PHYSICS

BOOKS - DC PANDEY PHYSICS (HINGLISH)

MODERN PHYSICS - 1

Example

1. The intensity of direct sunlight befor it passes through the earth's atmosphere is $1.4kW \mid m^2$. If it is completely absorbed, find the corresponding radiation pressure.

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2. An electron is accelerated by a potential difference of 25 volt . Find the de- Broglie wavelength associated with it.

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3. A partical of mass M at rest decays into two Particles of masses m_1 and m_2 having non-zero velocities. The ratio of the de - Broglie wavelengths

of the particles $\lambda_1 \mid \lambda_2$ is

(a) m_1 / m_2 (b)m_2 / m_1 (c) 1 (d)$\sqrt{,}_2 / \sqrt{\_}1$

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4. The energy of a photon is equal to the kinetic energy of a

proton. The energy of the photon is E. Let $\lambda_1$be the de-Broglie wavelength of the

proton and λ_2 be the wavelength of the photon. The ratio $\frac{\lambda_1}{\lambda_2}$ is proportional to

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

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5. An α- particle and a proton are accelerated from rest by a potential difference of 100V. After this, their de-Broglie wavelengths are λ_a and λ_p respectively. The ratio $\frac{\lambda_p}{\lambda_a}$, to the nearest integer, is.

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6. The potential energy of a partical varies as

. $U(x) = E_0 f \text{ or } 0 \le x \le 1 \quad = 0f \text{ or } x > 1F \text{ or } 0 \le x \le 1,$ de-Broglie wavelength is λ_1 and for xgt the de-Broglie wavelength is λ_2. Total energy of the partical is 2E_0. find $\frac{\lambda_1}{\lambda_2}$.

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7. Using the known values for haydrogen atom, calculate

. (a) radius of thirdj orbit for Li^{+2}

. (b) speed of electron in fourth orbit for He^{+}

. (c) angular momentum of electron in 3rd orbit of He^{+}.

A. $O.53 Å\ 2.19 \times 10^6 m/s\ 3\left(\frac{h}{2\pi}\right)$

B. $1.59 Å\ 2.19 \times 10^6 m/s\ 3\left(\frac{h}{3\pi}\right)$

C. $1.59 Å\ 2.19 \times 10^{-6} m/s\ 3\left(\frac{h}{2\pi}\right)$

D. $1.59 Å\ 2.19 \times 10^6 m/s\ 3\left(\frac{h}{2\pi}\right)$

Answer: D

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8. A doubly ionized lithium atom is hydrogen like with atomic

. number 3. Find the wavelength of the radiation to excite the electron in

. $Li++$ form the first to the third Bohr orbit. The ionization energy of

the hydrogen

. Atom is 13.6V.

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9. Find variation of angular speed and time period of single

. electron of hydrogen like atoms with n and Z.

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10. find kinetic energy, electrostatic potential energy and total

. energy of single electron in 2nd excited state of Li^{+2} atom.

A. $E = -13.6eV\ K.E = 13.6eV\ P.E = 27.2eV$

B. $E = 13.6eV\ K.E = 13.6eV\ P.E = 27.2eV$

C. $E = -13.6eV\ K.E = 13.6eV\ P.E = -27.2eV$

D. $E = 13.6eV\ K.E = 13.6eV\ P.E = -27.2eV$

Answer: C

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11. Find the kinetic energy, potential energy and total energy in

first and second orbit of hydrogen atom if potential energy in first orbit is

taken

to be zero.

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12. A small particle of mass m moves in such a way that the

potential energy $U = ar^2$, where a is constant and r is the distance of

the

particle from the origin. Assuming Bhor model of quantization of angular

momentum and circular orbits, find the rodius of nth allowed orbit.

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13. Calculate (a) the wavelength and (b) the frequencey of the $H\beta$

line of the Balmer series for hydrogen.

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14. Find the largest and shorted wavelengths in the Lyman

series for hydrogen. In what region of the electromagnetic spectrum does each

series lie?

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15. In a hypothetical atom, mass of electron is doubled, value

of atomic number is $Z = 4$. Find wavelength of photon when this electron jumps

from 3rd excited state to 2nd orbit.

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16. Find the cut off walelength for the continuous X - rays coming

form an X-ray tube operating at 40 kv.

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17. Use Moseley's law with b = 1 to find the frequency of the K_{α} X-ray of $La(Z = 57)$ if the frequency of the K_{α} X-ray of $Cu(Z = 29)$ is known to be $1 \cdot 88 \times 10^{18}$ Hz.

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18. Electrons with de - Brogli wavelengtyh λ fall on the target in an X-ray tube.The cut off wavelength of the emitted Xrays is

(a) $\lambda_0 = \frac{2mc\lambda^2}{h}$ (b)$\lambda_0 = \frac{2h}{mc}$

(c) $\lambda_0 \frac{2m^2c^2\lambda^3}{h^2}$ (d)$\lambda_0 = \lambda$

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19. Electrons with energy $80keV$ are incident on the tungsten target of an X - rays tube , k- shell electrons of tungsten have $72.5keV$ energy X-rays emitted by the tube contain only

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20. A metal plate is placed 5m from a monchromatic ligth

soure whose power output is 10^{-3}W. Consider that a given ejected

photoelectron may collect its energy from a circular area of the plate as

large as

ten atomic diameters 10^{-9} m in radius. The energy required to remove

an electron through the metal surface is about 5.0 eV. Assuming light to

be a

wave, how long would it take for such a 'target' to soak up this much

energy

from such a light source.

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21. The photoelectric work - function of potassium is 2.3 eV. If light

having a wavelength of 2800Å falls on potassium, find

(a) the kinetic energy in electron volts of the most energetic electrons ejected.

(b) the stopping potential in volts.

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22. When a beam of 10.6 eV photons of intensity $2.0W/m^2$ falls on a platinum surface of area $1.0 \times 10^{-4} m^2$ and work function 5.6 eV, 0.53% of the incident photons eject photoelectrons. Find the number of photoelectrons emitted per second and their minimum and maximum energy (in eV). Take $1eV = 1.6 \times 10^{-19} J$.

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23. Maximum kinetic energy of photoelectrons from a metal surface is K_0 when wavelngth of incident light is λ. If wavelength is decreased to $\lambda \mid 2$, the maximum kinetic energy of photoelectrons becomes

(a) $= 2K_0$ (b) $> 2K_0$ (c) $< 2K_0$

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24. Intensity and frequency of incident light both are doubled.

Then, what is the effect on stopping potential and saturation current.

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25. When a monochromatic point source of light is at a distance

of 0.2 m from a photoelectric cell, the cut off voltage and the saturation

current

are respectively 0.6 V and 18.0 mA. If the same source is placed 0.6 m away

from the photoelectric cell, then

(a) the stopping potential will be 0.2 V

(b) the stopping potential will be 0.6 V

(c) the saturation current will be 6.0 mA

(d) the saturation current will be 2.0 mA

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26. The threshold wavelength for photoelectric emission for a material is $5200 A^{\circ}$. Will the photoelectrons be emitted when this material is illuminated with monochromatic radiation from 1 watt ultra violet lamp?

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Example Type 1

1. A proton is fired from very for away towards a nucleus with charge Q = 120 e, where e is the electronic charge. It makes a closest approach of 10fm to the nucleus. The de - Broglie wavelength (in units of fm) of the proton at its start is [take the proton mass, $m_p = \left(5/3 \times 10^{-27} kg, h \leq \ = 4.2 \times 10^{-15} J - s/C,\right.$
$\left.\frac{1}{4\pi\varepsilon_0} = 9 \times 10^9 m/F, 1fm = 10^{-15}\right]$

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2. Find de-Broglie wavelength of single electron in 2 nd orbit of hydrogen atom by two methods.

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Example Type 2

1. The electirc potential between a proton and an electron is given by $V = V_0 \in \frac{r}{r_0}$, where r_0 is a constant. Assuming Bhor model to be applicable, write variation of r_n with n, being the principal quantum number. (a) $r_n \propto n$ (b) $r_n \propto \frac{1}{n}$ (c) r_n^2 (d)$r_n \propto \frac{1}{n^2}$

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2. Imagine an atom made up of a proton and a hypothetical particle of double the mass of the electron but having the same charge as the electron . Apply the Bohr atom model and consider all possible transitions of this hypothetical particle that will be emitted level . The longest wavelength photon that will be emitted has longest wavelength λ (given in terms of the Rydberg constant R for the hydrogen atom) equal to

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3. The recoil speed of a hydrogen atom after it emits a photon is going form n=5 state to n =1 state is ..... m/s.

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4. A hydrogen like atom (described by the Borh model) is observed to emit six wavelength, originating from all possible transitions between a group of levels. These levels have energies between - 0.85 eV and 0.544 eV (including both these values). (a)Find the atomic number of the atom.

(b) Calculate the smallest wavelength emitted in these transitions.

(Take, hc = 1240 eV - nm, ground state energy of hydrogen atom =-13.6 eV)

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5. A hydrogen like atom number Z is in an excited state of quantum number 2n. It can emit a maximum energy photon of 204 eV. If it makes a transition ot quantum state n, a photon of energy 40.8 eV is emitted. Find n, Z and the ground state energy (in eV) of this atom. Also calculate the minimum energy of hydrogen atom is -13.6 ev.

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6. A hydrogen like atom (atomic number Z) is in a higher excited state of quantum number n. The excited atom can make a transition ot the first excited state by successively emitting two photons of energy 10.2 eV and 17.0 eV, respectively. Alternatively, the atom from the same excited state can make a transition to the second excited state by successively emitting two photons of energies 4.25 eV and 5.95 eV, respectivley Determine the values of n and Z. (Ionization energy of H-atom = 13.6 eV)

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Example Type 3

1. Determine the energy of the characteristic X-ray (K_{β}) emitted from a tungsten (Z = 74) target when an electron drops from the M-shell (n=3) to a vacancy in the K-shell (n=1)

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2. The potential difference applied to an X-ray tube is 5k V and the current through it is 3.2 mA. Then, the number of electrons striking the target per second is. (a) 2×10^{16} (b) 5×10^{6} (c) 1×10^{17} (d) 4×10^{15}.

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3. Highly energetic electron are bombarded in a target of an element containing 30 neutrons Tne ratio of nucleus to that of Helium nucleus is $(14)^{1/3}$. Find (a) atomic number of the nucleus (b) the frequency of k_{a}

line of the X- rays producted $(R = 1.1 \times 10^7 m^{-1}$ and $c = 3 \times 10^8 m/s)$

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4. Stopping potential of 24, 100, 110 and 115 k V are measured for photoelectrons emitted from a certain element when it is radiated with monochromatic X-ray . If this element is used as a target in an X-ray tube,what will be the wavelength of K_a - line?

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Example Type 4

1. A monochromatic light soure of frequency f illuminates a metallic surface and ejects photoelectrons. The photoelectrons having maximum energy are just able to ionize the hydrogen atoms in ground state. When the whole experiment is repeated with an incident radiation of frequency

$\frac{5}{6}f$, the photoelectrons so emitted are able to excite the hydrogen atom beam which then emits a radiation of wavelength 1215Å. (a) What is the frequency of radiation? (b) Find the work- function of the metal.

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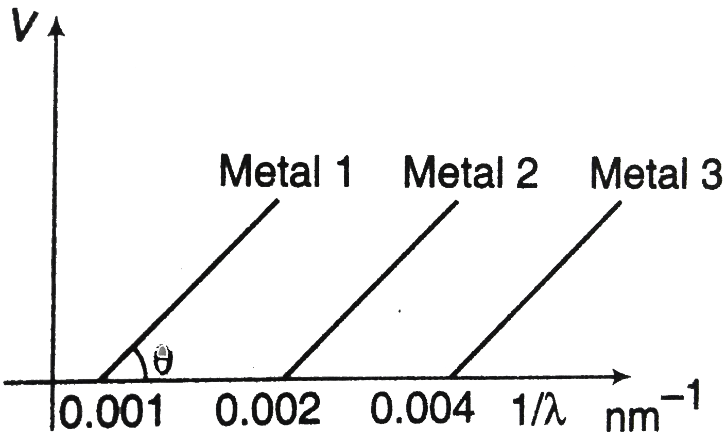
2. The graph between $1/\lambda$ and stopping potential (V) of three metals having work- functions Φ_1, Φ_2 and Φ_3 in an experiment of photoelectric effect is plotted as shown in the figure. Which of the following statement(s) is/are correct? (Here, λ is the wavelength of the incident ray). (a) Ratio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



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3. A beam of light has three wavelengths 4144Å, and 6216Å with a total instensity of $3.6 \times 10^{-3} Wm^{-2}$ equally distributed amongst the three wavelengths. The beam falls normally on an area $1.0 cm^2$ of a clean metallic surface of work function 2.3 eV. Assume that there is no loss of light by reflection number of photoelectrons liberated in two seconds.

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Miscellaneous Examples

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

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

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

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

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

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2. Photoelectrons are emitted when 400 nm radiation is incident on a surface of work - function 1.9 eV. These photoelectrons pass through a region containing a-particles. A maximum energy electron combines with an a -particle to from a He^{+} ion, emitting a single photon in this process. He^{+} ions thus formed are in their fourth excited state. Find the energies in eV of the photons lying in the 2 to 4 eV range, that are likely to be emitted during and after the combination. $\left[Take, h = 4.14 \times 10^{-15} eV - s\right]$

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3. Light form a dicharge tube containing hydrogen atoms falls on the surface of a piece of sodium. The kinetic energy of the fastest photoelectrons emitted from sodium is 0.73 eV. The work function for sodium is 1.82 eV. Find (a) the energy of the photons causing the photoelectrons emission.

(b) the quatum numbers of the two levels involved in the emission of these photons.

(c) the change in the angular momentum of the electron in the hydrogen atom, in the above transition, and

(d) the recoil speed of the emitting atom assuming it to be at rest before the transition. (Ionization potential of hydrogen is 13.6 eV.)

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4. If an X-ray tube operates at the voltage of 10kV, find the ratio of the de-broglie wavelength of the incident electrons to the shortest wavelength of X-ray producted. The specific charge of electron is $1.8 \times 10^{11} \frac{C}{k} g.$

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5. The wavelength of the first line of Lyman series for hydrogen is identical to that of the second line of Balmer series for some hydrogen like ion x. Calculate the atomic no of ion

A. 1

B. 3

C. 4

D. 2

Answer: D

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6. A moving hydrogen atom makes a head on collision with a stationary hydrogen atom. Befor collision both atoms are in in ground state and after collision they move together. What is the minimum value of the kinetic energy of the moving hydrogen atom, such that one of the atoms reaches one of the excited state?

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7. An imaginary particle has a charge equal to that of an electron and mass 100 times tha mass of the electron. It moves in a circular orbit around a nucleus of charge + 4 e. Take the mass of the nucleus to be infinite. Assuming that the Bhor model is applicable to this system. (a)Derive an experssion for the radius of nth Bhor orbit. (b) Find the wavelength of the radiation emitted when the particle jumps from fourth orbit to the second orbit.

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8. The energy levels of a hypothetical one electron atom are given by

$$E_n = -\frac{18.0}{n^2} eV$$

where n = 1,2,3,.... (a) Compute the four lowest energy levels and construct the energy levels diagram. (b) What is the first excitation potential (c) What wavelength (Å) can be emitted when these atoms in the ground state are bombarged by electrons that have been accelerated through a potential difference of 16.2 V? (e) what is the photoelectric threshold wavelength of this atom?

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9. In a photocell the plates P and Q have a separation of 5 cm, which are connected through a galvanometer without any cell. Bichromatic light of wavelengths 4000Å and 6000Å are incidenton plate Q whose work-functionis 2.39 eV. If a uniform magnetic field B exists parallel to the plates, find the minimum value of B for which the galvanometer shows zero deflection.

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Exercise 33 1

1. Find the energy and mometum of a photon of ultraviolet radiation of 280 nm wavelength.

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2. A small plate of a metal is placed at a distance of 2m from a monochromatic light source of wavelenght $4.8 \times 10^{-7} m$ and power 1.0

Watt. The light falls normally on the plate. Find the number of photons striking the metal plate per square metre per second.

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3. A proton and deuteron are accelerated by same potential difference.Find the ratio of their de-Broglie wavelengths.

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4. A deuteron and an α - partical have same kinetic energy. Find the ratio of their de-Broglie wavelengths.

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5. Two protons are having same kinetic energy. One proton enters a uniform magnetic field at right angles ot it. Second proton enters a uniform electric field in the direction of field. After some time their de

Broglie wavelengths are λ_1 and λ_2 then (a) $\lambda_1 = \lambda_2$ (b) $\lambda_1 < \lambda_2$ (c) $\lambda_1 > \lambda_2$ (d) some more information is required

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6. Find the de-Broglie wavelengths of (a) a 46 g golf ball with a velocity of 30m/s (b) an electron with a velocity of $10^7 m/s$.

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Exercise 33 2

1. Find the ionisation energy of a doubly Ionized lithium atom.

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2. A hydrogen atom is in a state with energy $-1.51eV$. in the Bohr model, what is the angular momentum of the electron in the atom with respect to an axis at the nucleus?

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3. As an electron makes a transition from an excited state to the ground state of a hydrogen like atom/ion

(a) kinetic energy, potential energy and total energy decrease

(b) kinetic energy decreases, potential energy increases but total energy remains same

(c) kinetic energy and total energy decrease but potential energy increases

(d) its kinetic energy increases but potential energy and total energy decrease

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4. The wavelength of the ultraviolet region of the hydrogen spectrum is 122 nm. The wavelength of the second sperctral line in the Balmer series of singly ionized helium atom is (a) 1215Å (b) 1640Å (C) 2430Å (d) 4687Å

A. 1215Å

B. 1649Å

C. 2430Å

D. 4687Å

Answer: A

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5. The largest wavelength in the ultraviolet region of the hydrogen spectrum is 122nm. The smallest wavelength in the infrared region of the hydrogen spectrum (to the nearest interger) is (a) 802 nm (b) 823 nm (c) 1882 nm (d) 1648 nm.

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6. A photon collides with a stationary hydrogen atom in ground state inelastically. Energy of the colliding photon is 10.2 eV. After a time interval of the order of micro second another photon collides with same hydrogen atom inelastically with an energy of 15eV. What wil be observed by the detector?

(a) 2 photons of energy 10.2 eV

(b) 2 photons of energy 1.4 eV

(c) One photon of energy 10.2 eV and an electron of energy 1.4 eV

(d) One photon of energy 10.2 eV and another photon of energy 1.4 eV

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7. A hydrogen atom and a Li^{2+} ion are both in the second excited state. If l_H and l_{Li} are their respective electronic angular momenta, and E_H and E_{Li} their respective energies, then (a) $l_H > l_{Li}$ and $|E_H| > |E_{Li}|$ (b) $l_H = l_{Li}$ and $|E_H| < |E_{Li}|$

(C) $l_H = l_{Li}$ and $|E_H| > |E_{Li}|$ (d) $l_H < l_{Li}$ and $|E_H| < |E_{Li}|$

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8. The transition from the state n=4 to n=3 in a hydrogen like atom results in ultraviolet radiation. Infreared radiaton will be obtained in the transition (a) $2 \rightarrow 1$ (b) $3 \rightarrow 2$ (c) $4 \rightarrow 2$ (d) $5 \rightarrow 4$

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9. As per Bohr model , the minimum energy (in eV) required to remove electron from the ground state of doubly ioinized Li alom $(Z = 3)$ is

A. -122.4 eV

B. 122.4 eV

C. -13.6 eV

D. 13.6 eV

Answer: B

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10. Consider the spectral line resulting from the transition $n = 2 \rightarrow n = 1$ in the atoms and ions given . The shortest wavelength is produced by

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11. The energy levels of a cartain atom are shown in figure. If a photon of

.....5E

frequency f is emitted when there is an electron transition from 5E to E .....

4E

what frequencies of photons could be produced by other energy level transitions?..... E

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12. Find the longest wavelength present in the Balmer series of hydrogen.

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Exercise 33 3

1. if λ_{Cu} is the wavelength of K_{α}, X-ray line fo copper (atomic number 29) and λ_{Mo} is the wavelength of the K_{α} X-ray line of molybdenum (atomic number 42), then the ratio $\frac{\lambda_{Cu}}{\lambda_{Mo}}$ is close to

(a) 1.99 (b) 2.14

(c) 0.50 (d) 0.48

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2. Which one of the following statement is $WRONG$ in the context of X-rays generated from X- rays tube ?

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3. K_{α} wavelength emitted by an atom of atomic number Z=11 is λ. Find the atomic number for an atom that emits K_{α} radiation with wavelength 4λ. (a) Z=6 (b) Z=4

(c) Z=11 (d) Z=44.

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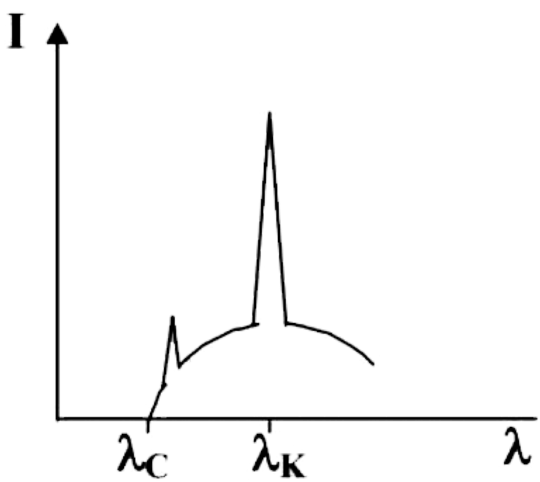
4. The intensity of X- ray from a coolidge tube is plotted againest wavelength λ as shown in the figure . The minimum wavelength found λ_c and the wavelength of thek_a line is λ_λ, As the accelerating voliage is increase



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5. X-ray are produced in an X-ray tube operating at a given accelerating voltage. The wavelength of the continuous X-ray has values from. (a) $0 \to \infty$

(b) $\lambda_{\min} \to \infty, where \lambda_{\min} > 0$

(c) 0 to $\lambda_{\max}, where \lambda_{\max} < \infty$

(d) $\lambda_{\min} ot \lambda_{\max}$, where $0 < \lambda(\min) < \lambda_{\max} < \infty$

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6. Characteristic X-rays of frequency 4.2×10^{18} Hz are produced when transitions from L-shell to K-shell take place in a cartain target meterial. Use Mosley's law to determine the atoic number of the target matderial. Given Rydberg constant $R = 1.1 \times 10^{7} m^{-1}$.

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Exercise 33 4

1. Light of wavelength 2000Å is incident on a metal surface of work function 3.0 eV. Find the minimum and maximum kinetic energy of the photoelectrons.

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2. Is it correct to say that $K_{\max}$ is proportional to f ? If not what would a correct statement of the relationship between $K_{\max}$ and f?

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3. When a metal is illuminated with light of frequency f, the maximum kinetic energy of the photoelectrons is 1.2 eV. When the frequency is increased by 50% the maximum kinetic energy increases to 4.2 eV. What is the threshold frequency for this metal?

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4. A metal surface is illuminated by light of two different wavelengths 248 nm and 310 nm. The maximum speeds of the photoelectrons corresponding to these wavelengths are μ_1 and mu_2 $respectively. If the ratio$u_1: u_2 = 2:1 and hc= 1240 eV` nm, the work function of the metal is neraly. (a)3.7 eV (b) 3.2 eV (c) 2.8eV (d) 2.5eV.

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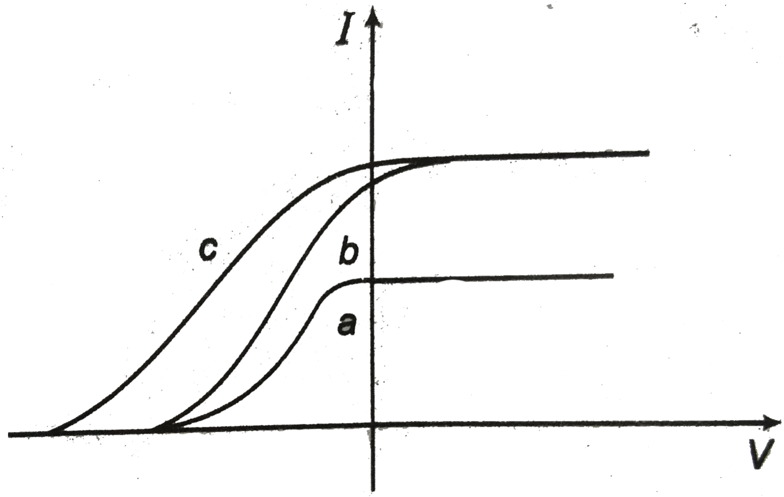
5. The figure shows the variation of photocurrent with anode potential for a photosensitve surface for three different radiations. Let l_a, l_b and l_c be the curves a, b and c, respectively



(a) $f_a = f_b$ and $l_a \neq l_b$ (b) $f_a = f_c$ and $l_a = l_c$

(c) $f_a = f_b$ and $l_a = l_b$ (d) $f_b = f_c$ and $l_b = l_c$

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6. The work function of a substance is 4.0 eV. The longest wavelength of light that can cause photoelectron emission from this substance is approximately. (a) 540 nm (b) 400nm (c) 310 nm (d) 220 nm

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7. The maximum kinetic energy of photoelectrons emitted from a surface when photons of energy 6 eV fall on it is 4eV. The stopping potential in volt is

(a)2 (b) 4 (c) 6 (d) 10

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8. Photoelectric effect supports quantum nature of light because

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

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

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

(d) electric charge of the photoelectrons is quantised

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Level 1 Assertion And Reason

1. Assertion: X-rays cannot be deflected by electric or magnetic fields

. Reason: These are electromagnetic waves.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A

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2. Assertion: if wavelength of light is doubled, energy and momentum of photons are reduced to half.

Reason: By increasing the wavelength, speed of photons will decrease.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: C

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3. Assertion: we can increases the saturation current in photoelectric experiment without increasing the intensity of light.

Reason: Instensity can be increased by increasing the frequency of incident photons.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A::B

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4. Assertion: Photoelectric effect proves the particle nature of light.

Reason: Photoemission starts as soon as light is incident on the metal surface, provided frequency of incident light is greater than or equal to the threshold frequency.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A

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5. Assertion: During de-excitation from n=6 to n=3 , total six emission lines may be obtained.

Reason: From $n = n \rightarrow n = 1 \rightarrow tal\left(n\frac{n-1}{2}\right.$ emission lines are obtained.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A::B

Watch Video Solution

6. Assertion: If frequency of incident light is doubled, the stopping potential will also become two times

Reason: Stopping potential is given by $V_0 = \frac{h}{e}(v - v_0)$

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: D

Watch Video Solution

7. Assertion: X-rays cannot be obtained in the emission spectrum of hydrogen atom.

Reason: Maximum energy of photons emitted form hydroen spectrum is 13.6 eV.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: A

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8. Assertion: If applied potential difference in coolidge tube is increased, then difference in coolidge tube.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: B

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9. Assertion: In n=2, energy of electron in hydrogen like atoms is more compared to n=1

.Reason: Electrostatic potential energy in n=2 is more.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: B

Watch Video Solution

10. Assertion: In continuous X-ray spectrum, all wavelength can be otained

. Reason: Accelerated (or retarded) charged particles rediate enrgy. This is the cause of production of continuous X-rays.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason or true but Reason is not the correct explanation of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: D

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Level 1 Objective

1. According to Einstein's photoelectric equation, the plot of the maximum kinetic energy of the emitted photoelectrons from a metal versus frequency of the incident radiation gives a straight line whose slope

A. depends on the nature of metal used

B. depends on the intensity or radiation

C. depends on both intensity of radiation and the nature of metal used

D. is the same for all metals and independent of the instensity or radiation

Answer: D

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2. The velocity of the electron in the first Bohr orbit as compared to that of light is about

A. 1/300

B. 1/500

C. 1/137

D. 1/187

Answer: C

Watch Video Solution

3. $\_86A^{222} \rightarrow_{84} B^{210}$. In this reaction, how many α and β particles are emitted?

A. $6\alpha, 3\beta$

B. $3\alpha, 4\beta$

C. $4\alpha, 3\beta$

D. $3\alpha, 6\beta$

Answer: B

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4. An X-ray tube is operated at 20 kV. The cut off wavelength is

A. 0.89Å

B. 0.75Å

C. 0.62Å

D. None of these

Answer: C

Watch Video Solution

5. An X-ray tube is opearted at 18 kV. The maximum velocity of electron striking the target is

A. $8 \times 10^7 m / s$

B. $6 \times 10^7 m / s$

C. $5 \times 10^7 m / s$

D. None of these

Answer: A

Watch Video Solution

6. what is the ratio of de-Broglie wavelength of electron in the second and third Bohr orbits in the hydrogen atoms?

A. $2/3$

B. $3/2$

C. $4/3$

D. $3/4$

Answer: A

Watch Video Solution

7. The energy of a hydrogen like atom (or ion) in its ground state is -122.4 eV. It may be

A. hydrogen atom

B. He^{+}

C. Li^{2+}

D. Be^{3+}

Answer: C

Watch Video Solution

8. The operating potential in an x-ray tube is increased by 2%. The percentage change in the cut off wavelength is

A. 1% increase

B. 2% increase

C. 2% decrease

D. 1% decrease

Answer: C

Watch Video Solution

9. The energy of an atom or ion in the first excited state is -13.6 eV. It may be

A. He^{+}

B. Li^{++}

C. Hydrogen

D. Deuterium

Answer: A

Watch Video Solution

10. in order that the short wavelength limit of the continuous X-ray spectrum be 1Å, the potential difference through which an electron must be accelerated is

A. 124 kV

B. 1.24 kV

C. 12.4 kV

D. 1240 kV

Answer: C

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11. The momentum of an x-ray photon with $\lambda = 0.5\text{Å}$ is

A. $13.26 \times 10^{-26} kg - m/s$

B. $1.326 \times 10^{-26} kg - m/g$

C. $13.26 \times 10^{-24} kg - m/s$

D. $13.26 \times 10^{-22} kg - m/s$

Answer: C

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12. The work function of a substance is 1.6 ev. The longest wavelength of light that can produce potoemisson form the substance is

A. 7750Å

B. 3875Å

C. 5800Å

D. 2900Å

Answer: A

Watch Video Solution

13. Find the binding anergy of an electron in the ground state of a hydrogen like atom in whose spectrum the thrid Balmer line is equal to 108.5 mm.

A. $54.4eV$

B. $13.6eV$

C. $112.4eV$

D. None of these

Answer: A

Watch Video Solution

14. What is the energy of a hydrogen atom in the first excited state if the potential energy is taken to be zero in the ground state?

A. 10.2 eV

B. 13.6 eV

C. 23.8 eV

D. 27.2 eV

Answer: C

Watch Video Solution

15. Light of wavelength 330nm falling on a piece of metal ejects electrons with sufficient energy with required voltage V_0 to prevent them reaching a collector. In the same set up, light of wavelength 220 nm ejects electrons which require twice the voltage V_0 to stop them in reaching a colleator. the numerical value of voltage V_0 is

A. $\frac{16}{15}V$

B. $\frac{15}{16}V$

C. $\frac{15}{8}V$

D. $\frac{8}{15}V$

Answer: C

Watch Video Solution

16. Maximum kinetic energy of a photoelectron is E when the wavelength of incident light is λ. If energy becomes four times when wavelength is reduced to one thrid, then work function of the metal is

A. $\frac{3hc}{\lambda}$

B. $\frac{hc}{3\lambda}$

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

D. $\frac{hc}{2\lambda}$

Answer: B

Watch Video Solution

17. if the frequency fo K_a X-ray emitted from the element with atomic number 31 is f, then the frequency of K_a x-ray emitted from the elemet with atomic number 51 would be

A. $\frac{5f}{3}$

B. $\frac{51f}{31}$

C. $\frac{9f}{25}$

D. $\frac{25f}{9}$

Answer: D

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18. According to Mseley's law, the ratio of the slope of graph between $\sqrt{f}$ and Z for K_{β} and K_{α} is

A. $\left(\frac{\sqrt{32}}{27}\right)$

B. $\left(\frac{\sqrt{27}}{32}\right)$

C. $\left(\frac{\sqrt{5}}{36}\right)$

D. $\left(\frac{\sqrt{36}}{5}\right)$

Answer: A

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19. if the electron in hydrogen orbit jumps form third orbit to second orbit, the wavelength of the emitted radiation is given by

A. $\lambda = \frac{R}{6}$

B. $\lambda = \frac{R}{6}$

C. $\lambda = \frac{36}{5R}$

D. $\lambda = \frac{5R}{36}$

Answer: C

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20. A potential of 10000 V is applied across an x-ray tube. Find the ratio of de-Broglie wavelength associated with incident electrons to the minimum wavelength associated with x-rays.

A. 10

B. 20

C. $1/10$

D. $1/20$

Answer: C

Watch Video Solution

21. When a metallic surface is illuminated with monochromatic light of wavelength λ, the stopping potential is $5V_0$. When the same surface is illuminated with the light of wavelength 3λ, the stopping potential is V_0. Then, the work function of the metallic surface is

A. $hc/6\lambda$

B. $hc/5\lambda$

C. $hc/4\lambda$

D. $2hc/4\lambda$

Answer: A

Watch Video Solution

Watch Video Solution

22. The threshold frequency for a certain photosensitive metal is v_0. When it is illuminated by light of frequency $v = 2v_0$, the stopping potential for photoelectric current is V_0. What will be the stopping potential when the same metal is illuminated by light of frequency $v = 3v_0$?

A. $1.5V_0$

B. $2V_0$

C. $2.5V_0$

D. $3V_0$

Answer: B

Watch Video Solution

23. The frequency of the first line in Lyman series in the hydrogen spectrum is v. What is the frequency of the corresponding line in the spectrum of doubly ionized Lithium?

A. v

B. 3 v

C. 9 v

D. 2 v

Answer: C

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24. Which enrgy state of doubly ionized lithium $(Li^{++}$ has the same energy as that of the gorund state of hydrogen?

A. n=1

B. n=2

C. n =3

D. n=4

Answer: C

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25. Two identical photo-cathodes receive light of frequencies v_1 and v_2. If the velocities of the photoelectrons (of mass m) coming out are v_1 and v_2 respectively, then

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

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

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

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

Answer: B

Watch Video Solution

26. The longest wavelength of the Lyman series for hydrogen atom is the same as the wavelength of a certain line in the spectrum of He^{+} when the electron makes a trensiton from $n \rightarrow 2$. The value of n is

A. 3

B. 4

C. 5

D. 6

Answer: B

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27. The wavelength of the K_a line for the uranium is $(Z = 92)\left(R = 1.0973 \times 10^7 m^{-1}\right.$

A. $1.5 Å$

B. 0.5Å

C. 0.15Å

D. 2.0Å

Answer: C

Watch Video Solution

28. The frquencies of K_{α}, K_{β} and L_{α} X-rays of a materail are γ_1, γ_2 and γ_3 respectively. Which of the following relation holds good?

A. $\gamma_2 = \sqrt{\gamma_1 + \gamma_3}$

B. $\gamma_2 = \gamma_1 + \gamma_3$

C. $\gamma_2 = \frac{\gamma_1 + \gamma_3}{2}$

D. $\gamma_3 = \sqrt{\gamma_1 \gamma_2}$

Answer: B

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29. A proton and an α - particle are accelerated through same potential difference. Then, the ratio of de-Broglie wavelength of proton and α-particle is

A. $\sqrt{2}$

B. $\frac{1}{\sqrt{2}}$

C. $2\sqrt{2}$

D. None of these

Answer: C

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30. If E_1, E_2 and E_3 represent respectively the kinetic energies of an electron, an $\alpha - partic \leq$ and a proton each having same de-Broglie wavelength, then

A. $E_1 > E_3 > E_2$

B. $E_2 > E_3 > E_1$

C. $E_1 > E_2 > E_3$

D. $E_1 = E_2 = E_3$

Answer: A

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31. if the potential energy of a hydrogen atom in the ground state is assumed to be zero, then total energy of $n = \infty$ is equal to

A. $13.6eV$

B. $27.2eV$

C. zero

D. None of these

Answer: B

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32. A 1000 W transmitter works at a frequency of 880kHz. The number of photons emitted per second Is

A. 1.7×10^{28}

B. 1.7×10^{30}

C. 1.7×10^{23}

D. 1×10^{25}

Answer: B

Watch Video Solution

33. Electromagnetic radiation of wavelength 3000Å is incident on an isolated platinum surface of work- function 6.30 eV. Due to the radiation, the

A. sphere becomes positively charged

B. sphere becomes negatively charged

C. sphere remains neutral

D. maximum kinetic energy of the ejected photoelectrons would be 2.03 eV

Answer: C

Watch Video Solution

34. The energy of a hydrogen atom in its ground state is $-13.6eV$. The energy of the level corresponding to the quantum number n=5 is

A. $-0.54eV$

B. $-5.40eV$

C. $-0.85eV$

D. $-2.72eV$

Answer: A

Watch Video Solution

35. Ultraviolet radiation of 6.2 eV falls on an aluminium surface (work - function = 4.2 eV). The kinetic energy in joule of the fastest electrons amitted is

A. 3.2×10^{-21}

B. 3.2×10^{-19}

C. 3.2×10^{-17}

D. 3.2×10^{-15}

Answer: B

Watch Video Solution

36. what should be the velocity of an electron so that its momentum becoumes equal to that of a photn of wavelength 5200Å

A. 700 m/s

B. 1000 m/s

C. 1400 m/s

D. 2800 m/s

Answer: C

Watch Video Solution

37. Photoelectric work- function of a metal is 1 eV. Light of wavelength $\lambda = 3000\text{Å}$ falls on it. The photoelectrons come out with maximum velocity

A. 10 m/s

B. `10^3m//s

C. 10^4 m//s`

D. $10^6 m / s$

Answer: D

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Level 1 Subjective

1. For a given element the wavelength of the K_α- line is 0.71 nm and of the K_β- line it is 0.63 nm. Use this information to find wavelength of the L_α line.

Watch Video Solution

2. The energy of the n=2 state in a given element is $E_2 = -2870 eV$. Given that the wavelengths of lthe K_α and K_β lines are 0.71 nm and 0.63 nm respectively, determine the energies E_1 and E_3.

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3. 1.5 mW of 400 nm light is directed at a photoelectric cell. If 0.1% of the incident photons produce photoelectrons, find the current in the cell.

Watch Video Solution

4. A photon has momentum of magnitude $8.24 \times 10^{-28} kg - m/s$. (a) What is the energy of this photon? Given your answer in joules and in electron volts

(b) What is the wavelength of this photon? In what region of the electormagnetic spectrum does lie?

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5. A 75 W light source emits light of wavelength 600 nm. (a) Calculate the frequency of the emitted light.

(b) How many photons per second does the source emit?

Watch Video Solution

6. An excited nucleus emits a gamma-ray photon with energy of 2.45 MeV.

(a) What is the photon frequency?

(b) what is the photon wavelength?

Watch Video Solution

7. (a) A proton is moving at a speed much less than the speed of light. It has kinetic energy K_1 and momentum p_1. If the momentum of the proton is doubled, so $p_2 = 2p_1$, how is its new kinetic energy K_2 related to $K - 1$?

(b)A photon with energy E_1 has momentum p_1 . if another photon has momentum p_2 that is twice p_1, how is the energy E_2 of the second photon related to E_1?

Watch Video Solution

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

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

(b) the force exerted by the light beam on the surface.

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9. A beam of white light is incident normaly on a plane surface absorbing 70% of the light and reflecting the rest. If the incident beam carries 10 w of power, find the force exerated by it on the surface.

Watch Video Solution

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

Watch Video Solution

Watch Video Solution

11. wavelength of Bullet. Calculate the de-Brogli wavelength of a 5.00 g bullet that is moving at 340 m/s will it exhibite wave like properties?

Watch Video Solution

12. (a) An electron moves with a speed of 4.70×10^{6} m//s. What is its de-Broglie wavelength?

(b) A proton moves with the same speed. Determine its de - Broglie wavelength.

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13. An electron has a de Broglie wavelength of 2.80×10^{-10} m. Determine

(a) the magnitude of its momentum,

(b) its kinetci energy(in joule and in electron volt).

Watch Video Solution

14. Find de-Broglie wavelength corresponding to the root-mean square velocity of hydrogen molecules at room temperature $(20^\circ C)$.

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15. An electron, in a hydrogen like atom , is in excited state. It has a total energy of -3.4 eV, find the de-Broglie wavelength of the electron.

Watch Video Solution

16. In the Bohr model of the hydrogen atom, what is the de-Broglie wavelength for the electron when it is in (a) the n=1 level?

(b) Then n=4 level? In each case, compare the de-Broglie wavelength to the circumference $2\pi r_n$ of the orbit.

Watch Video Solution

17. The binding energy of an electron in the gorund state of He atom is equal to $E_0 = 24.6eV$. Find the energy required to remove both electrons form the atom.

Watch Video Solution

18. Hydrogen atom is its ground state is excited by means of monochromatic radiation of wavelength 1023Å. How many different lines are possible in the resulting spectrum? Calculate the longes wavelength among them. You may assume the ionization energy of hydrogen atom as 13.6 eV.

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19. A doubly ionized lithium atom is hydrogen like with atomic number 3. Find the wavelength of the radiation required to excite the electron in Li^{++} from to the third Bohr orbit (ionization energy of the hydrogen atom equals 13.6 eV).

Watch Video Solution

20. Find the quantum number n corresponding to nth excited state of He^{++} ion if on transition to the ground state the ion emits two photons in succession with wavelength 108.5 nm and 30.4 nm. The ionization energy of the hydrogen atom is 13.6 eV.

Watch Video Solution

21. A hydrogen like atom (described by the Bohr model) is observed ot emit ten wavelengths, originating from all possible transition between a group of levels. These levels have energies between - 0.85 eV and -0.544 eV (including both these values). (a) Find the atomic number of the atom. (b) Calculate the smallest wavelength emitted in these transitions. (Take ground state energy of hydrogen atom =- 13.6 eV)

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22. The energy levels of a hypothetical one electron atom are shown in the figure. (a)Find the ionization potential of this atom.

(b) Find the short wavelength limit of the series terminating at n=2

(c) Find the excitaion potential for the state n=3.

(d) find wave number of the photon emitted for the transiton n=3 to n=1

$\propto\_ \_\_ \_\_ \_\_ \_\_ \_ 0eV$

$n=5\_ \_\_ \_\_ \_\_ \_\_ \_\_ \_-0.80eV$

n=4 ____________ -1.45 eV$n=3_ __ __ __ __ __ _-3.08eV$

n=2_____________ -5.30 eVn=1 _________________ -15.6 eV`.

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23. (a) An atom initally in an energy level with E = - 6.52 eV absorbs a photon that has wavelength 860 nm. What is the internal energy of the atom after it absorbs the photon?

(b) An atom initially in anergy level with E =-2.68 ev emits a photon that has wavelength 420 nm. What is the internal energy of the atom after it emits the photon?

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24. A silver balll is suspended by a string in a vacuum chamber and ultraviolet light of wavelength 2000Å is directed at it. What electrical potential will the ball acquire as a result? Work function of silver is 4.3 eV.

Watch Video Solution

25. A small particle of mass m move in such a way the potential energy $\left(U = \frac{1}{2}m^2\omega^2r^2\right)$ when a is a constant and r is the distance of the particle from the origin Assuming Bohr's model of quantization of angular momentum and circular orbits , show that radius of the nth allowed orbit is proportional to in

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26. Wavelength of K_α line of an element is λ_0. Find wavelength of K_β - line for the same elemetn.

Watch Video Solution

27. x-rays are produced in an X-ray tube by electrons asselerated through an electric potential difference fo 50.0 kV. An electron makes three collisions in the target coming to rest and loses half its remaining kinetic energy in each of the first two collisions. Determine the wavelenght of the resulting photons. (Neglecting the recoil of the heavey target atoms).

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28. From what meterial is the anod of an X-ray tube made if the K_{α} line wavelength of thej characteristic spectrum is 0.76Å?

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29. The short-wavelength limit shifts by 26 pm when the operating voltage in an X-ray tube is increased to 1.5 times the original value. What was the original value of the operating voltage?

Watch Video Solution

30. The k_{α} X-rays of aluminium (Z = 13) and zinc (Z = 30) have wavelengths 887 pm and 146 pm respectively. Use Moseley\'s law $\sqrt{\upsilon} = a(Z - b)$ to find the wavelength of the K_{α} X-ray of iron (Z = 26).

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31. Characteristic X-rays of frequency 4.2×10^{18} Hz are produced when transitions from L-shell to K-shell take place in a certain target material. Use Mosley's law to determine the atomic number of the target material. Given Rydberg constant $R = 1.1 \times 10^{7} m^{-1}$.

Watch Video Solution

32. The electric current in an X-ray tube (from the target to the filament) operating at $40kV$ is $10mA$. Assume that on an average, 1% of the total kinetic energy of the electrons hitting the target are converted into X-rays (a) what is the total power emitted as X-rays and (b) how much heat is produced in the target every second?

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33. The stopping potential for the photoelectrons emitted from a metal surface of work function 1.7 eV is 10.4 V. Find the wavelength of the radiaiton used. Also, identify the energy levels in hydrogen atom, which will emit this wavelength.

Watch Video Solution

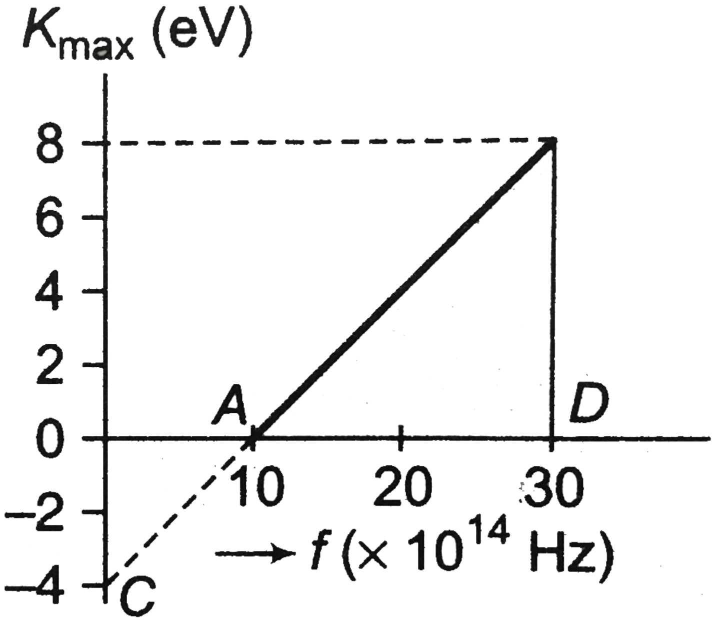
34. What will be the maximum kinetic energy of the photoelectrons ejected from magnesium (for which the work -function W=3.7 eV) when irradiated by ultraviolet light of frequency $1.5 \times 10^{15} s^{-1}$.

Watch Video Solution

35. A metallic surface is irradiated with monochromatic light of variable wavelength. Above a wavelength of 5000Å no photoelectrons are emitted from the surface. With an unknown wavelength, stopping potential fo 3V is neceddsry ot eliminate the photocurrent. Find the unknown wavelenght.

Watch Video Solution

36. A graph regarding photoelectric effect is shown between the maximum kinetic energy of electrons and the frequency of the incident light. On the basis of data as shown in the graph, calculate (a) threshold frequency , (b) work- function, (c) planck constant



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37. A metallic surface is illuminated alternatively with light of wavelenghts 3000Å and 6000Å. It is observed that the maximum speeds of the photoelectrons under these illuminations are in the ratio 3 : 1 . Calculate the work function of the metal and the maximum speed of the photoelectrons in two cases.

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38. Light of wavelength 180 nm ejects photoelectrons from a plate of metal whose work - function is 2 eV. If a uniform magnetic field of 5×10^{-5} T be applied parllel to the palte, what would be the radius of the path followed by electrons ejected normally from the plate with maximum energy.

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39. Light described at a palce by te equation $E = \left(100\frac{V}{m}\right)\left[\sin \times 10^{15} s^{-1} t + \sin\left(8 \times 10^{15} s^{-1} t\right]$ falls on a metal surface having work function 2.0 eV. Calcualte the maximum kinetic energy of the photoelectrons.

Watch Video Solution

40. The electric field associated with a light wave is given by $E = E_0 \sin\left[\left(1.57x10^7 m^{-1}(x - ct)\right)\right]$. Find the stopping potential when this light is used in an experiment on photoelectric affect with a metal having work - function 1.9 eV.

Watch Video Solution

Level 2 Single Correct

1. if we assume only gravitational attraction between proton and electron in hydrogen atom and the Bohr quantizaton rule to be followed, then the expression for the ground state energy of the atom will be (the mass of proton is M and that of electron is m.)

A. increases 4 times

B. decreases 4 times

C. increases 8 times

D. decreases 8 times

Answer: B

Watch Video Solution

Watch Video Solution

2. An electron in a hydrogen atom makes a transiton from first excited state ot ground state. The magnetic moment due to circulating electron

A. 21

B. 10

C. 15

D. None of these

Answer: B

Watch Video Solution

3. The excitation energy of a hydrogen -like ion in its first excited state is $40.8eV$ Find the energy needed to remain the electron from the ion

A. will not pass through origin

B. will be a straight line with slope 4

C. will be a rectangular hyperbola

D. will be a parabola

Answer: A

Watch Video Solution

4. An electron in a hydrogen in a hydrogen atom makes a transition from first excited state to ground state. The equivelent current due to circulating electron

A. decreases 16 times

B. increases 4 times

C. decreases 4 times

D. increases 32 times

Answer: C

Watch Video Solution

5. In a sample of hydrogen like atoms all of which are in ground state, a photon beam containing photos of various energies is passed. In absorption spectrum, five dark line are observed. The number of bright lines in the emission spectrum will be (assume that all transitions take place)

A. 21

B. 10

C. 15

D. none of these

Answer: C

Watch Video Solution

6. Let A_0 be the area enclined by the orbit in a hydrogen atom .The graph of in (A_0 / A_1) against $\ln(n)$

A. Will not pass through origin

B. Will be a straight line with slope 4

C. will be rectangular hyperbola

D. Will be parabola

Answer: B

Watch Video Solution

7. In the hydrogen atom, an electron makes a transition from n=2 to n=1. The magnetic field produced by the circulating electron at the nucleus

A. Decreases 16 times

B. Increases 4 times

C. Decreases 4 times

D. Increases 32 times

Answer: D

Watch Video Solution

8. A stationary hydrogen atom emits photon corresponding to the first line of Lyman series. If R is the Rydberg constant and M is the mass of the atom, then the velocity acquired by the atom is

A. $\frac{3Rh}{4M}$

B. $\frac{4M}{3Rh}$

C. $\frac{Rh}{4M}$

D. $\frac{4M}{Rh}$

Answer: A

Watch Video Solution

9. Light wave described by the equation $200V/m \sin(1.5 \times 10^{15} s^{-1} t \cos(0.5 \times 10^{15} s^{-1} t$ falls metal surface

having work function 2.0 eV. Then, the maximum kinetic energy photoelectrons is

A. $3.27eV$

B. $2.2eV$

C. $2.85eV$

D. none of these

Answer: D

Watch Video Solution

10. A hydrogne like atom is excited using a radiation . Consequently, six spectral line are observed in the spectrum. The wavelegth of emission radiation is found to be equal or smaller than the radiation used for excitation. This concludes that the gas was initially at

A. Ground state

B. First excited state

C. Second excited state

D. Third excited state

Answer: C

Watch Video Solution

11. The time period of the electron in the ground state of hydrogen atom is two times the times period of the electon in the first excited state of a certain hydrongen like atom (Atomic number Z). The value of Z is

A. 2

B. 3

C. 4

D. None of these

Answer: C

Watch Video Solution

12. The wavelengths of K_α X-rays from lead isotopes Pb^{204}, Pb^{206} and Pb^{208} are λ_1, λ_2 and λ_3 respectively. Choose the correct alternative.

A. $\lambda_1 < \lambda_2 < \lambda_3$

B. $\lambda_1 > \lambda_2 > \lambda_3$

C. $\lambda_1 = \lambda_2 = \lambda_3$

D. None of these

Answer: C

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13. in cases of hydrogen atom, whenever a photon is emitted in the Balmer series, (a)there is a probability emitting another photon in the Lyman series

(b) there is a probability of emitting another photon of wavelength

1213Å

(c) the wavelength of radiaton emitted in Lyman series is always shorter then the wavelength emitted in the Balmer series

(d) All of the above.

A. there is a probability emitting another photon in the Lyman series

B. there is a probability of emitting another photon of wavelength 1213 Å

C. the wavelength of radiation emitted in Lyman series is always shorter then the wavelength emitted in the Balmer series

D. All of the above.

Answer: D

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14. An electron of kinetic enregy K collides elastically with a stationary hydrogen atom is the ground state. Then,

A. $K > 13.6eV$

B. $K > 10.2eV$

C. $K < 10.2eV$

D. data insufficient

Answer: C

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15. In a stationary hydrogen atom, an electron jumps from n = 3 ot n =1. The recoil speed of the hydrogen atom is about

A. $4m/s$

B. $4cm/s$

C. $4mm/s$

D. $4 \times 10^{-4}m/s$

Answer: A

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16. An X-ray tube is operating at 150 kV and 10 mA. If only 1% of the electric power supplied is converted into X-rays, the rate at which the target is heated in calories per second is

A. 3.55

B. 35.5

C. 355

D. 3550

Answer: C

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17. An electron revolves round a nucleus of atomic number Z. if 32.4 eV of energy is required to excite an electron from the n=3 state to n=4 state, then the value of Z is

A. 5

B. 6

C. 4

D. 7

Answer: D

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18. If the de-Broglie wavelength of a proton is 10^{-13} m, the electric potentia through which it must have been accelerated is

A. $4.07 \times 10^4 V$

B. $8.15 \times 10^4 V$

C. $8.15 \times 10^3 V$

D. $4.07 \times 10^5 V$

Answer: B

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19. If E_n and L_n denote the total energy and the angular momentum of an electron in the nth orbit of Bohr atom, then

A. $E_n \propto L_n$

B. $E_n \propto \frac{1}{L_n}$

C. $E_n \propto L_n^2$

D. $E_n \propto \frac{1}{L_n^2}$

Answer: D

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20. An orbital electron is the ground state of hydrogen has the magnetic moment μ_1. This orbital electron is excited to 3rd excited state by some energy transfer to the hydrogen atom. The new magnetic moment fo the electron is μ_2 then

A. $\mu_1 = 4\mu_2$

B. $2\mu_1 = \mu_2$

C. $16\mu_1 = \mu_2$

D. $4\mu_1 = \mu_2$

Answer: D

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21. A moving hydrogen atom makes a head on collision with a stationary hydrogen atom. Before collision both atoms are in in ground state and after collision they move together. What is the minimum value of the kinetic energy of the moving hydrogen atom, such that one of the atoms reaches one of the excited state?

A. $20.4eV$

B. $10.2eV$

C. $54.4eV$

D. $13.6eV$

Answer: A

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22. In an excited state of hydrogen like atom an electron has total energy of $-3.4eV$. If the kinetic energy of the electron is E and its de-Broglie wavelength is λ, then

A. $\lambda = 6.6\text{Å}$

B. $E = 3.4eV$

C. Both are correct

D. Both are wrong

Answer: C

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Level 2 More Than One Correct

1. If the potential difference of coolidge tube probucing X-ray is increased, then choose the corrent option (s).

Here, λ_0 is cut off wavelength and λ_{Ka} and $\lambda_{K\beta}$ are wavelengths of K_α and K_β characteristic X-rays.

A. the interval between $\lambda_{K\alpha}$ and $\lambda_{K\beta}$ increases

B. the interval between $\lambda_{K\alpha}$ and λ_0 increases

C. the interval between $\lambda_{K\beta}$ and λ_0 increases

D. λ_0 does not change

Answer: B::C

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2. In Bohr model of the hydrogen atom, let R,v and E represent the radius of the orbit, speed of the electron and the total energy respectively.

Which of the following quantities are directly proportional to the quantum number n?

A. vR

B. RE

C. v/E

D. R/E

Answer: A::C

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3. The magnitude of angular momentum, orbital radius and time period of revolution of an electron in a hydrogen atom corresponding to the quantum number n are L , r and T respectively. Which of the following statement (s) is/are correct?

A. $\frac{rL}{T}$ is independent of n

B. $\frac{L}{T} \propto \frac{1}{n^2}$

C. $\frac{T}{r} \propto n$

D. $Lr \propto \frac{1}{n^3}$

Answer: A::B::C

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

A. move with the same speed

B. move with the same linear momentum

C. move with the same kinetic energy

D. have the same change of potential energy in a conservative field

Answer: A::C

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5. Hydrogen atom absorbs radiations of wavelength λ_0 and consequently emit radiations of 6 different wavelengths, of which two wavelengths are longer than λ_0. Chosses the correct alternative(s).

A. The final excited staate of the atoms is n=4

B. The initial state of the atoms is n =2

C. The initial state of the atoms is n =3

D. There ae three transitions belonging to Lyman series

Answer: A::B::D

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6. In coolidge tube, if f and λ represent the frequency and wavelength of K_{α} -line for a metal of atomic number Z, then identify the statement which represents a straight line

A. $\sqrt{f versus Z}$

B. $\frac{1}{\sqrt{\lambda}} versus Z$

C. $f versus Z$

D. $\lambda versus Z$

Answer: A::B

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Level 2 Comprehension Based

1. When a surface is irradiated with light of wavelength $4950Å$, a photocurrent appears which vanishes if a retarding potential greater than 0.6 volt is applied across the phototube. When a second source of light is used, it is found that the critical potential is changed to 1.1 volt. The work- function of the emitting surface is i

A. $2.2eV$

B. $1.5eV$

C. $1.9 eV$

D. $1.1 eV$

Answer: C

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2. When a surface is irradiated with light of wavelength 4950Å, a photocurrent appears which vanishes if a retarding potential greater than 0.6 volt is applied across the phototube. When a second source of light is used, it is found that the critical potential is changed to 1.1 volt. The wavelength of the second source is

A. 6150Å

B. 5150Å

C. 4150Å

D. 4500Å

Answer: C

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3. When a surface is irradiated with light of wavelength 4950Å, a photocurrent appears which vanishes if a retarding potential greater than 0.6 volt is applied across the phototube. When a second source of light is used, it is found that the critical potential is changed to 1.1 volt.

if the photoelectrons (after emission form the source) are subjected to a magnetic field of 10 tesla, the two retarding potentials would

A. Uniformly increase

B. Uniformly decrease

C. remain the same

D. none of these

Answer: C

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Level 2 Passage 2

1. in an experimental set up to study the photoelectric effect a point soure fo light of power 3.2×10^{-3} W was taken. The source can emit monoenergetic photons of energy 5eV and is located at a distance of 0.8 m from the centre of a stationary metallic sphere of work-function 3.0 eV. The radius of the sphere is $r = 8. .10^{-3}$ m. The efficiency of photoelectric emission is one for every 10^6 incident photons. Based on the information given above answer the questions given below. (Assume that the sphere is isolated and photoelectrons are instantly swepts away after the emission).

de-Broglie wavelength of the fastest moving photoelectron is

A. 6.63Å

B. 8.69Å

C. 2Å

D. 5.26Å

Answer: B

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Level 2 Passage 3

1. in an experimental set up to study the photoelectric effect a point soure fo light of power 3.2×10^{-3} W was taken. The source can emit monoenergetic photons of energy 5eV and is located at a distance of 0.8 m from the centre of a stationary metallic sphere of work-function 3.0 eV. The radius of the sphere is $r = 8. .10^{-3}$ m. The efficiency of photoelectric emission is one for every 10^6 incident photons. Based on the information given above answer the questions given below. (Assume that the sphere is isolated and photoelectrons are instantly swepts away after the emission).

It was observed that after some time emission of photoelectrons from the sphere stopped. Charge on the sphere when the photon emission stops is

A. $16\pi\varepsilon_0^r$ coulomb

B. $8\pi\varepsilon_0^r$ coulomb

C. $15\pi\varepsilon_0^r$ coulomb

D. $20\pi\varepsilon_0^r$ coulomb

Answer: B

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Level 2 Passage 4

1. in an experimental set up to study the photoelectric effect a point soure fo light of power 3.2×10^{-3} W was taken. The source can emit monoenergetic photons of energy 5eV and is located at a distance of 0.8 m from the centre of a stationary metallic sphere of work-function 3.0 eV. The radius of the sphere is $r = 8. .10^{-3}$ m. The efficiency of photoelectric emission is one for every 10^6 incident photons. Based on the information given above answer the questions given below. (Assume that the sphere is isolated and photoelectrons are instantly swepts away after the emission).

Time after which photoelectric emission stops is

A. 100s

B. 121s

C. 111s

D. 141s

Answer: C

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Level 2 Subjective

1. The wavelength for n=3 to n=2 transition of the hydrogen atom is 656.3 nm. What are the wavelength for this same transition in (a) positronium, which consists of an electron and a positron (b) singly ionized helium

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2. (a) Find the frequencies of revolution of electrons in n = 1 and n=2 Bohr orbits.

(b)What is the frequency of the photon emitted when an electron in an n=2 orbit drops to an n=1 hydrogen orbit?

(c)An electron typically spends about $10^{-8} s \in anexcitedstatebef$ or $eitdrops \to alowerstatebyemie \in gapho$

100xx10^(-8)` s?.

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3. A muan is an unstable elementary partical whose mass (μ^{-}) can be captured by a hydrogen nucleus (or proton) to from a muonic atom.

a Find the redius of the first Bohr orbit of this atom.

b Find the ionization energy of the atom.

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4. (a) A gas of hydrogen atoms is their ground state is bombarded by electrons with kinetic energy 12.5 ev. What emitted wavelengths would you expect to see?

(b) What if the electrons were replaced by photons of same anergy?.

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5. A source emits monochromatic light of frequency 5.5×10^{14} Hzat a rate of 0.1 W. Of the photons given out, 0.15% fall on the cathode of a photocell which gives a current of $6\mu A$ in an extrnal circuit.

(a) Find the enrgy of a photon.

(b) Find the number of photons leaving the source per second.

(C) Find the percentage of the photons falling on the cathode which produce photoelectrons.

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6. The hydrogen atom in its ground state is excited by means of monochromatic radiation. Its resulting spectrum has six different lines. These radiations are incident on a metal plate. It is observed that only two of them are responsible for photoelectric effect. if the ratio of maximum kinetic energy of photoelectrons is the two cases is 5 then find the work function of the metal.

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7. Electrons in hydrogen like atom $(Z = 3)$ make transition from the fifth to the fourth orbit and from the third orbit. The resulting radiation are incident normally on a metal plate and eject photoelectrons. The stopping potential for the photoelectrons ejected by the shorter wavelength is 3.95 volts. Calculate the work function of the metal and the stopping potential for the photoelectron ejected by longer wavelength (Rydberg constant $= 1.094 \times 10^7 m^{-1}$

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8. Find an expression fot the magneitc dipole moment and magnetic field induction at the centre of Bohr'r hypothetical hydrogen atom in the n th orbit of the electron in terms of universal constant.

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9. An electron and a proton are seperated by a large distance and the electorn approaches the proton with a kinectic energy of 2 eV. If the electron is captured by the proton to form a hydrogen atom in the ground state, what wavelength photon would be given off?

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10. Hydrogen gas in the atomic state is excited to an energy level such tht the electrostatic potential energy of H-atom becomes $-1.7eV$. Now, a photoelectric plate having work function w=2.3 eV is exposed to the emission spectra of this gas. Assuming all the transitions to be possible, find the minimum de-Broglie wavelength of the ejected photoelectrons.

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11. A gas of hydrogen - like atoms can absorb radiations of $698 eV$. Consequently , the atoms emit radiation of only three different wavelengths . All the wavelengthsare equal to or smaller than that of the absorbed photon.

a Determine the initial state of the gas atoms.

b Identify the gas atoms

c Find the minimum wavelength of the emitted radiation ,

d Find the ionization energy and the respective wavelength for the gas atoms.

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12. A photon with energy of 4.9 eV ejects photoelectrons from tungsten. When the ejcect phototelectrons from tungsten. When the ejected electron enters a cnstant magnetic field of strength B=2.5 mT at an angle of 60° with the field direction, the maximum pitch fo the helix described by the electron is found to be 2.7 mm. Find the work function of the metal in electron volt. Given that specific charge of electron is `1.76xx10^11 C/kg.

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13. For a certain hypothetical one electron atom, the wavelength $\left(\in \text{Å}\right)$ for the spectral lines for transitions originating at n=p and terminating at n=1 are given by $\lambda = \frac{1500p^2}{p^2 - 1}, wherep = 2, 3, 4$

(a)Find the wavelength of the least energetic and the most energetic photons in this series.

(b) Construct an energy level diagram for this element showing the energies of the lowest three levels.

(c) What is the ionization potential fo this elelment?

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14. A photocell is operating in saturation mode with a photocurrent 4.8 mA when a monochromatic radiation of wavelength $3000\text{Å}$and power of

1wM is incident. When another monochromatic radiation of wavelength 1650Å and power 5wM is indcident, it is observed that maximum velocity of photoelectron increases to two times. Assuming efficiency of photoelectron generation per incident photon to be same for both the cases, calculate.

(a) the threshold wavelength for the cell

(b) the saturation current in second case

(c) the efficiency of photoelectron generation per incident photon.

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15. The photons from the Balmer series in Hydrogen spectrum having wavelength between $450nm$ to $700nm$ are incident on a metal surface of work function $2eV$ Find the maximum kinetic energy of ejected electron (Given hc = 1242 eV nm)`

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16. Assume that the de Broglie wave associated with an electron can from a standing wave between the atom arrange in a one dimensional array with nodes at each of the atomic sites. It is found that one such standing wave if the distance d between the atoms of the array is $2A^0$ A similar standing wave is again formed if d is increased to 2.5Å . Find the energy of the electrons in electron volts and the least value of d for which the standing wave type described above can from .

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17. The nagative muon has charge equal to that of an electron but a mass that is 207 times as great. Consider hydrogen like atom consisting of a proton and a muon.

(a) What is the reduced mass of the atom?

(b) What is the ground-level energy (in eV)?

(c) What is the wavelength of the radiation emitted in the transiton from the n=2 level to the n=1 level?

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18. Assume a hypothetica hydrogen atom in which the potential energy between electron and proton at separation r is given by $U = \left[k \in r - \left(\frac{k}{2}\right)\right]$, where k is a constant. For such a hypothetical hydrogen atom, calcualete the radius of nth Bohr orbit and energy levels.

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19. An electron is orbiting is a circular orbit of radius r under the influence of a constant magnetic field of strength B. Assuming that Bohr postulate regarding the quantisation of angular momentum holds good for this elerctron, find

(a) the allowed values of te radius r of the orbit.

(b) the kinetic energy of the electron in orbit

(c) the potential energy of insteraction between the magnetic moment of the orbital current due to the electron moving in its orbit and the magnetic field B.

(d) the total energy of the allowed energy levels.

(e) the total magnetic flux due to the magnetic field B passing through the nth orbit. (Assume that the charge on the electronis -e and the mass of the electron is m).

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20. A mixture of hydrogen atoms (in their ground state) and hydrogen like ions (in their first excited state) are being excited by electrons which have been accelerated by same potential of emitted light are found in the ratio 5:1. Then, find

(a) the minimum value of V for which both the atoms get excited after collision with electrons.

(b) atomic number of other ion.

(c) the energy of emitted light.

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21. When a surface is irradiated with light of wavelength 4950Å, a photocurrent appears which vanishes if a retarding potential greater than 0.6 volt is applied across the phototube. When a second source of light is used, it is found that the critical potential is changed to 1.1 volt. if the photoelectrons (after emission form the source) are subjected to a magnetic field of 10 tesla, the two retarding potentials would

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

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23. A light beam of wavelength 400 nm is incident on a metal of work-function 2.2 eV. A particular electron absorbs a photon and makes 2 collisions before coming out of the metal

(a) Assuming that 10% of existing energy is lost to the metal in each collision find the final kinetic energy of this electron as it comes out of the metal.

(b) Under the same assumptions find the maximum number of collisions, the electron should suffer before it becomes unable to come out of the metal.

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