

Dual Nature of Radiation and Matter — NEET Physics

PYQ (2005-2021)

Class 12 Physics · 44 real NEET & AIPMT questions, year-tagged · answers checked by RankUp

NEET 2021

1. 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-Broglie wavelength λ_d , then :

- (A) $\lambda = (2m/hc) \lambda_d^2$
- (B) $\lambda_d = (2mc/h) \lambda^2$
- (C) $\lambda = (2mc/h) \lambda_d^2$
- (D) $\lambda = (2h/mc) \lambda_d^2$

NEET 2021

2. The number of photons per second on an average emitted by the source of monochromatic light of wavelength 600 nm, when it delivers the power of 3.3×10^{-3} watt will be : ($h = 6.6 \times 10^{-34}$ Js)

- (A) 10^{18}
- (B) 10^{17}
- (C) 10^{16}
- (D) 10^{15}

NEET 2020 · Q157

3. Light of frequency 1.5 times the threshold frequency is incident on a photosensitive material. What will be the photoelectric current if the frequency is halved and intensity is doubled ?

- (A) doubled
- (B) four times
- (C) one-fourth
- (D) zero

NEET 2020 · Q159

4. The energy required to break one bond in DNA is 10^{-20} J. This value in eV is nearly :

- (A) 6
- (B) 0.6
- (C) 0.06
- (D) 0.006

NEET 2020 · Q175

5. An electron is accelerated from rest through a potential difference of V volt. If the de Broglie wavelength of the electron is 1.227×10^{-2} nm, the potential difference is :

- (A) 10 V
- (B) 10^2 V
- (C) 10^3 V
- (D) 10^4 V

NEET 2019 · Q13

6. An electron is accelerated through a potential difference of 10,000 V. Its de Broglie wavelength is, (nearly): ($m_e = 9 \times 10^{-31}$ kg)

- (A) 12.2×10^{-13} m
- (B) 12.2×10^{-12} m
- (C) 12.2×10^{-14} m
- (D) 12.2 nm

NEET 2018 · Q12

7. An electron of mass m with an initial velocity $\vec{V} = V_0\hat{i}$ ($V_0 > 0$) enters an electric field $\vec{E} = -E_0\hat{i}$ ($E_0 = \text{constant} > 0$) at $t = 0$. If λ_0 is its de-Broglie wavelength initially, then its de-Broglie wavelength at time t is

- (A) $\lambda_0 t$
- (B) $\lambda_0(1 + eE_0t/(mV_0))$
- (C) $\lambda_0/(1 + eE_0t/(mV_0))$
- (D) λ_0

NEET 2018 · Q14

8. When the light of frequency $2\nu_0$ (where ν_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 $5\nu_0$, the maximum velocity of electrons emitted from the same plate is v_2 . The ratio of v_1 to v_2 is

- (A) 4 : 1
- (B) 1 : 4
- (C) 1 : 2
- (D) 2 : 1

NEET 2017 (Gujarati paper) · Q138

9. In an experiment of photoelectric effect the stopping potential was measured to be V_1 and V_2 with incident light of wavelength λ and $\lambda/2$, respectively. The relation between V_1 and V_2 is:

- (A) $V_2 < V_1$
- (B) $V_1 < V_2 < 2V_1$
- (C) $V_2 = 2V_1$
- (D) $V_2 > 2V_1$

NEET 2016 Phase 2 · Q39

10. Electrons of mass m with de-Broglie wavelength λ fall on the target in an X-ray tube. The cutoff wavelength (λ_0) of the emitted X-ray is

- (A) $\lambda_0 = 2mc\lambda^2/h$
- (B) $\lambda_0 = 2h/(mc)$
- (C) $\lambda_0 = 2m^2c^2\lambda^3/h^2$
- (D) $\lambda_0 = \lambda$

NEET 2016 Phase 2 · Q40

11. Photons with energy 5 eV are incident on a cathode C in a photoelectric cell. The maximum energy of emitted photoelectrons is 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

- (A) +3 V
- (B) +4 V
- (C) -1 V
- (D) -3 V

NEET 2016 Phase 1 · Q20

12. An electron of mass m and a photon have same energy E . The ratio of de-Broglie wavelengths associated with them is: (c being velocity of light)

- (A) $(1/c)(E/2m)^{(1/2)}$
- (B) $(E/2m)^{(1/2)}$
- (C) $c(2mE)^{(1/2)}$
- (D) $(1/c)(2m/E)^{(1/2)}$

13. 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 $V/4$. The threshold wavelength for the metallic surface is:

- (A) 4λ
- (B) 5λ
- (C) $5\lambda/2$
- (D) 3λ

AIPMT 2015

14. A certain metallic surface is illuminated with monochromatic light of wavelength λ . The stopping potential for photo-electric current for this light is $3V_0$. If the same surface is illuminated with light of wavelength 2λ , the stopping potential is V_0 . The threshold wavelength for this surface for photo-electric effect is:

- (A) $\lambda/6$
- (B) 6λ
- (C) 4λ
- (D) $\lambda/4$

AIPMT 2014

15. If the kinetic energy of the particle is increased to 16 times its previous value, the percentage change in the de-Broglie wavelength of the particle is:

- (A) 75
- (B) 60
- (C) 50
- (D) 25

AIPMT 2014

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:

- (A) 1.0 eV
- (B) 1.3 eV
- (C) 1.5 eV
- (D) 0.65 eV

NEET 2013

17. For photoelectric emission from certain metal the cutoff frequency is ν . If radiation of frequency 2ν impinges on the metal plate, the maximum possible velocity of the emitted electron will be (m is the electron mass)

- (A) $\sqrt{(h\nu/(2m))}$
- (B) $\sqrt{(h\nu/m)}$
- (C) $\sqrt{(2h\nu/m)}$
- (D) $2\sqrt{(h\nu/m)}$

NEET 2013

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

- (A) $\lambda_p \propto \lambda_e^2$
- (B) $\lambda_p \propto \lambda_e$
- (C) $\lambda_p \propto \sqrt{\lambda_e}$
- (D) $\lambda_p \propto 1/\sqrt{\lambda_e}$

AIPMT 2012 Mains

19. If the momentum of electron is changed by P , then the de Broglie wavelength associated with it changes by 0.5%. The initial momentum of electron will be

- (A) $200P$
- (B) $400P$
- (C) $P/200$
- (D) $100P$

AIPMT 2012 Mains

20. 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

AIPMT 2012 Prelims

21. An α -particle moves in a circular path of radius 0.83 cm in the presence of a magnetic field of 0.25 Wb/m^2 . The de Broglie wavelength associated with the particle will be

- (A) $0.01 \text{ \AA}$
- (B) $1 \text{ \AA}$
- (C) $0.1 \text{ \AA}$
- (D) $10 \text{ \AA}$

AIPMT 2012 Prelims

22. A 200 W sodium street lamp emits yellow light of wavelength $0.6 \mu\text{m}$. 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) 3×10^{19}
- (B) 1.5×10^{20}
- (C) 6×10^{18}
- (D) 62×10^{20}

AIPMT 2012 Prelims

23. Monochromatic radiation emitted when an electron in 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 material is

- (A) $2.5 \times 10^{15} \text{ Hz}$
- (B) $4 \times 10^{15} \text{ Hz}$
- (C) $5 \times 10^{15} \text{ Hz}$
- (D) $1.6 \times 10^{15} \text{ Hz}$

AIPMT 2011 Mains

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

- (A) 5 V
- (B) 1 V
- (C) 2 V
- (D) 3 V

AIPMT 2011 Prelims

25. A radioactive nucleus of mass M emits a photon of frequency ν and the nucleus recoils. The recoil energy will be

- (A) $h\nu$
- (B) $Mc^2 - h\nu$
- (C) $h^2\nu^2/(2Mc^2)$
- (D) Zero

AIPMT 2011 Prelims

26. In photoelectric emission process from a metal of work function 1.8 eV, the kinetic energy of most energetic electrons is 0.5 eV. The corresponding stopping potential is

- (A) 2.3 V
- (B) 1.8 V
- (C) 1.3 V
- (D) 0.5 V

AIPMT 2011 Prelims

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

- (A) Increase by 4 times
- (B) Increase by 2 times
- (C) Decrease by 2 times
- (D) Decrease by 4 times

AIPMT 2011 Prelims

28. Light of two different frequencies whose photons have energies 1 eV and 2.5 eV respectively illuminate a metallic surface whose work function is 0.5 eV successively. Ratio of maximum speeds of emitted electrons will be

- (A) 1 : 5
- (B) 1 : 4
- (C) 1 : 2
- (D) 1 : 1

AIPMT 2011 Prelims

29. Photoelectric emission occurs only when the incident light has more than a certain minimum

- (A) Frequency
- (B) Power
- (C) Wavelength
- (D) Intensity

AIPMT 2010 Mains · Q66

30. When monochromatic radiation of intensity I falls on a metal surface, the number of photoelectron 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

- (A) N and $2T$
- (B) $2N$ and T
- (C) $2N$ and $2T$
- (D) N and T

31. The electron in the hydrogen atom jumps from excited state ($n = 3$) to its ground state ($n = 1$) and the photons thus emitted irradiate a photosensitive material. If the work function of the material is 5.1 eV, the stopping potential is estimated to be (the energy of the electron in n th state $E_n = -13.6/n^2$ eV)

- (A) 5.1 V
- (B) 12.1 V
- (C) 17.2 V
- (D) 7 V

32. A source S_1 is producing 10^{15} photons per second of wavelength 5000 Å. Another source S_2 is producing 1.02×10^{15} photons per second of wavelength 5100 Å. Then (power of S_2)/(power of S_1) is equal to

- (A) 0.98
- (B) 1.00
- (C) 1.02
- (D) 1.04

33. The number of photo electrons emitted for light of a frequency ν (higher than the threshold frequency ν_0) is proportional to:

- (A) Threshold frequency (ν_0)
- (B) Intensity of light
- (C) Frequency of light (ν)
- (D) $\nu - \nu_0$

34. Monochromatic light of wavelength 667 nm is produced by a helium neon laser. The power emitted is 9 mW. The number of photons arriving per sec on the average at a target irradiated by this beam is:

- (A) 3×10^{16}
- (B) 9×10^{15}
- (C) 3×10^{19}
- (D) 9×10^{17}

35. The work function of a surface of a photosensitive material is 6.2 eV. The wavelength of the incident radiation for which the stopping potential is 5 V lies in the

- (A) X-ray region
- (B) Ultraviolet region
- (C) Visible region
- (D) Infrared region

36. A particle of mass 1 mg has the same wavelength as an electron moving with a velocity of 3×10^6 m s⁻¹. The velocity of the particle is (mass of electron = 9.1×10^{-31} kg)

- (A) 2.7×10^{-21} m s⁻¹
- (B) 2.7×10^{-18} m s⁻¹
- (C) 9×10^{-2} m s⁻¹
- (D) 3×10^{-31} m s⁻¹

37. 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}

38. 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

39. A photo-cell employs photoelectric effect to convert :

- (A) change in the frequency of light into a change in electric voltage
- (B) change in the intensity of illumination into a change in photoelectric current
- (C) change in the intensity of illumination into a change in the work function of the photocathode
- (D) change in the frequency of light into a change in the electric current

40. In a discharge tube ionization of enclosed gas is produced due to collisions between :

- (A) positive ions and neutral atoms/molecules
- (B) negative electrons and neutral atoms/molecules
- (C) photons and neutral atoms/molecules
- (D) neutral gas atoms/molecules

41. When photons of energy $h\nu$ 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) $K + E_0$
- (B) $2K$
- (C) K
- (D) $K + h\nu$

42. The momentum of a photon of energy 1 MeV in kg m/s, will be :

- (A) 0.33×10^6
- (B) 8×10^{-24}
- (C) 5×10^{-23}
- (D) 5×10^{-22}

43. 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 Å is/are :

- (A) none
- (B) A only
- (C) A and B only
- (D) all the three metals

44. A photosensitive metallic surface has work function, $h\nu_0$. If photons of energy $2h\nu_0$ fall on this surface, the electrons come out with a maximum velocity of 4×10^6 m/s. When the photon energy is increased to $5h\nu_0$, then maximum velocity of photoelectrons will be :

- (A) 16×10^6 m/s
- (B) 8×10^7 m/s
- (C) 4×10^5 m/s
- (D) 8×10^6 m/s

Answer key and explanations

1. Answer: (C) $\lambda = (2mc/h) \lambda d^2$

With negligible work function, $hc/\lambda = K = p^2/2m$ and $p = h/\lambda d$. So $hc/\lambda = h^2/(2m\lambda d^2)$, giving $\lambda = (2mc/h)\lambda d^2$. Check dimensions: mc/h has units of 1/length, so $(mc/h)\lambda d^2$ is a length.

2. Answer: (C) 10^{16}

Photon energy $E = hc/\lambda = (6.6 \times 10^{-34} \times 3 \times 10^8)/(600 \times 10^{-9}) = 3.3 \times 10^{-19}$ J. Number per second = $P/E = (3.3 \times 10^{-3})/(3.3 \times 10^{-19}) = 10^{16}$.

3. Answer: (D) zero

Halving $1.5\nu_0$ gives $0.75\nu_0$, which is below the threshold frequency, so no photoelectrons are emitted whatever the intensity and the current is zero. Intensity controls the current only when ν exceeds ν_0 .

4. Answer: (C) 0.06

$1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$, so $10^{-20} \text{ J} = 10^{-20}/1.6 \times 10^{-19} \approx 0.0625 \text{ eV} \approx 0.06 \text{ eV}$. Multiplying instead of dividing by the conversion factor gives meaningless magnitudes.

5. Answer: (D) 10^4 V

For an electron $\lambda = 1.227/\sqrt{V} \text{ nm}$, so $\sqrt{V} = 1.227/(1.227 \times 10^{-2}) = 100$ and $V = 10^4 \text{ V}$. Forgetting to square $\sqrt{V}$ gives 10^2 V .

6. Answer: (B) $12.2 \times 10^{-12} \text{ m}$

$\lambda = h/\sqrt{2meV} \approx 1.227/\sqrt{V} \text{ nm} = 1.227/100 \text{ nm} = 1.227 \times 10^{-11} \text{ m} = 12.2 \times 10^{-12} \text{ m}$. 12.2 nm would correspond to an accelerating voltage of only about 0.01 V.

7. Answer: (C) $\lambda_0/(1 + eE_0t/(mV_0))$

Force on the electron $F = -eE = +eE_0\hat{i}$, along its velocity, so $v = V_0 + eE_0t/m$. Since $\lambda = h/mv$, $\lambda = \lambda_0/(1 + eE_0t/(mV_0))$; the wavelength decreases, so the expression that multiplies λ_0 by the growing factor is wrong.

8. Answer: (C) 1 : 2

$\frac{1}{2}mv_1^2 = h(2\nu_0 - \nu_0) = h\nu_0$ and $\frac{1}{2}mv_2^2 = h(5\nu_0 - \nu_0) = 4h\nu_0$. So $v_1^2/v_2^2 = 1/4$ and $v_1 : v_2 = 1 : 2$; 1 : 4 is the ratio of kinetic energies, not speeds.

9. Answer: (D) $V_2 > 2V_1$

$eV_1 = hc/\lambda - \phi$ and $eV_2 = 2hc/\lambda - \phi = 2(eV_1 + \phi) - \phi = 2eV_1 + \phi$. Since the work function $\phi > 0$, $V_2 > 2V_1$. $V_2 = 2V_1$ would hold only if the work function were zero.

10. Answer: (A) $\lambda_0 = 2mc\lambda^2/h$

The electron's kinetic energy is $K = p^2/(2m) = h^2/(2m\lambda^2)$. The shortest X-ray wavelength carries all of this energy: $hc/\lambda_0 = h^2/(2m\lambda^2)$, so $\lambda_0 = 2mc\lambda^2/h$. The cutoff wavelength is not equal to the electron's de Broglie wavelength.

11. Answer: (D) -3 V

Work function $\phi = 5 - 2 = 3 \text{ eV}$. For 6 eV photons the maximum kinetic energy is $6 - 3 = 3 \text{ eV}$, so the anode must be at least 3 V negative with respect to the cathode: -3 V. A positive potential would attract the electrons rather than stop them.

12. Answer: (A) $(1/c)(E/2m)^{1/2}$

For the electron $\lambda_e = h/\sqrt{2mE}$; for the photon $\lambda_p = hc/E$. Ratio $\lambda_e/\lambda_p = E/(c\sqrt{2mE}) = (1/c)\sqrt{E/2m}$. The expression without $1/c$ is not dimensionless, so it cannot be a ratio of wavelengths.

13. Answer: (D) 3λ

$hc/\lambda - \phi = eV$ and $hc/2\lambda - \phi = eV/4$. Subtracting: $hc/2\lambda = 3eV/4$, so $eV = 2hc/3\lambda$, and $\phi = hc/\lambda - 2hc/3\lambda = hc/3\lambda$. Threshold wavelength $= hc/\phi = 3\lambda$.

14. Answer: (C) 4λ

$hc/\lambda = \phi + 3eV_0$ and $hc/2\lambda = \phi + eV_0$. Subtracting, $hc/2\lambda = 2eV_0$, so $eV_0 = hc/4\lambda$ and $\phi = hc/2\lambda - hc/4\lambda = hc/4\lambda$. Threshold wavelength $= hc/\phi = 4\lambda$.

15. Answer: (A) 75

$\lambda = h/\sqrt{2mK}$, so $\lambda \propto 1/\sqrt{K}$. Increasing K 16 times makes λ one quarter of its value, a 75% decrease; 25% is the remaining fraction, not the change.

16. Answer: (A) 1.0 eV

$E - \phi = 0.5$ eV and $1.2E - \phi = 0.8$ eV. Subtracting, $0.2E = 0.3$ eV, so $E = 1.5$ eV and $\phi = 1.0$ eV; 1.5 eV is the photon energy, not the work function.

17. Answer: (C) $\sqrt{2h\nu/m}$

Work function $= h\nu$ (cutoff). $KE_{\max} = h(2\nu) - h\nu = h\nu = (1/2)mv^2$, so $v = \sqrt{2h\nu/m}$. Using $\sqrt{h\nu/m}$ drops the factor 2 from the kinetic energy formula.

18. Answer: (A) $\lambda_p \propto \lambda_e^2$

Electron: $\lambda_e = h/\sqrt{2mE}$, so $\lambda_e^2 \propto 1/E$. Photon: $\lambda_p = hc/E \propto 1/E$. Therefore $\lambda_p \propto \lambda_e^2$. A direct proportion would be true only if both depended on E in the same way.

19. Answer: (A) 200P

$\lambda = h/p$ gives $|\Delta\lambda/\lambda| = \Delta p/p$ for small changes. So $0.005 = P/p_0$ and $p_0 = P/0.005 = 200P$. $P/200$ inverts the relation.

20. Answer: (B) 1 : 2

Maximum kinetic energies are $1 - 0.5 = 0.5$ eV and $2.5 - 0.5 = 2$ eV, a ratio of 1 : 4. Speed goes as $\sqrt{KE}$, so the speeds are in the ratio 1 : 2; 1 : 4 is the energy ratio, not the speed ratio.

21. Answer: (A) 0.01 Å

In a magnetic field, momentum $p = qBr$ with $q = 2e$ for an α -particle. $\lambda = h/(2eBr) = 6.63 \times 10^{-34}/(2 \times 1.6 \times 10^{-19} \times 0.25 \times 0.83 \times 10^{-2}) \approx 1.0 \times 10^{-12}$ m = 0.01 Å. Taking the charge as e instead of $2e$ doubles the wavelength.

22. Answer: (B) 1.5×10^{20}

Light power = 25% of 200 W = 50 W. Energy per photon $= hc/\lambda = (6.63 \times 10^{-34} \times 3 \times 10^8)/(0.6 \times 10^{-6}) \approx 3.3 \times 10^{-19}$ J. Number per second $= 50/3.3 \times 10^{-19} \approx 1.5 \times 10^{20}$. Using the full 200 W gives about 6×10^{20} , ignoring the efficiency.

23. Answer: (D) 1.6×10^{15} Hz

The $n = 2 \rightarrow 1$ transition in hydrogen emits a 10.2 eV photon. Work function $= 10.2 - 3.57 = 6.63$ eV $= 6.63 \times 1.6 \times 10^{-19}$ J. Threshold frequency $\nu_0 = \phi/h = (6.63 \times 1.6 \times 10^{-19})/(6.63 \times 10^{-34}) = 1.6 \times 10^{15}$ Hz. Using the full 10.2 eV gives about 2.5×10^{15} Hz, which is the photon frequency, not the threshold.

24. Answer: (C) 2 V

$eV_0 = h(\nu - \nu_0) = 6.63 \times 10^{-34} \times (8.2 - 3.3) \times 10^{14} = 3.25 \times 10^{-19}$ J, so $V_0 = 3.25 \times 10^{-19}/1.6 \times 10^{-19} \approx 2$ V. Using the incident frequency alone (ignoring the threshold) would give about 3.4 V, which is not the cut-off voltage.

25. Answer: (C) $h^2\nu^2/(2Mc^2)$

The photon carries momentum $p = h\nu/c$, and the nucleus recoils with equal and opposite momentum. Its kinetic energy is $p^2/2M = h^2\nu^2/(2Mc^2)$. It is not $h\nu$, which is the photon's own energy.

26. Answer: (D) 0.5 V

The stopping potential satisfies $eV_0 = K(\max) = 0.5$ eV, so $V_0 = 0.5$ V. The work function is irrelevant once $K(\max)$ is given; adding it (2.3 V) gives the photon energy, not the stopping potential.

27. Answer: (C) Decrease by 2 times

For electrons accelerated through V , $\lambda = h/\sqrt{2meV}$, so $\lambda \propto 1/\sqrt{V}$. Increasing V from 25 kV to 100 kV (4 times) reduces λ by $\sqrt{4} = 2$ times. 'Decrease by 4 times' wrongly takes $\lambda \propto 1/V$.

28. Answer: (C) 1 : 2

$K(\max) = h\nu - \phi$ gives $1 - 0.5 = 0.5$ eV and $2.5 - 0.5 = 2.0$ eV. Since $v \propto \sqrt{K}$, $v_1 : v_2 = \sqrt{0.5} : \sqrt{2} = 1 : 2$. Taking the ratio of photon energies (1 : 2.5) or of kinetic energies (1 : 4) are the traps.

29. Answer: (A) Frequency

Photoelectric emission requires the frequency to exceed the threshold frequency of the metal, whatever the intensity. Intensity or power only changes the number of electrons once emission occurs; a minimum wavelength is the wrong sense since there is a maximum wavelength.

30. Answer: (B) 2N and T

Doubling intensity doubles the number of photons per second, so the number of photoelectrons doubles to 2N. The maximum kinetic energy depends only on frequency and work function ($h\nu - \phi$), so it stays T. Doubling the kinetic energy would need a change in frequency, not intensity.

31. Answer: (D) 7 V

Photon energy for $n = 3 \rightarrow 1$ is $13.6(1 - 1/9) = 12.09$ eV. Maximum kinetic energy = $12.09 - 5.1 \approx 7.0$ eV, so the stopping potential is about 7 V. 12.1 V forgets to subtract the work function.

32. Answer: (B) 1.00

Power = $n \cdot hc/\lambda$. $P_2/P_1 = (n_2/n_1)(\lambda_1/\lambda_2) = 1.02 \times 5000/5100 = 1.00$. 1.02 counts only the photon numbers and ignores the lower energy of longer-wavelength photons.

33. Answer: (B) Intensity of light

Above threshold, each photon ejects at most one electron, so the number of photoelectrons depends on the number of photons arriving per second, i.e. the intensity. The frequency (and $\nu - \nu_0$) decides the kinetic energy of the electrons, not their number.

34. Answer: (A) 3×10^{16}

Energy per photon = $hc/\lambda = (6.63 \times 10^{-34} \times 3 \times 10^8)/(667 \times 10^{-9}) \approx 2.98 \times 10^{-19}$ J. Photons per second = $9 \times 10^{-3}/2.98 \times 10^{-19} \approx 3 \times 10^{16}$. Forgetting the milli prefix gives 3×10^{19} .

35. Answer: (B) Ultraviolet region

Photon energy = $\phi + eV_0 = 6.2 + 5 = 11.2$ eV, so $\lambda = 12400/11.2 \text{ eV} \cdot \text{\AA} \approx 1100 \text{ \AA}$ (about 110 nm). This lies in the ultraviolet; visible light is only about 1.8 to 3.1 eV, and X-rays need wavelengths below about 100 \AA.

36. Answer: (B) $2.7 \times 10^{-18} \text{ m s}^{-1}$

Equal de Broglie wavelengths ($\lambda = h/mv$) mean equal momenta. $1 \text{ mg} = 10^{-6} \text{ kg}$, so $v = (9.1 \times 10^{-31} \times 3 \times 10^6)/10^{-6} \approx 2.7 \times 10^{-18} \text{ m s}^{-1}$. Taking 1 mg as 10^{-3} kg gives $2.7 \times 10^{-21} \text{ m s}^{-1}$.

37. Answer: (D) 5×10^{15}

$n = P/(hf) = 2 \times 10^{-3}/(6.63 \times 10^{-34} \times 6.0 \times 10^{14}) = 2 \times 10^{-3}/3.98 \times 10^{-19} \approx 5 \times 10^{15}$ per second. 5×10^{16} is a power-of-ten slip.

38. Answer: (D) 4

The number of photoelectrons is proportional to intensity, which falls as $1/r^2$. Doubling the distance from 0.5 m to 1.0 m reduces it by $2^2 = 4$. A factor of 2 assumes intensity $\propto 1/r$.

39. Answer: (B) change in the intensity of illumination into a change in photoelectric current

Above the threshold, the photoelectric current is proportional to the intensity of the incident light, so a photocell turns changes in illumination into changes in photocurrent. Frequency changes alter the kinetic energy of the electrons, not the current, and the work function is a fixed property of the cathode.

40. Answer: (B) negative electrons and neutral atoms/molecules

In a discharge tube the strong electric field accelerates the free electrons, which knock electrons off neutral gas atoms or molecules and ionise them. Positive ions are heavy and gain much less speed between collisions, so they are not the main cause of ionisation.

41. Answer: (D) $K + h\nu$

Einstein's equation gives $K = h\nu - E_0$. At frequency 2ν , $K' = 2h\nu - E_0 = (h\nu - E_0) + h\nu = K + h\nu$. The kinetic energy does not simply double, because the work function is subtracted only once.

42. Answer: (D) 5×10^{-22}

$E = 1 \text{ MeV} = 1.6 \times 10^{-13} \text{ J}$ and $p = E/c = 1.6 \times 10^{-13}/(3 \times 10^8) \approx 5.3 \times 10^{-22} \text{ kg m/s}$. Skipping the MeV-to-joule conversion gives a meaningless number, and 5×10^{-23} is off by a factor of ten.

43. Answer: (C) A and B only

$E = 12400/4100 \approx 3.0$ eV. This exceeds the work functions of A (1.92 eV) and B (2.0 eV) but not C (5 eV), so only A and B emit. 'All three' ignores that $5 \text{ eV} > 3 \text{ eV}$.

44. Answer: (D) $8 \times 10^6 \text{ m/s}$

$KE_{\text{max}} = E - h\nu_0$. With $2h\nu_0$ it is $h\nu_0$; with $5h\nu_0$ it is $4h\nu_0$. Since $v \propto \sqrt{KE}$, the speed doubles to $8 \times 10^6 \text{ m/s}$. $16 \times 10^6 \text{ m/s}$ wrongly takes $v \propto KE$.

Questions as set in the AIPMT/NEET papers conducted by CBSE and NTA. Answers checked and explanations written by the RankUp team. RankUp is not affiliated with CBSE or NTA.