PHYSICS

BOOKS - CENGAGE PHYSICS

NATURE OF LIGHT AND PHOTOELECTRIC EFFECT

Worked Examples

1. A photon of frequency $5 \times 10^{14} Hz$ is incident on the surface of a metal. If the photoelectric thresh-old frequency for the metal is $3 \times 10^{14} Hz$, Calculate the

following

Energy of the photon

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2. A photon of frequency $5 \times 10^{14} Hz$ is incident on the surface of a metal. If the photoelectric thresh-old frequency for the metal is $3 \times 10^{14} Hz$, Calculate the following

Photoelectric work function in eV

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3. The threshold wavelength for a metal is 680nm. Calculate the maximum velocity of photoelectrons

emitted when radiation of wavelength 560nm is incident on the metal.

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4. Find the maximum wavelength of light that can cause photoelectric effect in lithium. Given work function of lithium is 2.5eV.

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Mandatory Exercise Exercise Set I

1. What is the name given to the minimum energy of incident radiation required to free an electron from the

surface of a metal?

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2. How does the photoelectric current vary with the intensity of incident radiation?

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3. Radiation of any frequency can pull out electrons from a metal. Say true or false.

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4. Does the kinetic energy of photoelectrons depend on the intensity of incident radiations?

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5. Is there a time lag between the incident radiation and the emission of electrons from a metal?

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6. Do you consider light as wave or as a particle to explain photoelectric effect?

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7. Write Einstein's photoelectric equation.

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Mandatory Exercise Exercise Set Ii

1. The relation between E h and ν is written as _____

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2. Value of 'h' is _____

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3. Photoelectric effect was discovered by _____ in 1887.

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4. The limiting or minimum frequency required for photoelectric effect is called _____

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Mandatory Exercise Exercise Set Iii

1. Photons have the following characteristics

A. Energy of a photon E= hν

B. Photons travel with the velocity of light

C. Photons are emitted when light of frequency ν is emitted by an atom

D. None of these

Answer:

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2. Which of the following are photocells?

A. Photoemissive cell

B. Photovoltaic cell

C. Photoconductive cell

D. Solar cell

Answer:

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3. A photon has an energy

where h is the Planck's constant, v is the frequency of radiation, λ is the wavelength of radiation, and c is the velocity of light.

A. E=hv

B. $E = hc\lambda$

C. $E = \frac{h}{v}$

D. $E = \frac{h\lambda}{c}$

Answer:

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4. According to Newton, light is made up of

A. photons

B. waves

C. corpuscles

D. None of these

Answer:

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5. Which of the following theory support wave nature of light?

A. Newton's corpuscular theory

B. Huygen's wave theory

C. Max Planck's quantum theory

D. Photoelectric effort

Answer:

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6. Which of the following theories support particle nature of light?

A. Huygen's wave theory

B. Maxwell's electromagnetic wave theory

C. Young's double slit experiment

D. Max Planck's quantum theory

Answer:

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7. Huygens's wave theory could explain

A. reflection

B. refraction

C. interference

D. all of these

Answer:

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8. According to Maxwell, light travels in the form of

A. oscillating electric and magnetic field

B. Photons

C. corpuscles

D. wave through medium to other

Answer:

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9. When light travels through a medium from vacuum, its speed

A. increases

B. decreases

C. remains same

D. increases or decreases depending on medium

Answer:

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10. What is the rest mass of photon?

A. zero

B. $9.1 \times 10^{-31} kg$

C. $1.67 \times 10^{-27} kg$

D. $6.625 \times 10^{-34} kg$

Answer:

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11. What is the value of Planck's constant?

A. $5.67 \times 10^{-8} J - s$

B. $6.625 \times 10^{-34} J.\ s$

C. $6.022 \times 10^{23} J.\ s$

D. $9 \times 10^9 J.\ s$

Answer:

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12. Energy of a photon is given by the relation

A. $E = mc^2$

B. E= hv

C. $E = mgh$

D. $E = \frac{1}{2}mv^2$

Answer:

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13. Which scientist linked the wave and particle nature of light?

A. Newton

B. Max Planck

C. Louis-de-Broglie

D. James Maxwell

Answer:

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14. How does photo current changes when we increase the intensity of radiation ?

A. increases

B. decreases

C. No change

D. May increase or decrease

Answer:

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15. Which of the following is true for photoelectric effect?

A. It is instantaneous

B. It requires a few seconds

C. Time required depends on intensity of light

D. Time required depends on frequency of light

Answer:

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16. How does kinetic energy of electrons change when we increase the intensity of light?

A. increase

B. decrease

C. No change

D. May increase or decrease

Answer:

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Mandatory Exercise Exercise Set Iv

1. A photon of frequency $5 \times 10^{14} Hz$ is incident on the surface of a metal. What is the energy of the incident photon in eV?

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2. A monochromatic source of light operation at 200 W emits 4×10^{20} photons per second. Find the wavelength of the light $(\text{in} 10^{-7} m)$.

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3. A photon of energy 2.16eV is incident on the surface of a metal of photoelectric work function 1.25eV. If the maximum velocity of a photoelectron emitted is $0.566 \times 10^{6} m s^{-1}$, calculate the mass of the electron.

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Challenging Exercise

1. How many photons are emitted per second by a 5mW laser source operating at 632.8nm?

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2. The work function of a material is 4.5eV. What is the maximum wavelength of incident light for which electrons will be emitted?

A. $2450Å$

B. $2755Å$

C. $3125Å$

D. $3525Å$

Answer:

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3. What is the work function of a metal if light of minimum frequency 8×10^{13}Hz is required for emission of photo electrons?

A. 0.16eV

B. 0.66eV

C. 0.33eV

D. 1.12eV

Answer:

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Olympiad And Ntse Level Exercises

1. The de - Broglie wavelength of a particle moving with a velocity $2.25 \times 10^8 m/s$ is equal to the wavelength of photon. The ratio of kinetic energy of the particle to the energy of the photon is (velocity of light is $3 \times 10^8 m/s$

A. $1/8$

B. $3/8$

C. $5/8$

D. $7/8$

Answer:

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2. A caesium photocell , with a steady potential difference of $60V$ across , is alluminated by a bright point source of light $50cm$ away. When the same light is placed $1m$ away the photoelectrons emitted from the cell

A. are one quarter as numerous

B. are half as numerous

C. each carry one quarter of their previous momentum

D. each carry one quarter of their previous energy

Answer:

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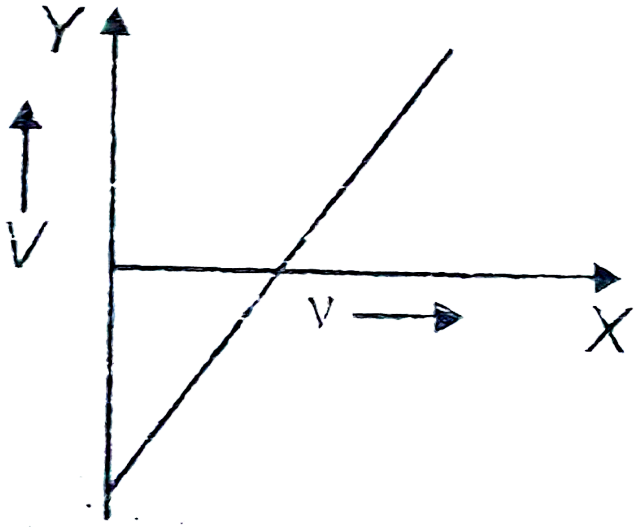
3. The stopping potential V for photo-electric emission from a metal surface is plotted along Y-axis and frequency v of incident light along X-axis. A straight line is obtained as shown . Planck's constant is given by



A. slope of the line

B. product of slope on the line and charge on the electron

C. product of intercept along Y-axis and mass of the electron

D. product of slope and mass of electron

Answer:

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4. Light of wavelength 4000Å falls on a photosensitive metal and a negative $2V$ potential stops the emitted electrons. The work function of the material (in eV) is approximately

$\left(h = 6.6 \times 10^{-34} Js, e = 1.6 \times 10^{-19} C, c = 3 \times 10^{8} ms^{-1}\right)$

A. 1.1

B. 2.0

C. 2.2

D. 3.1

Answer:

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5. Mercury violet $(\lambda = 4558\text{Å})$ is falling on a photosensitive material $(\phi = 2.5eV)$. The speed of the ejected electrons is in ms^{-1}, about

A. 3×10^5

B. 2.65×10^5

C. 4×10^4

D. 3.65×10^7

Answer:

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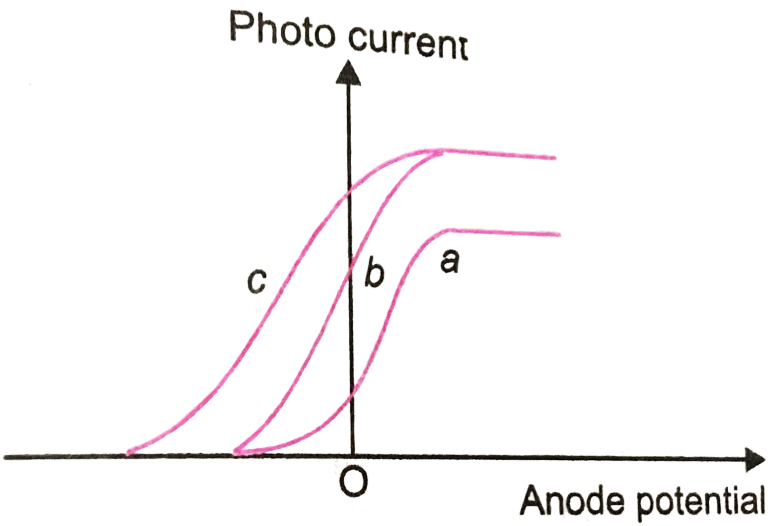
6. The fig. shows the variation of photon current with anode potential for a photo-sensitive surface for three different radiation. Let I_a, I_b and I_c be the intensities and f_a, f_b and f_c be the frequency for the curves a,b and

c respectively.



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. $f_a = f_b$ and $I_a = I_b$

Answer:

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7. Assertion : If different gases are filled turn by turn at the same pressure in the discharge tube the discharge in them takes place at the same potential.

Reason : The discharge depends only on the pressure of discharge tube and not on the ionisation potential of gas.

A. If both assertion and reason are true and reason is the correct explanation of assertion.

B. If both assertion and reason are true but reason is not the correct explanation of assertion.

C. If assertion is true but reason is false

D. If assertion and reason both are false

Answer:

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8. A physicist wishes to eject electrons by shining light on a metal surface. The light source emits light of wavelength of 450 nm. The table lists the only available metals and their work functions.

Metal	$W_0(eV)$
Barium	2.5
Lithium	2.3
tantalum	4.2
Tungsten	4.5

Which metal(s) can be used to produce electrons by the photoelectric effect from given source of light?

A. Barium only

B. Barium or lithium

C. Lithium, tantalum or tungsten

D. Tungsten or tantalum

Answer:

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9. A physicist wishes to eject electrons by shining light on a metal surfac. The light source emits light of wavelenght of 450 nm. The table lists the only available metals and their work functions.

Metal	$W_0(eV)$
Barium	2.5
Lithium	2.3
tantalum	4.2
Tungsten	4.5

Suppose photoelectric experiment is done separately with these metals with light of wavelenght 450 nm. The maximum magnitude of stopping potential amongst all the metals. is-

A. 2.75 volt

B. 4.5 volt

C. 0.45 volt

D. 0.25 volt

Answer:

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