22 - ELECTRON AND PHOTONS

(Answers at the end of all questions)

1) A photocell is illuminated by a small source placed 1 m away. When the same source of light is placed 1 / 2 m away, the number of electrons emitted by photocathode would
(a) increase by a factor of 4 (b) decrease by a factor of 4
(c) increase by a factor of 2 (d) decrease by a factor of 2 [AIEEE 2005]

2) The electrical conductivity of a semiconductor increases when electromagnetic radiation of wavelength shorter than 2480 nm is incident on it. The band gap in (eV) for the semi-conductor is
(a) 2.5 eV (b) 1.1 eV (c) 0.7 eV (d) 0.5 eV [AIEEE 2005]

3) According to Einstein's photoelectric equation, the plot of the kinetic energy of the emitted photoelectrons from a metal vs. the frequency of the incident radiation gives a straight line whose slope
(a) depends on the nature of the metal used
(b) depends on the intensity of the radiation
(c) depends both on the intensity of the radiation and the metal used
(d) is the same for all metals and independent of the intensity of radiation
[AIEEE 2004]

4) 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
(a) 540 nm (b) 400 nm (c) 310 nm (d) 220 nm [AIEEE 2004]

5) A charged oil-drop is suspended in uniform field of 3×10^4 V / m so that it neither falls nor rises. The charge on the drop will be (take the mass of charge = 9.9×10^{-15} kg and g = 10 m / s^2)
(a) 3.3×10^{-18} C (b) 3.2×10^{-18} C
(c) 1.6×10^{-18} C (d) 4.8×10^{-18} C [AIEEE 2004]

6) Two identical photocells receive light of frequencies ν_1 and ν_2. If the velocities of the photo-electrons (of mass m) coming out are v_1 and v_2 respectively, then
(a) $v_1 - v_2 = \left[\frac{2h}{m}(\nu_1 - \nu_2)\right]^{1/2}$ (b) $v_1^2 - v_2^2 = \frac{2h}{m}(\nu_1 - \nu_2)$
(c) $v_1 + v_2 = \left[\frac{2h}{m}(\nu_1 - \nu_2)\right]^{1/2}$ (d) $v_1^2 + v_2^2 = \frac{2h}{m}(\nu_1 - \nu_2)$ [AIEEE 2003]

7) The photoelectric threshold wavelength for potassium (work function being 2 eV) is (Take $h = 6.6 \times 10^{-34}$ Js).
(a) 310 nm (b) 620 nm (c) 1200 nm (d) 2100 nm [AIEEE 2003]

8) A particle of charge -16×10^{-18} C moving with velocity 10 ms^{-1} along the x-axis enters a region where a magnetic field of induction B is along the y-axis, and an electric field of magnitude 10^4 V / m is along the negative z-axis. If the charged particle continues moving along the x-axis, the magnitude of B is
(a) 10^{-3} Wb / m^2 (b) 10^3 Wb / m^2 (c) 10^5 Wb / m^2 (d) 10^{16} Wb / m^2 [AIEEE 2003]

9) The potential difference between the cathode and the target in a Coolidge tube is 100 kilovolt. What can be the minimum wavelength of the X-rays emitted by the tube ?
(a) 0.123 A° (b) 0.262 A° (c) 0.38 A° (d) 0.52 A° [AIEEE 2002]

10) If an electron of mass m and charge e is accelerated from the rest through a potential difference V in vacuum, then its final velocity will be

(a) $\frac{eV}{2m}$ (b) $\frac{eV}{m}$ (c) $\sqrt{\frac{2eV}{m}}$ (d) $\sqrt{\frac{eV}{m}}$ [AIEEE 2002]

11) A charge (q) passing through a uniform electric field ($\vec{E}$) and uniform magnetic field ($\vec{B}$) remains undeflected. Which of the following variations would still let the charge to remain undeflected ?

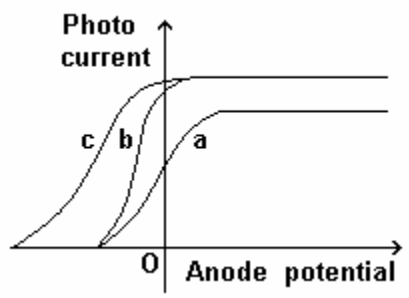
(a) signs of q and $\vec{B}$ are changed (b) signs of q and $\vec{E}$ are changed

(c) signs of $\vec{B}$ and $\vec{E}$ are changed (d) none of these [AIEEE 2002]

12) The energy of a photon is equal to the kinetic energy of a photon. The energy of a photon is E. Let λ_1 be the de-Broglie wavelength of the photon and λ_2 be the wavelength of the photon. The ratio $\lambda_1 : \lambda_1$ is proportional to

(a) E^0 (b) $E^{1/2}$ (c) E^{-1} (d) E^{-2} [IIT 2004]

13) The figure shows the variation of photocurrent with anode potential for a photo-sensitive surface for three different radiations. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequencies for the curves a, b and c respectively. Then which of the following is true ?



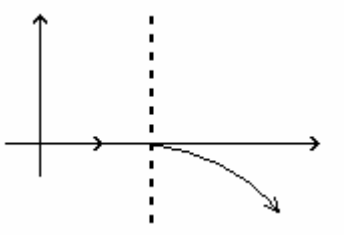
(a) $f_a = f_b$ and $I_a \neq I_b$

(b) $f_a = f_c$ and $I_a = I_c$

(c) $f_a = f_b$ and $I_a = I_b$

(d) $f_b = f_c$ and $I_b = I_c$ [IIT 2004]

14) For a positively charged particle moving in a x-y plane initially along the x-axis, there is a sudden change in its path due to the presence of electric and/or magnetic fields beyond P. The curved path is shown in the x-y plane and is found to be non-circular. Which one of the following combinations is possible ?



(a) $\vec{E} = 0;\ \vec{B} = b\hat{j} + c\hat{k}$ (b) $\vec{E} = a\hat{i};\ \vec{B} = c\hat{k} + a\hat{i}$

(c) $\vec{E} = 0;\ \vec{B} = c\hat{j} + b\hat{k}$ (d) $\vec{E} = a\hat{i};\ \vec{B} = c\hat{k} + b\hat{j}$ [IIT 2003]

15) The potential difference applied to an X-ray tube is 5 kV and the current through it is 3.2 mA. Then the number of electrons striking the target per second is

(a) 2×10^{16} (b) 5×10^{6} (c) 1×10^{17} (d) 4×10^{15} [IIT 2002]

16) 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

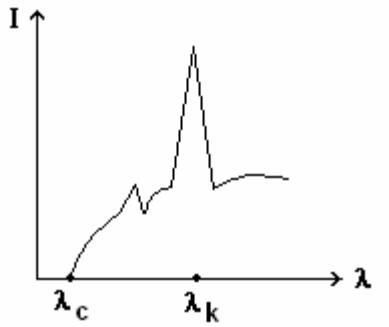
(a) 540 nm (b) 400 nm (c) 310 nm (d) 220 nm [IIT 1998]

17) The intensity of X-rays from a Coolidge tube is plotted against wavelength λ as shown in the figure. The minimum wavelength found is λ_c and the wavelength of the k_α line is λ_k. As the accelerating voltage is increased:

(a) $\lambda_k - \lambda_c$ increases (b) $\lambda_k - \lambda_c$ decreases

(c) λ_k increases (d) λ_k decreases

[IIT 2001]



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

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

(d) λ_{min} to λ_{max} where $0 < \lambda_{min} < \lambda_{max} < \infty$ [IIT 1998]

19) 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 volts is

(a) 2 (b) 4 (c) 6 (d) 10 [IIT 1997]

20) When photons of energy 4.25 eV strike the surface of a metal A, the ejected photoelectrons have maximum kinetic energy T_A eV and de Broglie wavelength λ_A. The maximum kinetic energy of photoelectrons liberated from another metal B by photons of energy 4.70 eV is $T_B = (T_A - 1.50)$ eV. If the de Broglie wavelength of these photoelectrons is $\lambda_B = 2\lambda_A$, then

(a) the work function of A is 2.25 eV (b) the work function of B is 4.20 eV

(c) T_A = 2.00 eV (d) T_B = 2.75 eV [IIT 1994]

21) When a monochromatic point source of light is at a distance of 0.2 m from a photoelectric cell, the cut-off voltage and the saturation current are respectively 0.6 V and 18.0 mA. If the same source is placed 0.6 m away from the photoelectric cell, then

(a) the stopping potential will be 0.2 V (b) the stopping potential will be 0.6 V

(c) the saturation current will be 6.0 mA (d) the saturation current will be 2.0 mA

[IIT 1992]

22) Photoelectric effect supports quantum nature of light because

(a) there is a minimum frequency of light below which no photoelectrons are emitted

(b) the maximum kinetic energy of photoelectrons depends only on the frequency of light and not on its intensity

(c) even when the metal surface is faintly illuminated, the photoelectrons leave the surface immediately

(d) electric charge of the photoelectrons is quantized [IIT 1987]

23) The threshold wavelength for photoelectric emission from a material is 5200 A°. Photoelectrons will be emitted when this material is illuminated with monochromatic radiation from a

(a) 50 watt infrared lamp (b) 1 watt infrared lamp

(c) 50 watt ultraviolet lamp (d) 1 watt ultraviolet lamp [IIT 1982]

24) The specific charge of an electron is
(a) 1.6×10^{-19} C (b) 9.1×10^{-31} Kg
(c) 1.76×10^{11} C / Kg (d) 5.7×10^{-12} Kg / C

25) Which of the following is never true for cathode rays ?
(a) They travel in straight lines. (b) They possess kinetic energy.
(c) They cause certain substances to fluorescence.
(d) They are electromagnetic waves.

26) An electric field of intensity 6×10^{4} volts / m is applied perpendicular to the direction of motion of the electron. A magnetic field of intensity 8×10^{-2} weber / m^2 is applied perpendicular to both the electric field and the direction of motion of the electron. What is the velocity of the electron if it passes undeflected ?
(a) 7.5×10^{5} m / s (b) 7.5×10^{-5} m / s
(c) 48×10^{-2} m / s (d) It is never possible.

27) Three particles having charges in the ratio 1 : 2 : 3 produce the same point on the photographic film in the Thomson experiment. Their masses are in the ratio of
(a) 1 : 2 : 3 (b) 3 : 2 : 1 (c) 2 : 3 : 1 (d) 1 : 3 : 2

28) In Millikan's oil drop experiment, an oil drop having a charge ne is held stationary with an external potential difference of 400 V. If the radius of the drop is doubled without any change of charge, the potential difference required to keep the drop stationary is
(a) 800 V (b) 1600 V (c) 3200 V (d) 200 V

29) An electron of mass 'm' and charge 'q' is accelerated from rest in a uniform electric field of strength 'E'. The velocity acquired by it as it travels a distance 'l' is
(a) $\sqrt{\frac{Eq}{ml}}$ (b) $\sqrt{\frac{2Eql}{m}}$ (c) $\sqrt{\frac{2Eq}{ml}}$ (d) $\sqrt{\frac{2Em}{ql}}$

30) If electron has an initial velocity perpendicular to the direction of the electric field, the path of the electron is
(a) a straight line (b) a parabola (c) a circle (d) an ellipse

31) When photoelectric emission is taking place, increasing the intensity of light will
(a) have no effect (b) increase the number of electrons released
(c) increase the maximum energy per electron
(d) cause a time delay in the emission of electrons

32) A photon of frequency ν is incident on a metal surface of threshold frequency ν_0. The kinetic energy of the emitted photoelectron is
(a) $h(\nu - \nu_0)$ (b) $h\nu$ (c) $h\nu_0$ (d) $h(\nu + \nu_0)$

33) The work function for photoelectric effect
(a) depends upon the frequency of the incident light
(b) is same for all metals
(c) is different for different metals
(d) none of these

34) A photo cell is illuminated by a small bright source placed 1 m away. When the same source of light is placed 2 m away, the electrons emitted by the photo-cathode
(a) each carries one-quarter of its previous energy
(b) each carries one-quarter of its previous momentum
(c) are half as numerous
(d) are one quarter as numerous

35) In order to increase the kinetic energy of the ejected photoelectrons, there should b e an increase in
(a) intensity of radiation (b) wavelength of radiation
(c) frequency of radiation (d) both the wavelength as well as intensity of radiation

36) Light of frequency 1.5 times the threshold frequency is incident on photo-sensitive material. If the frequency is halved and the intensity is doubled, the photo-current becomes
(a) quadrupled (b) doubled (c) halved (d) zero

37) The photoelectric effect is based on the law of conservation of
(a) energy (b) mass (c) linear momentum (d) angular momentum

38) A metallic surface ejects electrons when hit by green light but none when hit by yellow light. Will the electrons be ejected if the same surface is hit by red light ?
(a) yes (b) no (c) yes, if the red beam is sufficiently intense
(d) yes, if the red beam is incident for sufficient duration

39) Which of the following is not correct ?
(a) $h = E / \nu$ (b) mass of photon $= h / c\nu$
(c) $\lambda = \nu / c$ (d) momentum of photon $= h / \lambda$

40) A source of light is placed at a distance of 1 m from a photocell and cut-off potential is found to be V_0. If the distance is doubled, the cut-off potential will be
(a) $2 V_0$ (b) $V_0 / 2$ (c) V_0 (d) $V_0 / 4$

Answers

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
a	d	d	c	a	b	b	b	a	c	a	b	a	b	a	c	a	b	b	a,b,c

21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
b,d	a,b,c	c,d	c	d	a	a	c	b	b	b	a	c	d	c	d	a	b	c	c