Subject : Physics **Topic : Dual Nature of Matter and Radiation** **M.M. : 180**

Marking Scheme:
(i) Each question is allotted 4 (four) marks for each correct response.
(ii) ¼ (one fourth) marks will be deducted for indicating incorrect response of each question. No deduction from the total score will be made if no response is indicated for an item in the answer sheet.

Q.1 The de-broglie wavelength of the electron in the second Bohr orbit is (given the radius of the first orbit r_1 = 0.53 Å)
(1) 3.33 Å (2) 6.66 Å
(3) 9.99 Å (4) 1.06 Å

Q.2 The de-Broglie wavelength associated with an electron having a kinetic energy of 10 eV is
(1) 10 Å (2) 12.27 Å
(3) 3.9 Å (4) 0.10 Å

Q.3 The work function for tungsten and sodium are 4.5eV and 2.3 eV respectively. If the threshold wavelength λ for sodium is 5460Å, the value of λ for tungsten is
(1) 5893 Å (2) 10683 Å
(3) 2791 Å (4) 528 Å

Q.4 Light of wavelength 4000 Å is incident on a sodium surface for which the threshold wave length of photoelectrons is 5420 Å. The work function of sodium is
(1) 4.58 eV (2) 2.29 eV
(3) 1.14 eV (4) 0.57 eV

Q.5 Work function of a metal is 2.51 eV. Its threshold frequency is
(1) 5.9×10^{14} cycle/sec
(2) 6.5×10^{14} cycle/sec
(3) 9.4×10^{14} cycle/sec
(4) 6.08×10^{14} cycle/sec

Q.6 The photoelectric work function for a metal surface is 4.125eV. The cut-off wavelength for this surface is
(1) 4125 Å (2) 2062.5 Å
(3) 3000 Å (4) 6000 Å

Q.7 A radio transmitter radiates 1 kW power at a wavelength 198.6 metres. How many photons does it emit per second
(1) 10^{10} (2) 10^{20}
(3) 10^{30} (4) 10^{40}

Q.8 If the energy of a photon corresponding to a wavelength of 6000 Å is 3.32×10^{-19} J, the photon energy for a wavelength of 4000 Å will be
(1) 1.4 eV (2) 4.9 eV
(3) 3.1 eV (4) 1.6 eV

Q.9 The work functions of Silver and Sodium are 4.6 and 2.3 eV, respectively. The ratio of the slope of the stopping potential versus frequency plot for Silver to that of Sodium is –
(1) 1 (2) 2
(3) 3 (4) 4

Q.10 When the X-ray tube is operated at 1KV, then X-rays of minimum wavelength 6.22 Å are produced. If the tube is operated at 10 KV, then the minimum wavelength of x-rays will be-
(1) 0.622 Å (2) 6.22 Å
(3) 3.11 Å (4) zero

Q.11 The ratio of energies of x-rays of the wavelength 0.01Å and 0.5 Å will be-
(1) 1 : 1 (2) 1 : 2
(3) 1 : 5 (4) 50 : 1

Q.12 Formation of covalent bonds in compounds exhibits
(1) Wave nature of electron
(2) Particle nature of electron
(3) Both wave and particle nature of electron
(4) None of these

Q.13 If the kinetic energy of a free electron doubles, its deBroglie wavelength changes by the factor
(1) 1/2 (2) 2
(3) $1/\sqrt{2}$ (4) $\sqrt{2}$

Q.14 The work functions of potassium and sodium are 4.5eV and 2.3eV respectively. The approximate ratio of their threshold wavelength will be -
(1) 1 : 2 (2) 2 : 1
(3) 1 : 3 (4) 3 : 1

Q.15 The work function of a substance is 4.0 eV. The longest wavelength of light that can cause photoelectron emission from this substance is approximately –
(1) 310 nm (2) 400 nm
(3) 540 nm (4) 220 nm

Q.16 A photocell is illuminated by a small bright source placed 1m away. When the same source of light is placed 1/2m away, the number of electrons emitted by photocathode would –
(1) decrease by a factor of 4
(2) increase by a factor of 4
(3) decrease by a factor of 2
(4) increase by a factor of 2

Q.17 A certain metal when irradiated by light ($\nu = 3.2 \times 10^{16}$ Hz) emits photoelectrons with twice K.E. as did photoelectrons when the same metal is irradiated by light ($\nu = 2.0 \times 10^{16}$ Hz). The ν_0 of the metal is
(1) 1.2×10^{14} Hz (2) 8×10^{15} Hz
(3) 1.2×10^{16} Hz (4) 4×10^{12} Hz

Q.18 The surface of a metal is illuminated with the light of 400 nm. 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)
(1) 3.09 eV (2) 1.41 eV
(3) 1.51 eV (4) 1.68 eV

Q.19 When photon of energy 4.0 eV strikes the surface of a metal A, the ejected photoelectrons have maximum kinetic energy T_A eV end de-Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photon of energy 4.50 eV is $T_B = (T_A - 1.5)$ eV. If the de-Broglie wavelength of these photoelectrons $\lambda_B = 2\lambda_A$, then the work function of metal B is :
(1) 3 eV (2) 2 eV
(3) 4 eV (4) 1.5 eV

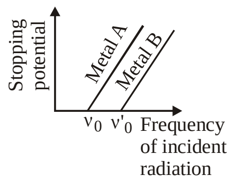
Q.20 The work function for Al, K and Pt is 4.28eV, 2.30eV and 5.65 eV respectively. Their respective threshold frequencies would be
(1) Pt > Al > K (2) Al > Pt > K
(3) K > Al > Pt (4) Al > K > Pt

Q.21 Consider a beam of electrons (each electron with energy E_0) incident on a metal surface kept in an evacuated chamber. Then –
(1) no electrons will be emitted as only photons can emit electrons.
(2) electrons can be emitted but all with an energy, E_0.
(3) electrons can be emitted with any energy, with a maximum of $E_0 - \phi$ (ϕ is the work function).
(4) electrons can be emitted with any energy, with a maximum of E_0.

Q.22 The de Broglie wavelength λ of an electron accelerated through a potential V in volt is –
(1) $\frac{1.227}{\sqrt{V}}$ nm (2) $\frac{0.1227}{\sqrt{V}}$ nm
(3) $\frac{0.01227}{\sqrt{V}}$ nm (4) $\frac{0.1227}{\sqrt{V}}$ nm

Q.23 In photoelectric effect, the photoelectric current is independent of
(1) intensity of incident light.
(2) potential difference applied between the two electrodes.
(3) the nature of emitter material.
(4) frequency of incident light.

Q.24 Variation of stopping potential V_0 with frequency ν of incident radiation for photosensitive materials A and B are shown.



From graph we conclude that
I. maximum kinetic energy of photoelectrons varies linearly with frequency.
II. for a frequency lower than a certain frequency photo emission is not possible.
III. density of metal A is more than that of B.
IV. metal A contains more electrons than that of B.
(1) I and II (2) I and IV
(3) III and IV (4) II and III

Q.25 The wavelength of a photon needed to remove a proton from a nucleus which is bound to the nucleus with 1 MeV energy is nearly
(1) 1.2 nm (2) 1.2×10^{-3} nm
(3) 1.2×10^{-6} nm (4) 1.2×10^{1} nm

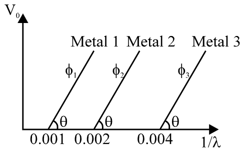
Q.26 The work function (ϕ) of some metals is listed below. The number of metals which will show photoelectric effect when light of 300 nm wavelength falls on the metal is

Metal	Li	Na	K	Mg	Cu
ϕ (eV)	2.4	2.3	2.2	3.7	4.8
Metal	Ag	Fe	Pt	W	
ϕ (eV)	4.3	4.7	6.3	4.75	

(1) 1 (2) 2
(3) 3 (4) 4

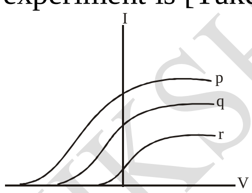
Q.27 The photoelectric threshold frequency of a metal is ν. When light of frequency 4ν is incident on the metal, the maximum kinetic energy of the emitted photoelectron is
(1) 4 $h\nu$ (2) 3 $h\nu$
(3) 5 $h\nu$ (4) (5/2) $h\nu$

Q.28 The graph between the stopping potential (V_0) and wave number ($1/\lambda$) is as shown in the figure. ϕ is the work function, then

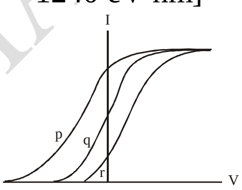


(1) $\phi_1 : \phi_2 : \phi_3 = 1 : 2 : 4$
(2) $\phi_1 : \phi_2 : \phi_3 = 4 : 2 : 1$
(3) Violet light (λ = 400nm) can be used to light photoelectrons from metal 2
(4) Both (1) and (3)

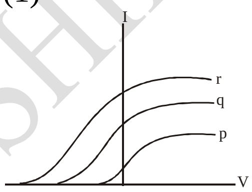
Q.29 Photoelectric effect experiments are performed using three different metal plates p, q and r having work functions ϕ_p = 2.0 eV, ϕ_q = 2.5 eV and ϕ_r = 3.0 eV respectively. A light beam containing wavelengths of 550nm, 450 nm and 350nm with equal intensities illuminates each of the plates. The correct I-V graph for the experiment is [Take hc = 1240 eV nm]



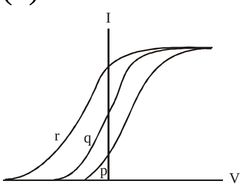
(1)



(2)



(3)



(4)

Q.30 A silver sphere of radius 1 cm and work function 4.7 eV is suspended from an insulating thread in free space. It is under continuous illumination of 200 nm wavelength light. As photoelectrons are emitted, the sphere gets charged and acquires a potential. The maximum number of photoelectrons emitted from the sphere is A × 10^Z (where 1 < A < 10). The value of Z is
(1) 4 (2) 5
(3) 6 (4) 7

Q.31 The work functions for metals A, B and C are respectively 1.92eV, 2.0eV and 5eV. According to Einstein's equation, the metals which will emit photoelectrons for a radiation of wavelength 4100Å is/are –
(1) none (2) A only
(3) A and B only (4) all three metals

Q.32 A photosensitive metallic surface has work function, $h\nu_0$. If photons of energy $2h\nu_0$ fall on this surface, the electrons come out with a maximum velocity of 4×10^6 m/s. When the photon energy is increased to 5 $h\nu_0$, then maximum velocity of photoelectrons will be –
(1) 2×10^7 m/s (2) 2×10^6 m/s
(3) 8×10^6 m/s (4) 8×10^5 m/s

Q.33 A photocell employs photoelectric effect to convert
(1) change in the intensity of illumination into a change in photoelectric current.
(2) change in the intensity of illumination into a change in the work function of the photocathode.
(3) change in the frequency of light into a change in the electric current.
(4) change in the frequency of light into a change in electric voltage.

Q.34 In a discharge tube ionization of enclosed gas is produced due to collisions between –
(1) negative electrons and neutral atoms/molecules.
(2) photons and neutral atoms/molecules.
(3) neutral gas atoms/molecules.
(4) positive ions and neutral atoms/molecules.

Q.35 The momentum of a photon of energy 1MeV in kg m/s, will be –
(1) 7×10^{-24} (2) 10^{-22}
(3) 5×10^{-22} (4) 0.33×10^6

Q.36 Monochromatic light of frequency 6.0×10^{14}Hz is produced by a laser. The power emitted is 2×10^{-3}W. The number of photons emitted, on the average, by the sources per second is –

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

Q.37 A 5 watt source emits monochromatic light of wavelength 5000Å. When placed 0.5m away, it liberates photoelectrons from a photosensitive metallic surface. When the source is moved to a distance of 1.0m, the number of photoelectrons liberated will be reduced by a factor of –

(1) 8 (2) 16
(3) 2 (4) 4

Q.38 The work function of a surface of a photosensitive material is 6.2 eV. The wavelength of the incident radiation for which the stopping potential is 5V lies in the –

(1) X-ray region (2) Ultraviolet region
(3) Visible region (4) Infrared region

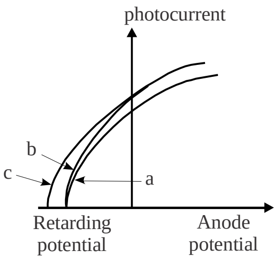
Q.39 A particle of mass 1 mg has the same wavelength as an electron moving with a velocity of 3×10^6m/s. The velocity of the particle is –

(1) 2.7×10^{-21} m/s (2) 2.7×10^{-18} m/s
(3) 9×10^{-2} m/s (4) 3×10^{-31} m/s
(Mass of electron = 9.1×10^{-31} kg)

Q.40 The number of photo electrons emitted for light of a frequency ν (higher than the threshold frequency ν_0) is proportional to

(1) Threshold frequency (ν_0)
(2) Intensity of light
(3) Frequency of light (ν)
(4) $\nu - \nu_0$

Q.41 The Figure shows a plot of photo current versus anode potential for a photo sensitive surface for three different radiations. Which one of the following is a correct statement?



(1) Curves (a) & (b) represent incident radiations of same frequency but of different intensities.
(2) Curves (b) & (c) represent incident radiations of different frequencies and different intensities.
(3) Curves (b) & (c) represent incident radiations of same frequency having same intensity.
(4) Curves (a) & (b) represent incident radiations of different frequencies and different intensities.

Q.42 Monochromatic light of wavelength 667 nm is produced by a helium neon laser. The power emitted is 9 mW. The number of photons arriving per sec. on the average at a target irradiated by this beam is:

(1) 3×10^{16} (2) 9×10^{15}
(3) 3×10^{19} (4) 9×10^{17}

For Q.43-Q.44

Work function of metal A is equal to the ionization energy of hydrogen atom in first excited state. Work function of metal B is equal to the ionization energy of He^+ ion in second orbit. Photons of same energy E are incident on both A and B. Maximum kinetic energy of photoelectrons emitted from A is twice that of photoelectrons emitted from B.

Q.43 Value of E (in eV) is :

(1) 20.8 (2) 32.2
(3) 24.6 (4) 23.8

Q.44 The difference in maximum kinetic energy of photoelectrons from A and from B :

(1) increases with increase in E
(2) decreases with increase in E.
(3) first increases than decrease with increase in E.
(4) remain constant.

Q.45 When a metallic surface is illuminated with radiation of wavelength λ, the stopping potential is V. If the same surface is illuminated with radiation of wavelength 2λ, the stopping potential is V/4. The threshold wavelength for the metallic surface is

(1) 4λ (2) 5λ
(3) $(5/2)\lambda$ (4) 3λ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