QB365 Question Bank Software Study Materials

Dual Nature of Radiation and Matter Important 2 Marks Questions With Answers (Book Back and Creative)

12th Standard

Physics

Total Marks : 40

2 Marks

20 x 2 = 40

1) Define work function of a metal. Give its unit.

Answer : The minimum energy needed for an electron to escape from the metal surface is called work function of that metal.

Unit: electron volt (eV).

2) What is photoelectric effect?

Answer : The ejection of electrons from the metal plate when illuminated by light or any electromagnetic radiation of suitable wavelength (or frequency) is called photoelectric effect.

3) Give the definition of intensity of light according to quantum concept and its unit.

Answer : According to quantum concept, intensity of light of given wavelength is defined as the number of energy quanta or photons incident per unit area per unit time, with each photon having same energy. Its unit is Wm^{-2}.

4) How many photons per second emanate from a 50 mW laser of 640 nm?

Answer : P = 50 mW; λ = 640nm = 640 x 10^{-9} m

P = 50 x 10^{-3}W

$$n = \frac{hc}{\lambda} = \frac{6.626\times10^{-34}\times3\times10^{8}}{640\times10-9} = 3.106 \times 10^{-19} J$$

$$n = \frac{E}{hv} = \frac{50 \times 10^{-3}}{3.106 \times 10^{-19}} = 1.61 \times 10^{17} s^{-1}$$

n = 1.61 x 10^{17} s^{-I}

5) Calculate the maximum kinetic energy and maximum velocity of the photoelectrons emitted when the stopping potential is 81 V for the photoelectric emission experiment.

Answer : V = 81 V

∴ K = eV = 1.6 x 10^{-19} x 81 = 1.296 x 10^{-17} = 1.3 x 10^{-17} J

$$V = \sqrt{\frac{2K}{m}}\sqrt{\frac{2 \times 1.3 \times 10^{-17}}{9.1 \times 10^{-31}}} = 5.345 \times 10^{6} ms^{-1}$$

v = 5.345 x 10^{6} m s^{-1}, K = 1.3 x 10^{-17} J

6) Calculate the energies of the photons associated with the following radiation:

(i) violet light of 413 nm

(ii) X-rays of 0.1 nm

(iii) radio waves of 10 m.

Answer : (i) λ_v= 413 nm = 413 x 10^{-9} m

$$E = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{413 \times 10^{-9} m}$$

E = 3.00 eV

(ii) λ = 0.1 nm = 0.1 x 10^{-9} m

$$E = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{0.1 \times 10^{-9}} = 19.878 \times 10^{-16}$$

$$E = \frac{19.878 \times 10^{-16}}{1.6 \times 10^{-19}} = 12.4237 \ = eV \ 12424 \ eV$$

E = 12424 eV.

(iii) λ = 10 m

$$E_r = \frac{hc}{\lambda_r} = \frac{19.878 \times 10^{-27}}{10}$$

$$= E = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{10 \times 1.6 \times 10^{-9}} = 1.2424 \times 10^{-7}$$

E_r = 1.24 x 10^{-7} eV.

7) At the given point of time, the earth receives energy from sun at 4 cal $cm^{-2}min^{-1}$. Determine the number of photons received on the surface of the Earth per cm^2 per minute. (Given: Mean wavelength of sun light = 5500 Å)

Answer : $P = 4\ \text{calcm}^{-2}\ \text{min}^{-1} = 4 \times 4.2 = 16.8\ \text{J cm}^{-2}\ \text{min}^{-1}$

$E = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^8}{5500 \times 10^{-10}} = 3.6 \times 10^{-19}\ \text{J}$

$n = \frac{E}{hv} = \frac{16.8}{3.6 \times 10^{-19}} = 4.67 \times 10^{19}$

$n = 4.67 \times 10^{19}$ per cm^2 per minute.

8) A radiation of wavelength 300 nm is incident on a silver surface. Will photoelectrons be observed? [work function of silver = 4.7 eV]

Answer : Energy of the incident photon is

E = hv = $\frac{hc}{\lambda}$ (in joules)

E = $\frac{hc}{\lambda e}$ (in eV)

Substituting the known values, we get

E = $\frac{6.626 \times 10^{-34} \times 3 \times 10^8}{300 \times 10^{-9} \times 1.6 \times 10^{-19}}$

E = 4.14 eV

The work function of silver = 4.7 eV. Since the energy of the incident photon is less than the work function of silver, photoelectrons are not observed in this case.

9) Write the expression for the de Broglie wavelength associated with a charged particle of charge q and mass m, when it is accelerated through a potential V.

Answer : The kinetic energy acquired by the electron is given by

$= \frac{1}{2}mv^2 = eV$

Therefore, the speed v of the electron is $v = \sqrt{\frac{2eV}{m}}$

Hence, the de Broglie wavelength of the electron is, $\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2meV}}$

10) Define stopping potential.

Answer : Stopping potential is that value of the negative (retarding) potential given to the anode which is just sufficient to stop the most energetic photoelectrons emitted and make the photocurrent is zero.

11) Work function of aluminium is 4.2 eV. If two photons, each of energy 2.5 eV, are incident on It surtace, will the emission of electrons take place? Justify your answer

Answer : In photoelectric effect, a single photon interacts with a single electron. As individual photo has energy (2.5 eV) which is less than work function, hence emission of electron will not take place.

12) Name the phenomenon which shows the quantum nature of electromagnetic radiation.

Answer : "Photoelectric effect" shows the quantum nature of electromagnetic radiation.

13) Define intensity of radiation on the basis of photon picture of light. Write its SI unit.

Answer : The amount of light energy or photon energy incident per meter square per second is called the intensity of radiation.
SI unit: $\frac{W}{m^2}$ or J/s-m^2.

14) How does the maximum kinetic energy of electrons emitted vary with the work function of the metal?

Answer : Maximum kinetic energy Ek = hv - W

Clearly, smaller the work function W, greater is the E_k This means that when work function of a metal increases, maximum kinetic energy of photoelectrons decreases.

15) Which of the two :

(i) light or

(ii) moving material particle is concerned with de-Broglie hypothesis?

Answer : Moving material particle is concerned with de Broglie hypothesis.

16) < div >It is harder to remove a free electron from copper than from sodium. Which metal has greater work function? Which metal has higher threshold wavelength?< /div >

Answer : < div >Since it is difficult to remove an electron from copper than sodium, thus work function of copper is greater. Threshold wavelength will be more for sodium.< /div >

17) < div >When monochromatic radiation of wavelength 2000 A falls upon a nickel plate, the later acquires a positive charge. When the wavelength is increased, at 3400 A the effect is found to cease, however intense the incident radiation may be. Explain it.< /div >

Answer : (i) If the wavelength of 3400 A is incident on nickel plate. Photo electron are not emitted because this wavelength is greater than the threshold wavelength of nickel.
(ii) But when 2000 A wavelength is incident of nickel it produces photo electrons. So that nickel plate acquires positive charge.

18) Why is the structure of crystals studied by X-rays?

Answer : < div >The distance between the atoms of the crystals is of the order of wavelength of X-rays. When X- rays fail on a crystal, they are diffracted. The diffraction is helpful in the study of crystal structure.< /div >

19) Without the discovery of X- rays the medical field would not have achieved this level advancement in diagnosis. Justify your answer.

Answer : It is true that discovery of X-rays helped medical field to reach this level of advancement.
(i) X-rays radiographs are used to detect fractures, foreign bodies, diseased organs etc.
(ii) X-rap can kill diseased tissues. they are employed to cure skin diseases, malignant tumours etc.

20) What are the differences between electromagnetic waves and matter waves?

Answer : (i) Electromagnetic wave is the wave generated by accelerated charged panicles which has variation of electric and magnetic fields along the direction of propagation.
(ii) The name associated with a moving matter particle is called matter waves. It does not depends on the charge of the particle.