ATOMIC PHYSICS

SYNOPSIS

DISCOVERY OF ELECTRON:

- At ordinary pressures and ordinary voltages gases are bad conductors of electricity.
- The p.d. required to start a spark through a gas is known as sparking potential. It is much greater than the p.d. required to maintain the spark once started.
- At ordinary pressures for moderately great spark lengths, the sparking potential is nearly proportional to the spark length, being about 30,000 V per cm in air between spherical electrodes of 1 cm diameter and less in case of pointed electrodes.
- According to Paschen's law, the sparking potential is directly proportional to the pressure (p) of the gas between the electrodes and the distance (d) between them.
- At ordinary pressures, the current is due to the presence of positive and negative ions as in the case of electrolytic conductivity of a solution.
- At low pressures, discharge i.e., the passage of current through gases occurs at much lower voltages than at high pressures.
- At lower pressures negative ion throws off its attendant atom or molecule and the resultant negatively charged particle, the electron travels free and faster than the positive ions.
- At low pressures in the discharge tube, as the pressure is reduced different phenomena such as sparking, positive column, glow of cathode, Faraday's dark space, Crooke's dark space and the striations of positive column are gradually observed.
- Finally at a pressure of about 0.01mm of Hg pressure, C7rooke's dark space completely fills the discharge tube with the walls of the tube glowing with light i.e., producing fluorescence on the walls of the tube. This is due to some radiation emitted from the cathode surface to which the name cathode rays has been given.
- Cathode rays were first observed by Plucker. J J Thomson after studying their properties called them "Streams of negative corpuscles", while Johnstone stoney who having found from the electrolysis that electricity was atomic in nature, suggested the name "electron".

e/m OF ELECTRON BY THOMSON METHOD:

- A narrow beam of cathode rays is subjected to crossed electric and magnetic fields i.e., magnetic and electric fields at right angles to each other. By measuring the deflections produced in the two fields their e/m can be determined.
- The electric and magnetic fields are so adjusted that the forces on the cathode ray beam are equal and opposite. The cathode ray beam goes undeflected. In such a case, Ee = Be v. Velocity of the cathode ray beam $v = \frac{E}{B}$.
- If an electron is accelerated through a p.d. V,it acquires a velocity v which is given by $v = \sqrt{\frac{2Ve}{m}}$ from which $\frac{e}{m} = \frac{v^2}{2V} = \frac{E^2}{2B^2V}$ ($\because v$ = E/B)
- e/m of an electron can also be found from the radius of the circular path, r = $\frac{mv}{Be}$ and v = E/B as $\frac{e}{m} = \frac{E}{B^2 r}$
- Specific charge of an electron =1.759x10^{11} C/kg.
- Its value does not depend upon the nature of the electrodes and the gas inside the discharge tube.
- Specific charge of an electron changes with velocity. It decreases as velocity increases because mass varies with velocity. According to Einstein's special theory of relativity, mass of a body moving with a velocity v is $m = \frac{m_o}{\sqrt{1-\frac{v^2}{c^2}}}$ where m_o is the rest mass of the body.

CHARGE OF AN ELECTRON BY MILLIKAN'S OIL DROP METHOD:

- Charged oil drops of heavy non volatile oil are produced by a spray atomiser.
- Observations are made on single drop by suitable application of an electric field opposed to the gravitational field.
- When an oil drop moves in only gravitational field the forces acting on it are 1) weight $mg = \frac{4}{3}\pi r^3 \rho g$, vertically downwards
- Buoyancy of air, $\frac{4}{3}\pi r^3 \sigma g$, vertically upwards and
- Backward viscous force of air, $6\pi\eta r v$, vertically upwards.

- The first two forces remain constant as an oil drop falls downwards but the viscous force increases till the sum of the upward forces becomes equal to the downward force. The resultant force becomes zero and the oil drop continues to move down with a constant velocity called terminal velocity (v_g) so that

$$6\pi\eta r v_g = \frac{4}{3}\pi r^3(\rho-\sigma)g$$

and radius of the oil drop = r = $\left[\frac{9}{2}\frac{\eta v_g}{(\rho-\sigma)g}\right]^{1/2}$

- If an electric field of intensity E is applied so that the charged oil drop moves upwards with terminal velocity, v_e, so that

$$qE = 6\pi\eta r v_e + \frac{4}{3}\pi r^3(\rho-\sigma)g$$

$$qE = 6\pi\eta r v_e + 6\pi\eta r v_g$$

$$q = \frac{6\pi\eta(v_e+v_g)r}{E}$$

where q is the charge on the oil drop.

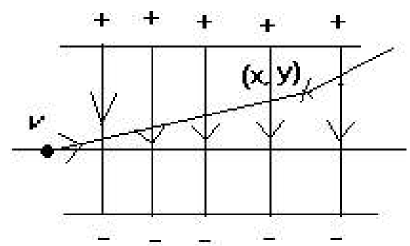
- The experiment is repeated with different charges on the same oil drop by using x - rays.
- The different values of q are found to be integral multiples of a least value which is the charge of an electron.
- Important inferences of the experiment :
  1. Charge is atomic in nature
  2. Charge is quantised.
- Charge of an electron = e= 1.602 x 10^{-19}C mass of an electron = m = 9.1 x 10^{-31} Kg

MOTION OF A CHARGED PARTICLE IN AN ELECTRIC FIELD:

- When a charged particle of charge q and mass m moving with a velocity v enters into an electric field parallel to the direction of the electric field, then it travels along a straight line. If it is negatively charged it moves in the opposite direction of electric field. If it is positively charged it moves in the direction of the electric field.
- If the electric field is in the vertical direction as shown in the figure and the charged particle enters horizontally into it, then the vertical force acting on it is F = Eq where E is the electric intensity. Its vertical acceleration is a = $\frac{Eq}{m}$. If the position of the charged particle at any instant of time t is (x,y), then time taken, t = $\frac{x}{v}$ and vertical displacement, s = y is obtained as y = $\frac{1}{2}\frac{Eq}{m}\left(\frac{x}{v}\right)^2$

($\because$ s = ut + $\frac{1}{2}$ at^2 and u = 0)

Hence the path of the charged particle in the electric field is a parabola.



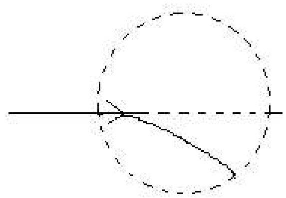
- If two charged particles enter into the same electric field with same velocity, the ratio of their deflections is $y_1/y_2 = (q_1m_2) / (q_2m_1)$.
- If two charged particles enter with the same K.E. into the same electric field, the ratio of their vertical displacements is $y_1 : y_2 = q_1 : q_2$
- If two charged particles enter into the same electric field with the same momentum, the ratio of their deflections is $\frac{y_1}{y_2}=\frac{q_1}{q_2}\frac{m_1}{m_2}$
- If a charged particle is accelerated through a p.d. of V, the velocity acquired by it is $v=\sqrt{\frac{2Vq}{m}}$

($\because$ workdone = Vq = K.E. acquired by it starting from rest)

MOTION OF A CHARGED PARTICLE IN A MAGNETIC FIELD:

- Force acting on a charged particle in a uniform magnetic field of induction B is F = Bq $v\sin\theta$.
- If the charged particle enters into the magnetic field parallel to the direction of the magnetic field it follows a straight line path with no change in its velocity as F = 0. ($\because$ θ = 0)
- If the charged particle enters normally into the magnetic field, the force F = Bq v and its direction is perpendicular to both the directions of the velocity of the charged particle and the magnetic field as given by Fleming's left hand rule. Hence the charged particle follows a circular path of radius r for which

the necessary centripetal force $\frac{mv^2}{r}$ is given by the magnetic force Bq v. Hence radius of the circular path $r=\frac{mv}{Bq}$



- The ratio of the radii of the charged particles that enter into the same magnetic field with the same velocity is $\frac{r_1}{r_2}=\left(\frac{m_1}{m_2}\right)\left(\frac{q_2}{q_1}\right)$

  Ratio of the deflections $=\frac{r_2}{r_1}$ as deflection is proportional to $\frac{1}{r}$
- The radius of the circular path in terms of momentum is r=$\frac{p}{Bq}$.

  The ratio of the radii of two charged particles entering into the same magnetic field with the same momentum is $\frac{r_1}{r_2}=\frac{q_2}{q_1}$
- The radius of the circular path in terms of K.E. is r=$\sqrt{2m\times K.E.}/Bq$

  The ratio of the radii of two charged particles entering into the same magnetic field with the same K.E. is $\frac{r_1}{r_2}=\sqrt{\frac{m_1}{m_2}}\times\frac{q_2}{q_1}$.
- The angular velocity of the charged particle in the circular path is $\omega=\frac{v}{r}=\frac{Bq}{m}$.

  The time period of revolution of the charged particle in the circular path is T=$\frac{2\pi}{\omega}=\frac{2\pi m}{Bq}$.

  It is independent of velocity.

  The frequency of revolution of the charged particle in the circular path is n=$\frac{1}{T}=\frac{Bq}{2\pi m}$.
- If a charged particle enters into a magnetic field at any other than angle than 0°, 90° and 180°, the charged particle follows a helical path.

QUANTUM THEORY OF LIGHT:

- Some phenomena like Black body radiation, photo electric effect, Compton effect etc. cannot be explained by wave theory of light.
- Max Planck proposed quantum theory of light, according to which light is emitted in the form of photons or quanta.
- The energy of each photon ,E = h $\nu=\frac{hc}{\lambda}$ where ν is frequency and λ is wavelength of light.
- A photon at rest has no mass. But when it moves with the velocity of light, c, its dynamic or kinetic mass, m=$\frac{h\nu}{c^2}$ ($\because$ By Einstein's mass energy relation $E=mc^2=h\nu$).
- The momentum of a photon

  =p=mc=$\frac{h\nu}{c^2}\times c=\frac{h\nu}{c}=\frac{h}{\lambda}$.
- The number of photons, n, emitted by a source of monochromatic radiation of frequency ν and power P in t second is P = $\left(\frac{n}{t}\right)h\nu$, where $\frac{n}{t}$ is the number of photons emitted per second.
- Energy of a photon in electron volt can be found by using the formula $E\ in\ eV\approx\frac{12400}{\lambda\ in\ A^o}$

PHOTOELECTRIC EFFECT:

- Photoelectric emission is the phenomenon in which a good number of substances, chiefly metals under the influence of a radiation such as γ-rays, X - rays, ultraviolet and even visible light emit electrons.
- These electrons are called photoelectrons and the current so formed is photo electric current. The photoelectric current is of the order of microampere.
- This was first discovered by W. Smith in 1883. It was observed by Hertz in 1887. A year later Hallwachs, Elster and Crietel investigated the phenomenon announced by Hertz.
- Einstein explained it extending the Planck's quantum theory by assuming that the photons emitted by a source of light travel through space in the form of photons and are incident on a metal surface in the form of photons.

- When the photon of a radiation is incident on a metal surface, during a collision between a photon and a semi free electron of the metal (an electron in the metallic bond) the electron comes out of the metal taking all the energy of the photon. It uses some of the energy to do work in coming out of the emitter.
- Einstein expressed the maximum K.E. of the liberated electron by an equation called Einstein's photoelectric equation. It is given by $K.E_{max} = h\nu - w$, where $h\nu$ is the energy of the photon absorbed by the emitter and w is the work function which is the work done by an electron to come out of the emitter. In deriving this formula, only the principle of conservation of energy is used.
- Work function is different for different metals. It is small for Alkali metals. Work function of sodium is 2.30 eV, potassium is 2.18 eV and ceasium is 1.88 eV.

RELATION BETWEEN W AND ν_0:

- As the electrons are to be liberated from a metal the minimum energy, w, required is obtained by substituting $K.E_{max}=0$ and the minimum frequency of radiation required to liberate it as $\nu = \nu_o$ called threshold frequency in $K.E_{max} = h\nu - w$

  $0 = h\nu_o - w$

  $w = h\nu_o = \frac{hc}{\lambda_0} \quad w\,in\,eV \approx \frac{12400}{\lambda\,in\,A^o}$
- Photoelectric emission from a metal is possible when light of certain minimum frequency called threshold frequency (ν_o) is incident. The corresponding wavelength is called threshold wavelength or cut-off wavelength (λ_0).
- As work function is different for different metals, the threshold frequency is different for different metals.
- For a given metal surface, the $K.E_{max}$ of the photoelectrons liberated is linearly dependent on the frequency of the incident light provided it is $\geq \nu_0$.
- The $K.E_{max}$ is independent of the intensity of the incident radiation.
- If the frequency of incident light $\nu < \nu_0$, even if the intensity of light is made very large there is no photoelectric emission. If the frequency of incident light $\nu \geq \nu_0$, there is photoelectric emission however small the intensity of incident light may be.
- For a given metal surface, if the light of frequency $\geq \nu_0$ is incident, the number of photoelectrons liberated per second or photoelectric current increases with the intensity of incident light. This is possible as more number of photons correspond to more intensity of incident light and it involves more collisions between electrons of the metal and the incident photons.
- The photoelectric current does not depend upon the frequency of the incident light provided $\nu \geq \nu_0$.
- As the photoelectric effect is a collision effect, it is an instantaneous process.
- The time interval between the incidence of light and emission of electrons is about 3×10^{-9} s. So it is taken as an instantaneous process.
- The photoelectrons liberated from a metal have Kinetic energies between 0 to $K.E_{max}$ as some of the collisions between the photons and electrons may take place inside the metal surface.
- In the photoelectric emission caused by high frequency radiatioins such as X-rays, γ-rays etc., electrons from K, L, M shells are emitted.
- Einstein's photoelectric equation in terms of λ and λ_0:

  $$K.E_{max} = h\nu - w = h\nu - h\nu_0 = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$$

MILLIKAN'S VERIFICATION OF EINSTEIN'S PHOTOELECTRIC EQUATION:

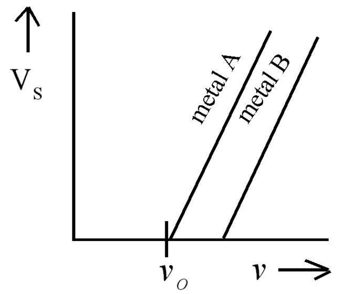
- Different Alkali metal blocks are mounted on a rotating wheel on which light of different frequencies is allowed to fall.
- Stopping potential (V_s) is the positive potential to be applied to the metal surface so that the electrons liberated from it are completely stopped or it is the negative potential to be applied to the anode so that the electrons liberated from a metal surface are completely stopped.
- For a particular metal surface, allowing light of frequency $\nu > \nu_0$, the corresponding stopping potential applied to the metal surface is found.
- Work done to stop the electrons =

  $V_s e = K.E_{max}$ (by work-energy theorem)

  $V_s e = h\nu - h\nu_0$ (by Einstein's photoelectric equation)

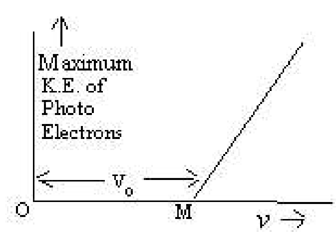
  $$V_s = \left(\frac{h}{e}\right)\nu - \left(\frac{h\nu_0}{e}\right)$$
- A graph plotted between V_s and ν is to be a straight line.
- Slope of the straight line $= \frac{h}{e}$
- Its X - intercept $= \nu_0$

- Its Y - intercept $= -\left(\dfrac{hv_0}{e}\right) = -\left(\dfrac{w}{e}\right)$.
- Graphs between V_s and v for two different metal blocks will be parallel as the slopes are same.

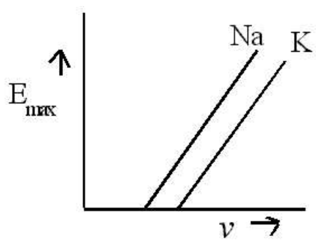


<u>SOME IMPORTANT GRAPHS</u>:

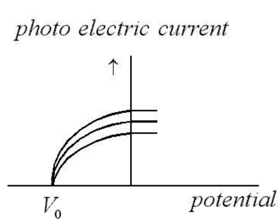
- It is clear from the graph that for $\upsilon < \upsilon_o$ there is no photoelectric emission for a given metal.



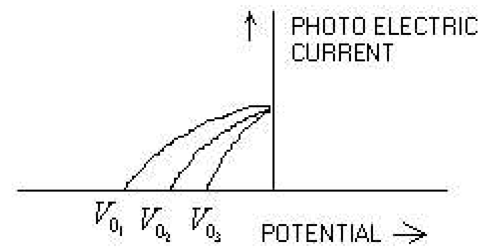
- It is clear from graph that different metals possess different values of threshold frequencies as well as work functions.



- The graph shows photoelectric current as a function of p.d. for light of different intensities I_1, I_2, I_3. We observe that V_o remains the same when the frequency ( ) of incident light is same for a given metal



- Different sources, having same intensity but of different wavelengths correspond to different values of stopping potentials $V_{0_1}, V_{0_2}, V_{0_3}$ for a given metal. It can be seen that $V_{0_1} > V_{0_2} > V_{0_3}$ if $\lambda_1 < \lambda_2 < \lambda_3$



PHOTOCELLS:

- These are the devices used to convert light energy into electric energy.
- These depend upon the outer and inner photoelectric effects.
- In the outer photoelectric effect photo electrons liberated are emitted out of the metal surface.
- In the inner photoelectric effect photoelectrons liberated are in the metal surface.
- There are three types of photo cells.
  1. Photo emissive cells
  2. Photo voltaic cells
  3. Photo conductive cells.
- Photo emissive cells depend upon outer photoelectric effect whereas photo voltaic and photo conductive cells depend upon inner photoelectric effect.
- Photo emissive cells are of two types.
  1. Vacuum type and 2. Gas filled type
- In the Vacuum type of photo emissive cell, an evacuated glass tube has its inner surface coated with an alkali metal.
  To study stellar spectra potassium hydride photosensitive surface is used.
  In the vacuum type, current is directly proportional to the intensity of incident radiation.
- In a gas filled emissive cell, an inert gas such as He, Ar or Ne at a low pressure, some tenths of a mm of Hg, is filled. Gas filled cells produce a much more intense photoelectric current due to ionization by collision in the gas. But there is no proportionality between the current and intensity of incident radiation.
- Photovoltaic cell is a true cell as it generates e.m.f. without the application of any external potential.
  When light is incident on a semi conductor coated

on a metallic plate covered by a semi transparent film electrons are emitted and travel in the direction opposite to the light rays.

The semi conductors used are cuprous oxide, selenium.

The metal plates used are copper plate, iron plate.

The semi transparent films used are silver, gold, platinum.

For small load resistances the current is nearly proportional to the intensity of incident radiation.

- In a photo conductive cell, conductivity of a semi conductor is increased when light falls on it. But the response is slow. The current is not proportional to the intensity of light.

USES OF PHOTO ELECTRIC CELLS: Photo electric cells are used

- in exposure meters
- to compare intensities of illuminations of two light sources.
- in recording and reproduction of sound in films
- in video cameras
- to study stellar spectra
- in electronic relay circuits such as Burglar's alarm, counting devices, switching on and off street lights, etc.

X - RAY SPECTRA:

- X - rays are generated when high speed electrons are suddenly stopped by high atomic number targets.
- X - rays are electromagnetic waves of wavelength between 100 A^0 to about 0.1 A^0.
- The X - rays emitted by an X - ray tube consists of different wavelengths.
- X - rays are reflected, refracted, diffracted by crystals and these are studied using Bragg's spectrometer.
- X - ray spectra are of two different types
  .i) continuous X - ray spectrum
  .ii) characteristic X - ray spectrum.

CONTINUOUS X - RAY SPECTRUM:

- It is similar to the continuous spectrum of light.
- It starts from a minimum wavelength ($\lambda_{\min}$).
- As the wavelength increases from $\lambda_{\min}$ intensity of X -rays increases till it reaches a maximum value which decreases there after.
- When the operating voltage or accelerating voltage of the X-ray tube is increased (i) $\lambda_{\min}$ decreases (ii) wavelength corresponding to maximum intensity decreases (iii) intensity corresponding to each wavelength increases. So the continuous spectrum depends upon operating voltage.
- It is independent of the nature of the target used in the X-ray tube.
- When a high speed electron crosses the nucleus of a target atom, the electric field of the nucleus decelerates the electron. The decrease in velocity gives rise to loss of K.E. which appears in the form X - radiation.
- When the electron is completely stopped, maximum energy X - ray is generated so that $h\nu_{\max} = Ve$

  $$\lambda_{\min} = \frac{hc}{Ve} \text{ and } \lambda_{\min} \text{ in } A^o \approx \frac{12400}{V \text{ in volt}}$$

  Where V is operating voltage.
- $\lambda_{\min}$ is inversely proportional to operating voltage.

CHARACTERISTIC X - RAY SPECTRA:

- It is like the line spectrum of light.
- For a particular target material used in the X - ray tube, X - rays of certain wavelengths are emitted. These appear as peaks superimposed on the continuous curve obtained when a graph is plotted between wavelength and intensity of X - rays.
- Intensity at the peaks increases as operating voltage increases but the wavelengths do not change.
- The wavelengths corresponding to the peaks depend upon the nature of the target material.
- When high speed electrons knock off the electrons in the inner shells such as K, L the electrons in higher shells make transition into those vacancies forming K, L series of X - rays respectively.
- For K_α X - ray, $E_L - E_k = h\nu_\alpha$

  For K_β X - ray, $E_M - E_k = h\nu_\beta$

  For K_γ X - ray, $E_N - E_k = h\nu_\gamma$

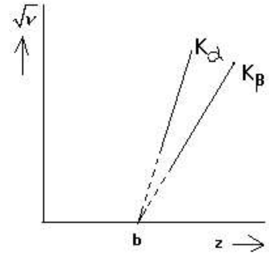
MOSELEY'S LAW:

- This is applicable for any spectral line of characteristic X - ray spectrum
- The square root of frequency of a spectral line is directly proportional to the atomic number

  $\sqrt{\nu} \ \alpha \ Z$

  $\sqrt{\nu} = a(Z - b)$
- 'a' and 'b' are constants that do not depend upon the nature of the target material.
- 'b' depends upon the series. b=1 for K - series and 7.4 for L - series.
- 'a' depends upon the line of the series. It is given by the slope of the graph between $\sqrt{\nu}$ and Z.

- 'b' is given by the X - intercept of the graph between $\sqrt{v}$ and Z.



- Its importance is
  - atomic number gives the number of protons or electrons
  - elements are arranged in modern periodic table according to increasing order of atomic number.
  - Correct positions of elements are determined.
  - new elements are discovered.
- Ratio of frequencies of a spectral line for different elements is $\frac{v_1}{v_2} = \left(\frac{Z_1 - b}{Z_2 - b}\right)^2$.
- Ratio of wavelengths of a spectral line for different elements is $\frac{\lambda_1}{\lambda_2} = \left(\frac{Z_2 - b}{Z_1 - b}\right)^2$

COMPTON EFFECT:

- When x-rays are scattered by a target the wavelength increases which is called Compton effect. This is also called incoherent scattering.
- This is explained by Compton using quantum theory.
- When an x-ray photon undergoes elastic collision with a free electron at rest of the target, part of the energy of the incident X-ray photon is given to the recoil electron. The remaining energy is with the scattered X-ray photon which increases the wavelength from λ to λ'.
- Compton shift $= \lambda' - \lambda = \Delta\lambda = \frac{h}{m_0 C}(1 - Cos\phi)$

  Where m_0 = rest mass of the electron,

  ϕ = scattering angle of X - ray photon. In deriving this formula, both the principles of conservation of energy and momentum are used.
- Compton shift is zero if $\phi = 0^0$ i.e., wavelength does not change which is the unmodified component. This scattering is called coherent scattering.
- If $\phi = 90^0$, $\Delta\lambda = \frac{h}{m_0 C}$ = 0.0242 A^0 = Compton wavelength of electron
- If $\phi = 180^0$ i.e., for back scattering, the Compton shift is maximum given by $\Delta\lambda = \frac{2h}{m_0 C}$ = 0.0484 A^0 = twice the Compton wavelength.
- Compton effect is observed only with X - rays and γ -rays. It is not observable with visible light as $\Delta\lambda$ is negligible when compared with the λ of visible light.

MATTER WAVES:

- deBroglie Hypothesis for dual nature of matter.

  i) The entire universe consists of only matter and radiation.

  ii) As radiation has dual nature, matter should also have dual nature, since nature loves symmetry.
- Wavelength of matter waves : $\lambda = \frac{h}{mv}$
- If a body is at rest, v=0 and $\lambda = \infty$ i.e., matter waves are not associated with bodies at rest.
- As velocity increases wavelength decreases.
- Matter waves do not depend upon the nature of the material.
- Matter waves are formed by the superposition of infinitely large number of waves of slightly different frequencies.
- Matter waves are in the form of a wave packet.
- If a charged particle is accelerated by applying a p.d. V then Vq = $\frac{1}{2}mv^2$

  $v = \sqrt{\frac{2Vq}{m}}$

  The corresponding de Broglie wavelength.

  $\lambda = \frac{h}{m\sqrt{\frac{2Vq}{m}}} = \frac{h}{\sqrt{2Vqm}}$

  For an electron accelerated through a p.d. V,

  $\lambda \ in \ A^0 \approx \sqrt{\frac{150}{V}}$
- If K.E. of a body is given, de Broglie wavelength, $\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m(K.E.)}}$

CONCEPTUAL QUESTIONS
CATHODE RAYS:

1. If 'C' denotes the velocity of light, velocity of cathode rays is
1) equal to C 2) greater than C
3) less than C 4) either greater or less than C

2. An electron has no initial velocity in a direction different from that of an electric field. The path of the electron is
1) a straight line 2) a circle
3) a parabola 4) an ellipse

3. Cathode rays enter an electric field normal to the field. Then their path in the electric field is
1) a parabola 2) a circle
3) a straight line 4) an ellipse

4. Cathode rays enter a uniform magnetic field normal to the field. Their path is
1) a parabola 2) a circle
3) a straight line 4) a hyperbola

5. When the electron in the discharge tube is accelerated to high speeds
1) The charge on the electron will decrease
2) The specific charge will decrease
3) The charge of the electron will increase
4) The value of e/m will increase

6. If a proton and an electron are accelerated through the same potential difference
1) both the proton and electron have same K.E
2) both the proton and electron have same momentum
3) both the proton and electron have same velocity
4) all the above

7. A cathode ray tube has a potential difference of V between the cathode and anode. The speed of the cathode rays is given by
1) $v \propto V$ 2) $v \propto V^{-1}$ 3) $v \propto \sqrt{V}$ 4) $v \propto V^2$

8. An oil drop of mass m and charge +q is balanced in vacuum by a uniform electric field of intensity E. The direction of this field should be
1) vertically up 2) vertically down
3) horizontal 4) inclined at 45^0 to the horizontal

9. An oil drop of mass m falls through a medium that offers a viscous drag force F. If the velocity of the drop is constant it means that
1) F>mg 2) F<mg 3) F≥mg 4) F=mg

10. An oil drop of mass m falls through a viscous medium. The viscous drag force (F) is proportional to the velocity of the drop. At the instant it begins to fall the net force that acts on the oil drop is
1) mg 2) mg-F 3) F-mg 4) F

11. In Millikan's experiment, the oil drops acquire charge by
1) induction 2) Friction
3) electric field 4) magnetic field

12. According to Stoke's law, the viscous drag force on an oil drop is proportional to
1) $\sqrt{V}$ 2) V^2 3) V^{-1} 4) V

13. An oil drop of radius r carrying a charge q remains stationary in the presence of electric field of intensity E. If the density of oil is ρ, then
1) $E=\frac{4}{3}\Pi r^3 \rho g q$ 2) $E=\frac{4}{3}\Pi r^3 \rho g$
3) $E=\frac{4}{3}\Pi r^3 \rho g / q$ 4) $E=\frac{4}{3}\Pi r^3 \rho / g^3$

14. A particle carrying a charge e enters perpendicularly into a uniform magnetic field of induction B with momentum p. Then the radius of the circular path is
1) $\frac{Be}{p}$ 2) $\frac{pe}{B}$ 3) $\frac{p}{Be}$ 4) Bep

15. The force experienced by the cathode rays when they pass through a uniform electric field of intensity $\overline{E}$ is
1) in the direction of the electric field
2) in the direction opposite to that of the electric field
3) at right angles to the electric field
4) zero because cathode rays do not have any charge

16. The force felt by an electron on entering into a magnetic field is independent of its
1) Charge 2) Strength of the field
3) Mass 4) Direction of its velocity

17. When an electron moves through a magnetic field, its speed will
1) decrease 2) increase
3) remain the same
4) increase first and then decrease

18. The direction of deflection of a cathode ray particle passing through a magnetic field can be found by
1) Fleming's left hand rule 2) Laplace's law
3) Maxwell's cork screw rule 4) Ampere's rule

19. Which of the following particles cannot be deflected by magnetic field?
1) electrons 2) neutrons
3) α - particles 4) protons

20. The speed of cathode rays can be increased by applying
1) magnetic field normal to its motion
2) electric field opposite to its motion
3) magnetic field opposite to its motion
4) electric field in the direction of its motion

21. A β - particle enters a magnetic field making an angle of 45^0 with the field lines. The path of the particle is
1) circular 2) elliptical
3) spiral 4) a straight line

22. When cathode rays pass through a magnetic field applied transversely, the rays get deflected
1) at right angles to the path of the beam
2) at right angles only to the magnetic field
3) at right angles to both the path and the magnetic field
4) along a parabolic path

23. An electron and a proton are injected into a uniform magnetic field at right angle to its direction with the same momentum. Then
1) electron's path is less curved than proton's path
2) proton's path will be less curved than electron's path
3) the paths of both will be equally curved
4) both the trajectories will be straight

24. A cathode ray particle is accelerated from rest through a potential difference of V volt. The speed of the particle is
1) $\sqrt{\frac{2eV}{m}}$ 2) $\frac{m}{eV}$ 3) $\sqrt{meV}$ 4) $\sqrt{\frac{4eV}{m}}$

25. In J.J.Thomson's method, electric field of intensity E, magnetic field of induction B and velocity V of the electrons were in mutually perpendicular directions. The condition for velocity is
1) V = E / B 2) V = B / E
3) V = B E 4) V = $\sqrt{B/E}$

26. A positive ion of mass M kg and charge e coulomb travels from rest through a p.d. of V volt. The final K.E. is
1) e V joule 2) MeV joule
3) Me/V joule 4) eV/M joule

27. The increasing order of specific charge for electron(e), proton(p), neutron(n) and alpha particle(α) is
1) e, p, n, α 2) n, α, p, e
3) n, p, e, α 4) n, p, α, e

28. In J.J. Thomson's experiment the specific charge of an electron (e/m) is related to potential difference (V) between the cathode and the anode as
1) $\frac{e}{m} \alpha V$ 2) $\frac{e}{m} \alpha \frac{1}{V}$
3) $\frac{e}{m} \alpha \frac{1}{\sqrt{V}}$ 4) $\frac{e}{m} \alpha V^2$

29. The important conclusion given by Millikan's experiment about the charge is
1) Charge is never quantised
2) Charge has no definite value
3) Charge is quantised
4) Charge on an oil drop always increases

30. An electric field E and a magnetic field B act over the same region in which an electron enters along x-axis. The combination of E and B which permits the electron to go undeflected is
1) E along Y-axis and B along Y-axis
2) E along Y-axis and B along Z-axis
3) E along X-axis and B along Z-axis
4) E along Y-axis and B along X-axis

31. An electron is projected into a magnetic field along the lines of force. Then
1) there will be no effect on its motion
2) the electron will travel along a circle and its speed remains unchanged
3) the electron will follow the path of a parabola and its speed will increase
4) the velocity will increase in magnitude but its direction will remain unchanged.

32. A uniform electric field and a uniform magnetic field are produced pointing in the same direction. An electron is projected with its velocity pointed in the same direction.
1) the electron will turn to its right
2) the electron will turn to its left
3) the electron velocity will increase in magnitude
4) the electron velocity will decrease in magnitude

33. An electron is not deflected on passing through a certain region, because
1) there is magnetic field in that region and the electron enters into it in any direction.
2) there may be magnetic field but the velocity of electron may be parallel to the direction of magnetic field
3) electron is a chargeless particle
4) there is electric field and the electron enters into it in any direction.

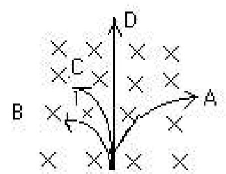
34. In Thomson's experiment, when the electron strikes the undeflected spot, then it moves with
1) constant acceleration 2) non uniform velocity
3) constant velocity 4) constant retardation

35. An electron enters a magnetic field with a speed of 10^8 cm/s. The particle experiences a force due to the magnetic field and the speed of the electron
1) will decrease 2) will increase
3) will remain constant
4) may in crease or decrease

36. A proton moving with a constant velocity passes through a region of space without any change in its velocity. If E and B represent the electric and magnetic fields respectively, this region of space may have

1) $E = 0; B = 0$ 2) $E = 0; B \neq 0$
3) $E \neq 0; B \neq 0$ 4) All the above

37. A neutron, a proton, an electron and an alpha particle enter a region of constant magnetic field with equal velocities. The magnetic field is along the inward normal to the plane of the paper. The tracks of the particles are labeled in the figure. The electron follows ____ track and alpha particle follows track ______



1) C,D 2) B, A 3) A,C 4) A,D

38. A proton and an electron simultaneously enter into a region in which a uniform magnetic field acts normal to the motion of both the particles. The frequency of revolution of

1) the proton is greater than that of the electron
2) the electron is greater than that of the proton
3) the proton is equal to that of the electron
4) both are having same frequency, but revolve in opposite direction

39. An electron moves with uniform velocity $\vec{v}$ and enters a region of uniform magnetic field $\vec{B}$. If $\vec{v}$ and $\vec{B}$ are parallel to each other, then the electron will

1) continue to move in the same direction
2) move in a direction perpendicular to $\vec{B}$
3) move in a circular path
4) will not move

40. In a region of space, cathode rays move along positive z-axis and a uniform magnetic field is applied along x-axis. If cathode rays pass undeviated, the direction of electric field will be along

1) Negative x-axis 2) Positive y-axis
3) Negative y-axis 4) Positive z-axis

41. Cathode rays are moving along the positive z-axis. An electric field is applied along positive y-axis. In the same region a magnetic field is also applied. The cathode rays pass undeviated in this region. The magnetic field is in the direction of

1) Positive x-axis 2) Negative x-axis
3) Negative y-axis 4) z-axis

42. Cathode rays gain K.E. when accelerated by an electric field. If they are subjected to a uniform magnetic field, then their

1) Energy increases
2) Momentum increases
3) Energy and momentum decrease
4) Energy and magnitude of momentum remain unaffected

43. When a charged particle moves through a magnetic field, the quantity which is not affected in the magnetic field is

1) particle velocity 2) particle acceleration
3) linear momentum of the particle
4) Kinetic energy of the particle

44. You are sitting in a room in which uniform magnetic field is present in vertically downward direction. When an electron is projected in horizontal direction, it will be moving in circular path with constant speed

1) clockwise in vertical plane
2) clockwise in horizontal plane
3) anticlockwise in vertical plane
4) anticlockwise in horizontal plane

45. A charged particle of charge Q and mass m moves with velocity v in a circular path due to transverse magnetic field, B, then its frequency is

1) $\frac{QB}{2\pi m}$ 2) $\frac{QvB}{2\pi m}$ 3) $\frac{QmvB}{2\pi}$ 4) $\frac{vB}{2\pi Qm}$

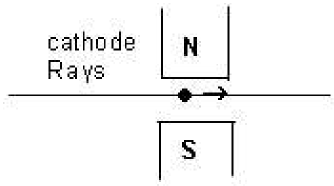
46. Imagine that you are sitting in a room with your back to one wall and that an electron beam traveling horizontally from the back wall towards the front one is deflected towards the right. What is the direction of the magnetic induction field that exists in the room?

1) vertically upwards
2) vertically downwards
3) horizontal and perpendicular to the direction of motion of the electron beam
4) horizontal and parallel to the direction of motion of the electron beam

47. A beam of cathode rays moving towards south is under the action of downward electric field. To prevent its deflection by the electric field, a magnetic field should be directed

1) eastward 2) westward
3) upward 4) downward

48. Cathode rays are made to pass between the poles of a magnet as shown in figure. The effect of magnetic field is



1) to deflect them towards the south pole
2) to deflect them perpendicular to the plane of the paper and towards the observer
3) to deflect them towards the north pole
4) to increase the velocity of the rays

49. In which of the following fields cathode rays show minimum deflection
1) Electric field 2) Magnetic field
3) Plasma field 4) Gravitational field

PHOTO ELECTRIC EFFECT

50. A photon of frequency 'X' has an energy
1) $\frac{h}{x^2}$ 2) $\frac{x}{h}$ 3) hx 4) hx^2

51. The rest mass of a photon is
1) zero 2) $1.6\times10^{-19}\,kg$
3) $3.1\times10^{-30}\,kg$ 4) $9.1\times10^{-31}\,kg$

52. The mass of a photon in motion is (given its frequency = x)
1) $\frac{hx}{c^2}$ 2) hx^3 3) $\frac{hx^3}{c^2}$ 4) zero

53. Intensity of light incident on a photo sensitive surface is doubled. Then
1) the number of emitted electrons is trebled
2) the number of emitted electrons is doubled
3) the K.E of emitted electrons is doubled
4) the momentum of emitted electrons is doubled

54. The work function of a metal is 4.2eV. Two photons each of energy 2.5eV strike an electron of the metal. Then
1) electron is emitted with zero energy
2) electron is not emitted
3) electron is emitted with increased energy
4) data insufficient

55. The Einstein's photoelectric equation is based upon the conservation of
1)Mass 2)momentum
3) angular momentum 4) energy

56. Light of wavelength λ falls on a metal having work function hc / λ_o . Photoelectric effect will take place only if
1) $\lambda \geq \lambda_0$ 2) $\lambda \geq 2\lambda_0$
3) $\lambda \leq \lambda_0$ 4) $\lambda < \lambda_0 / 2$

57. A point source of light is used in a photoelectric effect. If the source is removed farther from the emitting metal, the stopping potential
1) will increase 2) will decrease
3) will remain constant
4) will either increase or decrease

58. In a photo electric experiment, the maximum velocity of photoelectrons emitted
1) depends on intensity of incident radiation
2) does not depend on cathode material
3) depends on frequency of incident radiation
4) does not depend on wavelength of incident radiation

59. The number of electrons emitted by a surface exposed to light is directly proportional to
1)frequency of light 2) work function
3)threshold wavelength 4) intensity of light

60. Emission of electrons in photoelectric effect is possible, if
1) metal surface is highly polished
2) the incident light is of sufficiently high intensity
3) the light is incident at right angles to the surface
4) the incident light is of sufficiently low wavelength

61. Light of frequency 1.5 times the threshold frequency is incident on a photo sensitive metal. If the frequency of the incident light is halved and the intensity is doubled, the photo electric current becomes
1) quadrupled 2) doubled
3) halved 4) zero

62. In photoelectric effect, when photons of energy hν are incident electrons are emitted from the metallic surface with a kinetic energy. It is possible to say that
1) All ejected electrons have same K.E. equal to hν_0
2) The ejected electrons have a distribution of K.E. from zero to hν-hν_0
3) The most energetic electrons have K.E. equal to hν
4) All ejected electrons have K.E. equal to hν

63. If the distance of 100W lamp is increased from a photocell, the saturation current i in the photo cell varies with distance d as
1) $i \propto d^2$ 2) $i \propto d$ 3) $i \propto \frac{1}{d}$ 4) $i \propto \frac{1}{d^2}$

64. Photoelectric effect supports the quantum nature of light because
1) There is minimum frequency of light below which no photo electrons are emitted
2) The maximum K.E. of photo electrons depends only on the frequency of light and not on intensity
3) Even when a metal surface is faintly illuminated, the photoelectrons leave the surface immediately
4) All the above

65. When a monochromatic light of frequency ν is incident on a metal, stopping potential is V_0. Frequency of the incident light for which stopping potential becomes double is
1) ν 2) $\nu+\frac{eV_o}{h}$
3) $2\nu-\frac{eV_o}{h}$ 4) $\nu-\frac{eV_o}{h}$

66. The stopping potential for a photo cell depends
1) on the nature of the cathode and intensity of light
2) on both the intensity and frequency of incident light
3) only on the intensity of light
4) on both the nature of the cathode and frequency of incident light

67. The stopping potential of the photocell is independent of
1) wavelength of incident light
2) nature of the metal of photo cathode
3) time for which light is incident
4) frequency of incident light

68. The process of emission of photons due to the incidence of electrons on a metal plate is called
1) photoelectric effect 2)pair production
3) production of x-rays 4) production of γ -rays

69. With the decrease in the wave length of the incident radiation the velocity of the photoelectrons emitted from a given metal
1) remains same 2) increases
3) decreases 4) increases first and then decreases

70. The work function of a metal
1) is different for different metals
2) is the same for all the metals
3) depends on the frequency of the light
4) depends on the intensity of the incident light

71. In photoelectric emission, the velocity of electrons ejected from near the surface will be
1) the same as those coming from the interior of the metal
2) less than those coming from the interior of the metal
3) larger than those coming from the interior of the metal
4) may be smaller or larger than those coming from the interior of the metal

72. Sodium surface is illuminated with ultraviolet light and visible radiation successively and the stopping potentials are determined. Then the potential
1) is equal in both the cases
2) greater for ultraviolet light
3) more for visible light 4) varies randomly

73. Which of the following statement is wrong?
1) Einstein explained photo electric effect with the help of quantum theory
2) Millikan determined the value of planck's constant depending upon the property of photo electric effect
3) The maximum K.E. of the photo electrons depends upon the intensity of incident radiation
4) As the frequency of incident photon increases the corresponding stopping potential also increases

74. photoelectric effect is a phenomenon in which
1) electric energy is converted into mechanical energy
2) light energy is converted into electric energy
3) photons produce electrons
4) photons are converted into electrons

75. Work function is the energy required
1) to excite an atom
2) to produce X-rays
3) to eject an electron just out of the surface
4) to explode the atom

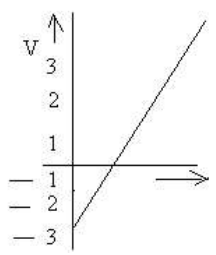
76. In photoelectric emission, the energy of the emitted electron is
1) larger than that of the incident photons
2) smaller than that of the incident photons
3) same at that of the incident photons
4) proportional to the intensity of the incident light

77. In photo electric effect, the slope of the straight line graph between stopping potential and frequency of the incident light gives the ratio of Planck's constant to
1) charge of electron 2) work function
3) photo electric current 4) K.E. of electron

78. A laser beam of output power 'P' consists only of wavelength λ. If Planck's constant is h and the speed of light is c, then the number of photons emitted per second is
1) Pλ/hc 2) Pλ/h 3) hc/Pλ 4) hc/P

79. A quartz lamp with iodine vapour releases ultraviolet light which falls on a photo electric cell. If a thick glass plate is now introduced between the lamp and photo electric cell then
1) the photo electric current increases
2) the maximum kinetic energy of photo electrons decreases
3) the photo electric current decreases
4) the maximum kinetic energy of photo electrons increases

80. From the graph shown, the value of Work function if the stopping potential, V, and frequency of the incident light, ν, are on y and x- axes respectively is



1) 1eV 2) 2eV 3) 4eV 4) 3eV

81. The emission of photo electrons in the process of photo electric effect is
1) due to increase in temperature of photo metal
2) due to incidence of photons of proper wavelength
3) due to incidence of photons of proper velocity
4) since it is in the strong field

82. Photo electrons are just released when a wave length $3100A^0$ is incident on it. To increase the K.E. of the photo electrons
1) the intensity of light should be increased
2) the wavelength of light should be increased
3) the wavelength of light should decreased
4) the intensity and wave length of light should be increased

83. In photoelectric effect, which of the following property of incident light will not affect the stopping potential
1) Frequency 2) Wavelength
3) Energy 4) Intensity

84. Threshold wavelength depends on
1) frequency of incident radiation
2) work function of the substance
3) velocity of electrons 4) energy of electrons

85. The best suitable metal for photo electric effect is
1) Iron 2) Steel 3) Aluminium 4) Caesium

86. A graph is drawn between frequency of the incident radiation (on X- axis) and stopping potential (on Y-axis). Then the slope of the straight line indicates
1) h.e 2) h/e 3) e/h 4) (e-h)

87. The maximum energy of emitted photo electrons is measured by
1) the current they produce
2) the potential difference they produce
3) the largest potential difference they can traverse
4) the speed with which they emerge

88. Photo electric effect can be explained only by assuming that light
1) is a form of transverse waves
2) is a form of longitudinal waves
3) can be polarized 4) consists of quanta

89. A source of light is placed at a distance 4m from a photocell and the stopping potential is then 7.7 volt. If the distance is halved, the stopping potential now will be
1) 7.7 volt 2) 15.4 volt
3) 3.85 volt 4) 1.925 volt

90. A milliammeter in the circuit of a photocell measures
1) number of electrons released per second
2) energy of photon
3) velocity of photoelectrons
4) momentum of the photo electrons

91. The K.E's of the photoelectrons are E_1 and E_2 with light of frequencies ν_1 and ν_2. The work function of the metal is

1) $\dfrac{E_2\nu_1 - E_1\nu_1}{\nu_1 - \nu_2}$ 2) $\dfrac{E_2\nu_1 - E_1\nu_1}{\nu_1 + \nu_2}$

3) $\dfrac{E_2\nu_2 - E_1\nu_1}{\nu_1 + \nu_2}$ 4) $\dfrac{E_2\nu_1 - E_1\nu_2}{\nu_2 - \nu_1}$

92. Three metals have work functions in the ratio 2:3:4. Graphs are drawn for all between the stopping potential and the incident frequency. The graphs have slopes in the ratio
1) 2: 3: 4 2) 4: 3: 2 3) 6: 4: 3 4) 1: 1: 1

93. If the threshold wavelength is double the incident wavelength λ, the maximum K.E. of the photoelectrons is

1) $\dfrac{hc}{\lambda}$ 2) $\dfrac{hc}{3\lambda}$ 3) $\dfrac{hc}{2\lambda}$ 4) $\dfrac{2hc}{\lambda}$

94. If intensity of radiation incident on a photocell be increased four times keeping frequency constant, then number of photoelectrons and energy of photoelectrons emitted become
1) four times, doubled
2) doubled, remains unchanged
3) remains unchanged, doubled
4) four times, remains unchanged

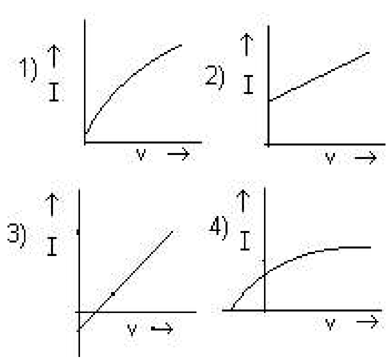
95. The cathode of a photo electric cell is changed such that the work function changes from W_1 to $W_2(W_1 > W_2)$. If the currents before and after change are I_1 and I_2, all other conditions unchanged, then (assuming $h\nu > W_2$)
1) $I_1 = I_2$ 2) $I_1 < I_2$ 3) $I_1 > I_2$ 4) $I_1 \leq I_2$

96. The process of photo electric emission depends on
1) Work function of surface
2) Nature of surface
3) Wavelength of incident light
4) All of the above

97. Two photons, each of energy 2.5 eV are simultaneously incident on the metal surface. If the work function of the metal is 4.5 eV, then from the surface of the metal
1) Two electrons will be emitted
2) Not even a single electron will be emitted
3) One electron will be emitted
4) More than two electrons will be emitted

98. There are two light sources A and B. The intensity of source A is more than that of B and the frequency of light emitted by source B is higher than that of A. The photo electric current obtained will be more from source(Assume that both the frequencies are greater than the threshold frequency of the metal on which these lights will be incident)
1) B 2) A 3) A and B 4) data insufficient

99. The curve between current (I) an potential difference (v) for a photo cell will be



100. If the energy of incident photon and work function of metal are E ev and ϕ_0 ev respectively, then the maximum velocity of emitted photo electrons will be

1) $\frac{2}{m}[E-\phi_0]$ 2) $\sqrt{\frac{2}{m}(E-\phi_0)}$

3) $\frac{m}{2}[E-\phi_0]$ 4) $2m\sqrt{E-\phi_0}$

101. When green light is incident on a metal, photo electrons are emitted by it but no photo electrons are obtained by yellow light. If red light is incident on that metal then
1) No electron will be emitted
2) Less electrons will be emitted
3) More electrons will be emitted
4) All of the above

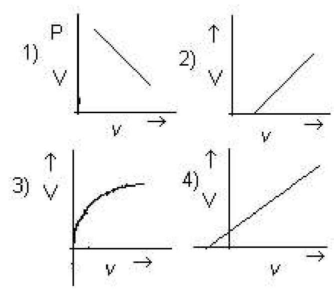
102. On reducing the wavelength of light incident on a metal, the velocity of emitted photo electrons will become
1) Zero 2) Less 3) More 4) infinity

103. The threshold wavelength of lithium is 8000 A^0. When light of wavelength 9000 A^0 is made to be incident on it, then the photo electrons
1) Will not be emitted
2) Will be emitted
3) Will sometimes be emitted and sometimes not
4) Nothing can be said

104. If the energy and momentum of a photon are E and p respectively, then the velocity of photon will be
1) E/p 2) $(E/p)^2$ 3) Ep 4) 3×10^7 m/s

105. In an experiment of photo electric emission for incident light of 4000 A^0, the stopping potential is 2V. If the wavelength of incident light is made 3000 A^0, then the stopping potential will be
1) Less than 2 volt 2) More than 2 volt
3) 2 volt 4) Zero

106. The curve between the frequency (ν) and stopping potential (V) in a photo electric cell will be



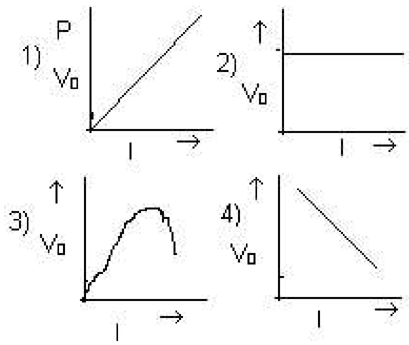
107. If the work function of a metal is ϕ_0, then its threshold wavelength will be

1) $hc\phi_0$ 2) $\frac{c\phi_0}{h}$ 3) $\frac{h\phi_0}{c}$ 4) $\frac{hc}{\phi_0}$

108. The work function of a metal is X eV When light of energy 2X eV is made to be incident on it then the maximum kinetic energy of emitted photo electron will be
1) 2 eV 2) 2X eV 3) X eV 4) 3X eV

109. The photo electric effect proves that light consists of
1) Photons 2) Electrons
3) Electromagnetic waves
4) Mechanical waves

110. The correct curve between the stopping potential(V_o) and intensity of incident light (I) is



111. The photo electrons emitted from the surface of sodium metal are
1) Of speeds from 0 to a certain maximum
2) Of same de Broglie wavelength
3) Of same kinetic energy
4) Of same frequency

112. The necessary condition for photo electric emission is
1) $h\nu \le h\nu_0$ 2) $h\nu \ge h\nu_0$ 3) $E > h\nu_0$ 4) $E_k < h\nu_0$

113. At stopping potential, the photo electric current becomes
1) Minimum 2) Maximum 3) Zero 4) Infinity

114. Stopping potential depends on
1) Frequency of incident light
2) Intensity of incident light
3) Number of emitted electrons
4) Number of incident photons

115. Which conservation law is obeyed in Einstein's photo electric equation?
1) Charge 2) Energy 3) Momentum 4) Mass

116. When photons of energy $h\nu$ are incident on the surface of a photosensitive material of work function $h\nu_0$, then
1) The K.E of all emitted elections is $h\nu_0$
2) The K.E of all emitted electrons is $h(\nu - \nu_0)$
3) The K.E of fastest electrons is $h(\nu - \nu_0)$
4) The K.E of all emitted electrons is $h\nu$.

117. The threshold wave length for photo electric emission from a material is 5,200 A^0. Photo electrons will be emitted when this material is illuminated with monochromatic radiation from a
1) 50 watt infrared lamp
2) 1 watt infrared lamp
3) 1 watt ultraviolet lamp
4) 50 watt sodium vapour lamp

118. A negatively charged electroscope with zinc disc discharges when irradiated by an ultraviolet lamp. What caused this?
1) α- particles from the source combine with electrons of the disc
2) electrons escape from the disc when ultraviolet radiation falls on it
3) ultraviolet rays ionize the air surrounding the electroscope
4) the disc becomes hot and thermionic emission takes place

X-RAY SPECTRA:

119. The shortest wavelength of x-rays produced in an x-ray tube depends on the
1) nature of gas in tube
2) atomic number of the target element
3) voltage applied to the tube
4) all the above

120. The wave length λ of the K_α line of characteristic x-ray spectra varies with atomic number approximately
1) $\lambda \propto z$ 2) $\lambda \propto \sqrt{z}$ 3) $\lambda \propto \frac{1}{z^2}$ 4) $\lambda \propto \frac{1}{\sqrt{z}}$

121. Moseley's law for characteristic x-rays is $\sqrt{\nu}$=a (z-b). In this
1) both a and b are independent of material
2) a is independent but b depends on the material
3) b is independent but a depends on the material
4) both a and b depend on the material

122. Consider the following two statements A and B and identify the correct choice in the given answer.
A: The characteristic x-ray spectrum depends on the nature of the material of the target.
B: The short wavelength limit of continuous x-ray spectrum varies inversely as the potential difference applied to the x-ray tube.
1) A is true and B is false
2) A is false and B is true
3) Both A and B are true
4) Both A and B are false

123. If the operating voltage of an x-ray tube is increased
1) x-ray intensity increases
2) x-ray wavelength limit on the maximum side increases
3) x-ray wavelength limit on the minimum side decreases
4) x-ray intensity decreases

124. The energy of a photon of characteristic X-rays from a Coolidge tube comes from
1) the Kinetic Energy of the striking electron
2) the Kinetic Energy of the free electrons of the target
3) the Kinetic Energy of the ions of the target
4) an atomic transition in the target

125. If a graph is plotted with atomic number on x-axis and square root of frequency of a spectral line of characteristic x-rays on the y-axis, then it will be
1) a straight line passing through the origin
2) a parabola
3) a straight line not passing through the origin
4) a rectangular hyperbola

126. When high speed electrons hit a target,
1) Only heat is produced
2) Only continuous X-rays are emitted.
3) Only continuous and characteristic X-rays are emitted
4)Heat is produced and simultaneously continuous and characteristic X-rays are emitted

127. The distribution of energy in the continuous X-ray spectrum depends on
1) the nature of the filament of X-ray tube
2) the material of the target
3) the nature of vacuum in the X-ray tube
4) the p.d. across the tube

128. In the characteristic X-ray spectra, the frequency of K_α line is
1) greater than that of K_β line
2) less than that of K_β line
3) equal to that of K_β line
4) equal to that of K_β line

129. X-rays are produced using molybdenum target at an angle applying accelerating voltage V. If molybdenum is replaced by tungsten, the cut off wavelength of X-rays produced will
1) increase 2) decrease
3) remain same 4) may change

130. Among the following which one is correct
1) X-ray continuous spectra is formed due to deceleration of cathode rays
2) X-ray characteristic line spectra is formed due to removal of electrons from the target atom by the cathode rays
3) The energy of soft X-rays is small
4) All the above

131. The binding energy of the innermost electron in tungsten is 40 keV. To produce characteristic X-rays using a tungsten target in X-ray tube the potential difference V between the cathode and the anticathode will be
1) V < 40 K V 2) V > 40 K V
3) V = 40 K V 4) V= $\sqrt{40}$ K V

132. Characteristic X-ray spectrum is a
1) Band spectrum
2) Line spectrum
3) Absorption spectrum
4) Continuous spectrum

133. The continuous X-ray spectrum has a definite
1) Maximum wavelength limit
2) Maximum frequency limit
3) Minimum wavelength limit
4) Energy limit

134. Characteristic X-rays depend upon the
1) Material of the target
2) Potential difference applied between anode and cathode
3) Filament current
4) Pressure in the tube

135. If two atoms have their atomic numbers z_1 and z_2. The ratio of the wavelengths λ_1 and λ_2 corresponding to their K_α lines is
1) $\frac{z_1^2}{z_2^2}$ 2) $\frac{z_2^2}{z_1^2}$ 3) $\frac{z_1}{z_2}$ 4) $\frac{z_2}{z_1}$

136. Characteristic X-rays are the result of
1) slowing down high velocity electrons in the positive field of a nucleus
2) knocking off of the tightly bound electrons from the inner shells
3) annihilation of electrons into radiation
4) reflection of cathode rays from the metal target of high Z and high melting point

137. The production of continuous X-ray spectrum is the reverse process of
1) Compton effect 2) Photo electric effect
3) Raman Effect 4) Seebeck effect

138. If $v_{k_\alpha} . v_{k_\beta} . v_{L_\alpha}$ are the frequencies of K_α, K_β and L_α x-rays respectively, then
1. $v_{k_\alpha} = v_{k_\beta} + v_{L_\alpha}$ 2. $v_{k_\beta} = v_{k_\alpha} + v_{L_\alpha}$
3. $v_{L_\beta} = v_{k_\alpha} - v_{k_\alpha}$ 4. $v_{L_\alpha} = v_{k_\beta} + v_{k_\alpha}$

Compton effect

139. Compton effect establishes
1) wave nature of photons
2) dual nature of photons
3) particle nature of photons
4) electromagnetic nature of photons

140. In Compton effect, an x-ray photon makes a collision with an electron of the scatterer. The electron is assumed to be initially
1)moving at a very high velocity
2) at rest
3) very tightly bound to the atom
4) a k-electron

141. If h is planck's constant, m_0 is rest mass of electron and c is the speed of light in vaccum, the S.I. unit of $\frac{h}{m_0 c}$ is
1) Angstrom 2) Js 3) Ns
4) m

142. For Compton effect with visible light the observed Compton shift is
1) very large because the electrons appear free
2) very small because the electrons appear free
3) is almost zero because the electrons appear bound
4) less than zero

143. The Compton wavelength shift depends on
1) wavelength of the incident photon
2) material of the scatterer
3) energy of the incident photon
4) scattering angle

144. The minimum value of Compton wavelength shift is
1) 0 2) h/m_0c 3) $2h/m_0c$ 4) $h/2\,m_0c$

145. In Compton effect, the quantity h/m_0c is called
1) Compton recovery wavelength
2) Scattered wavelength of photon
3) Compton wavelength of electron
4) Compton wavelength of photon

146. The value of Compton wavelength of electron is
1) 0.0243 A^0 2) 0.243 A^0
3) 2.43 A^0 4) 24.3 A^0

147. If the scattering angle of the photon in Compton effect is 180^0, the Compton shift is
1) Equal to the Compton wavelength of the electron
2) four times the Compton wavelength of the electron
3) two times the Compton wavelength of the electron
4) half the compton wavelength of the electron

148. In Compton effect, if the incident x-rays have low energy and the scattering atom has high atomic number then the electrons appear as
1) bound with no measurable Compton shift
2) free with measurable Compton shift
3) bound with measurable Compton shift
4) free with no measurable Compton shift

149. Relative to the original photon, the photon that emerges after a collision with an electron has
1) More energy 2) More momentum
3) Lower frequency 4) Lower wavelength

150. Which of the following phenomenon supports the quantum nature of light?
1) Compton effect 2) Interference
3) Diffraction 4) Polarisation

151. Compton effect is associated with
1) α-rays 2) β-rays
3) positive rays 4) X-rays

152. When an X-ray photon collides with an electron and bounces off, its new frequency
1) is lower than its original frequency
2) is same as its original frequency
3) is higher than its original frequency
4) depends upon the electron's frequency

MATTER WAVES:

153. De-Broglie wavelength depends on
1) mass of the particle 2) size of the particle
3) material of the particle
4) shape of the particle

154. The de Broglie wavelength associated with a particle of mass m, moving with a velocity v and energy E is given by
1) h/mv^2 2) mv/h^2 3) $h/\sqrt{2mE}$ 4) $\sqrt{2mE}/h$

155. Choose the correct statement
1) Any charged particle in motion is accompanied by matter waves
2) Any uncharged particle in motion is accompanied by matter waves
3) The matter waves are waves of probability amplitude
4) All the above

156. Choose the correct statement:
1) The wave velocity is less than phase velocity of the wave
2) The particle velocity is the same as phase velocity of the wave
3) The particle velocity is the same as group velocity of the wave
4) The wave velocity is the same as group velocity of the wave

157. An electron of charge e and mass m is accelerated from rest by a potential difference V. The de Broglie wavelength is
1) Directly proportional to the square root of potential difference.
2) Inversely proportional to the square root of potential difference
3) Directly proportional to the square root of electron mass
4) Inversely proportional to the cube root of electron mass

158. Which of the following particles - neutron, proton, electron and deuteron has the lowest energy if all have the same de Broglie wavelength
1) neutron 2) proton 3)electron 4)deuteron

159. The momentum of a proton is p. The corresponding wavelength is
1) h/p 2) h p 3) p/h 4) $\sqrt{hp}$

160. The graph between the de Broglie wavelength and the momentum of a photon is a
1) Rectangular hyperbola 2) Circle
3) Parabola 4) Straight line

161. A wave is associated with matter when it is
1) stationary 2) in motion with any velocity
3) in motion with velocity of light
4) in motion with velocity greater than that of light

162. An electron of mass 9.1 x 10^{-31}kg and charge 1.6 x 10^{-19} C is accelerated through a potential difference of V volt. The de Broglie wavelength (λ) associated with the electron is
1) $\frac{12.27}{\sqrt{V}}$ A^0 2) $\frac{12.27}{V}$ A^0
3) $12.27\sqrt{V}$ A^0 4) $\frac{1}{12.27\sqrt{V}}$ A^0

163. The de Broglie wavelength of a molecule of thermal energy KT (K is Boltzmann constant and T is absolute temperature) is given by
1) $\frac{h}{\sqrt{2mKT}}$ 2) $\frac{h}{2mKT}$
3) $h\sqrt{2mKT}$ 4) $\frac{1}{h\sqrt{2mKT}}$

164. Choose the only correct statement out of the following.
1) Only a charged particle in motion is accompanied by matter waves
2) Only subatomic particles in motion are accompanied by matter waves.
3) Any particle in motion, whether charged or uncharged, is accompanied by matter waves.
4) No particle, whether at rest or in motion is ever accompanied by matter waves.

165. The wavelengths of a proton and a photon are same. Then
1) Their velocities are same
2) Their momenta are equal
3) Their energies are same
4) Their speeds are same

166. The wave nature of the electron was verified using
1) Photo electric effect
2) Compton effect
3) The phenomenon of x-ray emission
4) Diffraction of electron by a crystal

167. The de Broglie wavelengths associated with a charged particle in electric and magnetic fields are λ_1 and λ_2, then
1) $\lambda_1 = \lambda_2$ 2) $\lambda_1 > \lambda_2$ 3) $\lambda_1 < \lambda_2$ 4) $\lambda_1 \geq \lambda_2$

168. If the value of Planck's constant is more than its present value, then the de Broglie wavelength associated with a material particle will be
1) More 2) Less 3) Same
4) More for lighter particles and less for heavy particles

169. The wavelength of matter waves does not depend on
1) Momentum 2) Velocity
3) Mass 4) Charge

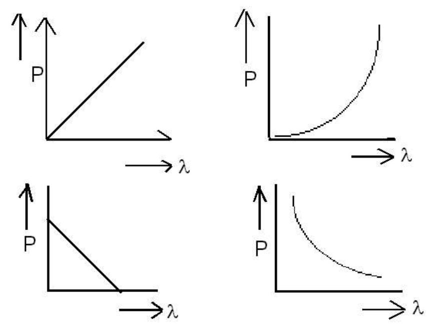
170. The wave nature of matter is not observed in daily life because their wave length is
1) Less 2) More
3) In infrared region 4) In ultraviolet region

171. The ratio of the wavelengths of a photon and that of an electron of same energy E will be
1) $\sqrt{\frac{2m}{E}}$ 2) $\sqrt{\frac{E}{2m}}$ 3) $C\sqrt{\frac{2m}{E}}$ 4) $\sqrt{\frac{EC}{2m}}$

172. An electron and a proton possess the same mount a of Kinetic energy. Then the relation between the wavelength of electron (λ_e) and the wavelength of proton (λ_p) is
1) $\lambda_e = \lambda_p$ 2) $\lambda_e > \lambda_p$ 3) $\lambda_e < \lambda_p$ 4) $\lambda_e \leq \lambda_p$

173. A proton and an electron are accelerated by the same potential difference. Let λ_e and λ_p denote the de Broglie wavelength of the electron and the proton respectively, then
1) $\lambda_e = \lambda_p$ 2) $\lambda_e < \lambda_p$ 3) $\lambda_e > \lambda_p$ 4) $\lambda_e \geq \lambda_p$

174. Which one of the following figures respesents the variation of particle momentum with associated de Broglie wavelength



KEY

1.3	2.1	3.1	4.2	5.2	6.1	7.3
8.1	9.4	10.1	11.2	12.4	13.3	14.3
15.2	16.3	17.3	18.1	19.2	20.2	21.3
22.3	23.3	24.1	25.1	26.1	27.2	28.2
29.3	30.2	31.1	32.4	33.2	34.3	35.3
36. 4	37.3	38.2	39.1	40.3	41.2	42.4
43.4	44.2	45.1	46.2	47.4	48.2	49.4
50.3	51.1	52.1	53.2	54.2	55.4	56.3
57.3	58.3	59.4	60.4	61.4	62.2	63.4
64.4	65.2	66.4	67.3	68.3	69.2	70.1
71.3	72.2	73.3	74.2	75.3	76.2	77.1
78.1	79.3	80.4	81.2	82.3	83.4	84.2
85.4	86.2	87.3	88.4	89.1	90.1	91.4
92.4	93.3	94.4	95.1	96.4	97.2	98.2
99.4	100.2	101.1	102.3	103.1	104.1	105.2
106.2	107.4	108.3	109.1	110.2	111.1	112.2
113.3	114.1	115.2	116.3	117.3	118.2	119.3
120.3	121.1	122.3	123.1	124.1	125.3	126.4
127.4	128.2	129.3	130.4	131.2	132.2	133.3
134.1	135.2	136.2	137.2	138.2	139.3	140.2
141.4	142.3	143.4	144.1	145.3	146.1	147.3
148.1	149.3	150.1	151.4	152.1	53.1	154.3
155.4	156.3	157.2	158.4	159.1	160.1	161.2
162.1	163.1	164.3	165.2	166.4	167.3	168.1
169.4	170.1	171.3	172.2	173.3	174.4	

NEW MODEL QUESTIONS

1. Photoelectric effect barely takes place in a certain material with green photons. Then it can also take place with

a) Red photons b) yellow photons c) Blue photons d) Violet photons

1) a, b 2) a, d 3) b, c 4) c, d

2. Four physical quantities are listed in column I. Their values are listed in column II in a random order

Column I	Column II
a) Thermal energy of air molecules at room temperature	e) 0.04 eV
b) Binding energy of heavy nuclei per nucleon.	f) 2 eV
c) X-ray photon energy	g) 1 keV
d) Photon energy of visible light	h) 7 Mev

The correct matching of columns I and II is given by

1) a-e, b-h, c-g, d-f 2) a-e, b-g, c-f, d-h
3) a-f, b-e, c-g, d-h 4) a-f, b-h, c-e, d-g

3. 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

c) Even when the metal surface is faintly illuminated, the photoelectrons leave the surface immediately.

1) a, b 2) b, c 3) a, c 4) a, b, c

4. When photons of energy 4.25 eV strike the surface 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 by photons of energy 4.70 eV is $T_B = (T_A - 1.50)$ eV. If the debroglie wavelength of these photo electrons 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) $T_B = 2.75 eV$

1) a, b, c 2) a, b, d 3) b, c, d 4) a, c

5. A charged particle drops through V volts. Match the de Broglie wavelengths for given particles

particle	λ *in* A^0
a) Electron	e) $\sqrt{\frac{0.0817}{V}}$
b) Deuteron	f) $\sqrt{\frac{0.0102}{V}}$
c) α-particle	g) $\sqrt{\frac{150}{V}}$
d) Proton	h) $\sqrt{\frac{0.0409}{V}}$

1) a-g, b-e, c-h, d-f 2) a-g, b-h, c-f, d-e
3) a-h, d-e, c-f, d-g 4) a-h, h-f, c-e, d-h

6. If E_1, E_2 and E_3 are the kinetic energies of a proton, α-particle and deuteron, which have the same wavelength, then

1) $E_1 > E_2 > E_3$ 2) $E_1 > E_3 > E_2$

3) $E_3 > E_2 > E_1$ 4) $E_3 > E_1 > E_2$

7. In a Coolidge tube

a) The intensity of x-rays is controlled by filament current

b) The intensity of x-rays is controlled by the accelerating voltage.

c) As the accelerating voltage is increased $\lambda_{\min}$ is decreased

d) $\lambda_{\min}$ is controlled by filament current

1) a, c 2) b, d 3) b, c 4) a, d

8. In Compton scattering

a) The modified line occurs because of scattering with a single electron

b) The unmodified line occurs because of scattering with the entire atom

c) The electron can recoil at an angle greater that 90^0.

d) The scattering photon and recoil electron can be projected on the same side of the incident direction

1) a, b, c 2) a, b, d 3) b, c 4) a, b

9. **Assertion (A) :** For a fixed incident photon energy, photoelectrons have a wide range of energies ranging form zero to the maximum value $K_{\max}$

Reason (R) : Initially, the electrons in the metal are at different energy level.

1) Both A and R are true and R is the correct explanation of A

2) Both A and R are true but R is not the correct explanation of A

3) A is true but R is false 4) A is false but R is true

10. **Assertion (A) :** In Compton effect both modified and unmodified lines may be present

Reason (R) : The modified line is due to elastic scattering of photon with an electron

1) Both A and R are true and R is the correct explanation of A

2) Both A and R are true but R is not the correct explanation of A

3) A is true but R is false 4) A is false but R is true

11. **Assertion (A) :** Photoelectric effect can not take place with free electron

Reason (R) : both momentum and energy can not be conserved simultaneously.

1) Both A and R are true and R is the correct explanation of A

2) Both A and R are true but R is not the correct explanation of A

3) A is true but R is false 4) A is false but R is true

12. **Assertion (A) :** In Compton scattering the scattered photon, the recoil electron and the incident photon are coplanar

Reason (R) : In Compton scattering energy is conserved.

1) Both A and R are true and R is the correct explanation of A

2) Both A and R are true but R is not the correct explanation of A

3) A is true but R is false 4) A is false but R is true

13. **Assertion (A) :** When accelerating voltage is increased the cut off wavelength of the continuous x-rays is decreased but the characteristic lines remain unaffected.

Reason (R) : Continuous X-ray spectrum is a nuclear phenomenon while characteristic x-rays are atomic phenomenon.

1) Both A and R are true and R is the correct explanation of A

2) Both A and R are true but R is not the correct explanation of A

3) A is true but R is false 4) A is false but R is true

14. **Assertion (A) :** Both cathode rays and β-particles are electrons. However, their origin is different.

Reason (R) : While cathode rays are of atomic origin, β-particles are of nuclear origin.

1) Both A and R are true and R is the correct explanation of A

2) Both A and R are true but R is not the correct explanation of A

3) A is true but R is false 4) A is false but R is true

15. Arrange the values of specific charges of the following particles in the descending order

a) Deuteron b) Triton c) Proton d) Positron

1) d,c,a,b 2) a,b,c,d 3) a,c,b,d 4) a,b,d,c

KEY

1) 4 2) 1 3) 4 4) 1 5) 2 6) 2 7) 1 8) 4
9) 1 10) 2 11) 1 12) 2 13) 2 14) 1 15) 1

NUMERICAL QUESTIONS
LEVEL-I
CATHODE RAYS:

1. An electron passes undeflected through perpendicular electric and magnetic fields of intensity 3.4×10^3 v/m and 2×10^{-3} Wb/m^2 respectively. Then its velocity is
1. 1.7×10^6 m/s 2. 6.8×10^6 m/s
3. 6.8 m/s 4. 1.7×10^8 m/s

2. A cathode emits 1.8×10^{17} electrons/s and all the electrons reach the anode when it is given a positive potential of 400 V. Given $e=1.6 \times 10^{-19}$ c, the maximum anode current is
1. 2.88 mA 2. 28.8 mA
3. 7.2 mA 4. 6.4 mA

3. Cathode ray tube is operating at 5 KV. Then the K.E. acquired by the electrons is
1.5 eV 2. 5 MeV 3. 5 KeV 4. 5 V

4. An electron of mass 9×10^{-31} kg moves with a speed of 10^7 m/s. It acquires a K.E. of
1. 562.50 eV 2. 1125 eV
3. 1250 eV 4. 281.25 eV

5. If the K.E. of a cathode ray beam is 8 Kev, then the tube should work at a p.d. of
1. 4 KV 2. 8 KV 3. 8 V 4. 4 V

6. An electron is kept in an electric field of intensity 20 V/cm. Then the force acting on it is ($e=1.6 \times 10^{-19}$ C)
1. 3.2×10^{-16} N 2. 3.2×10^{-19} N
3. 32×10^{-19} N 4. 32×10^{-18} N

7. A water drop of mass 3.2×10^{-18} kg is suspended stationary between two plates of an electric field. Given $g=10\ m/s^2$, the intensity of the electric field required is
1. 2 V/m 2. 200 V/m 3.20 V/m 4. 2000 V/m

8. An electron enters an electric field between two plates across which a p.d. of 1000 V is applied. If the distance between the two plates is 2 mm, the force acting on the electron is
1. 8×10^{-17} N 2. 8×10^{-16} N
3. 8×10^{-14} N 4. 8×10^{-15} N

9. An α - particle and a proton are subjected to the same electric field, then the ratio of the forces acting on them is
1. 2: 3 2. 1: 2 3. 3 :2 4. 2 :1

10. A proton and a deuteron are subjected to same electric field. If the force acting on the proton is 3.2×10^{-16} N, then the force acting on the deuteron is
1. 3.2×10^{-16} N 2.1.6×10^{-16} N
3. 6.4×10^{-16} N 4.9.6×10^{-16} N

11. The ratio of specific charges of an electron to that of a hydrogen ion is
1) 2:1 2) 1:1 3) 1: 1840 4) 1840:1

12. The specific charge of a proton is 9.6×10^7 coulomb/Kg. Then the specific charge of an alpha particle is
1) 2.4×10^7 C/kg 2) 4.8×10^7 C/kg
3) 9.6×20^7 C/kg 4) 1.4×10^7 C/kg

13. Two electron beams having velocities in the ratio 1:2 are subjected to the same transverse magnetic field. The ratio of the deflections is
1) 1:2 2) 2:1 3) 4:1 4) 1:4

14. The ratio of the specific charge e/m of a proton to that of an a-particle is
1) 1:5 2) 1:2 3) 1:1/4 4) 2:1

15. An electron is accelerated in an electric field of 40 V cm^{-1}. If e/m of electron is 1.76×10^{11} Ckg^{-1}, the acceleration is
1) $14.0 \times 10^{14}\ ms^{-2}$ 2) $14.0 \times 10^{10} ms^{-2}$
3) $7.0 \times 10^{10} ms^{-2}$ 4) $7.04 \times 10^{14} ms^{-2}$

PHOTO ELECTRIC EFFECT:

16. The frequency of a photon associated with an energy of 3.31 eV is (given $h = 6.62 \times 10^{-34}$ Js)
1. 0.8×10^{15} Hz 2. 1.6×10^{15} Hz
3. 3.2×10^{15} Hz 4. 8.0×10^{15} Hz

17. The wavelength associated with a photon of energy 3.31 eV is nearly
1. 4000 A° 2. 3750 A° 3. 5000 A° 4. 400 A°

18. The threshold wavelength for a surface having a threshold frequency of 0.6×10^{15} Hz is (given $c = 3 \times 10^8$ m/s)
1.4000 A° 2. 6000 A° 3. 5000A° 4. 3500A°

19. The threshold frequency of a metal surface having a work function of 3.31 eV is (given $h = 6.62 \times 10^{-34}$ Js)
1. 1.6×10^{15} Hz 2. 3.2×10^{15} Hz
3. 8.0×10^{15} Hz 4. 0.8×10^{15} Hz

20. The photoelectric threshold wavelength for a metal is 6620 A°. Its work function is (given $h = 6.62 \times 10^{-34}$ Js, $c = 3 \times 10^8$ m/s)
1. 1.87 eV 2. 2.00 eV 3. 3.00 eV 4. 2.87 e

21. Two photons have energies of 4.95×10^{-19} J and 14.85×10^{-19} J. Then the ratio of their wavelengths is
1. 1 : 3 2. 3 : 1 3. 1 : 2 4. 1 : 4

22. The energy of a photon of wavelength 662 nm is
1. 2.87 eV 2. 3.00 eV 3. 1.87 eV 4. 2.00 eV

23. The energy of emitted photoelectrons from a metal is 0.9 eV. The work function of the metal is 2.2 eV. Then the energy of the incident photon is
1. 0.9 eV 2. 2. 2 eV 3. 4. 4 eV 4. 3.1 eV

24. The intensity of incident radiation on a photocell is increased to 4 times. Then the number of photoelectrons emitted per second will be
1.doubled 2. halved
3. quadrupled 4.16 times the initial current

25. When green light is incident on a metal surface, photoelectrons are emitted. On the same metal surface when yellow light falls, photoelectric emission does not occur. Will there be photoelectric emission, when red light falls upon the same metal?
1. No 2. Yes
3. may or may not be emitted
4. data insufficient

26. A photocell emits 4×10^{12} electrons per second with maximum KE of E when the source of light is at a distance d from the photocell. If the distance is made equal to 2d, the number of electrons emitted per second and maximum K.E.will be
1. 2×10^{12}, E 2. 10^{12}, E
3. 4×10^{12}, 2E 4. 2×10^{12}, 2E

27. In a photoelectric cell, current stops when a negative potential of 0.5 V is given to the collector w.r.t the emitter. The maximum K.E of the emitted electrons is
1) 0.8×10^{-19} J 2) $0.8\times10^{-19}\,erg$
3) 0.5 J 4) 0.5 erg

28. The work function of a metal is 4 eV. The wavelength of incident light required to emit photo electrons of zero energy from its surface, will be
1) 5000 A^0 2) 3100 A^0
3) 1700 A^0 4) 2700 A^0

29. The work function for silver is 5.26×10^{-19} J. Its threshold wavelength is nearly
1. 4000 A^o 2. 5294 A^o 3. 3764 A^o 4. 5000 A^o

X-RAY SPECTRA:

30. The energy of the most energetic X-Ray photons produced in a coolidge tube working under a.p.d. of 50 KV is
1.50 KeV 2. 50 MeV 3. 50 eV 4.100 KeV

31. A p.d. of 60 KV is applied across the ends of an X-Ray tube. The energy of the most energetic x-Ray photon is
1. 9.6×10^{-19} J 2. 9.6×10^{-15} J
3. 9.6×10^{-16} J 4. 9.6×10^{-17} J

32. An X-Ray tube operates at 10^5 V. The maximum energy of X-Ray photons emitted from this tube will be
1. 10^5 V 2. 100 KV 3.100 KeV 4.200 KeV

33. An X-Ray tube operates at a p.d. of 12400 V. The wavelength of the highest frequency X-Rays emitted by this tube is nearly
1.12. 4 A^o 2.1.24 A^o 3. 2.48 A^o 4. 1 A^o

34. An X-ray tube operates at a p.d. of 24824 V. The minimum wavelength of X-Rays emitted by this tube is
1. 24.8 A^o 2. 0.5 A^o 3. 1 A^o 4. 2 A^o

35. An X-Ray tube emits X-Rays of wavelength 0.1 A^o under the application of a p.d. of
1.12.4 KV 2. 24.8 KV 3. 124 KV 4. 200 KV

36. X-Rays of shortest wavelength of 0.02 nm are produced, when an X-Ray tube operates at a p.d. of.
1. 62 KV 2. 124 KV 3. 248 KV 4. 100 KV

37. In an X-Ray tube the current is 1 mA. The number of electrons striking the target per second is (given e = 1.6×10^{-19} C)
1.6.25×10^{18} 2. 6.25×10^{16}
3. 6.25×10^{15} 4. 6.25×10^{14}

38. An X-Ray tube operates at a potential of 100 KV and 10 mA tube current. If only 1% of the electrical power is converted into X-Rays, the rate at which the target is heated is
1. 990 w 2. 99 w 3. 100 w 4. 1000 w

39. The energy of an X-Ray photon is 4 Kev. Then its wavelength is
1. 31 A^o 2. 3.1 A^o 3. 0.31 A^o 4.0.031 A^o

40. The energy of an X-Ray photon is 4.1333 Kev. Then its frequency is nearly
1.10^{15} Hz 2. 10^{16} Hz 3. 10^{17} Hz 4. 10^{18} Hz

41. In an X-Ray tube the target material is of atomic number Z. The frequency of the K_α line is proportional to
1. z 2. z^3 3. z^2 4. z^o

42. An X-Ray tube emits a wavelength of 1 A^o. The p.d. to be applied across the ends of the tube is (given h = 6.6×10^{-34} Js, e = 1.6×10^{-19} C and c = 3×10^8 m/s)
1.124 V 2. 1240 V 3. 12400 V 4. 10 KV

43. A p.d. of 15000 V is applied across the ends of a copper target. The speed of the emitted X-Rays inside the tube is (Assume standard values)
1. $3 \times 10^8\ ms^{-1}$ 2. $3 \times 10^7\ ms^{-1}$
3. $3 \times 10^6\ ms^{-1}$ 4. $3 \times 10^5\ ms^{-1}$

44. The energy of the incident photon is 12.38 e V, while the energy of the scattered photon is 9.4 ev. The K.E. of the recoil electron is nearly
1) 2 eV 2) 1 eV 3) 4 eV 4) 3 eV