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Class 12 Physics Chapterwise PYQs

2026 – 2003 | All CBSE Board Papers

Chapter-wise previous year questions, sorted by marks and year

Chapter 11: Dual Nature of Radiation and Matter

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1-Mark Questions (120 questions · Section A · MCQ)

Q1. Two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer from the options below: (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A). (B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). (C) Assertion (A) is true, but Reason (R) is false. (D) Both Assertion (A) and Reason (R) are false. Assertion (A): If accelerated electrons are passed through a narrow slit, a diffraction pattern is observed. Reason (R): Electrons behave as both particles and waves.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Both Assertion (A) and Reason (R) are false.

[2026 • Set 55-1-1]

Q2. From the graph, the work functions of A and B are (h is Planck's constant and e value of charge on an electron):

(A) ν_1 and ν_2
(B) V_1 and V_2
(C) $h\nu_1$ and $h\nu_2$
(D) $\frac{h\nu_1}{e}$ and $\frac{h\nu_2}{e}$

[2026 • Set 55-1-1]

Q3. For radiation of frequency $\nu > \nu_2$ incident on the surfaces of A and B, the maximum kinetic energy of ejected electron is:
(A) greater for metal A because it has a smaller work function.
(B) greater for metal B because it has a larger work function.
(C) greater for metal B because it has higher threshold frequency.
(D) the same for both metal A and metal B because it is independent of work functions of metals.

[2026 • Set 55-1-1]

Q4. If the intensity of the incident radiation for both metals A and B, is doubled keeping its frequency constant, then:
(A) the slope of the parallel lines will increase.
(B) the slope of the parallel lines will decrease.
(C) the threshold frequencies for both A and B will decrease.
(D) the slope of the parallel lines will not change but more electrons will be emitted per second.

[2026 • Set 55-1-1]

Q5. (OR variant for Q30(iv)) The threshold frequency for a metal surface is ν_0. If the radiation of frequency $3\nu_0$ illuminates the surface, the maximum kinetic energy (KE) of photoelectrons is E_1. If the frequency were increased to $6\nu_0$, the maximum KE of the photoelectrons becomes E_2. Then $\frac{E_1}{E_2}$ equals: OR Let m be the slope of the graph line for metal B. If e is the value of electron charge, then Planck's constant 'h' is given by:
(A) 1/3 (or me)
(B) 1/2 (or $\frac{1}{me}$)
(C) 2/5 (or $\frac{m}{e}$)
(D) 3/4 (or $\frac{e}{m}$)

[2026 • Set 55-1-1]

Q6. Assertion (A): On increasing the intensity of incident light of frequency ν $(> \nu_0)$ on a photosensitive surface, the photocurrent increases. Reason (R): The stopping potential for a photosensitive surface increases with increase of frequency ν $(> \nu_0)$ of incident light.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation

of Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

[2026 • Set 55-2-1]

Q7. The maximum kinetic energy of the electrons emitted from a photosensitive surface depends on:

(A) work function of the surface ϕ_0 only.

(B) frequency of the incident radiation ν only.

(C) intensity of the incident radiation I only.

(D) Both ϕ_0 and ν.

[2026 • Set 55-2-1]

Q8. A photosensitive surface is illuminated by radiations of wavelength λ_1, λ_2 $(> \lambda_1)$ and λ_3 one by one and photoemission is observed in each case. λ_1 and λ_2 lie in UV range and λ_3 in visible range. If V_1, V_2 and V_3 are stopping potentials in these cases respectively, then:

(A) $V_1 = V_2 = V_3$

(B) $V_1 > V_2 > V_3$

(C) $V_1 > V_3 > V_2$

(D) $V_3 > V_2 > V_1$

[2026 • Set 55-2-2]

Q9. The equivalent mass of a photon of wavelength 100 nm is:

(A) $2{\cdot}21 \times 10^{-35}$ kg

(B) $6{\cdot}63 \times 10^{-33}$ kg

(C) $1{\cdot}11 \times 10^{-35}$ kg

(D) $3{\cdot}31 \times 10^{-27}$ kg

[2026 • Set 55-2-3]

Q10. Assertion (A): Photoelectric current depends upon the intensity of the incident radiation.
Reason (R): Stopping potential is independent of the intensity of the incident radiation.
Select the correct answer from the codes (A), (B), (C) and (D) given below:

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Both Assertion (A) and Reason (R) are false.

[2026 • Set 55-3-1]

Q11. Radiation of wavelength 200 nm is incident on a photosensitive surface of work function $4{\cdot}2$ eV. The kinetic energy of fastest photoelectrons emitted from this surface will be close to:

(A) $3{\cdot}5$ eV
(B) $3{\cdot}0$ eV
(C) $2{\cdot}5$ eV
(D) $2{\cdot}0$ eV

[2026 • Set 55-3-1]

Q12. A proton and an alpha particle have equal momentum. The ratio of their kinetic energies (E_p/E_α) and de Broglie wavelengths associated with them $(\lambda_p/\lambda_\alpha)$ respectively are:

(A) $2,\ 1$
(B) $1,\ 2$
(C) $4,\ 1$
(D) $1,\ 4$

[2026 • Set 55-3-1]

Q13. The velocity of the photoelectrons emitted from a surface depends upon the:

(A) Wavelength of incident radiation only
(B) Intensity of incident radiation only
(C) Work function of the surface only
(D) Both wavelength of the incident radiation and work function of the surface

[2026 • Set 55-3-2]

Q14. The kinetic energy of a charged particle is increased to four times of its initial value. The de Broglie wavelength associated with the particle will:

(A) increase by 100% of its initial value.
(B) increase by 50% of its initial value.
(C) decrease by 25% of its initial value.
(D) decrease by 50% of its initial value.

[2026 • Set 55-4-1]

Q15. While studying photoelectric emission from a given surface, the wavelength of the incident radiation is changed from 600 nm to 400 nm, keeping the intensity of radiation the same. Then:

(A) cut-off potential will decrease.
(B) cut-off potential will increase.
(C) saturation current will decrease.
(D) saturation current will increase.

[2026 • Set 55-4-1]

Q16. Radiation of wavelength 331 nm irradiates the following metals:<table class='table table-striped style_table'><thead><tr><th>Metal</th><th>Work Function (eV)</th></tr></thead of the following statements is correct?

(A) Only Na and K show photoelectric emission.

(B) Only Mo will not show photoelectric emission.

(C) All of the given metals show photoelectric emission.

(D) None of them show photoelectric emission.

[2026 • Set 55-4-1]

Q17. In an experiment on photoelectric emission, the intensity of incident radiation is halved keeping its frequency constant. As a result:

(A) cut-off potential will increase.

(B) maximum kinetic energy of photoelectrons will remain the same.

(C) photocurrent will increase.

(D) cut-off potential will decrease.

[2026 • Set 55-4-2]

Q18. Photons of frequency ν are incident on the surfaces of two metals A and B of threshold frequencies $\frac{\nu}{2}$ and $\frac{\nu}{3}$. The ratio of maximum kinetic energy of electrons emitted from metal A to that from metal B is:

(A) $\frac{1}{3}$

(B) $\frac{3}{4}$

(C) $\frac{2}{3}$

(D) $\frac{3}{2}$

[2026 • Set 55-4-3]

Q19. Assertion (A): Photoelectric effect is a spontaneous phenomenon. Reason (R): According to the wave picture of radiation, an electron would take hours/days to absorb sufficient energy to overcome the work function and come out from a metal surface. Select the correct answer from the codes given below:

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Both Assertion (A) and Reason (R) are false.

[2026 • Set 55-5-1]

Q20. Light of which of the following colours will have the maximum energy in a photon associated with it?

(A) Red light
(B) Yellow light
(C) Green light
(D) Blue light

[2026 • Set 55-5-1]

Q21. The momentum of a photon associated with a microwave of wavelength 4.00 cm is:

(A) 1.66×10^{-32} kg ms^{-1}
(B) 1.83×10^{-34} kg ms^{-1}
(C) 2.05×10^{-34} kg ms^{-1}
(D) 1.66×10^{-34} kg ms^{-1}

[2026 • Set 55-5-2]

Q22. A 500 nm photon is incident normally on a perfectly reflecting surface and is reflected. The value of momentum transferred to the surface is:

(A) 3.87×10^{-43} kg ms^{-1}
(B) 2.5×10^{-30} kg ms^{-1}
(C) 2.65×10^{-27} kg ms^{-1}
(D) 1.33×10^{-27} kg ms^{-1}

[2026 • Set 55-5-3]

Q23. Let λ_e, λ_p and λ_d be the wavelengths associated with an electron, a proton and a deuteron, all moving with the same speed. Then the correct relation between them is:

(A) $\lambda_d > \lambda_p > \lambda_e$
(B) $\lambda_e > \lambda_p > \lambda_d$
(C) $\lambda_p > \lambda_e > \lambda_d$
(D) $\lambda_e = \lambda_p = \lambda_d$

[2025 • Set 55-1-1]

Q24. The stopping potential V_0 measured in a photoelectric experiment for a metal surface is plotted against frequency ν of the incident radiation. Let m be the slope of the straight line so obtained. Then the value of charge of an electron is given by (h is the Planck's constant.)

(A) mh
(B) $\frac{m}{h}$
(C) $\frac{h}{m}$
(D) $\frac{1}{mh}$

[2025 • Set 55-1-1]

Q25. A source produces monochromatic light of frequency 5.0×10^{14} Hz and the power emitted is 3.31 mW. The number of photons emitted per second by the source, on an average, is:

(A) 10^{16}
(B) 10^{12}
(C) 10^{10}
(D) 10^{20}

[2025 • Set 55-1-2]

Q26. In a photoelectric experiment with a material of work function 2.1 eV, the stopping potential is found to be 2.5 V. The maximum kinetic energy of ejected photoelectrons is:

(A) 0.4 eV
(B) 2.1 eV
(C) 2.5 eV
(D) 4.6 eV

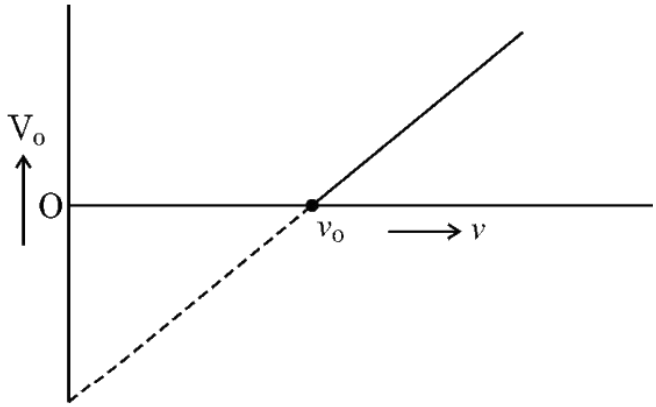
[2025 • Set 55-1-3]

Q27. Atomic spectral emission lines of hydrogen atom are incident on a zinc surface. The lines which can emit photoelectrons from the surface are members of

(A) Balmer series
(B) Paschen series
(C) Lyman series
(D) Neither Balmer, nor Paschen nor Lyman series

[2025 • Set 55-2-1]

Q28. Case study: When a photon of suitable frequency is incident on a metal surface, photoelectron is emitted from it. If the frequency is below a threshold frequency (ν_0) for the surface, no photoelectron is emitted. For a photon of frequency $\nu(\nu > \nu_0)$, the kinetic energy of the emitted photoelectrons is $h(\nu - \nu_0)$. The photocurrent can be stopped by applying a potential V_0, called 'stopping potential' on the anode. Thus maximum kinetic energy of photoelectrons $K_m = eV_0 = h(\nu - \nu_0)$. The experimental graph between V_0 and ν for a metal is shown in figure. This is a straight line of slope m.



The straight line graphs obtained for two metals

(A) coincide each other.

(B) are parallel to each other.

(C) are not parallel to each other and cross at a point on y-axis.

(D) are not parallel to each other and do not cross at a point on y-axis.

[2025 • Set 55-2-1]

Q29. The value of Planck's constant for this metal is

(A) $\frac{e}{m}$

(B) $\frac{1}{me}$

(C) me

(D) $\frac{m}{e}$

[2025 • Set 55-2-1]

Q30. The intercepts on ν-axis and V_0-axis of the graph are respectively:

(A) $\nu_0,\ \frac{h\nu_0}{e}$

(B) $\nu_0,\ h\nu_0$

(C) $\frac{h\nu_0}{e},\ \nu_0$

(D) $h\nu_0,\ \nu_0$

[2025 • Set 55-2-1]

Q31. When the wavelength of a photon is doubled, how many times its wave number and frequency become, respectively?

(A) $2,\ \frac{1}{2}$

(B) $\frac{1}{2},\ \frac{1}{2}$

(C) $\frac{1}{2},\ 2$

(D) $2,\ 2$

[2025 • Set 55-2-1]

Q32. The momentum of a photon is 5.0×10^{-29} kg m/s. Ignoring relativistic effects (if any), the wavelength of the photon is

(A) $1.33\ \mu$m
(B) $3.3\ \mu$m
(C) $16.6\ \mu$m
(D) $13.3\ \mu$m

[2025 • Set 55-2-1]

Q33. A beam of red light and a beam of blue light have equal intensities. Which of the following statements is true ?

(A) The blue beam has more number of photons than the red beam.
(B) The red beam has more number of photons than the blue beam.
(C) Wavelength of red light is lesser than wavelength of blue light.
(D) The blue light beam has lesser energy per photon than that in the red light beam.

[2025 • Set 55-4-1]

Q34. Assertion (A): For monochromatic incident radiation, the emitted photoelectrons from a given metal have speed ranging from zero to a certain maximum value. Reason (R): Each metal has a definite work function.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Both Assertion (A) and Reason (R) are false.

[2025 • Set 55-4-1]

Q35. Choose the correct statement :

(A) Photons of light show diffraction whereas electrons do not show diffraction.
(B) Electrons have momentum whereas photons do not have momentum.
(C) Photons of light and electrons both exhibit dual nature.
(D) All electromagnetic radiations do not have photons.

[2025 • Set 55-4-1]

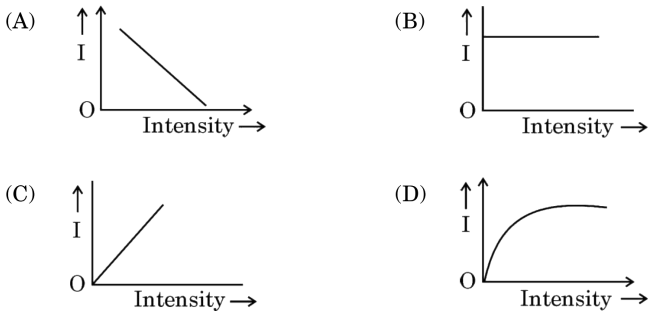
Q36. The kinetic energy of an alpha particle is four times the kinetic energy of a proton. The ratio $\frac{\lambda_\alpha}{\lambda_p}$ of de Broglie wavelengths associated with them will be:

(A) 1
(B) $\frac{1}{2\sqrt{2}}$
(C) $\frac{1}{4}$

(D) $\frac{1}{2}$

[2025 • Set 55-5-1]

Q37. Case Study: Einstein explained photoelectric effect on the basis of Planck's quantum theory, where light travels in the form of small bundles of energy called photons. The energy of each photon is $h\nu$, where ν is the frequency of incident light and h is Planck's constant. The number of photons in a beam of light determines the intensity of the incident light. A photon incident on a metal surface transfers its total energy $h\nu$ to a free electron in the metal. A part of this energy is used in ejecting the electron from the metal and is called its work function. The rest of the energy is carried by the ejected electron as its kinetic energy. (i) Which of the following graphs shows the variation of photoelectric current I with the intensity of light?



(A) (A) Curve concave-down rising then flat
(B) (B) Straight line through origin with positive slope
(C) (C) Straight horizontal line
(D) (D) Curve concave-up rising

[2025 • Set 55-5-1]

Q38. (ii) When the frequency of the incident light is increased without changing its intensity, the saturation current:

(A) increases linearly
(B) decreases
(C) increases non-linearly
(D) remains the same

[2025 • Set 55-5-1]

Q39. (iii) Which of the following graphs can be used to obtain the value of Planck's constant?

(A) Photocurrent versus Intensity of incident light
(B) Photocurrent versus Frequency of incident light
(C) Cut-off potential versus Frequency of incident light
(D) Cut-off potential versus Intensity of incident light

[2025 • Set 55-5-1]

Q40. (iv) (a) Red light, yellow light and blue light of the same intensity are incident on a metal surface successively. K_R, K_Y and K_B represent the maximum kinetic energy of photoelectrons respectively, then: OR (b) Which of the following metals exhibits photoelectric effect with visible light?

(A) (a) $K_R > K_Y > K_B$ OR (b) Caesium
(B) (a) $K_Y > K_R > K_B$ OR (b) Zinc
(C) (a) $K_B > K_Y > K_R$ OR (b) Cadmium
(D) (a) $K_B > K_R > K_Y$ OR (b) Magnesium

[2025 • Set 55-5-1]

Q41. Which of the following electromagnetic waves has photons of largest momentum?

(A) X-rays
(B) AM radio waves
(C) Microwaves
(D) TV waves

[2025 • Set 55-5-1]

Q42. The work function of a material is $2{\cdot}21\,\text{eV}$. Which of the following cannot produce photoelectrons from it?

(A) Red light
(B) Blue light
(C) Violet light
(D) Green light

[2025 • Set 55-6-1]

Q43. The momentum (in kg m/s) of a photon of frequency $6{\cdot}0 \times 10^{14}\,\text{Hz}$ is:

(A) $6{\cdot}63 \times 10^{-22}$
(B) $1{\cdot}326 \times 10^{-27}$
(C) $2{\cdot}652 \times 10^{-26}$
(D) $3{\cdot}978 \times 10^{-24}$

[2025 • Set 55-6-1]

Q44. The de Broglie wavelength associated with an electron moving with energy $5\,\text{eV}$ is:

(A) $0{\cdot}75\,\text{nm}$
(B) $1{\cdot}2\,\text{nm}$
(C) $2{\cdot}4\,\text{nm}$
(D) $0{\cdot}55\,\text{nm}$

[2025 • Set 55-6-2]

Q45. The wavelength of a photon is equal to the wavelength associated with an electron. Both will have the same value of:

(A) energy
(B) angular momentum
(C) velocity
(D) linear momentum

[2025 • Set 55-6-3]

Q46. Assertion (A): The minimum negative potential applied to the anode in a photoelectric experiment at which photoelectric current becomes zero, is called cut-off voltage. Reason (R): The threshold frequency for a metal is the minimum frequency of incident radiation below which emission of photoelectrons does not take place. Select the correct answer:

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Both Assertion (A) and Reason (R) are false.

[2025 • Set 55-7-1]

Q47. The frequency of a photon of energy 1.326 eV is:

(A) 1.18×10^{14} Hz
(B) 3.20×10^{14} Hz
(C) 4.20×10^{15} Hz
(D) 4.80×10^{15} Hz

[2025 • Set 55-7-1]

Q48. Two beams, A and B whose photon energies are 3.3 eV and 11.3 eV respectively, illuminate a metallic surface (work function 2.3 eV) successively. The ratio of maximum speed of electrons emitted due to beam A to that due to beam B is:

(A) $\frac{1}{3}$
(B) $\frac{1}{9}$
(C) 3
(D) 9

[2024 • Set 55-1-1]

Q49. The waves associated with a moving electron and a moving proton have the same wavelength λ. It implies that they have the same:

(A) momentum
(B) angular momentum
(C) speed
(D) energy

[2024 • Set 55-1-1]

Q50. Assertion (A): In photoelectric effect, the kinetic energy of the emitted photoelectrons increases with increase in the intensity of the incident light. Reason (R): Photoelectric current depends on the wavelength of the incident light.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

[2024 • Set 55-1-1]

Q51. Assertion (A): Photoelectric current increases with an increase in intensity of incident radiation, for a given frequency of incident radiation and the accelerating potential. Reason (R): Increase in the intensity of incident radiation results in an increase in the number of photoelectrons emitted per second and hence an increase in the photocurrent.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

[2024 • Set 55-2-1]

Q52. The work function for a photosensitive surface is 3.315 eV. The cut-off wavelength for photoemission of electrons from this surface is:

(A) $150\ nm$

(B) $200\ nm$

(C) $375\ nm$

(D) $500\ nm$

[2024 • Set 55-2-1]

Q53. A photosensitive surface has a work function of 2.00 eV. The maximum kinetic energy of electrons ejected from this surface by radiation of wavelength 300 nm is:

(A) $0.54\ eV$

(B) $1.07\ eV$

(C) $1.61\ eV$

(D) $2.14\ eV$

[2024 • Set 55-2-2]

Q54. The momentum (in SI units) associated with a photon of energy 1.5 eV is:

(A) 4×10^{-27}

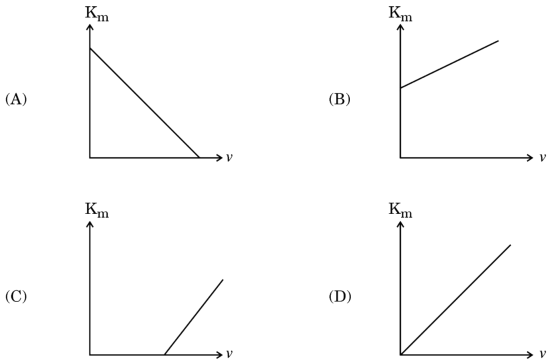
(B) 8×10^{-28}

(C) 2×10^{-30}

(D) 6×10^{-29}

[2024 • Set 55-2-3]

Q55. Which one of the following is the correct graph between the maximum kinetic energy (K_m) of the emitted photoelectrons and the frequency of incident radiation (ν) for a given photosensitive surface?



(A) (A)

(B) (B)

(C) (C)

(D) (D)

[2024 • Set 55-3-1]

Q56. Assertion (A): Photoelectric effect demonstrates the particle nature of light. Reason (R): Photoelectric current is proportional to frequency of incident radiation.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

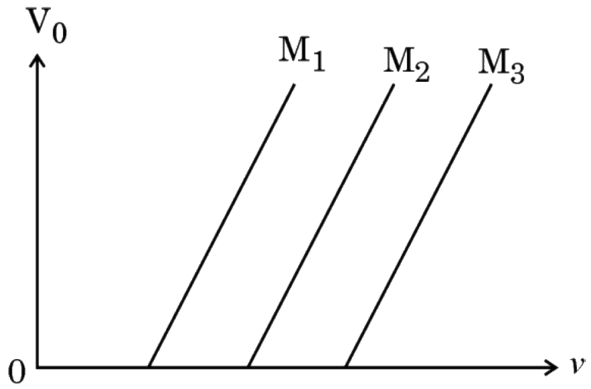
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

[2024 • Set 55-3-1]

Q57. The figure shows the variation of stopping potential V_0 with frequency ν of incident radiation, for three materials M_1, M_2 and M_3 with work functions ϕ_1, ϕ_2 and ϕ_3 respectively. Then:



(A) $\phi_1 > \phi_2 > \phi_3$
(B) $\phi_2 > \phi_3 > \phi_1$
(C) $\phi_3 > \phi_2 > \phi_1$
(D) $\phi_2 > \phi_1 > \phi_3$

[2024 • Set 55-3-2]

Q58. The wavelength of matter wave associated with an electron of kinetic energy K is λ. If the kinetic energy of the electron is doubled, the associated wavelength becomes:
(A) $\frac{\lambda}{\sqrt{2}}$
(B) $\frac{\lambda}{2}$
(C) $\sqrt{2}\lambda$
(D) 2λ

[2024 • Set 55-3-3]

Q59. Assertion (A): Electrons are ejected from the surface of zinc when it is irradiated by yellow light. Reason (R): Energy associated with a photon of yellow light is more than the work function of zinc.
(A) If both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).
(B) If both Assertion (A) and Reason (R) are true and Reason (R) is not the correct explanation of Assertion (A).
(C) If Assertion (A) is true and Reason (R) is false.
(D) If both Assertion (A) and Reason (R) are false.

[2024 • Set 55-4-1]

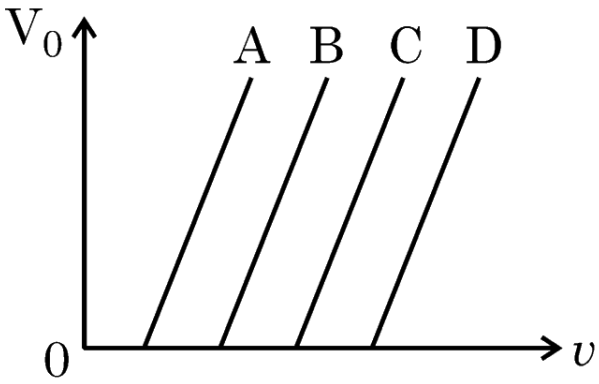
Q60. The quantum nature of light explains the observations on photoelectric effect as
(A) there is a minimum frequency of incident radiation below which no electrons are emitted.
(B) the maximum kinetic energy of photoelectrons depends only on the frequency of incident radiation.

(C) when the metal surface is illuminated, electrons are ejected from the surface after sometime.

(D) the photoelectric current is independent of the intensity of incident radiation.

[2024 • Set 55-4-1]

Q61. The variation of the stopping potential (V_0) with the frequency (ν) of the incident radiation for four metals A, B, C and D is shown in the figure. For the same frequency of incident radiation producing photo-electrons in all metals, the kinetic energy of photo-electrons will be maximum for metal:



(A) A

(B) B

(C) C

(D) D

[2024 • Set 55-5-1]

Q62. Assertion (A): Photoelectric effect demonstrates the particle nature of light. Reason (R): Photoelectric current is proportional to intensity of incident radiation for frequencies more than the threshold frequency.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false and Reason (R) is also false.

[2023 • Set 55-1-1]

Q63. A photon of energy 7 eV is incident on a metal surface having the work function of 3.75 eV. The stopping potential is:

(A) 1.75 eV

(B) 2.45 eV

(C) 3.25 eV

(D) 3.75 eV

[2023 • Set 55-1-2]

Q64. In an experiment, photons of energy 7.5 eV are incident on a metal surface. Electrons emitted from the metal surface are stopped by an electrode at a potential of -4.5 V w.r.t. the metal. The work function of the metal is:

(A) 3.0 eV

(B) 4.5 eV

(C) 7.5 eV

(D) 12.0 eV

[2023 • Set 55-1-3]

Q65. Which one of the following metals does not exhibit emission of electrons from its surface when irradiated by visible light?

(A) Rubidium

(B) Sodium

(C) Cadmium

(D) Caesium

[2023 • Set 55-2-1]

Q66. A photon of wavelength 663 nm is incident on a metal surface. The work function of the metal is 1.50 eV. The maximum kinetic energy of the emitted photoelectrons is

(A) 3.0×10^{-20} J

(B) 6.0×10^{-20} J

(C) 4.5×10^{-20} J

(D) 9.0×10^{-20} J

[2023 • Set 55-2-2]

Q67. The energy of a photon of wavelength 663 nm is

(A) 6.64×10^{-20} J

(B) 5.18×10^{-19} J

(C) 3.0×10^{-19} J

(D) 2.0×10^{-19} J

[2023 • Set 55-2-3]

Q68. A graph is plotted between the stopping potential (on y-axis) and the frequency of incident radiation (on x-axis) for a metal. The product of the slope of the straight line obtained and the magnitude of charge on an electron is equal to:

(A) h (Planck's constant)

(B) $\frac{h}{e}$

(C) he
(D) $\frac{e}{h}$

[2023 • Set 55-3-1]

Q69. Light of frequency 6.4×10^{14} Hz is incident on a metal of work function 2.14 eV. The maximum kinetic energy of the emitted electrons is about:

(A) 0.25 eV
(B) 0.51 eV
(C) 1.02 eV
(D) 0.10 eV

[2023 • Set 55-3-1]

Q70. In an experiment on photoelectric effect, the intensity of incident radiation is increased, keeping the frequency ν the same. The number of photoelectrons emitted will:

(A) increase
(B) decrease
(C) remain same
(D) depend on frequency

[2023 • Set 55-3-2]

Q71. A proton and an alpha particle have the same kinetic energy. The ratio of de Broglie wavelengths associated with the proton to that with the alpha particle is:

(A) 1
(B) 2
(C) $2\sqrt{2}$
(D) $\frac{1}{2}$

[2023 • Set 55-4-1]

Q72. Photons of energy 3.2 eV are incident on a photosensitive surface. If the stopping potential for the emitted electrons is 1.5 V, the work function for the surface is:

(A) 1.5 eV
(B) 1.7 eV
(C) 3.2 eV
(D) 4.7 eV

[2023 • Set 55-4-1]

Q73. Photons of energy 4.3 eV are incident on a photosensitive surface of work function 2.3 eV. The stopping potential for photoelectrons is:

(A) 2.0 eV
(B) 2.3 eV

(C) 4.3 eV
(D) 6.6 eV

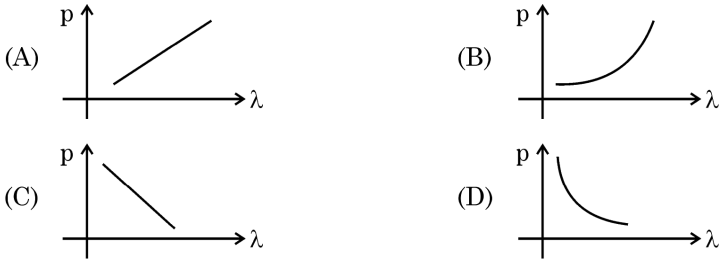
[2023 • Set 55-4-2]

Q74. A light of frequency ν is incident on a metal surface whose work function is W_0. The kinetic energy of emitted electron is K. If the frequency of the incident light is doubled then the kinetic energy of emitted electron will be:

(A) $2K$
(B) more than $2K$
(C) between K and $2K$
(D) less than K

[2023 • Set 55-4-3]

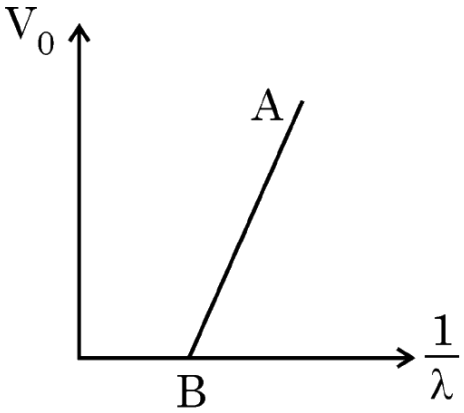
Q75. Which of the following graphs correctly represents the variation of a particle momentum with its associated de-Broglie wavelength?



(A) Graph (A)
(B) Graph (B)
(C) Graph (C)
(D) Graph (D)

[2023 • Set 55-5-1]

Q76. Figure shows a plot of stopping potential (V_0) versus $\frac{1}{\lambda}$ where λ is the wavelength of the radiation causing photoelectric emission from a surface. The slope of the line is equal to



(A) $\frac{h}{e}$

(B) $\frac{hc}{e}$
(C) $\frac{h}{c}$
(D) $\frac{h^2c}{e}$

[2023 • Set 55-5-2]

Q77. E, c and v represent the energy, velocity and frequency of a photon. Which of the following represents its wavelength?
(A) $\frac{hv}{c^2}$
(B) hv
(C) $\frac{hc}{E}$
(D) $\frac{hv}{c}$

[2023 • Set 55-5-3]

Q78. Two statements are given - one labelled Assertion (A) and the other labelled Reason (R). Select the correct answer to this question from the codes (A), (B), (C) and (D) as given below: (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A). (B) Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A). (C) Assertion (A) is true but Reason (R) is false. (D) Assertion (A) is false and Reason (R) is also false. Assertion (A): In his study of photoelectric emission, Hallwachs connected a negatively charged zinc plate to an electroscope. He found that negatively charged particles were emitted from the zinc plate under the action of visible light. Reason (R): An uncharged zinc plate becomes positively charged when it is irradiated by visible light.

[2021]

Q79. If the frequency of the radiation incident on a photosensitive surface increases $(\nu > \nu_0)$, how will the stopping potential change?

[2021]

Q80. An electron is accelerated through a potential difference of $100\,\text{V}$. Calculate the de Broglie wavelength associated with it.

[2021]

Q81. A proton and a deuteron are moving with the same speed. Find the ratio of the de Broglie wavelength (λ_p/λ_d) associated with them.

[2021]

Q82. Photons of energies $1\,\text{eV}$ and $2\,\text{eV}$ are successively incident on a metallic surface of work function $0{\cdot}5\,\text{eV}$. The ratio of kinetic energy of most energetic photoelectrons in the two cases will be

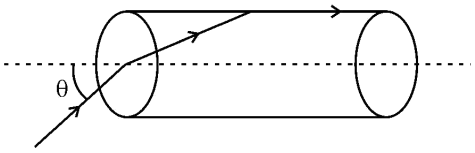
(A) $1:2$
(B) $1:1$
(C) $1:3$
(D) $1:4$

[2020 • Set 55-1-1]

Q83. A proton and an electron have equal speeds. Find the ratio of de Broglie wavelengths associated with them.

[2020 • Set 55-1-1]

Q84. The variation of the stopping potential (V_0) with the frequency (ν) of the light incident on two different photosensitive surfaces M_1 and M_2 is shown in the figure. Identify the surface which has greater value of the work function.



[2020 • Set 55-1-1]

Q85. What is the wavelength of a photon of energy 3.3×10^{-19} J?

[2020 • Set 55-2-1]

Q86. The threshold wavelength for two photosensitive surfaces A and B are λ_1 and λ_2, respectively. What is the ratio of the work functions of the two surfaces?

[2020 • Set 55-2-2]

Q87. The threshold frequencies of two photosensitive surfaces are ν_1 and ν_2, respectively. What is the ratio of the velocities of the photoelectrons emitted from these surfaces when light of frequency ν is incident on them and photoemission occurs?

[2020 • Set 55-2-3]

Q88. In photoelectric effect, the number of emitted photoelectrons is proportional to _____ of incident light.

OR

Light of frequency ν is incident on a photosensitive surface of threshold frequency ν_0 $(\nu > \nu_0)$. The value of kinetic energy of the emitted photoelectrons will be _____.

[2020 • Set 55-3-1]

Q89. The kinetic energy of a proton and that of an α-particle are 4 eV and 1 eV, respectively. The ratio of the de-Broglie wavelengths associated with them, will be

(A) $2:1$

(B) $1:1$
(C) $1:2$
(D) $4:1$

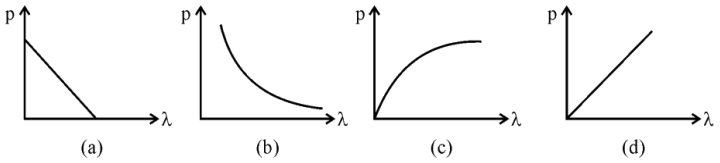
[2020 • Set 55-4-1]

Q90. A photocell connected in an electrical circuit is placed at a distance d from a source of light. As a result, current I flows in the circuit. What will be the current in the circuit when the distance is reduced to $d/2$?

(A) I
(B) $2I$
(C) $4I$
(D) $\sqrt{2}\,I$

[2020 • Set 55-4-1]

Q91. The graph showing the correct variation of linear momentum (p) of a charge particle with its de-Broglie wavelength (λ) is —



(A) (a)
(B) (b)
(C) (c)
(D) (d)

[2020 • Set 55-5-1]

Q92. If photons of frequency ν are incident on the surfaces of metals A & B of threshold frequencies $\nu/2$ and $\nu/3$ respectively, the ratio of the maximum kinetic energy of electrons emitted from A to that from B is

(A) $2:3$
(B) $3:4$
(C) $1:3$
(D) $3:2$

[2020 • Set 55-5-1]

Q93. Define the term "threshold frequency", in the context of photoelectric emission.

[2019 • Set 55-1-1]

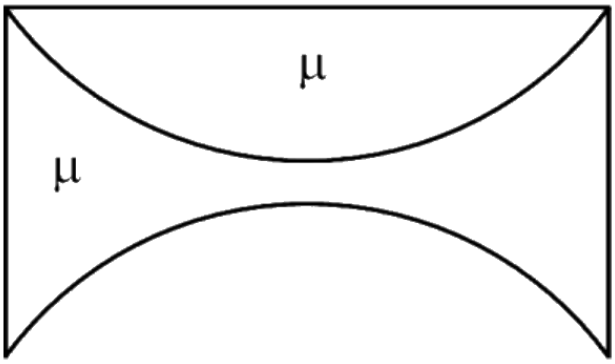
Q94. Define the term "Intensity" in photon picture of electromagnetic radiation.

[2019 • Set 55-1-1]

Q95. On the basis of the graphs shown in the figure, answer the following questions:

(a) Which physical parameter is kept constant for the three curves?

(b) Which is the highest frequency among ν_1, ν_2 and ν_3?



[2019 • Set 55-3-1]

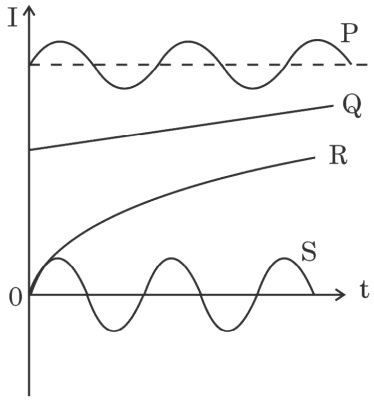
Q96. In photoelectric emission, when the frequency of incident radiation is doubled, will the maximum kinetic energy of photoelectrons also be doubled? Justify your answer.

[2019 • Set 55-3-2]

Q97. Define intensity of radiation based on photon picture of light.

[2019 • Set 55-3-3]

Q98. The figure shows the variation of stopping potential V_s with the frequency ν of the incident radiations for two photosensitive metals P and Q. Which metal has smaller threshold wavelength? Justify your answer.



[2019 • Set 55-4-1]

Q99. Plot a graph showing the variation of photoelectric current versus intensity of light.

[2019 • Set 55-4-2]

Q100. Plot a graph of stopping potential (V_s) versus the frequency (ν) of incident radiation in

photoelectric emission.

[2019 • Set 55-4-3]

Q101. Plot a graph of the de-Broglie wavelength associated with a proton versus its momentum.

[2019 • Set 55-5-1]

Q102. Plot a graph of the de-Broglie wavelength associated with electron as a function of accelerating potential.

[2019 • Set 55-5-2]

Q103. Draw graphs showing variation of photoelectric current with applied voltage for two incident radiations of equal frequency and different intensities. Mark the graph for the radiation of higher intensity.

[2018]

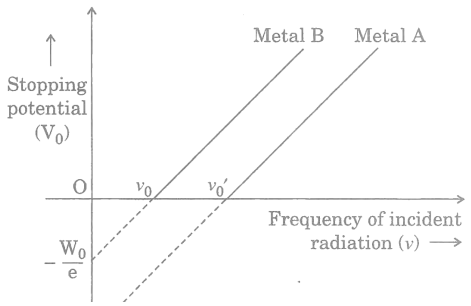
Q104. A photosensitive surface emits photoelectrons when red light falls on it. Will the surface emit photoelectrons when blue light is incident on it? Give reason.

[2017]

Q105. Name the phenomenon which shows the quantum nature of electromagnetic radiation.

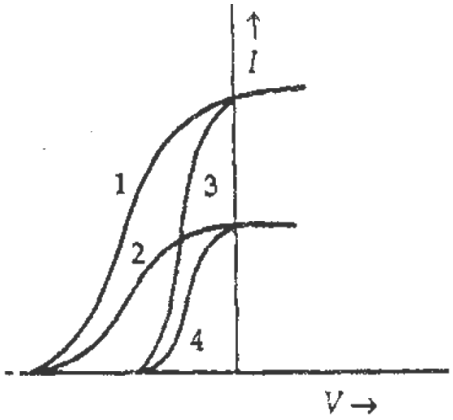
[2017]

Q106. The graph shows variation of stopping potential V_0 versus frequency of incident radiation ν for two photosensitive metals A and B. Which of the two metals has higher threshold frequency and why ?



[2014]

Q107. The given graph shows the variation of photo-electric current (I) versus applied voltage (V) for two different photosensitive materials and for two different intensities of the incident radiation. Identify the pairs of curves that correspond to different materials but same intensity of incident radiation.



[2013]

Q108. Does the 'stopping potential' in photoelectric emission depend upon

(i) the intensity of the incident radiation in a photocell?

(ii) the frequency of the incident radiation?

[2013]

Q109. A proton and an electron have same kinetic energy. Which one has greater de-Broglie wavelength and why?

[2012]

Q110. Show on a graph the variation of the de Broglie wavelength (λ) associated with an electron, with the square root of accelerating potential (V).

[2012]

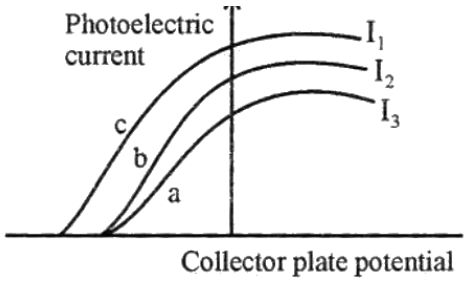
Q111. Define the term 'stopping potential' in relation to photoelectric effect.

[2011]

Q112. Show graphically, the variation of the de-Broglie wavelength (λ) with the potential (V) through which an electron is accelerated from rest.

[2011 • Set 55-1-1]

Q113. The figure shows a plot of three curves a, b, c showing the variation of photocurrent vs collector plate potential for three different intensities I_1, I_2 and I_3 having frequencies ν_1, ν_2 and ν_3, respectively incident on a photosensitive surface. Point out the two curves for which the incident radiations have same frequency but different intensities.



[2009]

Q114. The stopping potential in an experiment on photoelectric effect is $1.5\ V$. What is the maximum kinetic energy of the photoelectrons emitted?

[2009]

Q115. An electron and an alpha particle have the same de-Broglie wavelength associated with them. How are their kinetic energies related to each other?

[2008]

Q116. What is the stopping potential of a photocell, in which electrons with maximum kinetic energy of $6\ eV$ are emitted?

[2008]

Q117. An electron, an alpha-particle and a proton have the same kinetic energy. Which one of these particles has the largest de-Broglie wavelength?

[2007]

Q118. Ultraviolet radiations of different frequencies ν_1 and ν_2 are incident on two photosensitive materials having work functions W_1 and W_2 ($W_1 > W_2$) respectively. The kinetic energy of the emitted electrons is same in both the cases. Which one of the two radiations will be of higher frequency?

[2007]

Q119. With what purpose was famous Davisson-Germer experiment with electrons performed?

[2006]

Q120. Electrons are emitted from a photosensitive surface when it is illuminated by green light but electron emission does not take place by yellow light. Will the electrons be emitted when the surface is illuminated by (i) red light, and (ii) blue light?

[2005]

2-Mark Questions (60 questions · Section B · VSA)

Q1. In a photoelectric experiment, the emitter plate is irradiated with radiation of 200 nm. The photocurrent becomes zero when the collector plate potential is -0.80 V. Calculate

the work function (in eV) of the emitter.

[2026 • Set 55-1-1]

Q2. Find the ratio $\frac{\lambda_\alpha}{\lambda_p}$ of de Broglie wavelength λ_α associated with an alpha particle to de Broglie wavelength λ_p associated with a proton if both are moving with the (a) same velocity (b) same kinetic energy.

[2026 • Set 55-1-2]

Q3. In an electron microscope, accelerated electrons have wavelength of 0.011 nm. Calculate the voltage through which electrons were accelerated to attain this wavelength. (Take $e = 1.6 \times 10^{-19}$ C, $m_e = 9 \times 10^{-31}$ kg, $h = 6.6 \times 10^{-34}$ J·s)

[2026 • Set 55-1-3]

Q4. Find the ratio $(\lambda_\alpha/\lambda_p)$ of the de Broglie wavelengths λ_α and λ_p associated respectively with an alpha particle and a proton:

(i) if they are moving with the same kinetic energy.

(ii) just after they are accelerated through the same potential difference.

[2026 • Set 55-2-1]

Q5. A particle of mass M at rest splits up into two particles of masses m_1 and m_2 having non-zero velocities. Calculate the ratio of the de Broglie wavelengths associated with the two particles.

[2026 • Set 55-3-1]

Q6. Calculate the de Broglie wavelength of a neutron having kinetic energy of 150 eV.

[2026 • Set 55-3-2]

Q7. Light of frequency $5{\cdot}0 \times 10^{14}$ Hz is incident on a metal surface. If the maximum speed of photoelectrons emitted is $6{\cdot}63 \times 10^5$ m s^{-1}, calculate the threshold frequency for the surface.

[2026 • Set 55-3-3]

Q8. A light of wavelength 400 nm is incident on metal surface whose work function is 3.0×10^{-19} J. Calculate the speed of the fastest photoelectrons emitted.

[2025 • Set 55-2-1]

Q9. Radiations of two frequencies are incident on a metal surface of work function 2.0 eV one by one. The energies of their photons are 2.5 eV and 4.5 eV respectively. Find the ratio of the maximum speed of the electrons emitted in the two cases.

[2025 • Set 55-2-2]

Q10. The threshold wavelength of a metal is 450 nm. Calculate (i) the work function of the metal in eV and (ii) the maximum energy of the ejected photoelectrons in eV by incident radiation of 250 nm.

[2025 • Set 55-2-3]

Q11. The threshold frequency for a given metal is 3.6×10^{14} Hz. If monochromatic radiations of frequency 6.8×10^{14} Hz are incident on this metal, find the cut-off potential for the photoelectrons.

[2025 • Set 55-5-1]

Q12. A laser beam of frequency $3{\cdot}0 \times 10^{14}$ Hz produces average power of 9 mW. Find (i) the energy of photon of the beam, and (ii) the number of photons emitted per second on an average by the source.

[2025 • Set 55-6-1]

Q13. A laser beam of wavelength 500 nm and power 5 mW strikes normally on a perfectly reflecting surface of area 1 mm^2 of a body. It rebounds back from the surface. Find the force exerted by the laser beam on the body.

[2025 • Set 55-6-2]

Q14. Consider a neutron (mass m) of kinetic energy E and a photon of the same energy. Let λ_n and λ_p be the de Broglie wavelength of neutron and the wavelength of photon respectively. Obtain an expression for $\dfrac{\lambda_n}{\lambda_p}$.

[2024 • Set 55-1-1]

Q15. The minimum intensity of white light that our eyes can perceive is about 0.1 nW m^{-2}. Calculate the number of photons of this light entering our pupil (area 0.4 cm^2) per second. (Take average wavelength of white light $= 500$ nm and Planck's constant $= 6.6 \times 10^{-34}$ J s)

[2024 • Set 55-3-1]

Q16. Light of wavelength 500 nm is incident on caesium metal (work function 2.14 eV) and photoemission of electrons occurs. Calculate the (i) kinetic energy (in eV) of the fastest electrons and (ii) stopping potential for this situation. (Take $hc = 1240$ eV·nm)

[2024 • Set 55-3-2]

Q17. Light of wavelength 600 nm is incident on potassium (work function 2.3 eV). Will photoemission of electrons occur? What is the longest wavelength that will cause photoemission of electrons? (Take $hc = 1240$ eV·nm)

[2024 • Set 55-3-3]

Q18. A proton and α-particle are accelerated through different potentials V_1 and V_2 respectively

so that they have the same de Broglie wavelengths. Find $\frac{V_1}{V_2}$.

[2024 • Set 55-4-1]

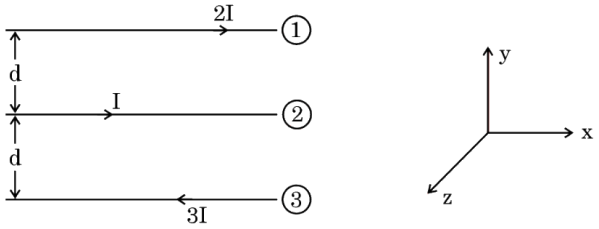
Q19. What are matter waves? A proton, an electron and an α-particle have the same kinetic energy. Write the de Broglie wavelengths associated with them in increasing order.

[2024 • Set 55-4-2]

Q20. The ratio of de Broglie wavelengths of a proton and a deuteron accelerated by potential V_p and V_d respectively, $\left(\frac{\lambda_p}{\lambda_d}\right)$ is $\frac{1}{2}$. Find $\frac{V_p}{V_d}$.

[2024 • Set 55-4-3]

Q21. The figure shows v_m^2 versus $\frac{1}{\lambda}$ graph for photoelectrons emitted from a surface where v_m is the maximum speed of electrons and λ is the wavelength of incident radiation. Using this graph and Einstein's photoelectric equation, obtain the expression for Planck's constant and work function of the surface.



[2023 • Set 55-4-1]

Q22. (a) How will the De Broglie wavelength associated with an electron be affected when the (i) velocity of the electron decreases? and (ii) accelerating potential is increased? Justify your answer.

OR

(b) How would the stopping potential for a given photosensitive surface change if (i) the frequency of the incident radiation were increased? and (ii) the intensity of incident radiation were decreased? Justify your answer.

[2023 • Set 55-5-1]

Q23. Plot a graph showing the variation of photo electric current, as a function of anode potential for two light beams having the same frequency but different intensities I_1 and I_2 ($I_2 > I_1$). Mention its important features.

[2023 • Set 55-5-3]

Q24. Plot suitable graphs to show the variation of photoelectric current with the collector plate potential for the incident radiation of

(i) the same intensity but different frequencies ν_1, ν_2 and ν_3 $(\nu_1 < \nu_2 < \nu_3)$

(ii) the same frequency but different intensities I_1, I_2 and I_3 $(I_1 < I_2 < I_3)$

[2022 • Set 55-1-1]

Q25. Photoelectric emission occurs when a surface is irradiated with the radiation of frequency (i) ν_1 and (ii) ν_2. The maximum kinetic energy of the electrons emitted in the two cases are K and $2K$ respectively. Obtain the expression for the threshold frequency for the surface.

[2022 • Set 55-2-1]

Q26. (i) Name the factors on which photoelectric emission from a surface depends.

(ii) Define the term 'threshold frequency' for a photosensitive material.

[2022 • Set 55-3-1]

Q27. What are matter waves? A proton and an alpha particle are accelerated through the same potential difference. Find the ratio of the de Broglie wavelength associated with the proton to that with the alpha particle.

[2022 • Set 55-4-1]

Q28. Why it is the frequency and not the intensity of light source that determines whether emission of photoelectrons will occur or not? Explain.

[2022 • Set 55-5-1]

Q29. For the light of wavelength 400 nm incident on the cathode of a photocell, the stopping potential is 6 V. If the wavelength of incident light is increased to 600 nm, calculate the new stopping potential. (Take $h = 4.14 \times 10^{-15}$ eV $\cdot$ s)

[2021]

Q30. (a) Write two main observations of photoelectric effect experiment which could only be explained by Einstein's photoelectric equation.

(b) Draw a graph showing variation of photocurrent with the anode potential of a photocell.

[2020 • Set 55-1-1]

Q31. Explain, how the process of emission of photoelectrons is different from the process of emission of β-particles.

[2020 • Set 55-1-3]

Q32. Define the terms (a) threshold frequency, and (b) stopping potential. How were these terms incorporated in Einstein's photoelectric equation?

[2020 • Set 55-3-1]

Q33. The de Broglie wavelengths associated with an electron and a proton are equal. Prove that the kinetic energy of the electron is greater than that of the proton.

[2020 • Set 55-3-2]

Q34. (a) In what ways are matter waves different from electromagnetic waves?

(b) If the kinetic energy of a particle is reduced to one-fourth $\left(\frac{1}{4}\right)$ of its initial value, how many times will the de Broglie wavelength associated with it become?

[2020 • Set 55-3-3]

Q35. Light of same wavelength is incident on three photo-sensitive surfaces A, B and C. The following observations are recorded.

(i) From surface A, photo electrons are not emitted.

(ii) From surface B, photo electrons are just emitted.

(iii) From surface C, photo electrons with some kinetic energy are emitted. Compare the threshold frequencies of the three surfaces and justify your answer.

OR

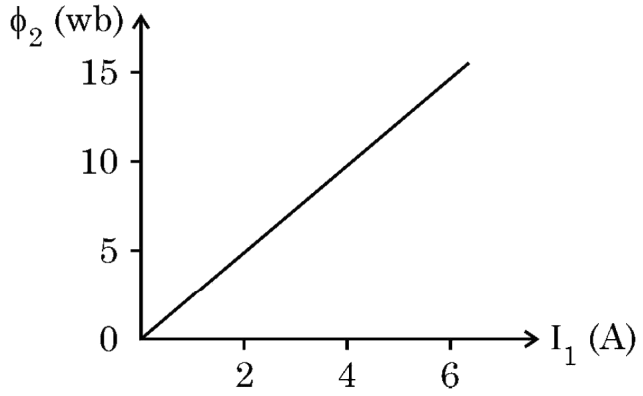
If the frequency of light incident on the cathode of a photo-cell is increased, how will the following be affected? Justify your answer.

(i) Energy of the photo electrons.

(ii) Photo current.

[2020 • Set 55-4-1]

Q36. Figure shows the stopping potential (V_0) for the photo electron versus $(1/\lambda)$ graph, for two metals A and B, λ being the wavelength of incident light.



(a) How is the value of Planck's constant determined from the graph ?

(b) If the distance between the light source and the surface of metal A is increased, how will the stopping potential for the electrons emitted from it be effected ? Justify your

answer.

[2020 • Set 55-5-1]

Q37. In case of photo electric effect experiment, explain the following facts, giving reasons.

(a) The wave theory of light could not explain the existence of the threshold frequency.

(b) The photo electric current increases with increase of intensity of incident light.

[2020 • Set 55-5-2]

Q38. Why is wave theory of electromagnetic radiation not able to explain photoelectric effect? How does photon picture resolve this problem?

[2019 • Set 55-1-1]

Q39. Plot a graph showing variation of de Broglie wavelength (λ) associated with a charged particle of mass m, versus $\frac{1}{\sqrt{V}}$, where V is the potential difference through which the particle is accelerated. How does this graph give us the information regarding the magnitude of the charge of the particle?

[2019 • Set 55-1-1]

Q40. An electron, a proton and an alpha particle have the same kinetic energy. Which one has the shortest wavelength?

[2019 • Set 55-1-2]

Q41. Explain with the help of Einstein's photoelectric equation any two observed features in photoelectric effect which cannot be explained by wave theory.

[2019 • Set 55-1-2]

Q42. Define the terms, (i) threshold frequency and (ii) stopping potential in photoelectric effect.

[2019 • Set 55-1-3]

Q43. Plot a graph of photocurrent versus anode potential for a radiation of frequency ν and intensities I_1 and I_2 $(I_1 < I_2)$.

[2019 • Set 55-1-3]

Q44. A photon and a proton have the same de-Broglie wavelength λ. Prove that the energy of the photon is $(2m\lambda c/h)$ times the kinetic energy of the proton.

[2019 • Set 55-2-1]

Q45. The wavelength of light from the spectral emission line of sodium is $590\,\text{nm}$. Find the

kinetic energy at which the electron would have the same de-Broglie wavelength.

[2019 • Set 55-2-3]

Q46. If light of wavelength 412.5 nm is incident on each of the metals given below, which ones will show photoelectric emission and why ?

Metal	Work Function (eV)
Na	1·92
K	2·15
Ca	3·20
Mo	4·17

[2018]

Q47. If light of wavelength 412.5 nm is incident on each of the metals given below, which ones will show photoelectric emission and why? Metal — Work Function (eV) Na — 1.92 K — 2.15 Ca — 3.20 Mo — 4.17

[2018]

Q48. Calculate the de-Broglie wavelength of the electron orbitting in the $n = 2$ state of hydrogen atom.

[2016]

Q49. A proton and an α particle are accelerated through the same potential difference. Which one of the two has (i) greater de-Broglie wavelength, and (ii) less kinetic energy? Justify your answer.

[2016]

Q50. Write briefly the underlying principle used in Davison-Germer experiment to verify wave nature of electrons experimentally. What is the de-Broglie wavelength of an electron with kinetic energy (K.E.) 120 eV?

[2016]

Q51. The equivalent wavelength of a moving electron has the same value as that of a photon of energy 6×10^{-17} J. Calculate the momentum of the electron.

[2015]

Q52. A proton and an α-particle have the same de-Broglie wavelength. Determine the ratio of (i) their accelerating potentials (ii) their speeds.

[2015]

Q53. A proton and a deuteron are accelerated through the same accelerating potential. Which one of the two has

(a) greater value of de-Broglie wavelength associated with it, and

(b) less momentum ? Give reasons to justify your answer.

[2014]

Q54. **(i)** Monochromatic light of frequency 6.0×10^{14} Hz is produced by a laser. The power emitted is 2.0×10^{-3} W. Estimate the number of photons emitted per second on an average by the source.

(ii) Draw a plot showing the variation of photoelectric current versus the intensity of incident radiation on a given photosensitive surface.

[2014]

Q55. A deuteron and an alpha particle are accelerated with the same accelerating potential. Which one of the two has (1) greater value of de-Broglie wavelength, associated with it and (2) less kinetic energy ? Explain.

[2014]

Q56. An α-particle and a proton are accelerated from rest by the same potential. Find the ratio of their de Broglie wavelengths.

[2012]

Q57. Write Einstein's photoelectric equation. State clearly the three salient features observed in photoelectric effect, which can be explained on the basis of the above equation.

[2012]

Q58. An electron is accelerated through a potential difference of 100 volts. What is the de-Broglie wavelength associated with it? To which part of the electromagnetic spectrum does this value of wavelength correspond?

[2010]

Q59. Plot a graph showing the variation of stopping potential with the frequency of incident radiation for two different photosensitive materials having work functions W_1 and W_2 ($W_1 > W_2$). On what factors does the (i) slope and (ii) intercept of the lines depend?

[2010]

Q60. The work function of lithium is 2.3 eV. What does it mean? What is the relation between the work function W and threshold wavelength of a metal?

[2003]

3-Mark Questions (73 questions · Section C · SA)

Q1. (a) A particle of charge q and mass m is accelerated through a potential difference V. Deduce an expression for the de Broglie wavelength associated with the particle.

[2026 • Set 55-2-3]

Q2. (b) Plot a graph for a particle of charge q and mass m showing variation of de Broglie wavelength λ, as $\frac{1}{\lambda}$ with $\sqrt{V}$, where V is the potential difference through which the particle is accelerated.

[2026 • Set 55-2-3]

Q3. (a) Explain how the dual aspect of matter is evident in the de Broglie relation.

(b) Radiation of wavelength λ is incident on a photosensitive surface. Find the de Broglie wavelength of electrons emitted from the surface. Assume that the work function of the surface is negligible.

[2026 • Set 55-4-1]

Q4. Photoemission of electrons occurs from a metal ($\phi_0 = 1.96\,\text{eV}$) when light of frequency $6.4 \times 10^{14}\,\text{Hz}$ is incident on it. Calculate:

(a) Energy of a photon in the incident light,

(b) The maximum kinetic energy of the emitted electrons, and

(c) The stopping potential.

[2026 • Set 55-5-1]

Q5. What are de Broglie waves? Show that the wavelength of the electromagnetic radiation is equal to the de Broglie wavelength of its quantum (photon).

[2026 • Set 55-5-2]

Q6. Answer the following giving reason:

(a) All the photo electrons do not eject with the same kinetic energy when monochromatic light is incident on a metal surface.

(b) The saturation current in case (a) is different for different intensity.

(c) If one goes on increasing the wavelength of light incident on a metal surface, keeping its intensity constant, emission of photo electrons stops at a certain wavelength for this metal.

[2025 • Set 55-1-1]

Q7. (a) Draw a plot of frequency ν of incident radiations as a function of stopping potential

V_0 for a given photo emissive material. What information can be obtained from the value of the intercept on the stopping potential axis?

(b) Calculate: (i) the momentum and (ii) de Broglie wavelength, of an electron with kinetic energy of 80 eV.

[2025 • Set 55-1-2]

Q8. (a) Mention any three features of results of experiment on photoelectric effect which cannot be explained using the wave theory of light.

(b) In his experiment on photoelectric effect, Robert A. Millikan found the slope of the cut-off voltage versus frequency of incident light plot to be 4.12×10^{-15} V s. Calculate the value of Planck's constant from it.

[2025 • Set 55-1-3]

Q9. Explain the following observations using Einstein's photoelectric equation :

(a) Photoelectric emission does not occur from a surface when the frequency of the light incident on it is less than a certain minimum value.

(b) It is the frequency, and not the intensity of the incident light which affects the maximum kinetic energy of the photoelectrons.

(c) The cut-off voltage (V_0) versus frequency (ν) of the incident light curve is a straight line with a slope $\frac{h}{e}$.

[2025 • Set 55-4-1]

Q10. (a) Define 'work function' of a metal. How can its value be determined from a graph between stopping potential and frequency of the incident radiation?

(b) The work function of a metal is 2.4 eV. A stopping potential of 0.6 V is required to reduce the photocurrent to zero, in a photoelectric experiment. Calculate the wavelength of light used.

[2025 • Set 55-7-1]

Q11. (a) Briefly explain Einstein's photoelectric equation.

(b) Four metals with their work functions are listed below: $K = 2.3$ eV, $Na = 2.75$ eV, $Mo = 4.17$ eV and $Ni = 5.15$ eV. The radiation of wavelength 330 nm from a laser source placed 1 m away, falls on these metals. Which of these metals will not show photoelectric emission? What will happen if the laser source is brought closer to a distance of 50 cm?

[2025 • Set 55-7-2]

Q12. Answer the following, giving reasons:

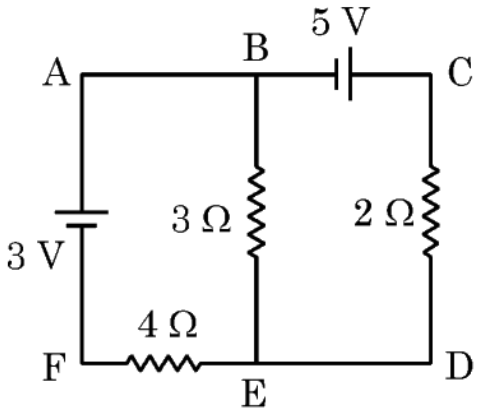
(a) The maximum kinetic energy of the photoelectrons is independent of the intensity of incident radiation.

(b) Photoelectric current increases with the increase in the intensity of the incident radiation.

(c) The stopping potential V_0 varies linearly with the frequency ν of the incident radiation for a given photosensitive surface.

[2025 • Set 55-7-3]

Q13. de Broglie wavelength λ as a function of $\frac{1}{\sqrt{K}}$ for two particles of masses m_1 and m_2 are shown in the figure. Here, K is the energy of the moving particles.



(a) What does the slope of a line represent?

(b) Which of the two particles is heavier?

(c) Is this graph also valid for a photon? Justify your answer in each case.

[2024 • Set 55-2-1]

Q14. (a) Briefly explain de Broglie hypothesis for wave nature of matter.

(b) Find the ratio of de Broglie wavelength associated with a proton and an alpha particle when both are (i) accelerated from rest through the same potential difference, and (ii) moving with the same kinetic energy.

[2024 • Set 55-2-2]

Q15. (a) Write Einstein's photoelectric equation. How did Millikan prove the validity of this equation?

(b) Explain the existence of threshold frequency of incident radiation for photoelectric emission from a given surface.

[2024 • Set 55-5-1]

Q16. A photosensitive surface of work function 2.1 eV is irradiated by radiation of wavelength 150 nm. Calculate (i) the threshold wavelength, (ii) energy (in eV) of an incident photon,

and (iii) maximum kinetic energy of emitted photoelectron.

[2024 • Set 55-5-2]

Q17. The threshold frequency for a metal is 3.0×10^{14} Hz. A beam of frequency 9.0×10^{14} Hz is incident on the metal. Calculate (i) the work function (in eV) of the metal and (ii) the maximum speed of photoelectrons.

[2024 • Set 55-5-3]

Q18. How does Einstein's photoelectric equation explain the emission of electrons from a metal surface? Explain briefly. Plot the variation of photocurrent with:

(a) collector plate potential for different intensity of incident radiation, and

(b) intensity of incident radiation.

[2023 • Set 55-1-1]

Q19. The threshold wavelength for a metal is 3315 Å{}. What should be the wavelength of light incident on the metal surface so that the maximum kinetic energy of the emitted photoelectrons be 1.25 eV?

[2023 • Set 55-1-2]

Q20. A particle is associated with a de Broglie wave of wavelength 1.2 nm. The kinetic energy of the particle is made four times. Calculate the new value of the wavelength of the wave.

[2023 • Set 55-1-3]

Q21. Calculate the wavelength of de Broglie waves associated with a proton having $\left(\frac{500}{1.673}\right)$ eV energy. How will the wavelength be affected for an alpha particle having the same energy?

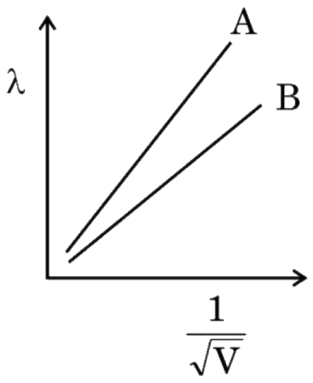
[2023 • Set 55-3-1]

Q22. (a) A particle of mass m and charge q is accelerated through a potential difference V. Plot a graph of de Broglie wavelength λ associated with it as a function of V.

(b) Calculate the energy acquired by, and de Broglie wavelength associated with, an electron accelerated through a potential difference of 400 V.

[2023 • Set 55-3-2]

Q23. (a) The figure shows de Broglie wavelength (λ) for two particles A and B having same charges but different masses as a function of $\frac{1}{\sqrt{V}}$, where V is the potential through which the particles are accelerated.



(i) Which of them is heavier and why? (ii) What does the slope of the line represent?

(b) Calculate the momentum of an electron having de Broglie wavelength of 3.0 Å.

[2023 • Set 55-3-3]

Q24. Photoelectrons are emitted from a metal surface when illuminated with UV light of wavelength 330 nm. The minimum amount of energy required to emit the electrons from the surface is 3.5×10^{-19} J. Calculate:

(i) the energy of the incident radiation, and

(ii) the kinetic energy of the photoelectron.

[2022 • Set 55-1-1]

Q25. Ultra-violet light of wavelength 200 nm from a source is incident on a metal surface. If the stopping potential is -2.5 V, (a) calculate the work function of the metal, and (b) How would the surface respond to a high intensity red light of wavelength 6328 Å produced by a laser?

[2022 • Set 55-1-2]

Q26. The de-Broglie wavelength associated with an electron is 0.30 nm. Calculate: (a) the speed, and (b) the kinetic energy (in eV), of the electron.

[2022 • Set 55-1-3]

Q27. Find the ratio of the de Broglie wavelengths associated with an alpha particle and a proton, if both

(a) have the same speeds,

(b) have the same kinetic energy,

(c) are accelerated through the same potential difference.

[2022 • Set 55-2-1]

Q28. An electron is accelerated from rest through a potential difference of 100 V. Find:

(i) the wavelength associated with

(ii) the momentum of and

(iii) the velocity required by, the electron.

[2022 • Set 55-3-1]

Q29. (a) Calculate the frequency of a photon of energy 6.5×10^{-19} J.

(b) Can this photon cause emission of an electron from the surface of Cs of work function 2.14 eV? If yes, what will be maximum kinetic energy of the photoelectron?

[2022 • Set 55-3-2]

Q30. The work function of a metal is 2.31 eV. Photoelectric emission occurs when light of frequency 6.4×10^{14} Hz is incident on the metal surface. Calculate:

(i) the energy of the incident radiation,

(ii) the maximum kinetic energy of the emitted electron and

(iii) the stopping potential of the surface.

[2022 • Set 55-3-3]

Q31. (a) Use Einstein's photoelectric equation to depict the variation of the maximum kinetic energy (E_k) of electrons emitted, with the frequency (ν) of the incident radiation.

(b) A photosensitive surface is illuminated with a beam of (i) yellow light, and (ii) red light, both of the same intensity. In which case will (I) photoelectrons have more E_k? (II) more number of electrons be emitted? Justify your answer in each case.

[2022 • Set 55-4-1]

Q32. The wavelength of the waves associated with a particle having kinetic energy E is λ. How and by what factor should its kinetic energy be changed so that the wavelength becomes $\left(\frac{\lambda}{3}\right)$? Also, find the ratio of the final to the initial velocity of the particle.

[2022 • Set 55-4-2]

Q33. A proton is accelerated through a potential difference V. After acceleration, the de Broglie wavelength associated with it is λ. If the proton is replaced by an alpha particle, then find the de Broglie wavelength associated with it if it were accelerated through the same potential difference V. What will be the momentum of the alpha particle?

[2022 • Set 55-4-3]

Q34. (a) Calculate the energy and momentum of a photon in a monochromatic beam of wavelength 331.5 nm.

(b) How fast should a hydrogen atom travel in order to have the same momentum as that

of the photon in part (a)?

[2022 • Set 55-5-1]

Q35. An alpha particle is accelerated through a potential difference of 100 V. Calculate:

(i) The speed acquired by the alpha particle, and

(ii) The de-Broglie wavelength associated with it. (Take mass of alpha particle $= 6.4 \times 10^{-27}$ kg)

[2022 • Set 55-5-2]

Q36. (a) Give an example each of a metal from which photoelectric emission takes place when irradiated by (i) UV light (ii) visible light.

(b) The work function of a metal is 4.50 eV. Find the frequency of light to be used to eject electrons from the metal surface with a maximum kinetic energy of 6.06×10^{-19} J.

[2022 • Set 55-5-3]

Q37. The maximum kinetic energy of the photoelectrons emitted is doubled when the wavelength of light incident on the photosensitive surface changes from λ_1 to λ_2. Deduce expressions for the threshold wavelength and work function for the metal surface in terms of λ_1 and λ_2.

[2020 • Set 55-2-1]

Q38. What do you mean by wave nature of an electron? How was quantisation of angular momentum of the orbiting electron in Bohr's model of hydrogen atom explained by de Broglie hypothesis?

[2020 • Set 55-3-1]

Q39. (a) Plot a graph to show the variation of stopping potential with frequency of incident radiation in relation to photoelectric effect.

(b) Use Einstein's photoelectric equation to show how from this graph, (i) Threshold frequency, and (ii) Planck's constant can be determined.

OR

(a) How does one explain the emission of electrons from a photosensitive surface with the help of Einstein's photoelectric equation?

(b) Work function of aluminium is 4.2 eV. If two photons each of energy 2.5 eV are incident on its surface, will the emission of electrons take place? Justify your answer.

(c) The stopping potential in an experiment on photoelectric effect is 1.5 V. What is the maximum kinetic energy of the photoelectrons emitted? Calculate in Joules.

[2019 • Set 55-3-1]

Q40. **(a)** State briefly, with what purpose was Davisson and Germer experiment performed and what inference was drawn from this.

(b) Obtain an expression for the ratio of the accelerating potentials required to accelerate a proton and an α-particle to have the same de-Broglie wavelength associated with them.

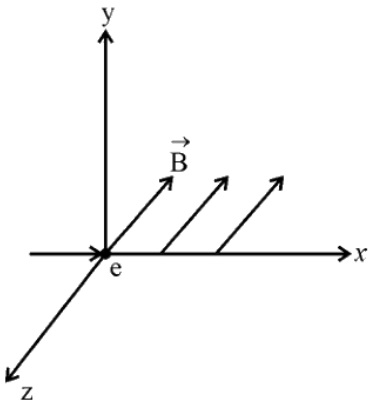
OR

(a) An electron and a proton are accelerated through the same potential. Which one of the two has (i) greater value of de-Broglie wavelength associated with it, and (ii) lesser momentum? Justify your answer in each case.

(b) How is the momentum of a particle related with its de-Broglie wavelength? Show the variation on a graph.

[2019 • Set 55-4-1]

Q41. When a given photosensitive material is irradiated with light of frequency ν, the maximum speed of the emitted photoelectrons equals v_{max}. The graph shown in the figure gives a plot of v_{max}^2 varying with frequency ν.



Obtain an expression for

(a) Planck's constant, and

(b) The work function of the given photosensitive material in terms of the parameters 'l', 'n' and the mass 'm' of the electron.

(c) How is threshold frequency determined from the plot?

[2019 • Set 55-5-1]

Q42. When light of frequency ν_1 is incident on a photosensitive surface, the stopping potential is V_1. If the frequency of incident radiation becomes $\nu_1/2$, the stopping potential changes to V_2. Find out the expression for the threshold frequency for the surface in terms of V_1 and V_2. If the frequency of incident radiation is doubled, will the maximum kinetic

energy of the photoelectrons also be doubled? Give reason.

[2019 • Set 55-5-2]

Q43. Write Einstein's photoelectric equation using the quantum picture of radiation. Explain briefly the three characteristic features observed in photoelectric effect which can be explained by Einstein's equation and not by the wave theory of light.

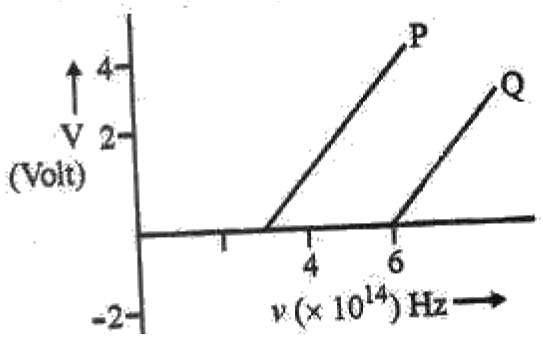
[2019 • Set 55-5-3]

Q44. **(i)** How does one explain the emission of electrons from a photosensitive surface with the help of Einstein's photoelectric equation?

(ii) The work function of the following metals is given: $\mathrm{Na} = 2.75\ \mathrm{eV}$, $\mathrm{K} = 2.3\ \mathrm{eV}$, $\mathrm{Mo} = 4.17\ \mathrm{eV}$ and $\mathrm{Ni} = 5.15\ \mathrm{eV}$. Which of these metals will not cause photoelectric emission for radiation of wavelength $3300\ \text{Å}$ from a laser source placed $1\ \mathrm{m}$ away from these metals? What happens if the laser source is brought nearer and placed $50\ \mathrm{cm}$ away?

[2017]

Q45. In the study of a photoelectric effect the graph between the stopping potential V and frequency ν of the incident radiation on two different metals P and Q is shown below:



(i) Which one of the two metals has higher threshold frequency?

(ii) Determine the work function of the metal which has greater value.

(iii) Find the maximum kinetic energy of electron emitted by light of frequency $8 \times 10^{14}\ \mathrm{Hz}$ for this metal.

[2017]

Q46. **(i)** State two important features of Einstein's photoelectric equation.

(ii) Radiation of frequency $10^{15}\ \mathrm{Hz}$ is incident on two photosensitive surfaces P and Q. There is no photoemission from surface P. Photoemission occurs from surface Q but photoelectrons have zero kinetic energy. Explain these observations and find the value of work function for surface Q.

[2017]

Q47. (a) Draw a plot showing the variation of photoelectric current with collector potential for different frequencies but same intensity of incident radiation.

(b) Use Einstein's photoelectric equation to explain the observations from this graph.

(c) What change will you observe if intensity of incident radiation is changed but the frequency remains the same?

[2017]

Q48. (a) Draw a graph showing variation of photocurrent with anode potential for a particular intensity of incident radiation. Mark saturation current and stopping potential.

(b) By how much would the stopping potential for a given photosensitive surface go up if the frequency of the incident radiations were to be increased from 4×10^{15} Hz to 8×10^{15} Hz?

[2017]

Q49. Using photon picture of light, show how Einstein's photoelectric equation can be established. Write two features of photoelectric effect which cannot be explained by wave theory.

[2017]

Q50. Explain giving reasons for the following:

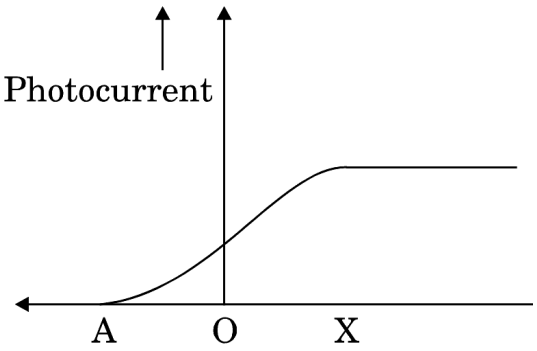
(a) Photoelectric current in a photocell increases with the increase in the intensity of the incident radiation.

(b) The stopping potential (V_0) varies linearly with the frequency (ν) of the incident radiation for a given photosensitive surface with the slope remaining the same for different surfaces.

(c) Maximum kinetic energy of the photoelectrons is independent of the intensity of incident radiation.

[2017]

Q51. The following graph shows the variation of photocurrent for a photosensitive metal:



(a) Identify the variable X on the horizontal axis.

(b) What does the point A on the horizontal axis represent?

(c) Draw this graph for three different values of frequencies of incident radiation ν_1, ν_2 and ν_3 ($\nu_1 > \nu_2 > \nu_3$) for same intensity.

(d) Draw this graph for three different values of intensities of incident radiation I_1, I_2 and I_3 ($I_1 > I_2 > I_3$) having same frequency.

[2017]

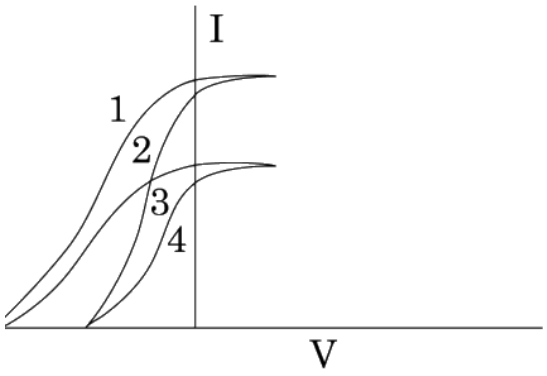
Q52. Sketch the graphs showing variation of stopping potential with frequency of incident radiations for two photosensitive materials A and B having threshold frequencies $\nu_A > \nu_B$.

(i) In which case is the stopping potential more and why?

(ii) Does the slope of the graph depend on the nature of the material used? Explain.

[2016]

Q53. The given graph shows the variation of photo-electric current (I) with the applied voltage (V) for two different materials and for two different intensities of the incident radiations. Identify and explain using Einstein's photo electric equation the pair of curves that correspond to (i) different materials but same intensity of incident radiation, (ii) different intensities but same materials.



[2016]

Q54. State two important properties of photon which are used to write Einstein's photoelectric equation. Define (i) stopping potential and (ii) threshold frequency, using Einstein's equation and drawing necessary plot between relevant quantities.

[2016]

Q55. (a) Define the term 'intensity of radiation' in photon picture.

(b) Plot a graph showing the variation of photo current vs collector potential for three different intensities $I_1 > I_2 > I_3$, two of which (I_1 and I_2) have the same frequency ν

and the third has frequency $\nu_1 > \nu$.

(c) Explain the nature of the curves on the basis of Einstein's equation.

[2016]

Q56. (a) Define the term 'intensity of radiation' in terms of photon picture of light.

(b) Two monochromatic beams, one red and the other blue, have the same intensity. In which case (i) the number of photons per unit area per second is larger, (ii) the maximum kinetic energy of the photoelectrons is more? Justify your answer.

[2015]

Q57. Write Einstein's photoelectric equation and mention which important features in photoelectric effect can be explained with the help of this equation. The maximum kinetic energy of the photoelectrons gets doubled when the wavelength of light incident on the surface changes from λ_1 to λ_2. Derive the expressions for the threshold wavelength λ_0 and work function for the metal surface.

[2015]

Q58. An electron microscope uses electrons accelerated by a voltage of 50 kV. Determine the de-Broglie wavelength associated with the electrons. Taking other factors, such as numerical aperture etc. to be same, how does the resolving power of an electron microscope compare with that of an optical microscope which uses yellow light ?

[2014]

Q59. (a) Why photoelectric effect can not be explained on the basis of wave nature of light? Give reasons.

(b) Write the basic features of photon picture of electromagnetic radiation on which Einstein's photoelectric equation is based.

[2013]

Q60. Define the terms (i) 'cut-off voltage' and (ii) 'threshold frequency' in relation to the phenomenon of photoelectric effect. Using Einstein's photoelectric equation show how the cut-off voltage and threshold frequency for a given photosensitive material can be determined with the help of a suitable plot/graph.

[2012]

Q61. Write Einstein's photoelectric equation. State clearly how this equation is obtained using the photon picture of electromagnetic radiation. Write the three salient features observed in photoelectric effect which can be explained using this equation.

[2012]

Q62. Write two characteristic features observed in photoelectric effect which support the

photon picture of electromagnetic radiation. Draw a graph between the frequency of incident radiation (ν) and the maximum kinetic energy of the electrons emitted from the surface of a photosensitive material. State clearly how this graph can be used to determine (i) Planck's constant and (ii) work function of the material.

[2012]

Q63. Draw a plot showing the variation of photoelectric current with collector plate potential for two different frequencies, $\nu_1 > \nu_2$, of incident radiation having the same intensity. In which case will the stopping potential be higher? Justify your answer.

[2011]

Q64. An electron and a photon each have a wavelength 1.00 nm. Find

(i) their momenta,

(ii) the energy of the photon and

(iii) the kinetic energy of electron.

[2011 • Set 55-1-1]

Q65. Light of wavelength 2000 Å falls on a metal surface of work function 4.2 eV. What is the kinetic energy (in eV) of the fastest electrons emitted from the surface?

(i) What will be the change in the energy of the emitted electrons if the intensity of light with same wavelength is doubled?

(ii) If the same light falls on another surface of work function 6.5 eV, what will be the energy of emitted electrons?

[2011 • Set 55-2-1]

Q66. A proton and an alpha particle are accelerated through the same potential. Which one of the two has (i) greater value of de-Broglie wavelength associated with it, and (ii) less kinetic energy? Justify your answers.

[2009]

Q67. An electromagnetic wave of wavelength λ is incident on a photosensitive surface of negligible work function. If the photo-electrons emitted from this surface have the de-Broglie wavelength λ_1, prove that $\lambda = \frac{2mc}{h}\lambda_1^2$.

[2008]

Q68. In a plot of photoelectric current versus anode potential, how does

(i) the saturation current vary with anode potential for incident radiations of different frequencies but same intensity?

(ii) the stopping potential vary for incident radiations of different intensities but same

frequency?

(iii) photoelectric current vary for different intensities but same frequency of incident radiations? Justify your answer in each case.

[2007]

Q69. Draw a schematic diagram of the experimental arrangement used by Davisson and Germer to establish the wave nature of electrons. Explain briefly how the de-Broglie relation was experimentally verified in case of electrons.

[2007]

Q70. Define the terms threshold frequency and stopping potential in relation to the phenomenon of photoelectric effect. How is the photoelectric current affected on increasing the (i) frequency (ii) intensity of the incident radiations and why?

[2006]

Q71. Ultraviolet light of wavelength 2271 Å from a 100 W mercury source radiates a photo cell made of molybdenum metal. If the stopping potential is 1.3 V, estimate the work function of the metal. How would the photo cell respond to high intensity (10^5 W m^{-2}) red light of wavelength 6328 Å produced by a He-Ne laser? Plot a graph showing the variation of photoelectric current with anode potential for two light beams of same wavelength but different intensity.

[2005]

Q72. Define the term 'work function' of a metal. The threshold frequency of a metal is f_0. When the light of frequency $2f_0$ is incident on the metal plate, the maximum velocity of electrons emitted is v_1. When the frequency of the incident radiation is increased to $5f_0$, the maximum velocity of electrons emitted is v_2. Find the ratio of v_1 to v_2.

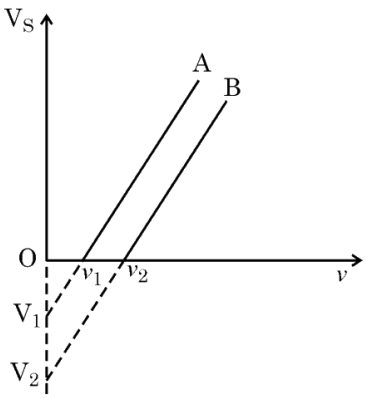
[2004]

Q73. Why are de-Broglie waves associated with a moving football not visible? The wavelength λ of a photon and the de-Broglie wavelength of an electron have the same value. Show that the energy of the photon is $\frac{2mc\lambda}{h}$ times the kinetic energy of the electron, where m, c and h have their usual meanings.

[2003]

4-Mark Questions (3 questions · Section D · Case Study)

Q1. A researcher performs an experiment on photo-electric effect using two metals A and B with unknown work functions. She illuminates the surfaces of A and B with monochromatic radiation of various frequencies and records the value of corresponding stopping potentials (V_s). The graph shows the variation of stopping potential (V_s) with the frequency of incident radiation (ν) for metals A and B.



[2026 • Set 55-1-1]

Q2. Figure shows the variation of photoelectric current measured in a photo cell circuit as a function of the potential difference between the plates of the photo cell when light beams A, B, C and D of different wavelengths are incident on the photo cell. Examine the given figure and answer the following questions:

(i) Which light beam has the highest frequency and why?

(ii) Which light beam has the longest wavelength and why?

(iii) Which light beam ejects photoelectrons with maximum momentum and why?

[2023 • Set 55-2-1]

Q3. What is the effect on threshold frequency and stopping potential on increasing the frequency of incident beam of light? Justify your answer.

[2023 • Set 55-2-1]