PHYSICS

BOOKS - CP SINGH PHYSICS (HINGLISH)

PHOTOELECTRIC EFFECT

Example

1. (a) Calculate the momentum of a photon of light of wavelength 500 nm.

(b) Find the number of photons emitted per second by a 25 W sourse of monochromatic light of wave length 600 nm.

(c) How many photons per second does a one watt bulb emit if its efficiency is 10% and the wavelength of light emitted is 500 nm?

(d) Monochromatic light of wavelength 300 nm is incident normally on a surface of area $4cm^2$. If the intensity of light is $150mW/m^2$, determine the rate at which photons strike the surface.

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2. (a) A parallel beam of monochromatic light of wavelength 500 nm is incident normally on a perfectly absorbing surface. The power through any cross section of the beam is 10 W. Find

(i) the number of photons absorbed per second by the surface and

the force exerted by the lilght beam on the surface.

(a) Radiation of wavelength 200 nm, propagating in the form of a parallel beam, fall normally on a plane metallic surface. The intensity of the beam is 5 mW and its cross-sectional area is $1.0 mm^2$. Find the pressure exerted by the radiation on the metallic surface if the radiation is completeley reflected.

(c) A parallel beam of monochromatic light of wavelength 663 nm is incident on a totally reflecting plane mirror. The angle of incidence is 60° and the number of photons striking the mirror per second is 1.0×10^{19} . Calculate the force exerted by the light beam on the mirror.

(d) A beam of white light is incident normally on a plane surface absorbing $70\%)$ of the light and reflecting the rest. If the incident beam carries 10 W of power, find the force exerted by it on the surface.

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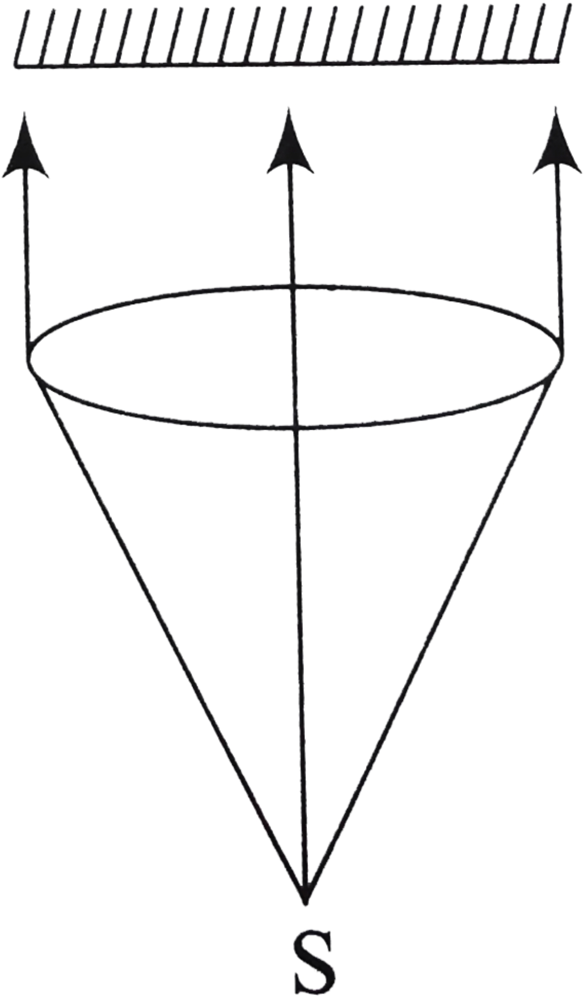
3. 

A totally reflecting, small plane mirror placed horizontally faces a parallel beam of light as shown in the Fig. The mass of the mirror is 20 g. Assume that there is no absorption in in the lens and that 30% of the light emitted by the source goes through the lens. Find the power (in $\times 10^8$W) of the source needed to support the weight of the mirror. Take $g = 10ms^{-2}$

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4. A hydrogen atom moving at a speed v absorbs a photon of wavelength 122 nm and stops. The value of v is (mass of hydrogen atom $= 1.67 \times 10^{-27}$ kg)

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5. (a) Photoelectric threshold of metallic silver is $\lambda = 3800\text{Å}$. Ultravilolet light of $\lambda = 260$ nm is incident on silver surface. Calculate :

(i) the value of work function in joule and eV

K_{max} of the emitted photoelectrons

(iii) v_{max} of the photoelectrons

(b) Ultraviolet light of wavelength 280 nm is used in an experiment on photoelectric effict with lithium $(\phi = 2.5eV)$ cathode. Find

(i) the maximum kinetic energy of the photoelectrons

(ii) the stopping potential

(c) Find the maximum magnitude of the linear momentum of a photelectron emitted when light of wavelength 400 nm falls on a metal $(\phi = 2.5eV)$.

(d) A monochromitc light source of intensity 5 mW emits 8×10^5 photons per second. This light ejects photoelectrons from a metal surface. The stopping potential for this set up is $2.0V$. Calculate the work function of the metal.

(e) The maximum kinetic energy of photoelectrons emitted from a certain metallic surface is 30 eV when imonochromatic radiation of wavelength λ falls on it. When the same surface is illuminated with light of wavelength 2λ the maximum kinetic energy of photo electrons is observed to be 10 eV. Calculate the wavelength λ and determine the maximum wavelength of incident radiation for which photoelectrons can be emitted by this surface.

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6. Light of wavelength 2000Å falls on an aluminium surface . In aluminium $4.2eV$ of energy is required to remove an electron from its surface. What is the kinetic energy , in electron volt of (a) the fastest and (b) the slowest emitted photo-electron . (c) What is the stopping potential ? (d) What is the cut - off wavelength for aluminum? (Plank's constant $h = 6.6 \times 10^{-34} J - s$ and speed of light `c = 3 xx 10^(8) m s^(-1).

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7. a. A stopping potential of $0.82V$ is required to stop the emission of photoelectrons from the surface of a metal by light of eavelength $4000A$. For light of wavelength $3000A$, the stopping potential is $1.85V$. Find the value of Planck's constant. [1 electrons volt (eV) $= 1.6 \times 10^{-19} J]$

b. At stopping potential, if the wavelength of the incident light is kept fixed at $4000A$, but the intensity of light increases two times, will photoelectric current be botained ? Give reasons for your answer.

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8. A 40 W ultraviolet light source of wavelength $2480A$. Illuminates a magnesium (mg) surface placed 2 m away. Determine the number of photons emitted from the surface per second and the number incident on unit area of Mg surface per second . The photoelectric work function for Mg is $3.68eV$. Calculate the kinetic energy of the fastest electrons ejected from the surface. Determine the maximum wavelength for which the photoelectric effects can be observed with Mg surface.

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9. (a) 1 mW of light of wavelength 456 nm is incident on a cesium surface. Calculate the photoelectric current produced, if the quantum efficiency of the surface for photoelectric emission is only $0.5\,\%$.

(b) In an experiment on photoelectric effect, light of wavelength 400 nm is incident on a cesium plate at the rate of $5.0W$. The potential of the collector plate is made sufficiently positive with respect to the emitter so that the current reaches its saturation value. Assuming that on the average one out of every 10^6 photons is able to eject a photoelectron, find the photocurrent in the circuit.

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10. When a beam of $10.6eV$ photons of intensity $2.0W/m^2$ falls on a platinum surface of area $1.0 \times 10^{-4}m^2$ and work function $5.6eV, 0.53\%$ of the incident photons eject photoelectrons. Find the number of photoelectrons emitted per second and their minimum and maximum energy (in eV).

Take $1eV = 1.6 \times 10^{-19}J$.

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11. (a) In a photoelectric experiment, the collector plate is at $2.0V$ with respect to the emitter plate made of copper $(\phi = 4.5eV)$. The emitter is illuminated by a source of monochromatic light of wavelength 200 nm. Find minimum and maximum kinetic energy of the photoelectrons reaching the collector.

(b) A small piece of cesium metal $(\phi = 1.9 eV)$ is kept a distance of 20 cm from a large metal plate having a charge density of $8.85 \times 10^{-9} C/m^2$ on the surface facing the cesium piece. A monochromatic light of wavelength 400 nm is incident on the cesium piece. Find minimum and the maximum kinetic energy of the photoelectrons reaching the large metal plate. Neglect any change in the electric field due to the presence of small piece of cesium.

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12. A small metal plate of work function ϕ is kept at a distance r from a singly ionised, fixed ion. A monochromatic light beam is incident on the metal plate and photoelectrons are emitted. Find maximum wavelength of the light beam so that some of that electrons may go round the ion along a circle.

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13. (a) A beam of 450 nm light is incident on a metal having work function $2.0eV$ and placed in a magnetic field B. The most energetic electron emitted perpendicular to the field are bent in circular are of radius 20 cm. Find the value of B.

(b) A small plate of metal (work function $= 1.17 eV$) is placed at a distance of 2 m from a monochromatic light source of wavelength 4.8×10^{-7} m and power $1.0 W$. The light falls normally on the plate. Find the number of photons striking the metal plate per square meter per second. If a constant uniform magnetic field of strength 10^{-4} T is applied parallel to the metal surface, find the radius of the largest circular path following by the emitted photoelectrons.

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14. When a surface is irradiated with light of wavelength 4950Å, a photocurrent appears which vanishes if a retarding potential appears which vanishes if a retarding potential greater than 1.2 volt is applied across the phototube. When a different source of light is used, it is found that the critical retarding potential is changed to 2.1 volt. Find the work function of the emitting surface and the wavelength of second source. If the photoelectrons (after emission from the surface) are subjected to a magnetic field of 10 tesla, what changes will be observed in the above two retarding potentials. Use $h = 6.6 \times 10^{-34} Js, e = 1.6 \times 10^{-19} C.$

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15. A monochromatic light of wavelength λ is incident on an isolated metallic sphere of radius a. The threshold wavelength is λ_0 which is larger then λ. Find the number of photoelectrons emitted before the emission of photo electrons stops.

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16. A silver ball is suspendend by a string in a vacuum chamber and ultraviolet light of wavelength 200 nm is directed at it. What electrical potential will the ball acquire as a result of it, if work function of silver is $4.7eV$? $\left[h = 6.6 \times 10^{-34}\right.$ J-s and $c = 3 \times 10^{8} m / \sec]$

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17. When the sun is directly overhead, the surface of the earth receives 1.4 xx $\left(10^{3}\right) W\left(m^{-2}\right)$ of sunlight. Assume that the light is monochromatic with average wavelength 500mn and that no light is absorbed in between the sun and the earth's surface. The distance between the sun and the earth is 1.5 xx $\left(10^{11}\right)$ m. (a) Calculate the number of photons falling per second on each square metre of earth's surface directly below the sun. (b) How many photons are there in each cubic metre near the earth's surface at any instant?

(c) How many photons does the sun emit per second?

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18. An isotropic popint source emits light with wavelength 589 nm. The radiation power of the source is P = 10 W.

(a) Find the number of photons passing through unit area per second at a distance of 2 m from the source

(b) Also calculate the distance between the source and the point at which the mean concentration of the photons is $100 / cm^3$.

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19. A proton of mass m moving with a speed v_0 apporoches a stationary proton that is free to move. Assuming impact parameter to be zero., i.e., head-on collision. How close will be incident proton go to other proton ?

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20. A light source, emitting there wavelengths 500nm, 600nm and 700 nm, has a total power of $10^{-3}W$ and a beam diameter $2 \times 10^{-3}m$. The density is distributed equally amongst the three wavelength.

The beam shines normally on a metallic surface of area on $10^{-4}m^2$ and having a work function of 1.9 eV. Assuming that each photon liberates an electron, calculate the charge emitted per unit area in one second.

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21. Two metallic plate A and B , each of area $5 \times 10^{-4}m^2$, are placed parallel to each at a separation of $1cm$ plate B carries a positive charge of $33.7 \times 10^{-12}C$ A monocharonatic beam of light , with photoes of energy $5eV$ each , starts falling on plate A at $t = 0$ so that 10^{16} photons fall on it per square meter per second. Assume that one photoelectron is emitted for every 10^6 incident photons fall on it per square meter per second. Also assume that all the emitted photoelectrons are collected by plate B and the work function of plate A remain constant at the value $2eV$ Determine

(a) the number of photoelectrons emitted up to $i = 10s$,

(b) the magnitude of the electron field between the plate A and B at $i = 10s, \text{ and}$

(c) the kinetic energy of the most energotic photoelectrons emitted at $i = 10s$ whenit reaches plate B

Negilect the time taken by the photoelectrons to reach plate B Take $\varepsilon_0 = 8.85 \times 10^{-12} C^2 N - m^2$

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22. In a photoelectric effect set up, a point source of light of power $3.2 \times 10^{-3} W$ emits monochromatic photons of energy $5eV$.The source is located at a distance of a stationary metallic sphere of work function $3eV$ and radius $8 \times 10^{-3} m$.The efficiency of photoelectron emission is one for every 10^{6} incident photons.Assume that the sphere is isolated and initially neutral and the photoelectrons are initially swept away after emission.

Find the number of photons emitted per second

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Exercises

1. Which of the following is correct regarding photons?

(i) A photon always travels at a speed $3 \times 10^8 m/\sec$ in vacuum.

(ii) The rest mass of photon is zero.

(iii) Let E and p be the energy and linear momentum of a photon and v and λ be the frequency and wavelength of the same light when it behaves as a wave. Then $E = hv = \frac{hc}{\lambda}$

$$p = \frac{hv}{c} = \frac{h}{\lambda} = \frac{E}{c}$$

(iv) A photon may collide with a meterial particle. The total energy and the total momentum remain conserved in such a collision. The photon may get absorbed and / or a new photon may be emitted. Thus, the number of photons may not be consverved.

A. (i),(ii),(iii)

B. (ii),(iii),(iv)

C. (i),(iii),(iv)

D. All of the above.

Answer: D

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2. The equation E=pc is valid

A. for an electron as well as for a photon

B. for an electron but not for a photon

C. for a photon but not for an electron

D. neither for an electron nor for a photon

Answer: C

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3. Let p and E denote the linear momentum and energy of a photon. If the wavelength is decreased,

A. both p and E increases

B. p increases and E decreases

C. p decreases and E increases

D. both p and E decreases

Answer: A

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4. The energy of a photon in eV of wavelength λ nm will be

A. $E(eV)=\frac{1242}{\lambda(nm)}$

B. $E(eV) = \dfrac{1000}{\lambda(nm)}$

C. $E(eV) = \dfrac{500}{\lambda(nm)}$

D. $E(eV) = \dfrac{250}{\lambda(nm)}$

Answer: A

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5. If 5% of the energy supplied to a bulb is irradiated as visible light, how many quanta are emitted per second by a 100 W lamp? Assume wavelength of visible light as 5.6×10^{-5} cm.

A. 1.4×10^{19}

B. 1.4×10^{20}

C. 2×10^{19}

D. 2×10^{20}

Answer: A

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6. A hydrogen atom moving at a speed v absorbs a photon of wavelength 122 nm and stops. The value of v is (mass of hydrogen atom $= 1.67 \times 10^{-27}$ kg)

A. $3.25m/\text{sec}$

B. $6.25m/\text{sec}$

C. $9.25m / \sec$

D. $12.25m / \sec$

Answer: A

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7. Let `(n_r) and (n_b) be respectively the number of photons emitted by a red bulb and a blue blub of equal power in a given time.

A. $n_1 = n_b$

B. $n_r < n_b$

C. $n_r > n_b$

D. none

Answer: C

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8. A beam of white light is incident normally on a plane surface absorbing 70% of the light and reflecting the rest. If the incident beam carries 20 W of power, the force exerted by it on the surface is

A. $1.3 \times 10^{-7} N$

B. $2.6 \times 10^{-7} N$

C. $1 \times 10^{-7} N$

D. $3.9 \times 10^{-7} N$

Answer: A

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9. Which of the following is correct regarding photo-electric effect?

(i) The photo-electric effect takes place if $\lambda \leq \lambda_0$ or $v \geq v_0$. maximum K.E. of photo-electron $K_{\max} = hv = \frac{hc}{\lambda}$

Einstein photo-electric effect equation $hv = hv_0 + K_{\max}$

(ii) The maximum K.E. of electron or stopping potential $V_s(K_{\max} = eV_s)$ for a given metal depends only on frequency or wavelength of incident light and not on its intensity

(iii) The saturation current (i =ne, n: number of photo-electrons ejected per unit time) depends on intensity and not frequency

(iv) Normally it is assumed that one photon eject one electron. Practically several incident photons eject one electron. If quantum efficiency is given

$$\left\{\text{Quantum efficiency} = \frac{\text{Number of electrons ejected}}{\text{Number of photons incident}}\right\}$$

Number of electrons ejected must be calculated must be calculated and then calculate saturation current

A. (i),(ii),(iii)

B. (ii),(iii),(iv)

C. (i),(iii),(iv)

D. all

Answer: D

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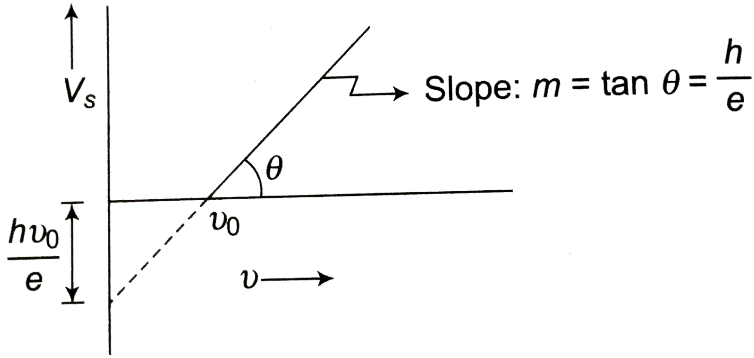
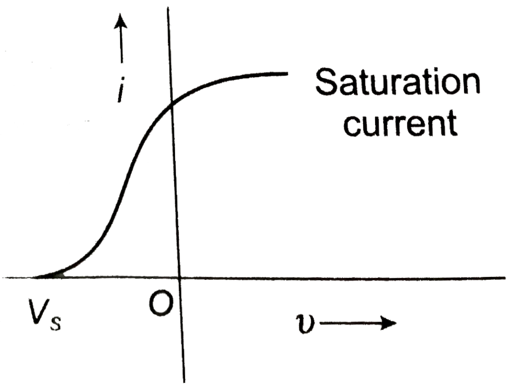
10. Which of the following is correct regarding Einstein photo-electric effect equation?

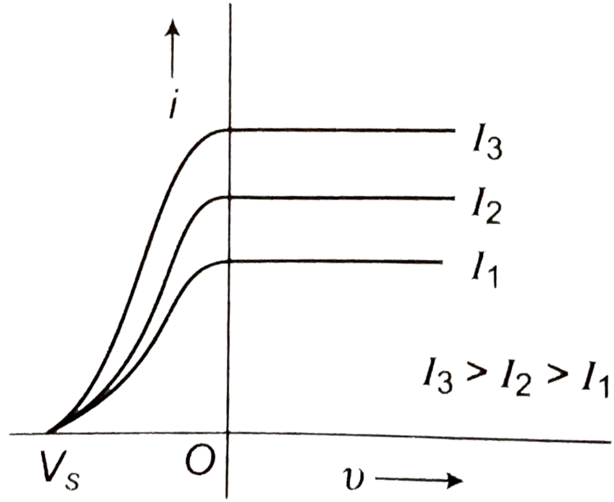
(i) The equation is $hv = hv_0 + K_{\max} = hv_0 + eV_s$

(ii) The variation of V_s with v is



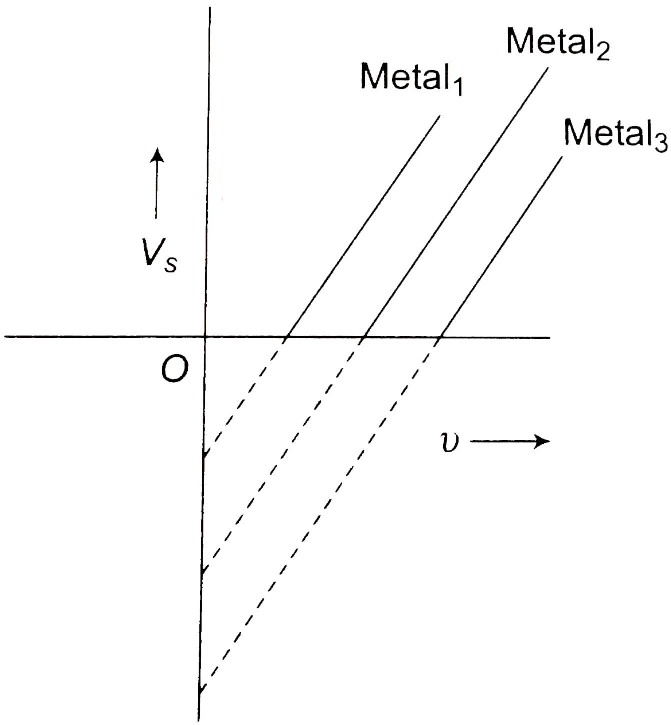
(iii) The variation of photo-current versus applied potential





i
I_3
I_2
I_1
$I_3 > I_2 > I_1$
V_s
O
υ

(iv)



Metal$_2$
Metal$_1$
Metal$_3$
V_s
O
υ

A. (i),(ii),(iii)

B. (ii),(iii),(iv)

C. (i),(iii),(iv)

D. all

Answer: D

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11. As the intensity of incident light increases

A. photoelectric current increases

B. photoelectric current decreases

C. kinetic energy of emitted photoelectrons increases

D. kinetic energy of emitted photoelectrons decreases

Answer: A

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12. The number of photo - electrons emitted per second from a metal surface increases when

A. the energy of incident photons increases

B. the frequency of incident light increases

C. the wavelength of the incident light increases

D. the intensity of the incident light increases

Answer: D

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13. Photons of frequency v fall on a metal surface for which the thershold frequency is $v_0 (v \geq v_0)$. Then,

A. all ejected electrons have the same K.E.

$h(v - v_0)$

B. the ejected electrons have a distribution of kinetic energy from zero to $h(v - v_0)$

C. the most energetic electrons have K.E. hv

D. the average K.E. of ejected electrons is hv_0

Answer: B

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14. Which of the following statements about photoelectric effict is/are false ?

(i) It exhibits the particle nature

(ii) Electrons are emitted only if the radiation has a frequency above a certain value

(iii) All the electrons emitted by radiation of a particular frequency have the same energy

(iv) Changing the intensity of radiation changes the maximum energy with which the electrons can be emitted

A. (i),(ii)

B. (ii),(iii)

C. (i),(iv)

D. (iii),(iv)

Answer: D

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15. When stopping potential is applied in an experiment on photoelectric effect, no photo current is observed. This means that

A. the emission of photoelectrons is stopped

B. the photoelectrons are emitted but are re-absorbed by the emitter metal

C. the photoelectrons are accumulated near the collector plate

D. the photoelectrons are dispersed from the sides of the apparatus

Answer: B

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16. In photoelectric effect

A. photons come out of a metal when it is hit by a beam of electrons

B. photons come out of the nucleus of an atom under the action of an electric field

C. electrons come out of a metal with a constant velocity which depends on the frequency and intensity of incident radiation

D. electrons come out of a metal with different velocities nor greater than a certain value which depends only on the frequency of the incident light and not on its intensity

Answer: D

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17. A metallic surface ejects electrons when exposed to green light of intensity I but not when exposed to yellow light of intensity I. It is possible to eject electrons from the same surface by

(i) yellow light of some intensity which is more than I

(ii) green light of any intensity

(iii) red light of any intensity

(iv) violet light of any intensity

A. (i),(ii)

B. (ii),(iii)

C. (i),(iv)

D. (ii),(iv)

Answer: D

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18. Lights of two different frequencies whose photons have energies 1 and 2.5 eV, respectively, successively illuminate a metal whose work function is 0.5 eV. The ratio of the maximum speeds of the emitted electrons

A. $1:5$

B. $1:4$

C. $1:2$

D. $1:1$

Answer: C

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19. Two identical photocathodes receive light of frequency f_1 and f_2 if the velocites of the photo electrons (of mass m) coming out are repectively v_1 and v_2 then

A. $v_1 - v_2 = \left[\frac{2h}{m}(f_1 - f_2)\right]^{\frac{1}{2}}$

B. $v_1^2 - v_2^2 = \frac{2h}{m}(f_1 - f_2)$

C. $v_1 + v_2 = \left[\frac{2h}{m}(f_1 + f_2)\right]^{\frac{1}{2}}$

D. $v_1^2 + v_2^2 = \frac{2h}{m}(f_1 + f_2)$

Answer: B

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20. Radiation of wavelength λ in indent on a photocell . The fastest emitted electron has speed v if the wavelength is changed to $\frac{3\lambda}{4}$, then speed of the fastest emitted electron will be

A. $v(3/4)^{1/2}$

B. $v(4/3)^{1/2}$

C. less than $v(4/3)^{1/2}$

D. greater than $v(4/3)^{1/2}$

Answer: D

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21. When a certain metallic surface is illuminated with monochromatic light of wavelength λ, the stopping potential for photoelectric current is $3V_0$ and when the same surface is illuminated with light of wavelength 2λ, the stopping potential is V_0. The threshold wavelength of this surface for photoelectrice effect is

A. 6λ

B. 3λ

C. 4λ

D. 8λ

Answer: C

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22. Photoelectric emission is observed from a metallic surface for frequencies v_1 and v_2 of the incident light rays $(v_1 > v_2)$. If the maximum values of kinetic energy of the photoelectrons emitted in the two cases are in the ratio of $1:k$, then the threshold frequency of the metallic surface is

A. $\dfrac{v_1 - v_2}{k - 1}$

B. $\dfrac{kv_1 - v_2}{k - 1}$

C. $\dfrac{kv_2 - v_1}{k - 1}$

D. $\dfrac{v_2 - v_1}{k}$

Answer: B

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23. A photon of wavelength 1000Å has energy $12.3eV$. If light of wavelength 5000Å, having intensity I, falls on a metal surface, the saturaion current is $0.40\mu A$ and the stopping potential is $1.36V$. The work function of metal is

A. $2.47eV$

B. $1.36eV$

C. $1.10eV$

D. $0.43eV$

Answer: C

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24. In the previous, if the intensity of light is made 4 I, the stopping potential will become

A. $1.36V$

B. $1.36 \times 2V$

C. $1.36 \times 4V$

D. $1.36 \times 16V$

Answer: A

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25. In question 23, if the intensity of light is made 4 I, the saturation current will become

A. $0.4\mu A$

B. $0.4 \times 2\mu A$

C. $1.6\mu A$

D. $0.4 \times 16\mu A$

Answer: C

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26. The threshold frequency for certain metal is v_0. When light of frequency $2v_0$ is incident on it, the maximum velocity of photoelectrons is $4 \times 10^6 ms^{-1}$. If the frequency of incident radiation is increaed to $5v_0$, then the maximum velocity of photoelectrons will be

A. $4 \times 10^6 m / \sec$

B. $6 \times 10^6 m / \sec$

C. $8 \times 10^6 m / \sec$

D. $16 \times 10^6 m / \sec$

Answer: C

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27. In an experiment on photoelectric effect light of wavelength $400nm$ is incident on a metal plate at rate of $5W$. The potential of the collector plate is made sufficiently positive with respect to emitter so that the current reaches the saturation value. Assuming that on the average one out of every 10^6 photons is able to eject a photoelectron, find the photocurrent in the circuit.

A. $0.4\mu A$

B. $0.8\mu A$

C. $1.2\mu A$

D. $1.6\mu A$

Answer: D

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28. If Planck's constant is denoted by h and the charge by e, experiments on photoelectric effect allow the determination of

A. only h

B. only e

C. both h and e

D. only h / e

Answer: D

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29. In order to increase the kinetic energy of ejected photoelectrons, there should be an increase in

A. I

B. λ

C. υ

D. both λ and I

Answer: C

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30. In photoelectric emission the number of electrons ejected per second is proportional to the

A. I

B. λ

C. υ

D. W

Answer: A

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31. When monochromatic radiation of intensity I falls on a metal surface, the number of photoelectrons and their maximum kinetic are N and T respectively. If the intensity of radiation is 2 I, the number of emitted electrons and their maximum kinetic energy are respectively.

A. N and 2T

B. 2N and T

C. 2N and 2T

D. N and T

Answer: B

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32. Light of frequeny 1.5 times the threshold frequency , imcident on a photo sensitive material .If the frequency of incident light is halved and the intensity is doubled the photo current becomes

A. four times

B. double

C. half

D. zero

Answer: D

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33. If the wavelength of light in an experiment on photoelectric effect is doubled,

(i) the photoelectric emission will not take place

(ii) the photoelectric emission may or may not take place

(iii) the stopping potential will increase

(iv) the stopping potential will decrease

A. (i),(ii)

B. (ii),(iii)

C. (i),(iv)

D. (ii),(iv)

Answer: D

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34. When ultraviolet radiation is incident on a surface, no photoelectrons are emitted. If another beam causes photoelectrons to be emitted from the surface, it may consist of

(i) radio waves

(ii) infrared rays

(iii) X-rays

(iv) gamma rays

A. (i),(ii)

B. (ii),(iii)

C. (i),(iv)

D. (iii),(iv)

Answer: D

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35. A non-monochromatic light is used in 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

Answer: C

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36. When the intensity of a light source is increased

A. the number of photons emitted by the source in unit time increases

B. the total energy of the photons emitted per unit time increases

C. more energetic photons are emitted

D. faster photons are emitted

Answer: A

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37. The photocurrent in an experiment on photoelectric effect increases if

A. the intensity of the source is increased

B. the exposure time increased

C. the intensity of the source is decreased

D. the exposure time is decreased

Answer: A

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38. A point source of light is used in a photoelectric effect. If the source is removed farther from the emitted metal, the stopping potential

A. will increase

B. will decrease

C. same

D. none

Answer: C

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39. A phot of energy hv is absorbed by a free electron of a metal having work function $\phi < hv$

A. The electron is sure to come out

B. The electron is sure to come out with a K.E. $= hv - \phi$

C. Either the electron does not come out or it comes out with a K.E. $= hv - \phi$

D. It may come out with K.E. $< (hv - \phi)$

Answer: D

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40. Photoelectric effect supports quantum nature of light because

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

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

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

(d) electric charge of the photo electrons is quantised

A. (i),(ii),(iii)

B. (ii),(iii),(iv)

C. (i),(iii),(iv)

D. all

Answer: A

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41. If the frequency of light in a photoelectric experiment is doubled the stopping potential will

A. be doubled

B. be halved

C. gt double

D. lt double

Answer: C

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42. Two identical metal plates show photoelectric effect by a light of wavelength λ_A falls on plate A and λ_B on plate $B(\lambda_A = 2\lambda_B)$. The maximum kinetic energy is

A. $2K_A = K_B$

B. $K_A < K_B/2$

C. $K_A = 2K_B$

D. $K_A > K_B/2$

Answer: B

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43. The cathode of a photoelectric cell is changed such that the work function changes from $(W_1 \to W_2(W_2 > W_1)$. If the current before and after change are I_1 and I_2, all other conditions remaining unchanged , then (assuming $hv > W_2$)

A. $i_1 = i_2$

B. $i_1 < i_2$

C. $i_1 > i_2$

D. $i_1 < i_2 < 2i_1$

Answer: A

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44. 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 of the photoelectrons is double

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

Answer: B

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45. The threshold wavelength for photoelectric emission from a material is 5200Å. Photoelectrons will be emitted when this material is illuminated with monochromatic radiation from a

(a) 50 W infrared lamp

(b) 1 W infrared lamp

(c) 50 W ultraviolet lamp

(d) 1 W ultraviolet lamp

.

A. (i),(ii)

B. (ii),(iii)

C. (i),(iv)

D. (iii),(iv)

Answer: D

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46. A photoelectric cell is illuminated by a point source of light $1m$ away . When the source is shifted to $2m$ then

A. carry $1/4^{th}$ of their previous energy

B. carry $1/4^{th}$ of their previous momenta

C. are $1/2$ as numberous

D. are $1/4$ as numerous

Answer: D

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47. If the distance of 100 Watt lamp is increased from a photocell, the saturation current i in the photo cell varies with distance d as

A. $i \propto d^2$

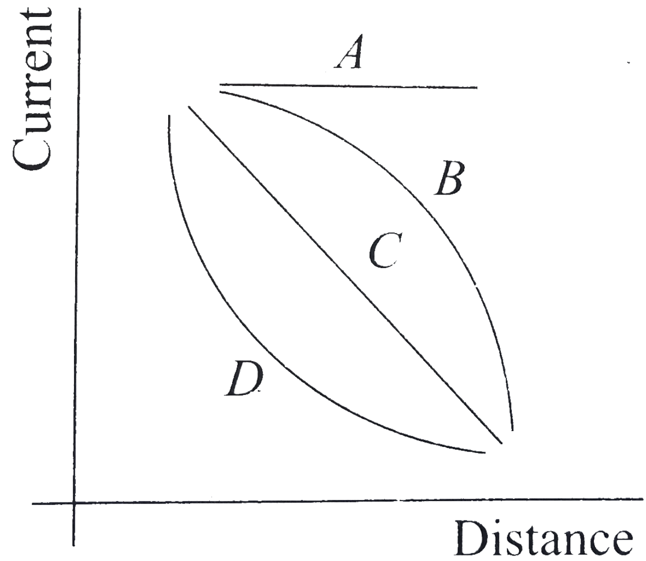
B. $i \propto d$

C. $i \propto d^{-1}$

D. $i \propto d^{-2}$

Answer: D

48.



A point source causes photoelectric effect from a small metal plate. Which of the curves in Fig. may represent the saturation photo-current as a function of the distance between the source and the metal?

A. a

B. b

C. c

D. d

Answer: D

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49. 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

A. (i),(ii)

B. (ii),(iii)

C. (i),(iv)

D. (ii),(iv)

Answer: D

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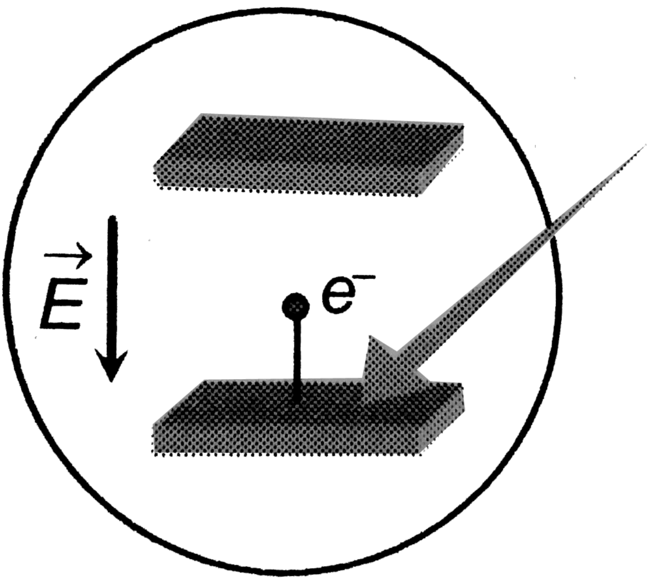
50. The collector plate in an experiment on photoelectric effect is kept vertically above the emitter plate . Light source is put on and a saturation photo current is recorded . An electric field is switched on which has a vertically downward direction . Then



A. the photocurrent will increase

B. the K.E. of the electrons will increase

C. the stopping potential will decrease

D. the threshold wavelength will increase

Answer: B

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51. The electric field associated with a light wave is given by $E = E_0 \sin\left[\left(1.57 \times 10^7 m^{-1}(x - ct)\right)\right]$. Find the stopping potential when this light is used in an experiment on photoelectric affect with a metal having work - function 1.9 eV.

A. $0.6V$

B. $1.2V$

C. $1.8V$

D. $2.4V$

Answer: B

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52. A beam of light of wavelength λ is incident on a metal having work function ϕ and placed on a metal having work function ϕ and placed in a magnetic field B. The most energetic electrons emitted perpendicular to the field are bent in circular arcs of radius R. Then

A. $B = \dfrac{mv}{eR}$, where $\dfrac{hc}{\lambda} = \phi + \dfrac{1}{2}mv^2$

B. $B = \dfrac{mR}{eV}$, where $\dfrac{hc}{\lambda} = \phi + \dfrac{1}{2}mv^2$

C. $B = \dfrac{mv}{eR}$, where $\dfrac{hc}{\lambda} + \phi = \dfrac{1}{2}mv^2$

D. none

Answer: A

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53. A photon of energy E ejects a photoelectron from a metel surface whose work function is ϕ_0. If this electron enters into a unifrom magnetic field of induction B in a direction perpendicular to the field and describes a circular path of radius r, then the radius r, is given by, (in the usual notation)

A. $\sqrt{\dfrac{2m(E-\phi)}{eB}}$

B. $\sqrt{2m(E-\phi)eB}$

C. $\sqrt{\dfrac{2e(E-\phi)}{mB}}$

D. $\sqrt{\dfrac{2m(E-\phi)}{Be}}$

Answer: D

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54. A monochromatic light of wavelength λ is incident on an isolated metallic sphere of radius a. The threshold wavelength is λ_0 which is larger then λ. Find the number of photoelectrons emitted before the emission of photo electrons stops.

A. The stopping potential will be $\frac{hc}{e}\left(\frac{1}{\lambda}-\frac{1}{\lambda_0}\right)$

B. The + ve charge acquired by the sphere until emission of electrons stopped $(4\pi \in_0 a) \times \frac{h}{e}\left(\frac{1}{\lambda}-\frac{1}{\lambda_0}\right)$

C. The number of photoelectrons emitted before the emisson of photoelectrons will stop will be $(4\pi \in_0 a) \times \frac{hc}{e^2}\left(\frac{1}{\lambda}-\frac{1}{\lambda_0}\right)$

D. All option are correct

Answer: D

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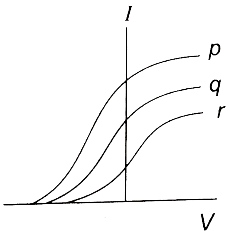
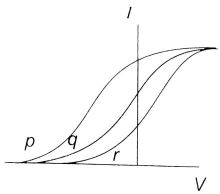
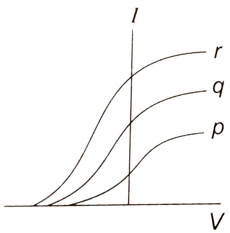
55. Photoelectric effect experiments are performed using three different metal plates p, q and$r$ having work function $\phi_p = 2.0eV, \phi_e = 2.5eV$ and $\phi_r = 3.0eV$ respectively A light beam containing wavelength of $550nm, 450nm$ and $350nm$ with equal intensities illuminates each of the plates . The correct $I - V$ graph for the experiment is [Take hc = 1240 eV nm]



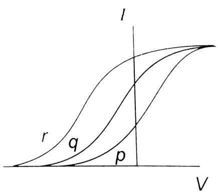
A.



B.



C.



D.

Answer: A

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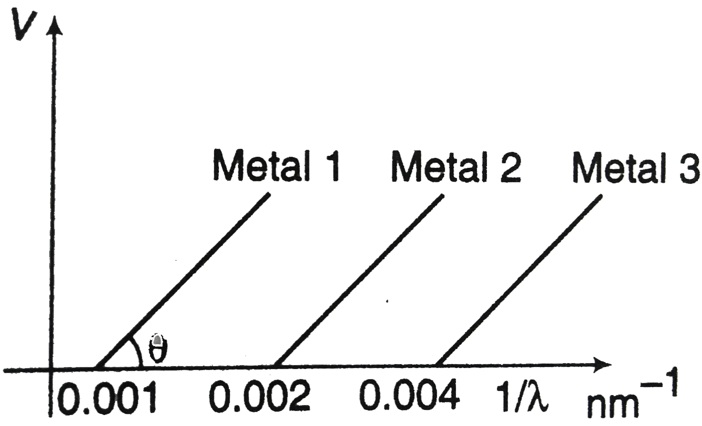
56. The graph between $1/\lambda$ and stopping potential (V) of three metals having work- functions Φ_1, Φ_2 and Φ_3 in an experiment of photoelectric effect is plotted as shown in the figure. Which of the following statement(s) is/are correct? (Here, λ is the wavelength of the incident ray). (a) Ratio of work functions $\phi_1 : \phi_2 : \phi_3 = 1 : 2 : 4$ (b) Ratio of work functions $\phi_1 : \phi_2 : \phi_3 = 4 : 2 : 1$ (c) tan θ is directly proportional to hc / e, where h is Planck constant and c is the speed of light (d) The violet colour light can eject photoelectrons from metals 2 and 3 .



A. (i),(iii)

B. (i),(iv)

C. (ii),(iii)

D. (i),(ii),(iv)

Answer: A

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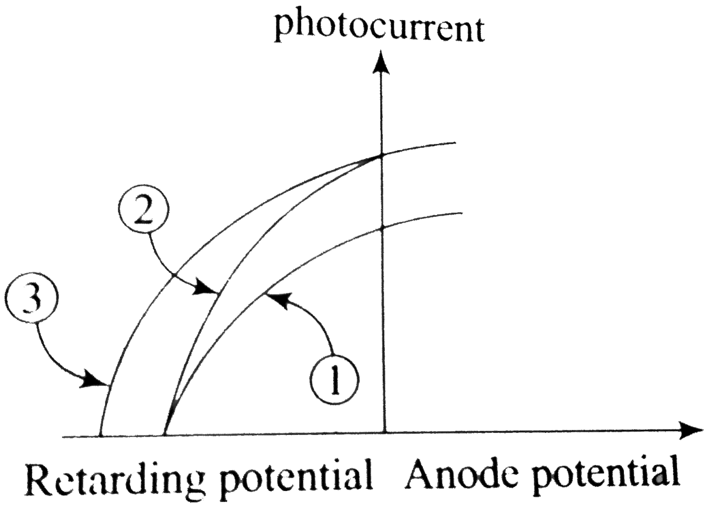
57. The figure shows a plot of photo current versus anode potential for a photosensitive surface for three different radiations. Which one of the following is a correct statement ?



A. curves a and b represent incident radiations of different frequencies and different intensities

B. curves a and b represents incident radiations of same frequency but of different intensities

C. curves b and c represents incident radiations of different frequencies and different intensities

D. curves b and c represents incident radiations of same frequency having same intensity

Answer: B

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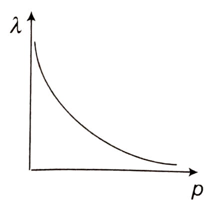
58. Which of the following is correct regarding de-Broglie wavelength?

A. Every moving particle has a wave associated with it and is given by de-Broglie wavelength

$$\lambda = \frac{h}{P} = \frac{h}{mv} = \frac{h}{\sqrt{2mK}}$$

B. Whether wave behaviour will dominate or particle behaviour, it depends on the dimension of object with which particle interacts

C. The variation of de-Broglie wavelength λ with momentum of particle p



D. All option are correct

Answer: D

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59. de-Broglie wavelength associated with an electron accelerated through a potential difference V is λ. What will be its wavelength when the accelerating potential is increased to 4V?

A. 2λ

B. 4λ

C. $\frac{\lambda}{2}$

D. $\frac{\lambda}{4}$

Answer: C

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60. An electron of mass m_e and a proton of mass m_p are accelerated through the same potential difference. The ratio of the de Broglie wavelength associated with an electron to that associated with proton is

A. 1

B. $\frac{m_e}{m_p}$

C. $\frac{m_p}{m_e}$

D. $\sqrt{\frac{m_p}{m_e}}$

Answer: D

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61. A proton and an electron are accelerated by the same potential difference, let λ_e and λ_p denote the de-Broglie wavelengths of the electron and the proton respectively

A. $\lambda_e = \lambda_p$

B. $\lambda_e < \lambda_p$

C. $\lambda_e > \lambda_p$

D. none

Answer: C

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62. In which of the following cases the heavier of the two particles has a smaller de-Broglie wavelength ? The two particles

A. (i),(ii),(iii)

B. (ii),(iii),(iv)

C. (i),(iii),(iv)

D. all

Answer: C

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

A. $25\ \%$

B. $75\ \%$

C. $60\ \%$

D. $50\ \%$

Answer: B

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64. The de - Broglie wavelength of a neutron at $27^{\circ} C$ is λ. What will be its wavelength at $927^{\circ} C$?

A. $\lambda / 2$

B. $\lambda / 3$

C. $\lambda / 4$

D. $\lambda / 9$

Answer: A

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65. λ_e, λ_p and λ_α are the de-Broglie wavelength of electron, proton and α particle. If all the accelerated by same potential, then

A. $\lambda_e < \lambda_p < \lambda_\alpha$

B. $\lambda_e < \lambda_p > \lambda_\alpha$

C. $\lambda_e > \lambda_p > \lambda_\alpha$

D. $\lambda_e = \lambda_p > \lambda_\alpha$

Answer: C

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66. When the mkomentum of a proton is changed by an amount p_0, the corresponding change in the de-Broglie wavelength is found to be 0.25%. Then, the original momentum of the proton was

A. p_0

B. $100p_0$

C. $400p_0$

D. $4p_0$

Answer: C

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67. If an electron and a photon propagate in the form of waves having the same wavelength , it implies that they have the same

A. energy

B. momentum

C. velocity

D. angular momentum

Answer: B

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68. What are matter waves? Show that de-Broglie wavelength associated with an electron of energy, V-electron volt is approx. $\frac{12.27}{\sqrt{V}}\text{Å}$.

A. electromagnetic waves

B. transverse mechanical waves

C. longitudinal mechanical waves

D. neither electromagnetic nor mechanical waves

Answer: D

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69. The time required in emitting photoelectrons is

A. 10^{-8} sec

B. 10^{-4} sec

C. 1 sec

D. 1 hr

Answer: A

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70. In the Davisson and Germer experiment , the velocity of electrons emitted from the electron gun can be increased by

A. decreasing the potential difference between the anode and filament

B. increasing the potential difference between the anode and filament

C. increasing the filament current

D. decreasing the filament current

Answer: B

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71. When the energy of the incident radiation is increased by 20%, kinetic energy of the photoelectrons emitted from a metal surface increased from $0.5eV \rightarrow 0.8eV$. The work function of the metal is

A. $1.0eV$

B. $1.3eV$

C. $1.5eV$

D. $0.65eV$

Answer: A

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72. Light with an enargy flux of $25 \times 10^4 W m^{-2}$ falls on a perfectly reflecting surface at normal incidence. If the surface area is $15 cm^2$, the average force exerted on the surface is

A. $2.50 \times 10^{-6} N$

B. $1.20 \times 10^{-6} N$

C. $3.0 \times 10^{-6} N$

D. $1.25 \times 10^{-6} N$

Answer: A

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

A. 75

B. 60

C. 50

D. 25

Answer: A

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