 6513 Å.
(d) The energy of incident photon is 2.9 eV.

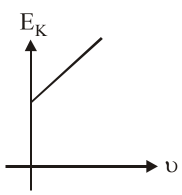
27. The work functions of metals A and B are in the raio 1 : 2. If light of frequencies f and 2f are incident on the surfaces of A and B respectively, the ratio of the maximum kinetic energies of photoelectrons emitted is (f is greater than threshold frequency of A, 2f is greater than threshold frequency of B)

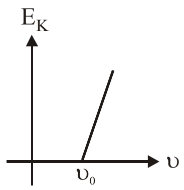
(a) 1 : 1 (b) 1 : 2 (c) 1 : 3 (d) 1 : 4

28. Which one of the following graphs represents the variation of maximum kinetic energy (E_K) of the emitted electrons with frequency υ in photoelectric effect correctly ?

(a)


(b)


(c)


(d)


29. The potential difference that must be applied to stop the fastest photoelectrons emitted by a nickel surface, having work function 5.01 eV, when ultraviolet light of 200 nm falls on it, must be:

(a) 2.4 V (b) – 1.2 V (c) – 2.4 V (d) 1.2 V

30. X-rays are produced in X-ray tube operating at a given accelerating voltage. The wavelength of the continuous X-rays has values from

(a) 0 to ∞
(b) λ_{min} to ∞, where $\lambda_{min} > 0$
(c) 0 to λ_{max}, where $\lambda_{max} < \infty$
(d) λ_{min} to λ_{max}, where $0 < \lambda_{min} < \lambda_{max} < \infty$

31. 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

(a) increase by 2 times (b) decrease by 2 times
(c) decrease by 4 times (d) increase by 4 times

32. In the Davisson and Germer experiment, the velocity of electrons emitted from the electron gun can be increased by

(a) increasing the potential difference between the anode and filament
(b) increasing the filament current
(c) decreasing the filament current
(d) decreasing the potential difference between the anode and filament

33. Two radiations of photons energies 1 eV and 2.5 eV, successively illuminate a photosensitive metallic surface of work function 0.5 eV. The ratio of the maximum speeds of the emitted electrons is :

(a) 1 : 4 (b) 1 : 2 (c) 1 : 1 (d) 1 : 5

34. Photoelectric emission is observed from a metallic surface for frequencies v_1 and v_2 of the incident light rays ($v_1 > v_2$). If the maximum values of kinetic energy of the photoelectrons emitted in the two cases are in the ratio of 1 : k, then the threshold frequency of the metallic surface is

(a) $\frac{v_1 - v_2}{k - 1}$ (b) $\frac{kv_1 - v_2}{k - 1}$

(c) $\frac{kv_2 - v_1}{k - 1}$ (d) $\frac{v_2 - v_1}{k}$

35. Which of the following is/are false regarding cathode rays?

(a) They produce heating effect
(b) They don't deflect in electric field
(c) They cast shadow
(d) They produce fluorescence

36. The ratio of the respective de Broglie wavelengths associated with electrons accelerated from rest with the voltages 100 V, 200 V and 300 V is

(a) 1 : 2 : 3 (b) 1 : 4 : 9 (c) $1 : \frac{1}{\sqrt{2}} : \frac{1}{\sqrt{3}}$ (d) $1 : \frac{1}{2} : \frac{1}{3}$

RESPONSE GRID					
	25. ⓐⓑⓒⓓ	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ	29. ⓐⓑⓒⓓ
	30. ⓐⓑⓒⓓ	31. ⓐⓑⓒⓓ	32. ⓐⓑⓒⓓ	33. ⓐⓑⓒⓓ	34. ⓐⓑⓒⓓ
	35. ⓐⓑⓒⓓ	36. ⓐⓑⓒⓓ			

Space for Rough Work

37. A 5 watt source emits monochromatic light of wavelength 5000 Å. 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

(a) 8 (b) 16 (c) 2 (d) 4

38. In the photoeletric effect, electrons are emitted

(a) at a rate that is proportional to the amplitude of the incident radiation

(b) with a maximum velocity proportional to the frequency of the incident radiation

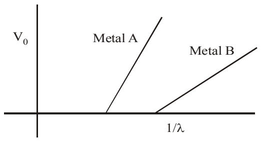
(c) at a rate that is independent of the emitter

(d) only if the frequency of the incident radiations is above a certain threshold value

39. The threshold frequency for a photosensitive metal is 3.3×10^{14} Hz. If light of frequency 8.2×10^{14} Hz is incident on this metal, the cut-off voltage for the photoelectric emission is nearly

(a) 2V (b) 3V (c) 5V (d) 1V

40. In an experiment on photoelectric effect, a student plots stopping potential V_0 against reciprocal of the wavelength λ of the incident light for two different metals A and B. These are shown in the figure.



Looking at the graphs, you can most appropriately say that:

(a) Work function of metal B is greater than that of metal A

(b) For light of certain wavelength falling on both metal, maximum kinetic energy of electrons emitted from A will be greater than those emitted from B.

(c) Work function of metal A is greater than that of metal B

(d) Students data is not correct

41. White X-rays are called white due to the fact that

(a) they are electromagnetic radiations having nature same as that of white light.

(b) they are produced most abundantly in X ray tubes.

(c) they have a continuous wavelength range.

(d) they can be converted to visible light using coated screens and photographic plates are affected by them just like light.

42. The wavelength associated with an electron, accelerated through a potential difference of 100 V, is of the order of

(a) 1000 Å (b) 100 Å (c) 10.5 Å (d) 1.2 Å

43. 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 sources per second is

(a) 5×10^{16} (b) 5×10^{17} (c) 5×10^{14} (d) 5×10^{15}

44. The de-Broglie wavelength of neutron in thermal equilibrium at temperature T is

(a) $\frac{30.8}{\sqrt{T}}$ Å (b) $\frac{3.08}{\sqrt{T}}$ Å (c) $\frac{0.308}{\sqrt{T}}$ Å (d) $\frac{0.0308}{\sqrt{T}}$ Å

45. Which of the following cannot be explained on the basis of photoelectric theory?

(a) Instantaneous emission of photoelectrons

(b) Existence of threshold frequency

(c) Sufficiently intense beam of radiation can emit photoelectrons

(d) Existence of stopping potential

RESPONSE GRID					
	37. ⓐⓑⓒⓓ	38. ⓐⓑⓒⓓ	39. ⓐⓑⓒⓓ	40. ⓐⓑⓒⓓ	41. ⓐⓑⓒⓓ
	42. ⓐⓑⓒⓓ	43. ⓐⓑⓒⓓ	44. ⓐⓑⓒⓓ	45. ⓐⓑⓒⓓ	

DAILY PRACTICE PROBLEM DPP CHAPTERWISE CP25 - PHYSICS			
Total Questions	45	Total Marks	180
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	45	Qualifying Score	60
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

1. **(d)** Wavelength of particle $(\lambda_1) = \frac{h}{mv} = \frac{h}{(1\times10^{-3})\times v}$

where v is the velocity of the particle.
Wavelength of electron

$$(\lambda_2) = \frac{h}{(9.1\times10^{-31})\times(3\times10^6)}$$

But $\lambda_1 = \lambda_2$

$$\therefore \frac{h}{(1\times10^{-3})\times v} = \frac{h}{(9.1\times10^{-31})\times(3\times10^6)}$$

$$\Rightarrow v = \frac{9.1\times10^{-31}\times3\times10^6}{10^{-3}}$$

$= 2.73\times10^{-21}\ ms^{-1}$

2. **(a)** For electron De-Broglie wavelength,

$$\lambda_e = \frac{h}{\sqrt{2mE}}$$

For photon $E = pc$

$\Rightarrow$ De-Broglie wavelength, $\lambda_{Ph} = \frac{hc}{E}$

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

3. **(d)** The electron ejected with maximum speed v_{max} are stopped by electric field E =4N/C after travelling a distance d =1m

$$\frac{1}{2}mv_{max}^2 = eEd = 4eV$$

The energy of incident photon $= \frac{1240}{200} = 6.2$ eV

From equation of photo electric effect

$$\frac{1}{2}mv_{max}^2 = h\nu - \phi_0$$

$$\therefore \phi_0 = 6.2 - 4 = 2.2 \text{ eV}$$

4. **(b)** $\lambda_{min} = 1$ Å (given)

$$\because \lambda_{min} = \frac{1240}{E} \text{ (eV) (nm)}$$

$$\text{Thus, } E = \frac{1240(\text{eV})(\text{nm})}{0.01(\text{nm})} = 12400 \text{ eV}$$

$E = 12.4$ KeV

5. **(a)** The maximum kinetic energy of an electron accelerated through a potential difference of V volt is $\frac{1}{2}mv^2 = eV$

$\therefore$ maximum velocity $v = \sqrt{\frac{2eV}{m}}$

$$v = \sqrt{\frac{2\times1.6\times10^{-19}\times15000}{9.1\times10^{-31}}}$$

$v = 7.26\times10^7$ m/s

6. **(b)** Photoelectrons are emitted in A alone. Energy of electron needed if emitted from $A = \frac{h\upsilon}{e}$eV

$$\therefore E_A = \frac{(6.6\times10^{-34})\times(1.8\times10^{14})}{1.6\times10^{-19}} = 0.74 \text{ eV}$$

$$E_B = \frac{(6.6\times10^{-34})\times(2.2\times10^{14})}{1.6\times10^{-19}} = 0.91 \text{ eV}$$

Incident energy 0.825 eV is greater than E_A (0.74 eV) but less than E_B (0.91 eV).

7. **(a)** According to relation, $E = \frac{1}{2}mv^2$

$$\sqrt{\frac{2E}{m}} = v$$

$$\lambda = \frac{h}{\sqrt{2mE}}$$

Because $m_1 < m_3 < m_2$

So for same λ, $E_1 > E_3 > E_2$.

8. (a) Emission of electron from a substance under the action of light is photoelectric effect. Light must be at a sufficiently high frequency. It may be visible light, U.V, X-rays. So U.V. cause electron emission.

9. (b) $\lambda_0 = \frac{c}{v_0} = \frac{3\times10^8}{5\times10^{14}} = 6\times10^{-7}\,m = 6000\,Å$

10. (c) $\lambda = \frac{h}{mv},\ v = \frac{m_0}{\sqrt{1-\left(\frac{v}{c}\right)^2}},\ v\to c,\ m\to\infty$

hence, $\lambda \to 0$.

11. (a) Give that, only 25% of 200W converter electrical energy into light of yellow colour

$$\left(\frac{hc}{\lambda}\right)\times N = 200\times\frac{25}{100}$$

Where N is the No. of photons emitted per second, h is planck's constant and c is speed of light.

$$N = \frac{200\times25}{100}\times\frac{\lambda}{hc}$$

$$= \frac{200\times25\times0.6\times10^{-6}}{100\times6.2\times10^{-34}\times3\times10^8} = 1.5\times10^{20}$$

12. (d) For photon $E = h\nu$

$$E = \frac{hc}{\lambda} \Rightarrow \lambda_2 = \frac{hc}{E} \quad ...(i)$$

for proton $E = \frac{1}{2}m_p v_p^2$

$$E = \frac{1}{2}\frac{m_p^2 v_p^2}{m} \Rightarrow p = \sqrt{2mE}$$

From De Broglie Eqn.

$$p = \frac{h}{\lambda_1} \Rightarrow \lambda_1 = \frac{h}{p} = \frac{h}{\sqrt{2mE}} \quad ...(ii)$$

$$\frac{\lambda_2}{\lambda_1} = \frac{hc}{E\times\frac{h}{\sqrt{2mE}}} \propto E^{-1/2}$$

13. (a) $h\nu = W_0 + E_k = 3.5 + 1.2 = 4.7$ eV

14. (a) $\phi = 6.2$ eV $= 6.2\times1.6\times10^{-19}$ J

$V = 5$ volt

$$\frac{hc}{\lambda} - \phi = eV_0$$

$$\Rightarrow \lambda = \frac{hc}{\phi + eV_0}$$

$$= \frac{6.6\times10^{-34}\times3\times10^8}{1.6\times10^{-19}(6.2+5)} \approx 10^{-7}\ m$$

This range lies in ultra violet range.

15. (c) Applying Einstein's formula for photo-electricity

$$h\nu = \phi + \frac{1}{2}mv^2; \qquad h\nu = \phi + K$$

$$\phi = h\nu - K$$

If we use 2ν frequency then let the kinetic energy becomes K'

So, $h\,.\,2\nu = \phi + K'$

$2h\nu = h\nu - K + K'$

$K' = h\nu + K$

16. (a) $\because \lambda_0 = \frac{hc}{\phi}$

$$\therefore (\lambda_0)_{sodium} = \frac{6.6\times10^{-34}\times3\times10^8}{2\times1.6\times10^{-19}} = 6188\,Å$$

$$\because \lambda_0 \propto \frac{1}{\phi} \Rightarrow \frac{(\lambda_0)_{sodium}}{(\lambda_0)_{copper}} = \frac{(\phi)_{copper}}{(\phi)_{sodium}}$$

$$\Rightarrow (\lambda_0)_{copper} = \frac{2}{4}\times6188 = 3094\,Å$$

To eject photo-electrons from sodium the longest wavelength is 6188 Å and that for copper is 3094 Å.

Hence for light of wavelength 4000 Å, sodium is suitable.

17. (c) $\frac{1}{2}mv^2 = \frac{hc}{\lambda} - \phi \Rightarrow v = \sqrt{\frac{2(hc-\lambda\phi)}{\lambda m}}$

18. (d) de-Broglie wavelength,

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2.m.(K.E)}}$$

$$\therefore \lambda \propto \frac{1}{\sqrt{K.E}}$$

If K.E is doubled, wavelength becomes $\frac{\lambda}{\sqrt{2}}$

19. (b) $\frac{1}{2}mv_1^2 = 2W_0 - W_0 = W_0$ and

$$\frac{1}{2}mv_2^2 = 10W_0 - W_0 = 9W_0$$

$$\therefore \frac{v_1}{v_2} = \sqrt{\frac{W_0}{9W_0}} = \frac{1}{3}$$

20. (a) The work function has no effect on photoelectric current so long as $h\nu > W_0$. The photoelectric current is proportional to the intensity of incident light. Since there is no change in the intensity of light, hence $I_1 = I_2$.

21. (c) $n \to 2-1$

$E = 10.2$ eV

$kE = E - \phi$

$Q = 10.20 - 3.57$

$h\upsilon_0 = 6.63$ eV

$$\upsilon_0 = \frac{6.63\times1.6\times10^{-19}}{6.67\times10^{-34}} = 1.6\times10^{15}\text{ Hz}$$

22. (d) $h\nu = W + \frac{1}{2}mv^2$ or $\frac{hc}{\lambda} = W + \frac{1}{2}mv^2$

Here $\lambda = 3000\text{ Å} = 3000\times10^{-10}$ m

and W = 1 eV = 1.6×10^{-19} joule

$$\therefore \frac{(6.6\times10^{-34})(3\times10^8)}{3000\times10^{-10}}$$

$$= (1.6\times10^{-19}) + \frac{1}{2}\times(9.1\times10^{-31})v^2$$

Solving we get, $v \cong 10^6$ m/s

23. (b) According to Einstein's photoelectric equation, $h\nu = \phi_0 + K_{max}$

We have

$h\nu = \phi_0 + 0.5$ ...(i)

and $1.2h\nu = \phi_0 + 0.8$ ...(ii)

Therefore, from above two equations $\phi_0 = 1.0$ eV.

24. (c) $\lambda_{max.} = \frac{2d\sin\theta}{n_{min.}} = \frac{2\times15\times\sin 90^\circ}{1} = 30\text{Å}$

25. (d) $W_0 = h\nu_1 - eV_1$

$= h\nu_2 - eV_2$

$eV_2 = h(\nu_2 - \nu_1) + eV_1$

$$V_2 = \frac{h(n_2 - n_1)}{e} + V_1$$

26. (b) $KE_{max} = h\nu - \phi$

$1\text{eV} = h\nu - 1.9\text{eV} \Rightarrow h\nu = 2.9$ eV

Now threshold wavelength (maximum wavelength), $\lambda_0 = \frac{hc}{E}$

$$\Rightarrow \lambda_0 = \frac{6.6\times10^{-34}\times3\times10^8}{1.9\times1.6\times10^{-19}} = 6513\text{ Å}$$

And threshold frequency

$$\nu_0 = \frac{c}{\lambda_0} = \frac{3\times10^8}{6513\times10^{-10}} = 4.6\times10^{14}\text{Hz}$$

27. (b) $E = W_0 + K_{max}$ ...(i)

$\Rightarrow hf = W_A + K_A$ ...(ii)

and $2hf = W_B + K_B = 2W_A + K_B \left(\because \frac{W_A}{W_B} = \frac{1}{2}\right)$

Dividing equation (i) by (ii)

$$\frac{1}{2} = \frac{W_A + K_A}{2W_A + K_B} \Rightarrow \frac{K_A}{K_B} = \frac{1}{2}$$

28. (d) $h\upsilon - h\upsilon_0 = E_K$, according to photoelectric equation, when $\upsilon = \upsilon_0$, $E_K = 0$.

Graph (d) represents $E_K - \upsilon$ relationship.

29. (d) $K_{max} = \frac{hc}{\lambda} - W = \frac{hc}{\lambda} - 5.01$

$$= \frac{12375}{\lambda(\text{in Å})} - 5.01$$

$$= \frac{12375}{2000} - 5.01 = 6.1875 - 5.01 = 1.17775$$

$\simeq 1.2$ V

30. (b)

31. (b) $\lambda \propto \frac{1}{\sqrt{V}}$

$$\Rightarrow \frac{\lambda_1}{\lambda_2} = \sqrt{\frac{V_2}{V_1}} = \sqrt{\frac{100\text{keV}}{25\text{keV}}} = 2$$

$$\Rightarrow \lambda_2 = \frac{\lambda_1}{2}$$

32. (a) In the Davisson and Germer experiment, the velocity of electrons emitted from the electron gun can be increased by increasing the potential difference between the anode and filament.

33. (b) According to Einsten's photoelectric effect, the K.E. of the radiated electrons

$K.E_{max} = E - W$

$\frac{1}{2}mv_1^2 = (1 - 0.5)\text{ eV} = 0.5\text{ eV}$

$\frac{1}{2}mv_2^2 = (2.5 - 0.5)\text{ eV} = 2\text{ eV}$

$$\frac{v_1}{v_2} = \sqrt{\frac{0.5}{2}} = \frac{1}{\sqrt{4}} = 1/2$$

34. (b) By using $h\nu - h\nu_0 = K_{max}$

$\Rightarrow h(\nu_1 - \nu_0) = K_1$ ..... (i)

And $h(\nu_2 - \nu_0) = K_2$ ..... (ii)

$$\Rightarrow \frac{\nu_1 - \nu_0}{\nu_2 - \nu_0} = \frac{K_1}{K_2} = \frac{1}{K}, \text{ Hence } \nu_0 = \frac{k\nu_1 - \nu_2}{K - 1}.$$

35. (b) Cathode rays get deflected in the electric field.

36. (c) As we know

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

$$\therefore \frac{1}{\sqrt{100}} : \frac{1}{\sqrt{200}} : \frac{1}{\sqrt{300}} = 1 : \frac{1}{\sqrt{2}} : \frac{1}{\sqrt{3}}$$

37. (d) Number of emitted electrons N_E

$\propto$ Intensity

$$\propto \frac{1}{(\text{Distance})^2}$$

Therefore, as distance is doubled, N_E decreases by (1/4) times.

38. **(d)** Photoelectrons are emitted if the frequency of incident light is greater than the threshold frequency.

39. **(a)** K.E. $= h\nu - h\nu_{th} = eV_0$ (V_0 = cut off voltage)

$$\Rightarrow V_0 = \frac{h}{e}(8.2\times10^{14} - 3.3\times10^{14})$$

$$= \frac{6.6\times10^{-34}\times4.9\times10^{14}}{1.6\times10^{-19}} \approx 2V.$$

40. **(d)** $\frac{hc}{\lambda} - \phi = eV_0$

$$v_0 = \frac{hc}{e\lambda} - \frac{\phi}{e}$$

For metal A — For metal B

$$\frac{\phi_A}{hc} = \frac{1}{\lambda} \qquad \frac{\phi_B}{hc} = \frac{1}{\lambda}$$

As the value of $\frac{1}{\lambda}$ (increasing and decreasing) is not specified hence we cannot say that which metal has comparatively greater or lesser work function (ϕ).

41. **(c)**

42. **(d)** Potential difference = 100 V

K.E. acquired by electron = $e(100)$

$$\frac{1}{2}mv^2 = e(100) \quad \Rightarrow v = \sqrt{\frac{2e(100)}{m}}$$

According to de Broglie's concept

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

$$\Rightarrow \lambda = \frac{h}{m\sqrt{\frac{2e(100)}{m}}}$$

$$= \frac{h}{\sqrt{2me(100)}} = 1.2\times10^{-10} = 1.2Å$$

43. **(d)** Since $p = nh\nu$

$$\Rightarrow n = \frac{p}{h\nu} = \frac{2\times10^{-3}}{6.6\times10^{-34}\times6\times10^{14}} = 5\times10^{15}$$

44. **(a)** From formula

$$\lambda = \frac{h}{\sqrt{2mKT}}$$

$$= \frac{6.63\times10^{-34}}{\sqrt{2\times1.67\times10^{-27}\times1.38\times10^{-23}T}}m$$

[By placing value of h, m and k)

$$= \frac{30.8}{\sqrt{T}}Å$$

45. **(c)** The photoelectric equation $K_{max} = h\nu - \phi_0$ Explains that the intensity of incident radiation will increase photocurrent only beyond the threshold frequency.