DUAL NATURE OF MATTER & RADIATION

1. **STATEMENT - 1** The number of photoelectrons emitted by a metal plate illuminated by light of a certain frequency, greater than the threshold of frequency, depends on the area of the plate.
STATEMENT - 2 The number of; electrons emitted per second will depend on the number of photons falling on the plate per second.
(a) Statement -1 and Statement - 2 are True
(b) Statement -1 and Statement - 2 are False.
(c) Statement - 1 is True, Statement - 2 is False.
(d) Statement - 1 is False, Statement - 2 is True.

2. A particle of mass M at rest decays into two particles of masses m_1 and m_2 having nonzero velocities. The ratio of the de Broglie wavelength of the particles -
(a) $\frac{m_1}{m_2}$ (b) $\frac{m_2}{m_1}$
(c) 1 (d) $\sqrt{\frac{m_2}{m_1}}$

3. The de Broglie wavelength of a bus moving with speed v is λ. Some passengers left the bus at a stopage. Now when the bus moves with twice its initial speed. Now kinetic energy is found to be twice its initial value. What will be the de Broglie wavelength, now -
(a) λ (b) 2λ
(c) λ/2 (d) λ/4

4. The number of photons of wavelength 540 nm emitted per second by an electric bulb of power 100 W is (taking $h = 6 \times 10^{-34}$ j-s).
(a) 100 (b) 1000
(c) 3×10^{20} (d) 3×10^{18}

5. A proton accelerated through d potential difference of 100V, has de-Broglie wavelength λ_0. The de-Broglie wavelength of an α-particle, accelerated through 800V is-
(a) $\lambda_0/\sqrt{2}$ (b) $\lambda_0/2$
(c) $\lambda_0/4$ (d) $\lambda_0/8$

6. The magnitude of the de Broglie wavelength (λ) of an electon (e), proton (p), neutron (n) and α particle (α) all having the same energy of MeV, in the increasing order will follow the sequence - ^
(a) $\lambda_e, \lambda_p, \lambda_n, \lambda_\alpha$ (b) $\lambda_\alpha, \lambda_n, \lambda_p, \lambda_e$
(c) $\lambda_e, \lambda_n, \lambda_p, \lambda_\alpha$ (d) $\lambda_p, \lambda_e, \lambda_\alpha, \lambda_n$

7. De Broglie wavelength of an electron in the n^{th} bohr orbit is λ_n and angular momentum is J_n then-
(a) $J_n \propto \lambda_n$ (b) $\lambda_n \propto 1/J_n$
(c) $\lambda_n \propto J_n^2$ (d) None of these

8. A proton with KE equal to that a photon (E = 100 keV). λ_1 is the wavelength of proton and λ_2 is the wavelength of photon. Then λ_1/λ_2 is proportional to -
(a) $E^{1/2}$ (b) $E^{-1/2}$
(c) E (d) E^{-1}

9. An electron of mass m and charge e initially at rest gets accelerated by a constant electric field E. The negative rate of change of De-Broglie wavelength of this electron at time t is-
(a) $\frac{2h}{eEt^2}$ (b) $-\frac{2h}{eEt^2}$
(c) $\frac{h}{eEt^2}$ (d) $-\frac{h}{eEt^2}$

10. Number of identical photons incident on a perfectly black body of mass m kept at rest on smooth horizontal surface. Then the acceleration of the body if n number of photons incident per second is: (Assume wavelength of photon to be λ)
(a) $\frac{nh}{2\pi\lambda m}$ (b) $\frac{nh}{\lambda m}$
(c) $\frac{2\pi nh}{\lambda m}$ (d) $\frac{\lambda m}{nh}$

11. λ is proportional to -
(a) $\frac{1}{E}$ for both photons and particles
(b) $\frac{1}{E}$ for photons, $\frac{1}{\sqrt{E}}$ for particle
(c) $\frac{1}{\sqrt{E}}$ for both photons and particles
(d) $\frac{1}{\sqrt{E}}$ for photons, $\frac{1}{E}$ for particles

12. A radiation of energy E falls normally on a perfectly reflecting surface. Find the change in momentum -
(a) E/c (b) 2E/c
(c) Ec (d) E/c^2

13. A double slit interference experiment is performed by a beam of electrons of energy 100 eV and the fringe spacing is observed to be β. Now if the electrons energy is increased to 10 keV, then the fringe spacing -
(a) remains the same (b) becomes 10β
(c) becomes 100β (d) becomes β/10

14. In Davisson-Germer experiment maximum intensity is observed at -
(a) 50° and 54 volt (b) 54° and 50 volt
(c) 50° and 50 volt (d) 65° and 50 volt

15. The interatomic distance between atoms in a crystal is 2.8Å. Then if such a crystal is used in Davisson-Germer experiment, the maximum order of diffraction that can be observed for a beam of electrons accelerated by 100V shall be -
(a) n = 1 (b) n = 2
(c) n = 10 (d) n = ∞

16. In Davisson-Germer experiment the relation between Bragg's angle ϕ and diffraction angle θ is-

(a) $\theta = 90° - \phi$ (b) $\theta = \frac{90°-\phi}{2}$

(c) $\theta = 180° - \phi$ (d) $\phi = \left(\frac{180°-\theta}{2}\right)$

17. **STATEMENT - 1** An insulated metal plate emits photoelectrons when first illuminated by ultraviolet light but then the number of photoelectrons emitted per unit time decreases until it stops altogether.

STATEMENT - 2 As more and more electrons leave the plate, its potential increases, decreasing the number of free electrons and finally stopping them.

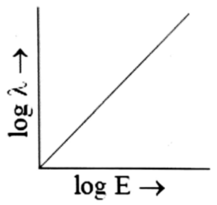
(a) Statement -1 and Statement - 2 are True

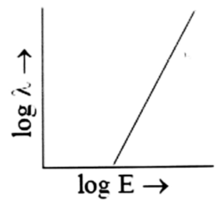
(b) Statement - 1 and Statement - 2 are False.

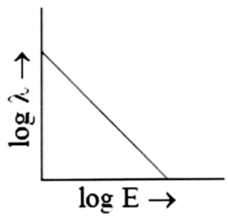
(c) Statement - 1 is True, Statement - 2 is False.

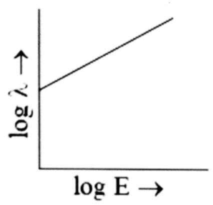
(d) Statement -1 is False, Statement - 2 is True.

18. The log-log graph between the energy E of an electron and its de-Broglie wavelength λ will be -

(a) 

(b) 

(c) 

(d) 

19. The de-Broglie wavelength of a vehicle moving with velocity v is λ. Its load is changed so that the velocity as well as the momentum are doubled. Then the new de-Broglie wavelength of the vehicle will be-

(a) λ (b) 2λ

(c) $\lambda/2$ (d) $\lambda/4$

20. An electron moving with a velocity of 10^6 m/s in the X-direction enters a region of uniform magnetic field of strength 0.2T in Y-direction. Then its de-Broblie wavelength (in the magnetic field region in comparison to outside)-

(a) increases

(b) decreases

(c) remains the same

(d) nothing can be predicted

21. The wavelength of a photon is equal to the de-Broglie wavelength of a thermal neutron at 127°C. The energy of that photon is-

(a) 6×10^3 eV (b) 3×10^4 eV

(c) 8.0×10^3 eV (d) 1.2×104 eV

22. A proton and an α-particle are accelerated through the same potential differences. The ratio of their de-Broglie wavelengths λ_p/λ_a is

(a) 1 (b) 2

(c) $\sqrt{8}$ (d) $1/\sqrt{8}$

23. The ratio of de-Broglie wavelength of molecules of hydrogen and helium in two gas jars kept separately at temperatures of 27°C and 127°C respectively is -

(a) $2/\sqrt{3}$ (b) 2/3

(c) $\sqrt{3}/4$ (d) $\sqrt{8/3}$

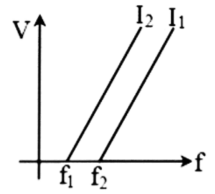
24. If the kinetic energy of the particle is increased by 16 times, the percentage change in the de-Broglie wavelength of the particle is-

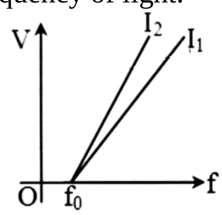
(a) 25% (b) 75%

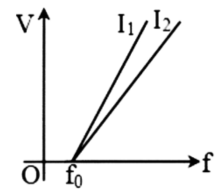
(c) 60% (d) 50%

25. A photoelectric experiment is performed at two different light intensities I_1 and I_2 ($>I_1$).

Choose the correct graph showing the variation of stopping potential versus frequency of light.

(a) 

(b) 

(c) 

(d) None of these

26. Choose the correct statement (s) related to the photocurrent and the r potential difference between the If plate and the collector-

(a) Photocurrent always increase with the increase in potential difference

(b) when the potential difference is zero, the photocurrent is also zero

(c) Photocurrent attain a saturation value of some positive value of the potential difference

(d) None of these

27. The collector plate in an experiment on photoelectric effect is kept vertically above the emitter plate. Light source is put on and a saturation photocurrent is recorded. An electric field is switched on which has a vertically downward direction.

(a) The photocurrent will increase

(b) The kinetic energy of the electrons will increase

(c) The stopping potential will decrease

(d) The threshold wavelength will increase

28. The frequency and intensity of a light source are both doubled. Consider the following statements.
(a) The saturation photocurrent remains almost the same.
(b) The maximum kinetic energy off the photoelectrons is doubled.
(a) Both a and b are true
(b) a is true but b is false
(c) a is false but b is true
(d) Both a and b are false

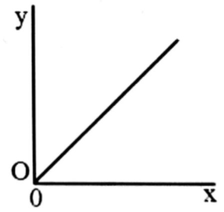
29. Match column I with column II

COLUMN I	COLUMN II
(A) De-Broglie wavelength associated with electron in	(P) $\frac{0.286}{\sqrt{V}}$
(B) De-Broglie wavelength associated with proton in A	(Q) $\frac{0.202}{\sqrt{V}}$
(C) De-Broglie wavelength associated with alpha particle in	(R) $\frac{12.27}{\sqrt{V}}$
(D) De-Broglie wavelength associated with deuteron in A	(S) $\frac{0.101}{\sqrt{V}}$

(a) A→Q;B→R;C→P;D→S
(b) A→R;B→P;C→S;D→Q
(c) A→S;B→R;C→P;D→Q
(d) A→P;B→R;C→Q;D→S

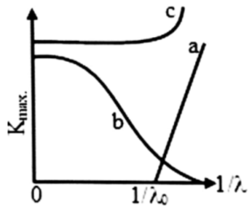
30. It takes 4.2 eV to remove one of the feast tightly bound electrons from a metal surface. When UV photons of a single frequency strike a metal, electrons with kinetic energies ranging from 0 to 2.6 eV are ejected. The energy of incident photon is -
(a) 2.6 eV (b) 6.8 eV
(c) 13.6 eV (d) 13.6/4 eV

31. In a series of photoelectric emission experiments on a certain metal surface, possible relationships between the following quantities were investigated threshold frequency f_0, light intensity P, photocurrent I, maximum kinetic; energy of photoelectrons T_{max}.



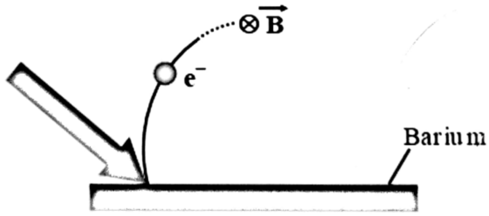
Two of these quantities, when plotted "as a graph of y against x, give a straight line through the origin. Which of the following correctly identifies x and y with the photoelectric quantities?
(a) X = I; Y = f_0 (b) X = f; Y = T_{max}
(c) X = P; Y = I (d) X = P; Y = T_{max}

32. The correct graph between the maximum energy of a photoelectron and the inverse of wavelength of the incident radiation is given by the curve -



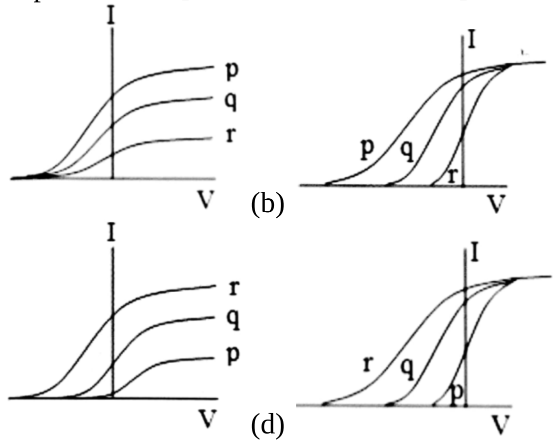
(a) a (b) b
(c) c (d) None of above

33. Light of wavelength 2475 Å is incident on barium. Photoelectrons emitted describe a circle of radius 100 cm by a magnetic field of flux density $\frac{1}{\sqrt{17}} \times 10^{-5}$ Tesla. Work function of the barium is (Given $\frac{e}{m}$ = 1.7 × 10^{11})-



(a) 1.8 eV (b) 2.1 eV
(c) 4.5 eV (d) 3.3 eV

34. Photoelectric effect experiments are performed using three different metal plates p, q and r having work functions ϕ_p = 2.0 eV, ϕ_q = 2.5 eV and ϕ_r = 3.0 eV, respectively. A light beam containing wavelengths of 550 nm, v 450 nm and 350 nm with equal intensities illuminates each of the' plates. The correct I-V graph for the experiment is: [Take he = 1240 eV nm]



35. When the electromagnetic radiations of frequencies 4 × 10^{15} Hz and 6 × 10^{15} Hz fall on the same metal, in different experiments, the ratio of maximum kinetic energy of electrons liberated is 1 : 3. The threshold frequency for the metal is:
(a) 2 × 10^{15} Hz (b) 1 × 10^{15} Hz
(c) 1 × 10^{15} Hz (d) 1.67 × 10^{15} Hz

36. When one centimetre thick surface is illuminated with light of wavelength λ, the stopping potential is V. When the same surface is illuminated by light of

wavelength 2λ, stopping potential is $\frac{V}{3}$, threshold wavelength for metallic surface is :

(a) $\frac{4\lambda}{3}$ (b) 4λ

(c) 6λ (d) $\frac{8\lambda}{3}$

37. The surface of a metal is illuminated with the light of 400 run. The kinetic energy of the ejected photoelectrons was found to be 1.68 eV. The work function of the metal is (hc = 1240 eV nm)-

(a) 3.09 eV (b) 1.41 eV

(c) 1.51 eV (d) 1.68 eV

38. A non-monochromatic light is used in v an experiment on photoelectric effect. The stopping potential -

(a) is related to the mean wavelength

(b) is related to the longest wavelength

(c) is related to the shortest wavelength

(d) is not related to the wavelength

39. The electric field associated with a light wave is $E = E_0 \sin [1.57 \times 10^7 (x - ct)]$ where x is in metre and t is in in second. If this light is used to produce photoelectric emission from the surface of a metal of work function 1.9 eV, then the stopping potential will be -

(a) 1.2 V (b) 1.5 V

(c) 1.75 V (d) 1.75 V

40. When a light source is placed at a distance of 1m from the emitter, it emits electrons of energy 4 eV. If the distance is changed to 0.5 m, then -

(a) the number of electrons emitted will be same but their energy will become double

(b) the number of electrons emitted will be same but their energy will become four times

(c) it will emit twice the number of electrons of same energy

(d) It will emit four times the number of electrons in earlier case with same energy

41. In photoelectric effect, the number of photoelectrons emitted is proportional to -

(a) intensity of incident beam

(b) frequency of incident beam

(c) velocity of incident beam

(d) work function of photo cathode

42. Light of wavelength λ strikes a photosensitive surface and electrons are ejected with kinetic energy E. If the kinetic energy is to be increased to 2E, the wavelength must be changed to λ' where-

(a) $\lambda' = \frac{\lambda}{2}$ (b) $\lambda' = 2\lambda$

(c) $\frac{\lambda}{2} < \lambda' < \lambda$ (d) $\lambda' = \lambda$

43. How many photons are emitted by a laser source of 5×10^{-3} W operating at 632.2 nm in 2 seconds-

(a) 3.2×10^{16} (b) 1.6×10^{16}

(c) 8.4×10^{16} (d) None of these

44. The maximum kinetic energy of photoelectrons emitted from a surface when photons of energy 6 eV fall on it is 4 eV. The stopping potential in volt is -

(a) 2 (b) 4

(c) 6 (d) 10

45. The work function of a metal is 2.3 eV. If light of wave number 2×10^6 m^{-1} falls on it, the kinetic energies of fastest and slowest ejected electron will be respectively-

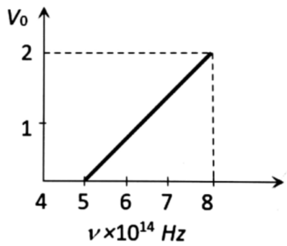
(a) 2.48 eV and 0.18 eV

(b) 0.18 eV and 0.18 eV

(c) 1.8 eV and 0.18 eV

(d) 0.18 eV and zero

46. The stopping potential (V_0) versus frequency (v) plot of a substance is shown in figure the threshold wave length is?



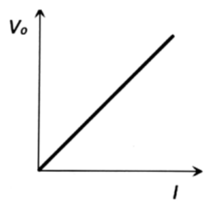
(a) 5×10^{14} m

(b) 6000 Å

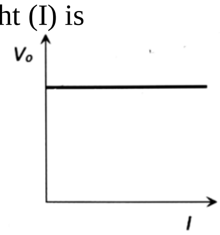
(c) 5000 Å

(d) Cannot be estimated from given data

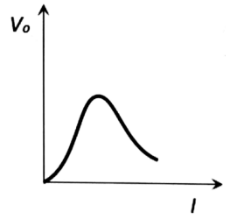
47. The correct curve between the stopping potential (V) and intensity of incident light (I) is



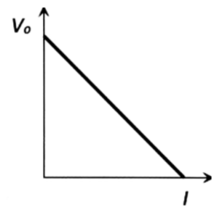
(a)



(b)



(c)



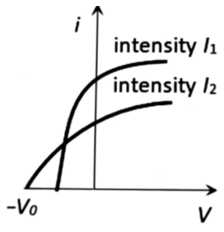
(d)

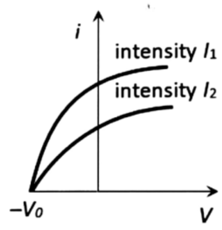
48. A particle A has a charge q and particle B has charge +4q with each of them having the mass m. When they are allowed to move From rest through same potential difference, the ratio of their de Droglie wavelengths $\lambda_A : \lambda_B$ will be

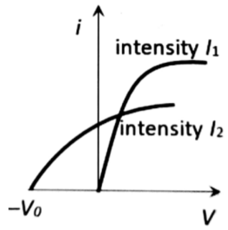
(a) 4:1 (b) 1:4

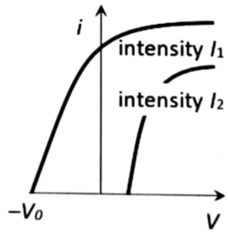
(c) 1:2 (d) 2:1

49. The curves (a), (b) (c) and (d) show the variation between the applied potential difference (V) and the photoelectric current (i), at two different intensities of light ($I_1 > I_2$). In which figure is the correct variation shown

(a)


(b)


(c)


(d)


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

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