PHYSICS

BOOKS - CENGAGE PHYSICS (ENGLISH)

ATOMIC PHYSICS

Illustration

1. An electron in a hydrogen atom makes a trsnsition $n_1 \rightarrow n_2$ where n_1 and n_2 are principal quantum numbers of the two states. Assume the Bohr model to be valid. The time period of the electron in the initial

state is eight times that in the final state. The possible values of n_1 and n_2 are

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2. How many time does the electron go round the first bohr orbit of hydrogen atoms in $1s$?

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3. What is the angular momentem of an electron in Bohr's hydrogen atom whose energy is $-3.5eV$?

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4. If the average life time of an excited state of hydrogen is of the order of $10^{-8}s$, estimate how many rotations an electron makes when it is in the state $n = 2$ and before it suffers a transition to state $n = 1(Bohrradiusa_0 = 5.3 \times 10^{-11}m)$?

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5. Consider energy level diagram of a hydrogen atom.How will the kinetc energy and potential energy of electron moves from a lower level to a higher level?

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6. Soppose potential energy between electronand proton at seperation r is given by $U = k \log r, wherek$ is a constant. For such a hypothetical hydrogen atom , calculate the radins of nth Bohr and its energy level

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7. Determine the minimum wavelength of a photon the can cause ionization of He ^(+) ion.

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8. Find the quantum number n corresponding to the excited state of He^(+) ion if on transition to the ground state that ion emits two photons in succession with wavelengths state that ion emits two photons in succession with wavelengths 1026.7 and $304 Å$. $(R = 1.096 \times 10^7 m^{-1}$

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9. A gas of hydrogen like atoms can absorb radiation of 68 eV. Consequently, the atom emits radiations of only three different wavelengths. All the wavelengths are equal 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 radiations.

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

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10. Find the ratio of ionization energy of bohr 's hydrogen atom doubly liothium ion (Li^2)

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11. The Bohr moden does not apply when more than one electron orbit the nucleues because it does not account for the electrostatic force that the electron exert on one another.For instance , an electrically neutral lithium atom (Li) contains three electrons in orbit around a nucleus that includes three protons $(Z = 3)$, and Bohr's model can be used for the doubly charged positive ion of lithium $\left(Li^2 \hat{} (+)\right)$ that results when two electrons are removed from the neutral atom, leaving only one electron to orbit the nucleus . Obtain the ionization energy that is needed to remove the remaining electron from $\left(Li^2 \hat{} (+)\right)$

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12. 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 level diagram.

(b) What is the first excitation potential

(c) What wavelength (Å) can be emitted when these atoms in the ground state are bombarded by electrons that have been accelerated through a potential difference of 16.2 V?

(d) If these atoms are in the ground state, can they absorb radiation having a wavelength of 2000 Å ?

(e) what is the photoelectric threshold wavelength of this atom?

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13. 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 the first to the third Bohr orbit (ionization energy of the hydrogen atom equals 13.6 eV).

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14. A single electron orbit around a stationary nucleus of charge $+Ze$ where Z is a constant and e is the magnitude of the electronic charge. It requires$47.2eV$ to excite the electron from the second bohr orbit to the third bohr orbit. Find

(i) The value of Z

(ii) The energy required by nucleus to excite the electron from the third to the fourth bohr orbit

(iii) The wavelength of the electronmagnetic radiation required to remove the electron from the first bohr orbit to inlinity

(iv) The energy potential energy potential energy and the angular momentum of the electron in the first bohr orbit

(v) The radius of the first bohr orbit (The ionization energy of hydrogen atom $= 13.6eV$ bohr radius $= 5.3 \times 10^{-11} matre$ velocity of light $= 3 \times 10^{8} m / \sec$ planks 's constant $= 6.6 \times 10^{-34}$ jules - sec)

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15. In atension of state n from a state of excitation energy given is $10.19eV$, hydrogen atom emits a photon with wavelength 4890Å . Determine the binding energy of the initial state.

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16. The first excitation potential of a hypothetical hydrogen- like atom is $15V$. Find the third excitation potential of the atom.

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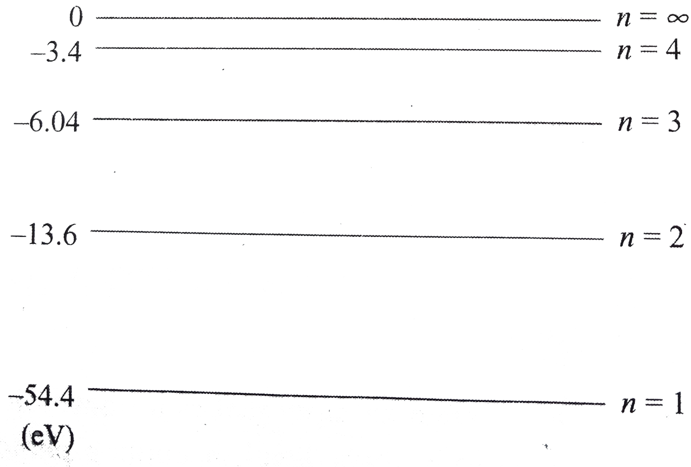
17. The energy level excitation potential of a hydrogen - like atom is shown in Figure



a Find the value of Z

b If initially the atom is in the ground state ,then

(i) determine its excitation potential, and

m (ii) determine its ionization potential.

c Can it absorbe a photom of $42eV$?

d Can it absorbe a photom of $56eV$?

e Calculate the radius of its first Bohr orbit.

f Calculate the kinectic and potential energy of an electron in the first orbit.

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18. Brackett series of lines are producted when electrons excited t high energy level make transitions to the $n = 4$ level.

a Determine the longest wavelength in this series.

b Determine the wavelength that corresponds to the transition from $n_f = 6 \rightarrow n_i = 4$.

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19. Electrons of energy $12.09eV$ can excite hydrogen atoms . To which orbit is the electron in the hydrogen atom raisd and what are the wavelengths of the radiations emitted as it dropes back to the ground state?

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20. A hydrogen atom is in the third excited state. It make a transition to a different state and a photon is either obsorbed or emitted. Determine the quantum number n of the final state and the energy energy of the photon If it is

a emitted with the shortest possible wavelength.

b emitted with the longest possible wavelength and

c absorbed with the longest possible wavelength.

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21. The Bamber series for the hydrogen atom corresponds to electron that terminal in the state of quantum number $n = 2$.

a Find the longest wavelength photon emitted and determine its energy.

b Find the shortest wavelength photon emitted in the balmer series.

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22. How many different wavelengths may be observed in the spectrum from a hydrogen sample if the atoms excited to states with principal quantum number n?

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23. A positronium "atom" is a system that consists of a positron and an electron that orbit each other. Campare the wavelengths of the spectral lines of positronium with those of ordinary hydrogen.

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24. A μon is an unstable elementary particle whose mass is $207m_e$ and whose charge is $either^+e$ or $-_e$. A negative muon $(\mu - 1)$ can be captured by a nucleus to form a muonic atom.

(a) A proton captures a μ^-. Find the radius of the first

Bohr orbit of this atom.

(b) Find the ionization energy of the atom.

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25. A particle known as mu meson has a charge equal to that of no electron and mass 208times the mass of the electron B moves in a circular orbit around a nucleus of charge $+3e$ Take the mass of the nucleus to be infinite Assuming that the bohr's model is applicable to this system (a)drive an expression for the radius of the nth Bohr orbit (b) find the value of a for which the radius of the orbit it appropriately the same as that at the first bohr for a hydrogen atom (c) find the wavelength of the radiation emitted when the u - mean jump from the orbit to the first orbit

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26. A neutron which is going to collde head on to a stationary H atom has intial kinetic energy of $24.5 eV$. Discuss different possibilites of collsion.

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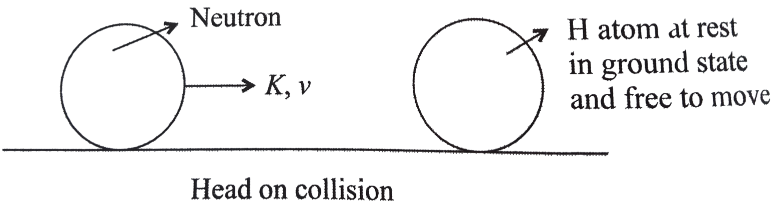
27. In the figure , what type of collision can be possible , if `K = 14 eV, 20.4 eV,22 eV, 24.18 eV,(elastic // inelastic //

perfectly inelastic).



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28. A He^{+} ion is at rest and is in ground state. A necutron with intial kinetic energy$K$ collides heads on with the He^{+} ion. Find minimum value of K so that there can be an inelastic collision between these two particals.

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29. In the previous question , find minimum value of K so that all types of collisions are piossible.

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30. A He^{+} ion is at rest and is in ground state. A necutron with intial kinetic energy K collides heads on with the He^{+} ion. Find minimum value of K so that there can be an inelastic collision between these two particals.

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31. 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. The minimum value of the kinetic energy of the moving hydrogen atom, such that one of the atoms reaches one of the excitation state is

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32. A neutron with an energy of $4.6 MeV$ collides elastically with proton and is retarded. Assuming that upon each collision the neutron is deflected by 45°, find the number of collisions which will reduce its energy to $0.23 eV$.

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33. Explain why nearly all H atoms are in the ground state at room temperature and hence emit no light.

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34. Consider a hydrogen-like atom whose energy in nth excited state is given by

$$E_n = -\frac{13.6Z^2}{n^2}$$

When this excited makes a transition from excited state to ground state , most energetic photons have energy

$E_{\max} = 52.224eV$. and least energetic photons have energy

$E_{\min} = 1.224eV$

Find the atomic number of atom and the initial state or excitation.

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35. A gas of identical hydrogen-like atoms has some atoms in the lowest in lower (ground) energy level A and some atoms in a partical upper (excited) energy level B and there are no atoms in any other energy level.The atoms of the gas make transition to higher energy level by absorbing monochromatic light of photon energy $2.7eV$.

Subsequenty , the atom emit radiation of only six different photon energies. Some of the emitted photons have energy $2.7eV$ some have energy more , and some have less than $2.7eV$.

a Find the principal quantum number of the intially excited level B

b Find the ionization energy for the gas atoms.

c Find the maximum and the minimum energies of the emitted photons.

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36. A hydrogen like atom (atomic number Z) is in a higher excited state of quantum number n. The excited atom can make a transition to 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, respectively Determine the values of n and Z. (Ionization energy of H-atom = 13.6 eV)

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37. Electrons in hydrogen like atoms (Z = 3) make transitions form the fifth to the fourth orbit and from the fourth to the third orbit. The resulting radiations are incident normally on a metal plate and eject photoelectrons. The stopping potential for the metal and the stopping potential for the photoelectrons ejected by the longer wavelength.

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38. The radiation emitted when an electron jumps from $n = 3$ to $n = 2$ orbit of hydrogen atom falls on a metal to produce photoelectrons. The electrons emitted from the metal surface with maximum kinetic energy are made to move perpendicular to a magnetic field of $\frac{1}{320}$ T is a radius of $10^{-3}m$. Find:

A. the kinetic energy of the electrons,

B. work function of metal, and

C. wavelength of radiation.

(Planck's constant $h = 6.62 \times 10^{-32} J - s$)

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39. An X-ray tube operates at 20 kV. A particular electron loses 5% of its kinetic energy to emit an X-ray photon at the first collision. Find the wavelength corresponding to this photon.

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40. An X-ray tube operates at $20kV$. Find the maximum speed of the electron strinking the anode , given the charge of electron is 1.6×10^{-19} coulomb and mass of electron is $9 \times 10^{-31} kg$.

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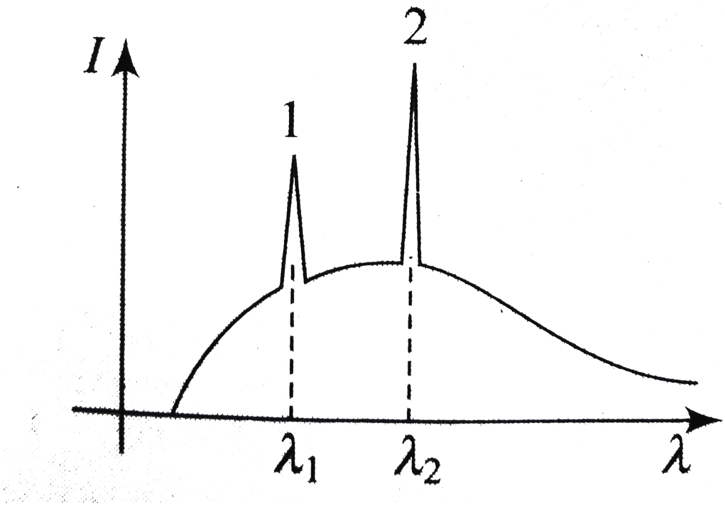
41. A voltage applied to an X-ray tube being increased $\eta = 1.5$ times, the short wave limit of an x-ray continuous spectrum shifts by $\Delta\lambda = 26$pm. Find the initial voltage applied to the tube.

42. In figure find which is K_a and K_β



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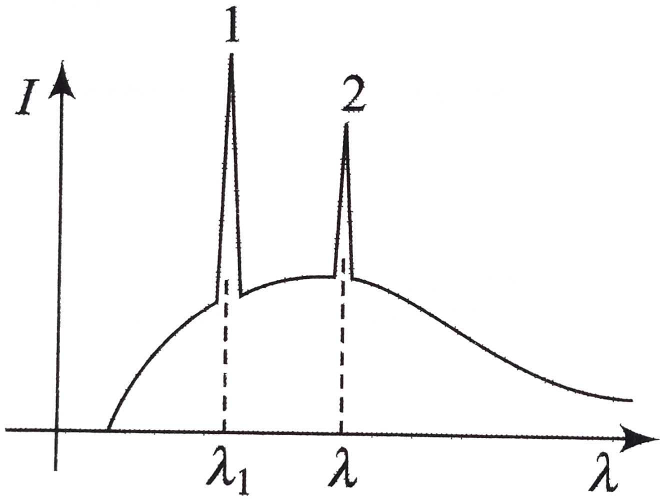
43. In figure find which is K_a and L_α'



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44. The K_α X-ray emission line of tungsten occurs at $\lambda = 0.02nm$. The energy difference between K and L level in this atom is about

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45. When 0.50 Å X-ray strike a material , the photoelectron from the K shell are observed to move in a circle of radius $2.3nm$ in a magnetic field of 2×10^{-2} tesle acting perpendicular to direct of emission of photoelectron . What is the binding elergy of $k - shell$ electron?

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46. If the K_{α} radiation of $Mo(Z = 42)$ has a wevelength of 0.71Å, calculate wevelength of the corresponding radiation of $Cu, i.e., k_{\alpha}f$ or $Cu(Z = 29)$ assuming b = 1.

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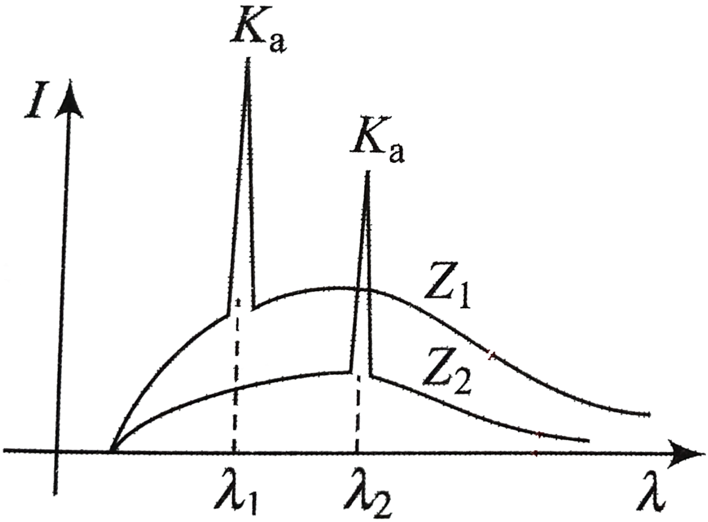
47. Compare Z_1 and Z_2



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48. A cobalt target $(Z = 27)$ is bomberded with electron and the wavelength of its characteristic

spectrum are measured . A second , fainter characcteristic spectrum is also found because of an impurity in the target. The wevelength of the K_{α} lines are 178.9 pm (cobalt) and $143.5 \pm$ (impurity). What is the impurity?

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49. An X-ray tube with a copper target is found to be emiting lines other than those due to copper. The K_{α} line of coper is known to have a wavelength 1.5405Å and the other two K_{α} lines observed have wavelengths 0.7090Å and 1.6578Å Identify the impurities.

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50. The K-absorption edge of an unknown element is

0.171Å

a. Identify the element.

b. Find the average wavelength of the $K_{\alpha}, K_{\alpha}, K_{\beta}, K_{\gamma}$

lines.

c.

If a $100eV$ electron strikes the target of this element ,

what is the minimum wavelength of the x-ray emitted?

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Solved Examples

1. Ultraviolet light of wavelength $800A$ and $700A$ when allowed to fall on hydrogen atoms in their ground states is found to liberate electrons with kinetic energies $1.8eV$ and $4.0eV$, respectively. Find the value of Planck's constant.

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2. A single electron orbit around a stationary nucleus of charge $+Ze$ where Z is a constant and e is the magnitude of the electronic charge. It requires$47.2eV$ to excite the electron from the second bohr orbit to the third bohr orbit. Find

(i) The value of Z

(ii) The energy required by nucleus to excite the electron from the third to the fourth bohr orbit

(iii) The wavelength of the electronmagnetic radiation required to remove the electron from the first bohr orbit to inlinity

(iv) The energy potential energy potential energy and the angular momentum of the electron in the first bohr orbit

(v) The radius of the first bohr orbit (The ionization energy of hydrogen atom $= 13.6 eV$ bohr radius $= 5.3 \times 10^{-11} matre$ velocity of light $= 3 \times 10^{8} m / \sec$ planks 's constant $= 6.6 \times 10^{-34}$ jules - sec)

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3. The ionization energy of a hydrogen like bohr atom is 4 Rydbergs (i) What is the wavelength of the radiation emitted when the electron jumps from the first excited state to the ground state ?(ii) what is the radius of the orbit for this atom ?

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4. (a)Find the wavelength of the radiation required to excited the electron is Li^{++} from the first to the third Bohr orbit (b) How many spectral lines are obseved in the emission spactrum of the above excited system?

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5. The energy of an electron in an excited hydrogen atom is $-3.4eV$. Calculate the angular momentum . Given : Rydbrg's $R = 1.09737 \times 10^{-7} m^{-1}$. Plank's constant $h = 6.626176 \times 10^{-34} J - s$, speed of light`c = 3 xx 10^(8) m s^(-1).

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6. Light of wavlength of $2000A$ falls on an aluminimum surface. In aluminium, $4.2eV$ are required to remove an electron from its surface. What is the kinetic energy, in electron volt, of (a) the fastest, and (b) the slowest emitted photo-electrons. © What is the stopping potential? (Planck's constant $h = 6.6 \times 10^{-34} Js$, and speed of light $c = 3 \times 10^{8} ms^{-1}$)

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7. Find the frequency of light which ejects electrons from a metal surface. Fully stopped by a retarding potential of $3V$, the photoelectric effect begins in this metal at a frequency of $6 \times 10^{14} Hz$. Find the work function for this metal. (Given $h = 6.63 \times 10^{-34} Js$).

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

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9. Hydrogen atom is ground state is excited by mean of monochromatic radiation of wavelength 975Å How many different lines are possible in the resulting spectrum ? Calculate the longest wavelength for hydrogen atom as ionization energy is $13.6eV$

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10. A gas of identical hydrogen-like atoms has some atoms in the lowest in lower (ground) energy level A and some atoms in a partical upper (excited) energy level B and there are no atoms in any other energy level.The atoms of the gas make transition to higher energy level by absorbing monochromatic light of photon energy $2.7eV$.

Subsequenty , the atom emit radiation of only six different photon energies. Some of the emitted photons have energy $2.7eV$ some have energy more , and some have less than $2.7eV$.

a Find the principal quantum number of the intially excited level B

b Find the ionization energy for the gas atoms.

c Find the maximum and the minimum energies of the emitted photons.

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11. The wavelength of the characteristic X - ray k_{α} line emitted by a hydrogens like element is 0.32λ . The wavelength of the K_{β} line emitted by the same element will be .....

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12. 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 quantum 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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13. Two hydrogen-like atoms A and B are of different masses and each atom contains equal numbers of protons and neutrons. The difference in the energies between the first Balmer lines emitted by A and B, is $5.667eV$. When atom atoms A and B moving with the same velocity , strike a heavy target , they rebound with the same velocity in the process, atom B imparts twice the momentum to the target than that A imparts. Identify the atom A and B.

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

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

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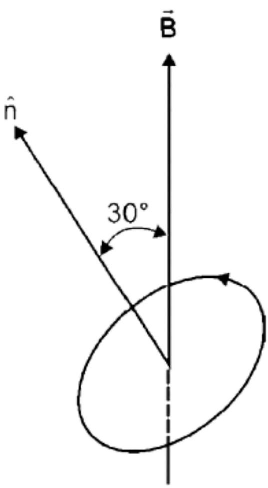
15. An electron in the ground state of hydrogen atom is revolving in anticlock-wise direction in a circular orbit of radius R.

(i) Obtain an experssion for the orbital magnetic dipole moment of the electron.

(ii) The atom is placed in a uniform magnetic induction $\vec{B}$ such that the plane - normal of the electron - orbit makes an angle of 30° with the magnetic induction . Find the torque experienced by the orbiting electron.



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16. The radiation emitted when an electron jumps from $n = 3$ to $n = 2$ orbit of hydrogen atom falls on a metal to produce photoelectrons. The electrons emitted from the metal surface with maximum kinetic energy are made to move perpendicular to a magnetic field of $\frac{1}{320}$ T is a radius of $10^{-3} m$. Find:

A. the kinetic energy of the electrons,

B. work function of metal, and

C. wavelength of radiation.

(Planck's constant $h = 6.62 \times 10^{-32} J - s$)

17. 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.

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18. Assume that the de-Broglie were associated with an electron can form a standing wave between the atoms arranged in a one dimensional array with nodes at each of the atomic sites. It is found that one such standing wave is formed if the distance d between the atoms of the array is 2Å. A similar standing wave is again formed if d is increased to 2.5Å but not for any intermediate value of d. Find the energy of the electron in eV and the least value of d for which the standing wave of the type described above can form.

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19. A gas of hydrogen like ions is prepared in such a way that ions are only in the ground state and the first excited state. A monochromatic light of wavelength 1216 Å is absorbed by the ions. The ions are lifted to higher excited states and emit radiations of six wavelengths. Find the principal quantum number of the final excited state.

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20. Photoelectrons are emitted when $400nm$ radiation is incident on a surface of work - function 1.9 eV. These photoelectrons pass through a region containing α-particles. A maximum energy electron combines with an α -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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21. When a beam of 10.6 eV photons of intensity 2.0 W/m^2 falls on a platinum surface of area $1.0 \times 10^{-4} m^2$ and photons eject photoelectrons. Find the number of photoelectrons emitted per second

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22. An electron in hydrogen-like atom makes a transition from nth orbit or emits radiation corresponding to Lyman series. If de Broglie wavelength of electron in nth orbit is equal to the wavelength of rediation emitted , find the value of n . The atomic number of atomis 11.

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23. An X-ray tube operated at $40kV$ emits a continous X-ray spectrum with a short wavelength limit $\lambda_{\min} = 0.310Å$. Calculate Plank's constant.

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Exercise 4.1

1. State the Following statement as statements as TRUE and FALSE.

a. The redius of nth Bohr is proporitional to n^2.

b. The total energy of electron in the nth orbit is inversely proporitional to n^2.

c. The time period revolution of electron in the nth orbit is directly proporitional to n^2.

d. The kinetic energy of electron is double of its potential energy with a negative sign.

e. Velocity of electron in an atom is independent of its mass.

f. Only balmer series of hydrogen atom lines in the visible range.

g. The angular momentum of an electron revolving in the first orbit of hydrogen is equal to that in first orbit of helium.

h. The binding energy of decuterium atom is more than that of hydrogen atom.

i Lyman series of hydrogen atom lines in the infrared region.

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2. Transition between three energy energy levels in a particular atom give rise to three Spectral line of wevelength , in increasing magnitudes. λ_1, λ_2 and λ_3. Which one of the following equations correctly ralates λ_1, λ_2 and λ_3?

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3. A hydrogen atom in a having a binding of $0.85eV$ makes transition to a state with excited energy $10.2eV$ (a) identify the quantum number n of theupper and the lower energy state involved in the transition (b) Find the wavelength of the emitted radiation

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4. Calculate (a) the wavelength and (b) the frequencey of the $H\beta$ line of the Balmer series for hydrogen.

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5. Find the longest and shortest wavelengths in the Lyman series for hydrogen. In what region of the electromagnetic spectrum does each series lie?

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6. 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^{+}.

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7. 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 radius of nth allowed orbit.

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8. An imaginary particle has a charge equal to that of an electron and mass 100 times the mass of the electron. It moves in a circular orbit around a nucleus of charge + $4e$. Take the mass of the nucleus to be infinite. Assuming that the Bhor model is applicable to this system. (a)Derive an expression for the radius of n^{th} 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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9. Hydrogen gas in the atomic state is excited to an energy level such that 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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10. Taking into account the motion of the nucleus of a hydrogen atom , find the expressions for the electron's binding energy in the ground state and for the Rydberg constant. How much (in percent) do the binding energy and the Rydberg constant , obtained without taking into account corresponding values of these of these quantities?

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11. An electron having energy $20eV$ collides with a hydrogen atom in the ground state. As a result of the colllision , the atom is excite to a higher energy state and the electron is scattered with reduced velocity. The atom subsequentily returns to its ground state with emission of rediation of wavelength $1.216 \times 10^{-7} m$. Find the velocity of the scattered electron.

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12. According to classical physics, an electron in periodic motion with emit electromagnetic radiation with the same frequency as that of its revolution. Compute this value for hydrogen atom in nth quantum theory permit emission of such photons due to transition between adjoining orbits ? Discuss the result obtained.

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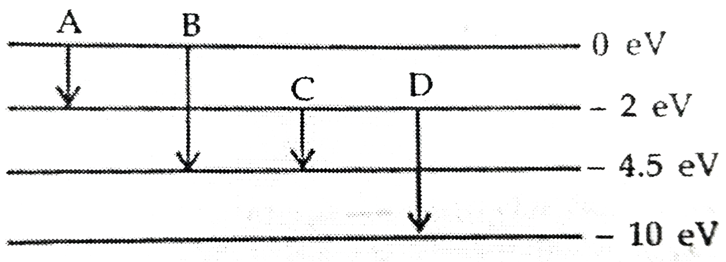
13. (a) The enegy levels of an atom are as shown below.

Which of them will result in the transition of a photon

of wavelength 275 nm ?



(b) Which transition corresponds to emission of

radiation of maximum wavelength ?

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14. The ground state energy of hydrogen atom is -13.6

eV.

(i) What is the kinetic energy of an electron in the 2^{nd}

excited state ?

(ii) If the electron jumps to the ground state from the 2^{nd} excited state, calculate the wavelength of the spectral line emitted.

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15. Suppose that means were available for stripping 28 electrons from $\_29Cu$ in vapour of this metel.

a. Compute the first three energy level for the remaining electron.

b. Find the wavelength of the spectral line of the series for which $n_1 = 1, n_2 = 3, 4$. What is the ionization potential for the last electron?

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Exercise 4.2

1. state True or False for the given statement a. X-ray are electromagnetic waves because these are producted by the deceleration of fast moving electron .

b. X-ray are electromagnetic waves because these produce line spectrum.

c. the cut-off wavelength depends on the target material .

d. The intensity of K_{α} transition is more probable then of K_{β}

transition.

e. Frequency of K_{α} radiation is more than that of K_{β}.

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2. Find the cut off wavelength for the continuous X - rays coming

from an X-ray tube operating at 40 kV.

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3. Calculate the wavelength of K_{α} line for the target made of tungsten $(Z = 74)$.

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4. Obtain a relation between the frequencies of K_{α}, K_{β} and L_{α} line for a target metrial .

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5. An X-ray tube operates at $20kV$. Find the maximum speed of the electron strinking the anode , given the charge of electron is 1.6×10^{-19} coulomb and mass of electron is $9 \times 10^{-31}kg$.

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6. (a) An X-ray tube produces a continuous spectrum of radiation with its shorts wavelength end ate0.45Å. What is the maximum energy of the photon in the radiation? (b) From your answer to (a) , guess what order of accelerating voltage (for electrons) is required in such a tube?

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7. The wavelength of the characteristic X-ray K_α line emitted from Zine $(Z = 30) is 1.415 \text{Å}$. Find the wavelength of the K_α line emitted from molybdenum $Z = 42)$.

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8. If the shorts series limit of the balmer series for hydrogen is 3644Å, find the atomic number of the element which gives X-ray wavelength down to 1Å. Identify the element.

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9. A material whose K -absorption edge is 0.2Å is irradiated by X-ray of wavelength 0.15Å , find the maximum energy of the photoelectrons that are emitted from the K shell.

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10. Calculate the wavelength of the emitted characteristic X-ray from a tungsten $(Z = 74)$ target when an electrons drops from an M shell to a vacancy in the shell.

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11. A potential diffrence , the $20kv$ is applied across an X-ray s tube . The minimum wavelength of x- ray generated is ....$\AA$.

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12. The wavlength of K_{α}, X-rays produced by an X-ray tube 0.76Å . The atomic number of the anode material of the tube is

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Subject

1. The peak emission from a black body at a certain temprature occurs at a wavelength of 9000Å. On increase its temperature , the total radiation emmited is increased its 81 times. At the intial temperature when the peak radiation from the black body is incident on a metal surface , it does not cause any photoemission from the surface . After the increase of temperature, the peak from the black body caused photoemission. To bring these photoelectrons to rest , a potential equivalent to the excitation energy between $n = 2$ and $n = 3$ bohr levels of hydrogen atoms is required. Find the work function of the metal.

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2. In a hydrogen-like atom , an electron is orbating in an orbit having quantum number n. Its frequency of revolution is found to be 13.2×10^{15} Hz. Energy required to move this electron from the atom to the above orbit is $54.4 eV$. In a time of ? nano second the electron jumps back to orbit having quantum number

$n/2$.If τ be the average torque acted on the electron during the above process, then find $\tau \times 10^{27}$ in Nm. (given: $h/\lambda = 2.1 \times 10^{-34} J - s$, friquency of revolution of electron in the ground state of H atom $v_0 = 6.6 \times 10^{15}$ and ionization energy of H atom $(E_0 = 13.6 eV)$

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3. 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 quantization of angular momentum holds good for this electron, 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 interaction 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 electron is -e and the mass of the electron is m).

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4. A hydrogen-like gas is kept in a chamber having a slit of width $d = 0.01 mm$. The atom of the gas are continuously excited to a certain energy state . The excite electron make transition to lower levels , From the initial excite state to the second excited state and then from the second excited state ground state. In the process of deexcitation, photons are emitted and come out of the container through a slit. The intensity of the photons is observed on a screen placed parallel to the plane of the slit . The ratio of the angular width of the central maximum corresponding to the two transition is $25/2$. The angular width of the central maximum due to first transition is 6.4×10^{-2} radian. Find the atomic number of the gas and the principal quantum number of the inital excited state.

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5. A gas containining hydrogen-like ions, with atomic number Z, emits photons in transition $n+2 \rightarrow n, wheren = Z$ These photons fall on a metallic plate and eject electrons having minimum de Broglie wavelength $\lambda of 5 \text{Å}$. Find the value of Z , if the work function of metal is $4.2 eV$

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6. A hydrogen atom $\left(mass = 1.66 \times 10^{-27}\right.$ kg) ionzation potential = 13.6eV), moving with a velocity $\left(6.24 \times 10^{4} ms^{-1}\right.$ makes a completely inelastic head-on collision with another stationary hydrogen atom. Both atoms are in the ground state before collision . Up to what state either one atom may be excited?

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7. Radiation from hydrogen gas excited to first excited state is used for illuminating certain photoelectric plate . When the radiation from same unknown hydrogen-like gas excited to the same level is used to expose the same plate , it is found that the de Broglie wavelength of the fastest photoelectron has decreased $2.3 time$gt It is given that the energy corresponding to the longest wavelength of the Lyman series of the known gas is 3 times the ionization energy of the hydrogen gas

$(13.6eV)$. Find the work function of photoelectric plate in eV. $\left[Take(2.3)^2 = 5.25\right]$

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8. 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 energies of the first four levels of x.

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9. When the voltage applied to an X-ray tube is increased from $V_1 = 10$ kV to $V_2 = 20$ kV, the wavelength difference between limit of the continous X-ray spectrum increases by a factor 3 The atomic number of the element of which the tube anticathode is made will be (30-x), Find Value of x.

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10. X-ray are emitted by a tube containing the electron gt Noibum $(Z = 41)$ as anticathode and the K_{α} X-ray an allowed to be incident on an unknown gas containing hydrogen- like atom ions. It is found that the X-ray cause the emission of photoelectrons with an energy of $2.7keV$ from these ions. Find

a. the minimum voltage at which the X-ray tube should be opreated so that the momentum of the emitted photoelectrons is doubled.

b. the approximate value of Z for the target of the anticathode after the momentum has been doubled.

c. the approximate value of Z the atomic number of the atom of the gas.

d. the number of the ion produced in the gas caused by X-ray , if the inetensity of X-ray is $100mWm^{-2}$ and 1% of the X-rays cause ionization.

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11. Electrons of energy $12.09eV$ can excite hydrogen atoms . To which orbit is the electron in the hydrogen atom raisd and what are the wavelengths of the radiations emitted as it dropes back to the ground state?

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12. If the shorts series limit of the balmer series for hydrogen is 3644Å, find the atomic number of the element which gives X-ray wavelength down to 1Å. Identify the element.

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13. The positronium consisting of an electron and a positron corresponding binding energy and wavelength of first line in Lyman series of such a system.

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14. A $\mu - meson$("charge -e , mass = 207 m, where m is mass of electron") can be captured by a proton to form a hydrogen - like "mesic" atom. Calculate the radius of the first Bohr orbit , the binding energy and the wavelength of the line in the Lyman series for such an atom. The mass of the proton is 1836 times the mass of the electron. The radius of the first Bohr orbit and the binding energy of hydrogen are 0.529Å and $13.6eV$, repectively. $Take$R = 1.67 xx 109678 cm^(-1)`

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15. A $\pi - meason$ hydrogen atom is a bound state of negative charged pion (denoted by $\pi^{-}, m_{\pi} = 273m_e$) and a proton. Estimate the number of revolutions a $\pi - meason$ makes (averagely) in the ground state on the atom before , it decays (mean life of a $\pi - meason \cong 10^{-8}s$, mass of proton $= 1.67 \times 10^{-27}kg$).

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16. Supose the potential energy between electron and proton at a distance r is given by $-\frac{Ke^2}{3r^3}$. Applicatiojn of Bohr's theroy of hydrogen atom in this case shows that

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17. A $100eV$ electron collides with a stationary helium ion (He^{+}) in its ground state and excites to a higher level. After the collision , He^{+} ion emits two photons in succession with wavelength 1085Å and 304Å. Find the principal quantum number of the excite in its ground state and. Also calculate energy of the electron after the collision. Given $h = 6.63 \times 10^{-34} Js$.

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Single Correct

1. if the wavelength of the first line of the balmer series of hydrogen is 6561Å, the wavelength of the second line of the series should be

A. $\frac{27}{20} \times 4861\text{Å}$

B. $\frac{20}{27} \times 4861\text{Å}$

C. $20 \times 4861\text{Å}$

D. 4861Å

Answer: A

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2. Three photons coming from excited atoms hydrogen sample are picked up .There energies are $12.1eV, 10.2eV$ and $1.9eV$ these photons must come from

A. a single atom

B. two atom

C. three atom

D. either two atom or three atom

Answer: D

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3. Whenever a hydrogen atom emits a photon in the Balmer series .

A. it need not emit any more photon

B. it may emit another photon in the Paschen series

C. it may emit another photon in the Lyman series

D. it may emit another photon in the Balmer series

Answer: C

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4. two electron are revolving around a nucleus at distance r and 4 r`. The ratio of their periods is

A. $1:4$

B. $4:1$

C. $8:1$

D. $1:8$

Answer: D

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5. A hydrogen atom in ground state absorbs $10.2eV$ of energy .The orbital angular momentum of the electron is increases by

A. $1.05 \times 10^{-34} Js$

B. $2.11 \times 10^{-34} Js$

C. $3.16 \times 10^{-34} Js$

D. $4.22 \times 10^{-34} Js$

Answer: A

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6. In terms of Rydberg constant R, the shortest wavelength in the Balmer series of the hydrogen , atom spestrum will have wavelength

A. $1/R$

B. $4/R$

C. $3/2R$

D. $9/R$

Answer: B

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7. The ratio of minimum to maximum wavelength in Balmer series is

A. $5:9$

B. $5:36$

C. $1:4$

D. $3:4$

Answer: A

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8. The frequency of revolution of an electron in nth orbit is f_n. If the electron makes a transition from nth orbit to $(n = 1)$ th orbit , then the relation between the frequency (v) of emitted photon and f_n will be

A. $v = f_n^2$

B. $v = \sqrt{f}_n$

C. $v = \frac{1}{f_n}$

D. $v = f_n$

Answer: D

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9. In a hydrogen like atom electron makes transition from an energy level with quantum number n to another with quantum number (n - 1). If $n >> 1$, the frequency of radiation emitted is proportional to

A. $v \propto \frac{1}{n}$

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

C. $v \propto \frac{1}{n^3}$

D. $v \propto \frac{1}{n^4}$

Answer: C

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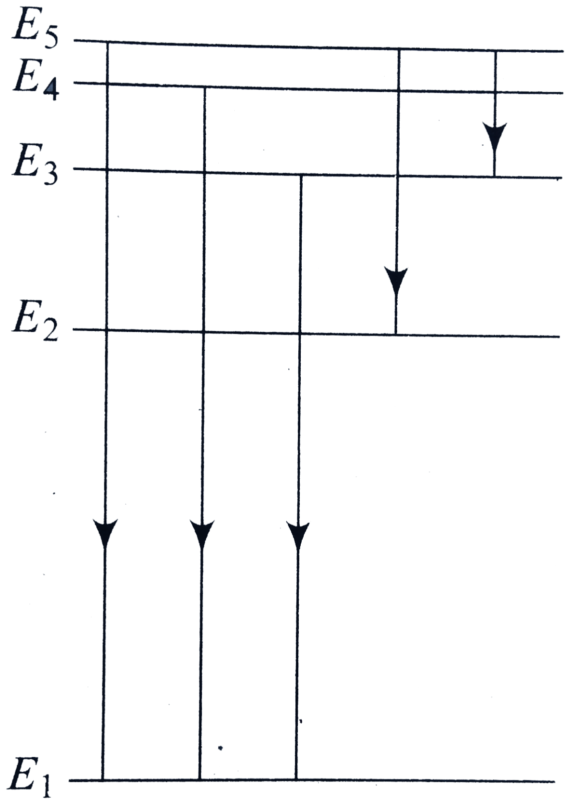
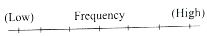
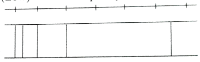
10. Figure shown five energy levels of an atom , one being much lower than the other four. Five transitios between the levels are idicated, each of which produces a photon of definite energy and frequency.



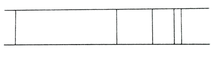
Which one of the spectrum below best corresponding to the set of transition indicated?



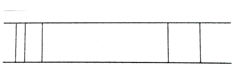
A. a.

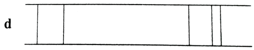


B. b.



C. c.



D. 

Answer: D

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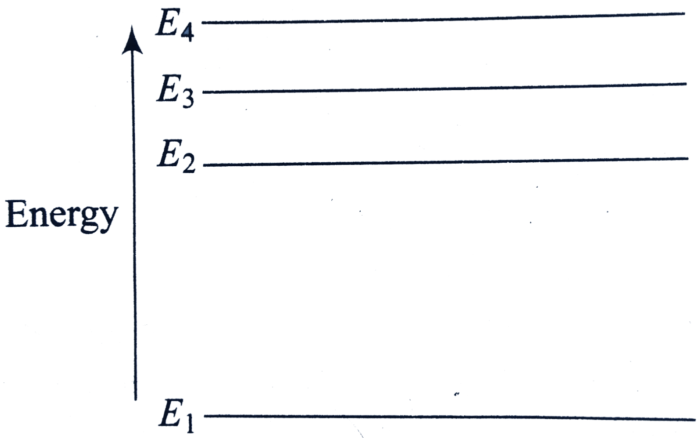
11. Figure represent some of the lower energy level of the hydrogen atom in simplified from.

If the transition of an electron from $E_4 \rightarrow E_2$ were accociated with the emission of blue light , which one of the following transition could be accociated with the emission of red light?



A. $E_4 \rightarrow E_1$

B. $E_3 \rightarrow E_1$

C. $E_3 \rightarrow E_2$

D. $E_1 \rightarrow E_3$

Answer: C

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12. The orbiting $v_n of e^-$ in the nth orbit in the case of positronium is x-field compared to that in the nth orbit in a hydrogen atom , where x has the value

A. 1

B. $\sqrt{2}$

C. $1/\sqrt{2}$

D. 2

Answer: A

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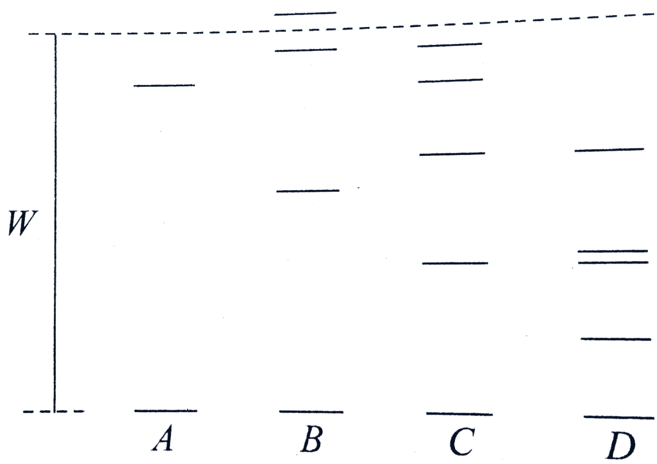
13. Figure shown the electron energy level , referred to the ground state (the lowest possible energy) as zero , for five different isoleted atoms. Which atom can produce radiation of the shortest wavelength when atoms in the ground state are bombarded with electrons energy W?



A. A

B. B

C. C

D. D

Answer: B

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14. When an electron jumps from a level $n = 4$ to $n = 1$, the momentum of the recoiled hydrogen atom will be

A. $6.5 \times 10^{-27} kgms^{-1}$

B. $22.75 \times 10^{-19} kgms^{-1}$

C. $13.6 \times 10^{-27} kgms^{-1}$

D. zero

Answer: A

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15. Check the corretness of the following statement about the Bohr model of hydrogen atom:

(i) The acceleration of the electron in $n = 2$ orbit is more than that in $n = 1$ orbit.

(ii) The angular momentum of the electron in $n = 2$ orbit is more than that in $n = 1$ orbit.

(iii) The KE of the electron in $n = 2$ orbit is more than that in $n = 1$ orbit.

A. All the statements are correct.

B. Only (i) and (ii) are correct.

C. Only (ii) and (iii) are correct.

D. Only (iii) and (i) are correct.

Answer: C

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16. When a hydrogen atom is raised from the ground state to an excited state

A. both KE and PE increase

B. both KE and PE decrease

C. PE increase and KE decrease

D. PE decrease and KE increase

Answer: C

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17. As the electron in the Bohr orbit is hydrogen atom passes from state $n=2$ to $n=1$, the $KE(K)$ and $PE(U)$ charge as

A. K two-fold. U also two-fold

B. K four-fold. U also four-fold

C. K four-fold. U also two-fold

D. K two-fold. U also four-fold

Answer: B

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18. Consider a spectral line resulting $n = 5$ to $n = 1$, in the atom and loss given below. The shortest wavelength is produced by

A. helium atom

B. deuterium atom

C. singly ionization helium

D. ten times ionized sodium atom

Answer: D

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19. Which of the following statement is true regarding Bohr's model of hydrogen atom ?

(I) Orbiting speed of electrons decreases as if falls to discrete orbits away from the nuclues.

(II) Radii of allowed orbits of electrons are proportional to the principle quantum number.

(III) Frequency with which electrons orbit around the nucleus in discrete orbits is inversely proportional to the principle quantum number.

(IV) Binding froce with which the elctron is bound to the nuclues increases as it shifts to outer orbits.

Selected the correct answer using the codes given below:

A. i and iii

B. ii and iv

C. i, ii and iii

D. ii, iii and iv

Answer: A

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20. In Bohr's model of hydrogen atom a_0 is the radius of the ground state orbit , m is the mass, e the charge of and electron and ε_0 is the vacuum permittivity. The speed of the electron is

A. 0

B. $\dfrac{e}{\sqrt{\varepsilon_0 a_0 m}}$

C. $\dfrac{e}{4\pi\sqrt{\varepsilon_0 a_0 m}}$

D. $\dfrac{4\pi\sqrt{\varepsilon_0 a_0 m}}{e}$

Answer: C

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21. Hydrogen atoms are excited from ground state of the principal quantum number 4. Then, the number of spectral lines observed will be

A. 3

B. 6

C. 5

D. 2

Answer: B

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22. When an electron jumps from $n_1 th$ or $bit \rightarrow$ n_(2)`

th orbit, the energy radiated is given by

A. $hv = E_1 / E_2$

B. $hv = E_2 / E_1$

C. $hv = E_1 - E_2$

D. $hv = E_2 - E_1$

Answer: C

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23. In Bohr's model of hydrogen atom, let PE represents potential energy and TE the total energy. In going to a higher level

A. PE increase and TE decrease

B. PE decrease and TE increase

C. PE increase and TE increase

D. PE decrease and TE decrease

Answer: C

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

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

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

Answer: B

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25. The energy change is greatest for a hydrogen atom when its state changes from

A. $n = 2 \rightarrow n = 1$

B. $n = 3 \rightarrow n = 2$

C. $n = 4 \rightarrow n = 3$

D. $n = 5 \rightarrow n = 4$

Answer: A

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26. The electron in a hydrogen atom jumps from ground state to the higher energy state where its velcoity is reduced to one-third its initial value. If the radius of the orbit in the ground state is r the radius of new orbit will be

A. 3 r

B. 9 r

C. $\frac{r}{3}$

D. $\frac{r}{9}$

Answer: B

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27. Energy of an electron in an excited hydrogen atom is $-3.4eV$. Its angualr momentum will be: $h = 6.626 \times 10^{-34} J - s$.

A. 2.11×10^{-34}

B. 3×10^{-34}

C. 1.055×10^{-34}

D. 0.5×10^{-34}

Answer: A

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28. The wavelength of the first line of Lyman series in hydrogen atom is 1216. The wavelength of the first line of Lyman series for 10 times ionized sodium atom will be added

A. 0.1Å

B. 1000Å

C. 100Å

D. 10Å

Answer: D

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29. energy E of a hydrogen atom with principal quantum number n is given by $E = \frac{-13.6}{n^2} eV$.The energy of a photon ejected when the electron jumps from $n = 3$ state $n = 2$ state of hydrogen is approximately

A. $1.9 eV$

B. $2.3 eV$

C. $3.4 eV$

D. $4.5 eV$

Answer: A

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30. If $13.6eV$ energy is required to ionized the hydrogen atom then the energy required to ionize the hydrogen atom , then the energy required to remove an electron from $n = 2$ is

A. $10.2eV$

B. $0eV$

C. $3.4eV$

D. $6.8eV$

Answer: C

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31. In which of the following systems will be the radius of the first orbit $(n = 1)$ be minimum ?

A. Doubley ionized lithium

B. Singly ionized lithium

C. Deuterium atom

D. hydrogen atom

Answer: A

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32. The radius of the Bohr orbit in the ground state of hydrogen atom is 0.5Å. The radius o fthe orbit of the electron in the third excited state of He^{+} will be

A. 8Å

B. 4Å

C. 0.5Å

D. 0.25Å

Answer: B

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33. Let v_1 be the frequency of the series limit of the Lyman series, v_2 be the frequency of the first line of the

Lyman series, and v_3 be the frequency of the series limit of the Balmer series. Then

A. $v_1 - v_2 = v_3$

B. $v_2 - v_1 = v_3$

C. $v_3 = \frac{1}{2}(v_1 + v_2$

D. $v_2 + v_1 = v_3$

Answer: A

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34. The speed of electron in the second orbit of Be^{3+} ion will be

A. $\frac{C}{137}$

B. $\frac{2C}{137}$

C. $\frac{3C}{137}$

D. $\frac{4C}{137}$

Answer: B

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35. The potential energy of an electron in the fifth orbit of hydrogen atom is

A. $0.54eV$

B. $-0.54eV$

C. $1.08eV$

D. $-1.08eV$

Answer: D

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36. If the radius of an orbit is r and the velocity of electron in it is v, then the frequency of electron in the orbit will be

A. $2\pi rv$

B. $\frac{2\pi}{vr}$

C. $\frac{vr}{2\pi}$

D. $\frac{v}{2\pi r}$

Answer: D

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37. A sample of hydrogen is bombarded by electrons. Through what potential difference should the electrons be accelerated so that third line of Lyman series be emitted?

A. $2.55V$

B. $10.2V$

C. $12.09V$

D. $12.75V$

Answer: D

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38. When a hydrogen atom emits a photon during the transition n=5 to n=1 , its recoil speed is approximately

A. $10^{-4} ms^{-1}$

B. $2 \times 10^{-2} ms^{-1}$

C. $4 ms^{-1}$

D. $8 \times 10^{2} ms^{-1}$

Answer: C

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39. If R is the Rydberg's constant for hydrogen the wave number of the first line in the Lyman series will be

A. $\frac{R}{2}$

B. $2R$

C. $\frac{R}{4}$

D. $\frac{3R}{4}$

Answer: D

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40. With the increase in peinciple quantum number, the energy difference between the two successive energy levels

A. decrease

B. increase

C. first decrease and then increase

D. remain the same

Answer: A

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41. If λ_1 and λ_2 are the wavelength of the first members of the Lyman and Paschen series, respectively , then $\lambda_1 : \lambda_2$ is

A. $1:3$

B. $1:30$

C. $7:50$

D. $7:108$

Answer: D

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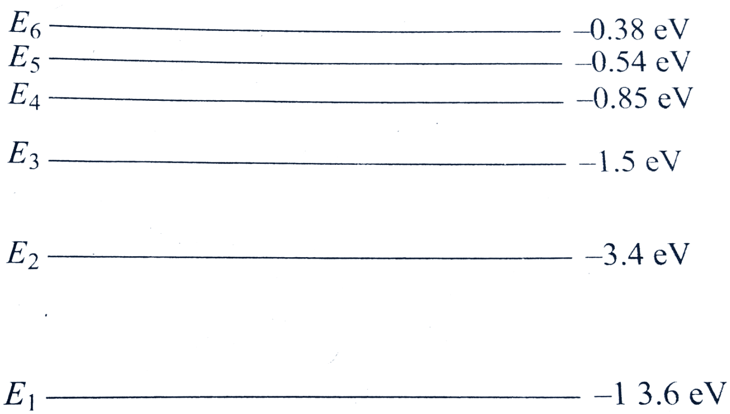
42. In figure E_1 and E_2 represent some of the energy levels of the hydrogen atom.



Which one of the following transitions produced a photon of wavelength in the ultraviolet region of the electromagnetic spectrum?

A. $E_2 - E_1$

B. $E_3 - E_2$

C. $E_4 - E_3$

D. $E_6 - E_4$

Answer: A

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43. Which of the following parameters are the same for all hydrogen like atoms and ions in their ground state?

A. Radius of the orbit

B. speed of the electron

C. Energy of the atom

D. Orbitanangular momentum of the electron

Answer: D

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44. An atom emits a spectral line of wavelength λ when an electron makes a transition between levels of energy E_1 and E_2. Which expression correctly relates λE_1 and E_2 ?

A. $\lambda = \dfrac{hc}{E_1 + E_2}$

B. $\lambda = \dfrac{2hc}{E_1 + E_2}$

C. $\lambda = \dfrac{2hc}{E_1 - E_2}$

D. $\lambda = \dfrac{hc}{E_1 - E_2}$

Answer: D

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45. The frequency of emission line for eny transition in positronium atom (consisting of a positron and an electron) is x times the frequency of the corresponding line in the case of H atom , where x is

A. $\sqrt{2}$

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

C. $1/2\sqrt{2}$

D. $1/2$

Answer: D

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46. If the wavelength of photon emitted due to transition of electron from third orbit to first orbit in a hydrogen atom is λ then the wavelength of photon emitted due to transition of electron from fourth orbit to second orbit will be

A. $\frac{128}{27}\lambda$

B. $\frac{25}{9}\lambda$

C. $\frac{36}{7}\lambda$

D. $\frac{125}{11}\lambda$

Answer: A

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47. Which of the following is true when Balmer gave his model for hydrogen atom?

A. It was not known that hydrogen lines could be explained as different of term like $R/n^2 with R$ being a constant and n an integet.

B. It was not known that positive charge is concentrated in a nnucleus of small size.

C. It was not known that radiant by $hvwithh$ being a constant and v a frequency.

D. Bohr knew term like R/n^2 and in the process of choosing allowed the orbits to fit them, he got" angular momentum $= n/2\pi$ as a deduction.

Answer: D

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48. The shortest wavelength in the Lyman series of hydrogen spectrum is 912Å correcponding to a photon energy of $13.6eV$. The shortest wavelength in the Balmer series is about

A. $912\text{Å}/2$

B. 912Å

C. $912 \times 2\text{Å}$

D. $912 \times 4\text{Å}$

Answer: D

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49. The ratio of maximum to minimum possible radiation energy Bohr's hypothetical hydrogen atom is equal to

A. 2

B. 4

C. $4/3$

D. $3/2$

Answer: C

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

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

C. $\frac{Rh}{2M}$

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

Answer: A

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51. In interperting Rutherford's experiments on the scattering of alpha particle by thin foils, one must examine what were known factors, and what the experiment settle. Which of the following are true in this context?

A. The number of electrons in the target atoms $(i. e. Z)$ was settled by these experiments.

B. The validity of Coulomb's law for distance as small as 10^{-13} was known before these experiments.

C. The experiment settled that size of the nucleus could not be larger than a certain value.

D. The experiment also settled that size of the nucleus could not be smaller than a certain value.

Answer: C

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52. An electron jumps from the fourth orbit to the second orbit hydrogen atom. Given the Rydberg's constant $R = 10^7 cm^{-1}$. The frequecny , in Hz , of the emitted radiation will be

A. $\frac{3}{16} \times 10^5$

B. $\frac{3}{6} \times 10^{15}$

C. $\frac{9}{16} \times 10^5$

D. $\frac{9}{16} \times 10^{17}$

Answer: D

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53. Given mass number of gold $= 197$, Density of gold $= 19.7 gcm^{-3}$. The radius of the gold atom is approximately:

A. $1.5 \times 10^{-8} m$

B. $1.5 \times 10^{-9} m$

C. $1.5 \times 10^{-10} m$

D. $1.5 \times 10^{-12} m$

Answer: C

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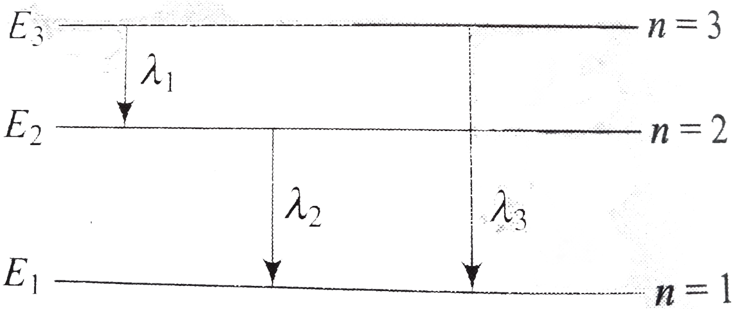
54. Three energy levels of an atom are shown in figure . The wavelength corresponding to three possible transition are $\lambda_1, \lambda_2.$, and λ_3. The value of λ_3 in terms of λ_1 and λ_2 is given by



A. $\lambda_1 = \lambda_2 - \lambda_3$

B. $\lambda_1 = \lambda_3 - \lambda_2$

C. $\frac{1}{\lambda_1} = \frac{1}{\lambda_2} + \frac{1}{\lambda_3}$

D. $\frac{1}{\lambda_1} = \frac{1}{\lambda_3} + \frac{1}{\lambda_2}$

Answer: C

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55. The ratio of the speed of the electron in the first Bohr orbit of hydrogen and the speed of light is equal to (where e, h and c have their usual meaning in cgs system)

A. $2\pi h / e^2$

B. $er^2 h / 2\pi c$

C. $e^2 c / 2\pi h$

D. $2\pi e^2 / hc$

Answer: D

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56. Suppose two deuterons must get as close as $10^{-14}m$ in order for the nuclear force to overcome the repulsive electrostatic force. The height of the electrostatic harrier is nearest to

A. $0.14MeV$

B. $2.3MeV$

C. $1.8 \times 10MeV$

D. $0.56MeV$

Answer: A

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57. An electron in H atom makes a transition from $n = 3 \to n = 1$. The recoil momentum of the H atom will be

A. $6.45 \times 10^{-27} Ns$

B. $6.8 \times 10^{-27} Ns$

C. $6.45 \times 10^{-24} Ns$

D. $6.8 \times 10^{-24} Ns$

Answer: A

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58. A hydrogen-like atom emits radiation of frequency 2.7×10^{15} Hz when if makes a transition from n = 2 to n = 1. The frequency emitted in a transition from n = 3 to n = 1 will be

A. $1.8 \times 10^{15} Hz$

B. $3.2 \times 10^{15} Hz$

C. $4.7 \times 10^{5} Hz$

D. $6.9 \times 10^{15} Hz$

Answer: B

Watch Video Solution

59. An electron in a hydrogen atom makes a trsnsition $n_1 \rightarrow n_2$ where n_1 and n_2 are principal quantum numbers of the two states. Assume the Bohr model to be valid. The time period of the electron in the initial state is eight times that in the final state. The possible values of n_1 and n_2 are

A. $n_1 = 4, n_2 = 2$

B. $n_1 = 8, n_2 = 2$

C. $n_1 = 8, n_2 = 3$

D. $n_1 = 6, n_2 = 2$

Answer: A

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60. An electron revolving in an orbit of radius 0.5Å in a hydrogen atom executes per secon. The magnetic momentum of electron due to its orbital motion will be

A. $1.256 \times 10^{-23} Am^2$

B. $653 \times 10^{-26} Am^2$

C. $10^{-3} Am^2$

D. $256 \times 10^{-26} Am^2$

Answer: A

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61. The total energy of an electron in the ground state of hydrogen atom is $-13.6eV$. The potiential energy of an electron in the ground state of Li^{2+} ion will be

A. $122.4eV$

B. $-122.4eV$

C. $244.8eV$

D. $-244.8eV$

Answer: D

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62. A doubly ionized lithium atom is hydrogen like atom

with atomic

. number 3. Find the wavelength of the radiation to

excite the electron in

. Li^{2+} from the first to the third Bohr orbit. The

ionization energy of the hydrogen

. Atom is 13.6V.

A. $134.25Å$

B. $125.5Å$

C. $113.7Å$

D. $110Å$

Answer: C

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63. In Bohr modal of hydrogen atom, the force on the electron depends on the principal quantum number as

A. $F \propto n^2$

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

C. $F \propto n^4$

D. $F \propto \frac{1}{n^4}$

Answer: D

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64. The minimum energy to ionize an atom is the energy required to

A. add one electron to the atom

B. excite the atom from its ground state to its first excite state

C. remove one outermost electron from the atom

D. remove one innermost electron from the atom

Answer: C

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65. If electron with principal quantum number $n > 4$ were not allowed in nature , the number of possible element would be

A. 32

B. 60

C. 64

D. 4

Answer: B

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66. The orbital velocity of electron in the ground state is v. If the electron is excited to enegry staet $-0.54eV$ its orbital velocity will be

A. v

B. $\frac{v}{3}$

C. $\frac{v}{5}$

D. $\frac{v}{7}$

Answer: C

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67. If potential energy between a proton and an electron is given by $|U| = ke^2/2R^3$, where e is the charge of electron and R is the radius of atom , that radius of Bohr's orbit is given by $(h = Plank's\,cons\tan t, k = cons\tan t)$

A. $\dfrac{ke^2m}{h^2}$

B. $\dfrac{6\pi^2}{n^2}\dfrac{ke^2m}{h^2}$

C. $\dfrac{2\pi}{n}\dfrac{ke^2m}{h^2}$

D. $\dfrac{4\pi^2ke^2m}{n^2h^2}$

Answer: B

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68. In H-atom , a transition takes place from n=3 to n=2 orbit. Calculate the wavelength of the emitted photon, will the photon be visible ? To which spectral series will this photon belong (Take $R = 1.097 \times 10^7 m^{-1}$)

A. 6606Å

B. 4861Å

C. 4340Å

D. 4101Å

Answer: A

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69. An alpha particle of energy 5 MeV is scattered through 180° by a fixed uranium nucleus. The distance of closest approach is of the order of

A. $10^{-15}cm$

B. $10^{-13}cm$

C. $10^{-12}cm$

D. $10^{-19}cm$

Answer: C

Watch Video Solution

70. How many time does the electron go round the first bohr orbit of hydrogen atoms in $1s$?

A. 6.62×10^{15}

B. 100

C. 1000

D. 1

Answer: A

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71. The radius of hydrogen atom in its ground state is $5.3 \times 10^{-11} m$. After collision with an electron it is found to have a radius of $21.2 \times 10^{-11} m$. What is the principal quantum number n of the final state of atom ?

A. 1

B. 2

C. 3

D. 4

Answer: B

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72. The wavelength of the first line of Balmer series is $6563 Å$. The Rydberg's constant for hydrogen is about

A. $1.09 \times 10^5 m^{-1}$

B. $1.09 \times 10^6 m^{-1}$

C. $1.097 \times 10^7 m^{-1}$

D. $1.09 \times 10^8 m^{-1}$

Answer: C

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73. A hydrogen atom and a Li^{++} ion are both in the second excited state. If l_H and l_Li are the 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 $|E_H| < |E_{LI}|$

Answer: B

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74. Imagine an atom made up of proton and a hypothetical particle of double the mass of the electron but havign the same charge as the electron. Apply the Bhor atom model and consider all possible transitions of this hypothetical particle to the first excited level. The longest wavelength photon that will be emitted has wavelength λ (given in terms of the Rydberg constant R for the hydrogen atom) equal to (a) $9/5R$ (b) $\frac{36}{5}R$ (c) $18/5R$ (d) $4/R$

A. $\frac{9}{5R}$

B. $\frac{36}{5R}$

C. $\frac{18}{5R}$

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

Answer: C

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75. The electirc potential between a proton and an electron is given by $V = V_0 \ln\left(\frac{r}{r_0}\right)$, 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)$r_n \propto \frac{1}{n^2}$

A. $r_n \propto n$

B. $r_n \propto 1/n$

C. $r_n \propto n^2$

D. $r_n \propto 1/n^2$

Answer: A

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76. In order to break a chemical bond in the molecules of human skin, causing sunburn , a photon energy of about $3.5eV$ is required. This corresponds to wavelength in the

A. infrared region

B. X-ray region

C. visible region

D. ultraviolet region

Answer: D

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77. The longest wavelength that the singly ionized helium atom in its ground state will obsorb is

A. 912Å

B. 304Å

C. 606Å

D. 1216Å

Answer: B

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78. An electron in a hydrogen atom makes a trsnsition $n_1 \rightarrow n_2$ where n_1 and n_2 are principal quantum numbers of the two states. Assume the Bohr model to be valid. The time period of the electron in the initial state is eight times that in the final state. The possible values of n_1 and n_2 are

A. $n_1 = 6, n_2 = 3$

B. $n_1 = 4, n_2 = 2$

C. $n_1 = 8, n_2 = 1$

D. $n_1 = 3, n_2 = 1$

Answer: D

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79. In which of the following transition will the wavelength be minimum ?

A. $n=5 \rightarrow n=4$

B. $n=4 \rightarrow n=3$

C. $n=3 \rightarrow n=2$

D. $n=2 \rightarrow n=1$

Answer: D

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80. 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

A. Two proton of energy $10.2 eV$

B. Two proton of energy $1.4 eV$

C. One photon of energy $10.2 eV$ and one electron of energy $1.4 eV$

D. One electron having kinetic energy nearly $11.6eV$.

Answer: D

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81. The shortest wavelength of the Brackett series of hydrogen like atom (atomic number =Z) is the same as the shortest wavelength of the Blamer series of hydrgeon atom . The value ofn Z is

A. 4

B. 2

C. 3

D. 6

Answer: B

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82. In a hypothetivsl system, a particle of mass m and charge -3q is moving around a very heavy particle having charge q. Assuming Bohr's model to be true ot this system the orbital velocity of mass m when it is nearest to heavy particle is

A. $\frac{3q^2}{2\varepsilon_0 h}$

B. $\frac{3q^2}{4\varepsilon_0 h}$

C. $\frac{3q}{2\pi\varepsilon_0 h}$

D. $\frac{3q^2}{4\pi\varepsilon_0 h}$

Answer: A

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83. The angular momentum of an electron in a hydrogen atom is proportional to

A. $1/\sqrt{r}$

B. $1/r$

C. $\sqrt{r}$

D. r^2

Answer: C

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84. The rartio $(\text{in} S1 units)$ of magnetic dipole moment to that of the angular momentum of an electron of mass mkg and charge e coulomb in Bohr's orbit of hydrogen atom is

A. $\frac{e}{2m}$

B. $\frac{e}{m}$

C. $\frac{2e}{m}$

D. none of these

Answer: A

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85. If an electron in $n = 3$ orbit of hydrogen atom jumps down to $n = 2$ orbit, the amount of energy reeased and the and the wavelength of radiation emitted are

A. $0.85eV, 6566\text{Å}$

B. $0.89eV, 1240\text{Å}$

C. $1.89eV, 6566\text{Å}$

D. $1.5eV, 6566\text{Å}$

Answer: C

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86. In hydrogen spectrum, the shortest wavelength in Balmer series is the λ. The shortest wavelength in the Brackett series will be

A. 2λ

B. 4λ

C. 9λ

D. 16λ

Answer: B

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87. The minimum orbital angular momentum of the electron in a hydrogen atom is

A. $\frac{3h}{2\pi}$

B. $\frac{9h}{2\pi}$

C. $\frac{h}{2\pi}$

D. $\frac{h}{6\pi}$

Answer: C

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88. The first excitation potential of a hypothetical hydrogen- like atom is $15V$. Find the third excitation potential of the atom.

A. V electron volt

B. $\frac{3V}{4}$ electron volt

C. $\frac{4V}{3}$ electron volt

D. cannot be calculate by given information

Answer: C

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89. Two hydrogen atoms are in excited state with electrons in$n = 2$ state.First one is moving to wards left and emits a photon.' of energy E_1 towards right. Second one is moving towards right with same speed and emits a photon of energy E_2 towards right. Taking recoil of nucleus.into account during_emission process :

A. $E_1 > E_2$

B. $E_1 < E_2$

C. $E_1 = E_2$

D. information insufficient

Answer: B

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90. In a hydrogen atom following the Bohr's psotulates the product of linear momentum and angular momentum is proportional ot $(n)^x$ where 'n' is the orbit number. Find the valur of x.

A. 0

B. 2

C. -2

D. 1

Answer: A

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91. The voltage applied to an X-ray tube is $18 kV$. The maximum mass of photon emitted by the X-ray tube will be

A. $2 \times 10^{-13} kg$

B. $3.2 \times 10^{-36} kg$

C. $3.2 \times 10^{-32} kg$

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

Answer: C

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92. The wavelength of K_α X-rays of two metals A and B are$4/1875R$ and $1/675R$, respectively , where R is rydberg 's constant. The number of electron lying between A and B according to this lineis

A. 3

B. 6

C. 5

D. 4

Answer: D

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93. Which electronic transition in Li^{2+} ion would emit radiation of same wavelength as the wavelength of second Balmar line of H-atom?

A. $n = 4 \rightarrow n = 2$

B. $n = 8 \rightarrow n = 2$

C. $n = 8 \rightarrow n = 4$

D. $n = 12 \rightarrow n = 6$

Answer: D

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94. The photon radiated from hydrogen corresponding to the second line of Lyman series is absorbed by a hydrogen like atom X in the second excited state. Then, the hydrogen-like atom X makes a transition of nth orbit.

A. $X = He^{+}, n = 4$

B. $X = Li^{++}, n = 6$

C. $X = He^{+}, n = 6$

D. $X = Li^{++}, n = 9$

Answer: D

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95. The element which has a K_{α} X-rays line of wavelength 1.8Å is

$\left(R = 1.1 \times 10^{7} m^{-1}, b = 1 \text{ and } \sqrt{5/33} = 0.39\right)$

A. $Co, Z = 27$

B. $Iron, Z = 26$

C. $Mn, Z = 25$

D. $Ni, Z = 28$

Answer: A

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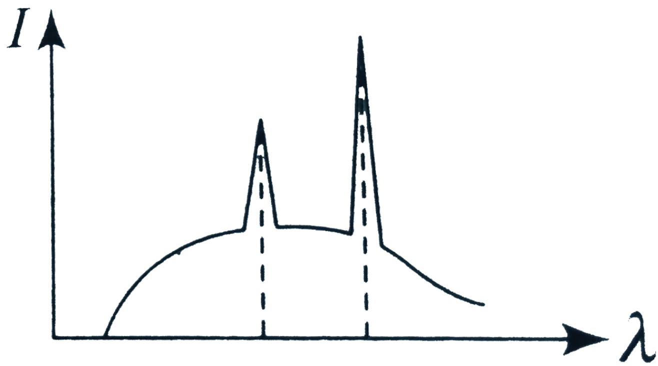
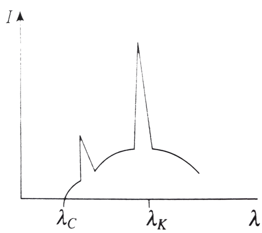
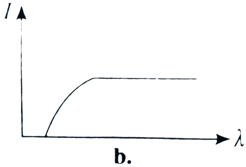
96. When an electron acceleration by potential different U is bombarded on a specific metal, the emitted X-ray spectrum obtained is shown in figure . If the potential different is reduced to $U/3$, the correct spectrum is

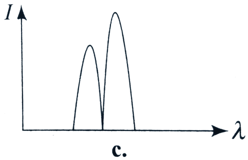


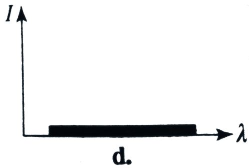
a.

A.



B. 

C. 

D. 

Answer: B

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97. In a hydrogen atom , the electron atom makes a transition from $n = 2 \rightarrow n = 1$. The magnetic field produced by the circulating electron at the nucleus

A. decrease 16 time

B. increase 4 time

C. decrease 4 time

D. increase 32 time

Answer: D

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

A. increase 2 time

B. increase 4 time

C. increase 8 time

D. remain the same

Answer: C

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99. When the voltage applied to an X-ray tube is increased from $V_1 = 10$ kV to $V_2 = 20$ kV, the wavelength difference between limit of the continous X-ray spectrum increases by a factor 3 The atomic number of the element of which the tube anticathode is made will be (30-x), Find Value of x.

A. 28

B. 29

C. 65

D. 66

Answer: B

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100. Monochromatic radiation of wavelength λ is incident on a hydrogen sample in ground state. hydrogen atoms absorb a fraction of light and subsequently and radiation of six different wavelength .Find the value of λ

A. $203nm$

B. $95nm$

C. $80nm$

D. $73nm$

Answer: B

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101. The power of an X-ray tube is $16W$. If the potential difference applied across the tube is $51kV$, then the number of electrons striking the target per second is

A. 8.4×10^{16}

B. 5×10^{17}

C. 2×10^{16}

D. 2×10^{19}

Answer: C

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102. A hydrogen like atom (atomic number Z) is in a higher excited state of quantum number n. The excited atom can make a transition to 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, respectively Determine the values of n and Z. (Ionization energy of H-atom = 13.6 eV)

A. 6 and 6

B. 3 and 3

C. 6 and 3

D. 3 and 6

Answer: C

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103. Hydrogen atom in a sample are excited to $n = 5$ state and it is found that photons of all possible wavelength are present in the emission spectra. The minimum number of hydrogen atom in the sample would be

A. 5

B. 6

C. 10

D. infinite

Answer: B

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104. A sample of hydrogen atom is in excited state (all the atoms). The photons emitted from this sample are made to pass through a filter through which light having wavelength greater than $800 nm$ can only pass. Only one type of photons are found to pass the filter. The sample's excited state initially is $[Take hc = 1240 eV - nm,$ ground state energy of hydrogen atom $= -13.6 eV]$.

A. Fifth excited state

B. Fourth excited state

C. third excited state

D. Second excited state

Answer: C

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105. Mark out the correct statement regarding X-rays.

A. When fast moving electrons strike the metal target, they enter the metal larged and in a very short time span come to rest , and thus an electromagnetic charged electron produces electromagnetic waves (X-ray).

B. Characteristic X-rays are produced due to transition of an electron from higher energy levels to vacant lower energy levels.

C. X-ray spectrum is a discrete spectra just like hydrogen spectra.

D. Both (a) and (b) are correct.

Answer: B

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106. An electron collides with a hydrogen atom in its ground state and excites it to $n = 3$,. The energy gives to hydrogen aton n this inclastic collision is [Neglect the recoiling of hydrogen atom]

A. $10.2eV$

B. $12.1eV$

C. $12.5eV$

D. none of these

Answer: B

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107. Electron in a hydrogen-like atom $(Z = 3)$ make transition from the forth excited state to the third excited state and from the third excited state to the second excited state. The resulting radiations are incident potential for photoelectrons ejested by shorter wavelength is $3.95eV$.

Calculate the work function of the metal and stopping potiential for the photoelectrons ejected by the longer wavelength.

A. $2.0V$

B. $0.75V$

C. $0.6V$

D. none of these

Answer: B

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108. In which of the following transition will the wavelength be minimum ?

A. $n_1 = 5, n_2 = 4$

B. $n_1 = 4, n_2 = 3$

C. $n_1 = 3, n_2 = 2$

D. $n_1 = 2, n_2 = 1$

Answer: D

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109. An electron of kinetic energy K collides elastically with a stationary hydrogen atom in the ground state.

Then,

A. must be elastic

B. must be completely incleastic

C. may be partially elastic

D. information is insufficient

Answer: A

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110. If the average life time of an excited state of hydrogen is of the order of $10^{-8}s$, estimate how many whits an alectron makes when it is in the state $n = 2$

and before it suffers a transition to state $n = 1(Bohrrediusa_0 = 5.3 \times 10^{-11} m)$?

A. 10^7

B. 8×10^6

C. 2×10^5

D. none of these

Answer: B

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111. An electron of energy $11.2 eV$ undergoes an inelastic collision with a hydrogen atom in its ground state [Neglect recoiling of atom as $m_H > > m_e$]. Then is this case

A. the outgoing electron ha senergy $11.2 eV$

B. the entireenergy is absorbed by the H atom and the electron stops

C. $10.2 eV$ of the incident electron energy is obsorbed by the H atom and the electron would come out with $1.0 eV$ energy

D. none of the above

Answer: C

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112. The recoil speed of hydrogen atom after it emits a photon in going from $n = 2state \rightarrow n = 1$ state is nearly

$\left[TakeR_{\infty} = 1.1 \times 10^{7} m \text{ and } h = 6.63 \times 10^{-34} Js\right]$

A. $1.5ms^{-1}$

B. $3.3ms^{-1}$

C. $4.5ms^{-1}$

D. $6.6ms^{-1}$

Answer: B

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113. A beam of $13.0 eV$ electrons is used to bombard gaseous hydrogen. The series obtained in emission spectra is // are

A. Lyman series

B. Balmer series

C. Brackett series

D. All of these

Answer: D

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114. The wavelength of the spectral line that corresponds to a transition in hydrogen atom from $n = 10$ to ground state would be [In which part of electromagnetic spectrum this line liues?]`

A. $92.25nm$, ultraviolet

B. $92.25nm$, infrared

C. $86.95nm$, ultraviolet

D. $97.65nm$, ultraviolet

Answer: A

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115. The angular momentum of an electron in hydrogen atom is $4h / 2\pi$. Kinetic energy this electron is

A. $4.35eV$

B. $1.51eV$

C. $0.85eV$

D. $13.6eV$

Answer: C

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116. Difference between nth and (n+1) the Bohr's radius of 'H' atom is equal ot it s (n-1) th Bohr's radius . The value of n is

A. 1

B. 2

C. 3

D. 4

Answer: D

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117. 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. 6

B. 4

C. 11

D. 44

Answer: A

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

A. $\dfrac{e^3}{\pi\varepsilon_0 m^2 v_0}$

B. $\dfrac{e^3}{\pi\varepsilon_0 m v_0}$

C. $\dfrac{e^2}{\pi\varepsilon_0 m v_0^2}$

D. None of these

Answer: C

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119. 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 $1.8 \times 10^{11} \dfrac{C}{kg}$.

A. 1

B. 0.1

C. 1.8

D. 1.2

Answer: B

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120. The potential different across the Coolidge tube is $20kV$ and $10mA$ current flows through the voltage supply. Only 0.5% of the energy carried by the electrons striking the target is converted into X-ray. The power carried by the X-ray beam is p. Then

A. $P = 0.1W$

B. $P = 1W$

C. $P = 2W$

D. $P = 10W$

Answer: B

Watch Video Solution

121. Determine the minimum wavelength that hydrogen in its ground state can obsorb. What would be the next smaller wavelength that would work?

A. $133nm$

B. $13.3nm$

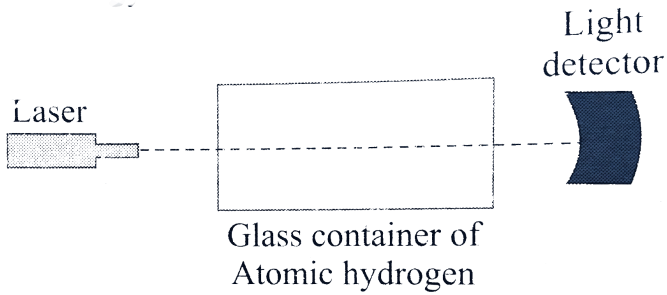
C. $10.3nm$

D. $103nm$

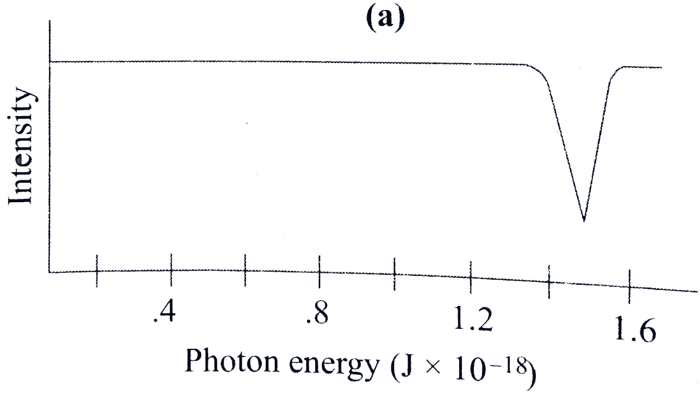
Answer: D

Watch Video Solution

122. In order to determine the value of E_0, a scienctist shines photons ("light particles ")of various energies at a cloud of atomic hydrogen. Most of the hydrogen atom occupy transition through that cloud : see figure is a graph of part of the scientist's data, showing the idensity of the transmitted light as a function of the photon energy. A hydrogen atom's electron is likely to obsorb a photon only if the photon gives the electron enough energy to knock it into a higher shell.



(a)



(b)

According to this experiment , what is the approximate value of E_0?

A. $1.6 \times 10^{-18} J$

B. $2.1 \times 10^{-18} J$

C. $3.2 \times 10^{-18} J$

D. $6.4 \times 10^{-18} J$

Answer: B

Watch Video Solution

123. In the above question, if the scientist continues taking data at higher photon energies he will find the next major "dip" in the intensity graph at what photon energy ?

A. $\frac{1}{9}E_0$

B. $\frac{8}{9}E_0$

C. $3E_0$

D. $9E_0$

Answer: B

Watch Video Solution

124. Electrons with energy 80 ke V are incident on the tungsten

target of on X-ray tube. K-shell electrons of tungsten have 72.5 ke V energy.

X-ray emitted by the tube contain only

(a) a continuous X-ray spectrum (Bremsstrahlung) with a minimum wavelength of

$\approx 0.155Å$. (b) a continuos X-ray spectrum (Bremsstrahlung) with all wavelegths

(c) the characteristic X-ray spectrum of tungsten

(d) a continuous X-ray spectrum (Bremsstrahlung) witha minimum wavelength of

$\approx 0.155Å$ and the characteristic X-ray spectrum of tungsten.

A. a continuos X-ray spectrum (Bremsstrablung) with a minimum wavelength of $-0.155Å$

B. a continuos X-ray spectrum (Bremsstrablung) all wavelengthsS

C. a continuos X-ray spectrum of tungsten

D. a continuos X-ray spectrum (Bremsstrablung) with a minimum wavelength of -0.155Å and the charateristic X-ray spectrum of tungsten

Answer: D

Watch Video Solution

125. Consider a hypothetical annihilation of a stationary electron with a stationary positron. What is the wavelength of the resulting radiation?

A. $\lambda = \frac{h}{m_0 c}$

B. $\lambda = \frac{2h}{m_0 c^2}$

C. $\lambda = \frac{h}{2m_0c^2}$

D. None of these

Answer: A

Watch Video Solution

126. 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. $1:10$

B. $10:1$

C. $5:1$

D. $1:5$

Answer: A

Watch Video Solution

127. If the potential difference applied across a Coolidge tube is increased , then

A. wavelength of K_{α} will increase

B. $\lambda_{\min}$ will increase

C. different between wavelength of K_{α} and $\lambda_{\min}$ increase

D. none of these

Answer: C

Watch Video Solution

128. 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. 3.57

B. 35.7

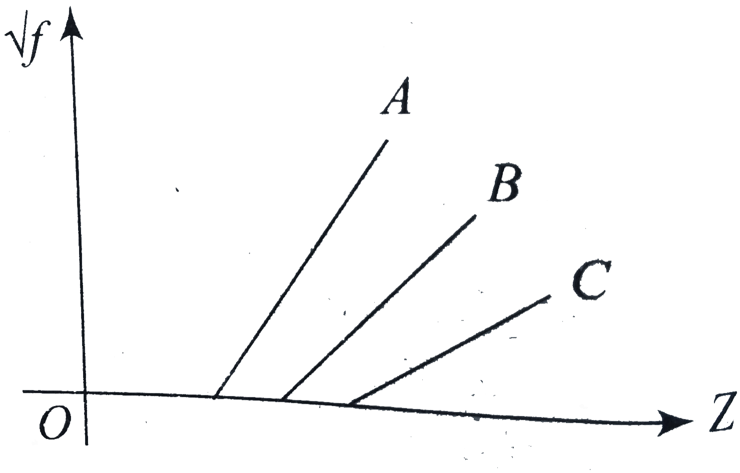
C. 4.57

D. 15

Answer: A

Watch Video Solution

129. Figure shown Moseley's plot between $\sqrt{f}$ and Z where f is the frequency and Z is the atomic number. Three lines A, B, and C always in the graph may repersent



A. $K_{\alpha}, K_{\beta}, \text{ and } K_{\gamma}$ lines, respectively

B. $K_{\gamma}, K_{\beta}, \text{ and } K_{\alpha}$ lines, respectively

C. $K_{\sigma}, L_{\sigma}, \text{ and } K_{\alpha}$ lines, respectively

D. Nothing

Answer: D

Watch Video Solution

130. An electron in the ground state of hydrogen has an angular momentum L_1 and an electron in the fist excited state of lithium has an angular momentum L_2. Then,

A. $L_1 = L_2$

B. $L_1 = 4L_2$

C. $L_2 = 2L_1$

D. $L_1 = 2L_2$

Answer: C

Watch Video Solution

131. The approximate value of quantum number n for the circular orbit of hydrogen of $0.0001mm$ in diameter is

A. 1000

B. 60

C. 10000

D. 31

Answer: D

Watch Video Solution

132. If electron with principal quantum number $n > 4$ were not allowed in nature , the number of possible element would be

A. $\frac{1}{2}n(n+1)$

B. $\left\{\frac{n(n+1)}{2}\right\}^2$

C. $\frac{1}{6}n(n+1)(2n+1)$

D. $\frac{1}{3}n(n+1)(2n+1)$

Answer: D

Watch Video Solution

133. The velocity of an electron in the first orbit of H atom is v . The velocity of an electron in the second orbit of He^{+} is

A. $2v$

B. v

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

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

Answer: B

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134. Find recoil speed (approximately in ms^{-1}) when a hydrogen atom emits a photon during the transition from $n = 5 \rightarrow n = 1$

A. $4.718 ms^{-1}$

B. $7.418 ms^{-1}$

C. $4.178 ms^{-1}$

D. $7.148 ms^{-1}$

Answer: C

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135. If a hydrogen atom emit a photon of energy $12.1 eV$, its orbital angular momentum changes by Δ L. then Δ L equals

A. $1.05 \times 10^{-34} Js$

B. $2.11 \times 10^{-34} Js$

C. $3.16 \times 10^{-34} Js$

D. 4.22×10^{-34}

Answer: B

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136. An electron of kinetic energy K collides elastically with a stationary hydrogen atom in the ground state. Then,

A. $0 < E < \infty$

B. $0 < E < 10.2eV$

C. $0 < E < 13.6eV$

D. $0 < E < 3.4eV$

Answer: B

Watch Video Solution

137. The wavlength of K_{α}, X-rays produced by an X-ray tube 0.76Å . The atomic number of the anode material of the tube is

A. 30

B. 40

C. 50

D. 60

Answer: B

Watch Video Solution

138. Let the potential energy of the hydrogen atom in the ground state be zero . Then its energy in the excited state will be

A. $10.2eV$

B. $13.6eV$

C. $23.8eV$

D. $27.2eV$

Answer: C

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139. When photons of wavlength λ_1 are incident on an isolated sphere suspended by an insulated thread, the corresponding stopping potential is found to be ΔV. When photons of wavelength λ_2 are used, the corresponding stopping potential was thricle of the above value. If light of wavelength λ_3 is used, the stopping potential for this case would be

A. $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{1}{2\lambda_2}-\frac{1}{\lambda_1}\right]$

B. $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{1}{2\lambda_2}-\frac{3}{\lambda_1}\right]$

C. $\frac{hc}{e}\left[\frac{1}{\lambda_3}+\frac{1}{\lambda_2}-\frac{1}{\lambda_1}\right]$

D. $\frac{hc}{e}\left[\frac{1}{\lambda_3}-\frac{1}{\lambda_2}-\frac{1}{\lambda_1}\right]$

Answer: B

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140. The ionization of the ionized sodium atom Na^{10} is:

A. $13.6eV$

B. $13.6 \times 11eV$

C. $(13.6/11)eV$

D. $13.6 \times (11^2)eV$

Answer: D

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141. The shortest wavelength produced in an X-ray tube operating at 0.5 million volt is

A. dependent on the target element

B. about $2.5 \times 10^{-12} m$

C. double of the shortest wavelength produced at 1 milllion volt

D. dependent only on the target material

Answer: C

Watch Video Solution

142. If the K_{α} radiation of $Mo(Z = 42)$ has a wevelength of 0.71Å, calculate wevelength of the corresponding radiation of $Cu, i.e., k_{\alpha}f$ or $Cu(Z = 29)$ assuming b = 1.

A. 1Å

B. 2Å

C. 1.52Å

D. 1.25Å

Answer: B

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143. A beam of electron accelerated by a large potential difference V is mode of strike a metal target of produce X-ray . For what value of V , will the resulting X-ray have the lower minimum wavelength?

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144. The minimum kinetic energy required for ionization of a hydrogen atom is E_1 in case electron is collided with hydrogen atom , it is E_2 if the the hydrogen ion is collided and E_3 when helium ion collided . Then.

A. $E_1 = E_2 = E_3$

B. $E_1 > E_2 > E_3$

C. $E_1 < E_2 < E_3$

D. $E_1 > E_3 > E_2$

Answer: C

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145. According to Bohr's theory, the time averaged magnetic field at the centre (i.e. nucleus) of a hydrogen atom due to the motion of electrons in the nth orbit is proportional to : (n = principal quantum number)

A. $\frac{n^3}{z^5}$

B. $\frac{n^4}{z}$

C. $\frac{z^2}{n^3}$

D. $\frac{z^3}{n^5}$

Answer: D

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146. Magnetic moment due to the motion of he electron in nth energy state of hydrogen atom is proportional to

A. n

B. n^0

C. n^5

D. n^3

Answer: A

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147. The ratio between total acceleration of the electron in singly ionized helium atom and hydrogen atom(both in ground state) is

A. 1

B. 8

C. 4

D. 16

Answer: B

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148. The shortest wavelength of the Brackett series of hydrogen like atom (atomic number =Z) is the same as the shortest wavelength of the Blamer series of hydrgeon atom . The value ofn Z is

A. 2

B. 3

C. 4

D. 6

Answer: A

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149. A hydrogen atom is in an exited state of principal quantum number n it emits a photon of wavelength λ when returns to the ground state The value of n is

A. $\sqrt{\lambda R(\lambda R - 1)}$

B. $\sqrt{\frac{\lambda(R-1)}{\lambda R}}$

C. $\sqrt{\frac{\lambda R}{\lambda R - 1}}$

D. $\sqrt{\lambda}(R-1)$

Answer: C

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150. A neutron moving with a speed v makes a head on collision with a hydrogen atom in ground state kept at rest. The minimum kinetic energy of neutron for which inelastic collision will take place is (asssume that mass of proton is nearly equal to the mass of neutron)

A. $10.2eV$

B. $20.4eV$

C. $12.1eV$

D. $16.8eV$

Answer: B

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151. In a hydrogen atom, the electron is in nth excited it comes down to first excited state by emitting ten different wavlength . The value of n is

A. 6

B. 7

C. 8

D. 9

Answer: A

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152. Angular momentum (L) and radius of hydrogen atom ae related as

A. $Lr = cons\tan t$

B. $Lr^2 = cons\tan t$

C. $Lr^4 = cons\tan t$

D. none of these

Answer: D

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153. The angular momentum of an electron in an orbit is quantized because it is a necessary condition for the

compatibility with

A. wave nature of electron

B. particle nature of electron

C. Pauli's exclusion behavior

D. none of these

Answer: A

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154. Find the maximum angular speed of the electron of a hydrogen atoms in a statoonary orbit

A. $6.2 \times 10^{15} rads^{-1}$

B. $4.1 \times 10^{16} rads^{-1}$

C. $24 \times 10^{10} rads^{-1}$

D. $9.2 \times 10^{6} rads^{-1}$

Answer: B

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155. In hydrogen and hydrogen like atoms the ratio of difference of energy $E_{4n} - E_{2n}$ and $E_{2n} - E_{n}$ varies with atomic number Z and principal quantum number n as

A. $\frac{z^2}{n^2}$

B. $\frac{z^4}{n^4}$

C. $\frac{z}{n}$

D. none of these

Answer: D

Watch Video Solution

156. According to Bahor's theory of hydrogen atom the product of the binding energy of the electron in the nth orbit and its radius in the nth ornit.

A. is proportional to n^2

B. is inversely proportional to n^3

C. has a consatnt valueof $10.2eV - \text{Å}$

D. has a consatnt valueof $7.2eV - \text{Å}$

Answer: D

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157. An electron and a photon have same wavelength If p is the momentum of electron and E the energy photon. The magnitude of p/E is SI unit is

A. 3.0×10^8

B. 3.33×10^{-9}

C. 9.1×10^{-31}

D. 6.64×10^{-34}

Answer: B

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158. In X-ray tube when the accelerating voltage V is halved.the difference between the wavelength of K_{α} line and minimum wavelength of continuous X-ray spectrum

A. remain constant

B. because more than two times

C. because half

D. because less than two times

Answer: D

Watch Video Solution

159. 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. $E = 6.8eV : \lambda = 6.6 \times 10^{-10}m$

B. $E = 3.4eV : \lambda = 6.6 \times 10^{-10}m$

C. $E = 3.4eV : \lambda = 6.6 \times 10^{-11}m$

D. $E = 6.8eV : \lambda = 6.6 \times 10^{-11} m$

Answer: B

Watch Video Solution

160. The circumference of the second Bohr orbit of electron in hydrogen atom is $600nm$. The potential difference that must be applied between the plates so that the electron have the de Broglie wavelength corresponding in this circumference is

A. $10^{-5} V$

B. $\frac{5}{3} 10^{-5} V$

C. $5 \times 10^{-5} V$

D. $3 \times 10^{-5} V$

Answer: D

Watch Video Solution

161. X-ray emitted from a copper target and a molybdenum target are found to contains a line of wavelength $22.85 nm$ attributed to the K_{α} line of an impurity element . The K_{α} line of copper $(Z = 29)$ and molybdenum $(Z = 42)$ have wavelength $15.42 nm$ and $7.12 nm$, respectively. The atomic number of the impurity element is

A. 22

B. 23

C. 24

D. 25

Answer: C

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162. An electron in a Bohr orbit of hydrogen atom with quantum number n has an angular momentum $4.2176 \times 10^{-34} kg - m^2 / \text{sec}$.If the electron drops from this level to the next lower level , the wavelength of this lines is

A. $18nm$

B. $187.6 \pm$

C. $1876Å$

D. $1.876 \times 10^4 Å$

Answer: D

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163. In the Bohr model of a $\pi - mesic$ atom , a $\pi - mesic$ of mass m_π and of the same charge as the electron is in a circular orbit of ratio of radius r about the nucleus with an orbital angular momentum $h/2\pi$. If the radius of a nucleus of atomic number Z is given by

$R = 1.6 \times 10^{-15} Z^{\frac{1}{3}} m$, then the limit on Z for which $(\varepsilon_0 h^2 / \pi m e^2 = 0.53 \text{Å} \text{ and } m_\pi / m_e = 264) \pi - mesic$ atoms might exist is

A. < 105

B. > 105

C. < 37

D. > 37

Answer: C

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164. In the spectrum of singly ionized helium , the wavelength of a line observed is almost the same as the first line of Balmer series of hydrogen . It is due to transition of electron

A. $\text{o}mn_1 = 6 \rightarrow n_2 = 4$

B. $\text{o}mn_5 = 6 \rightarrow n_2 = 3$

C. $\text{o}mn_1 = 4 \rightarrow n_2 = 2$

D. $\text{o}mn_1 = 3 \rightarrow n_2 = 2$

Answer: A

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165. AK_{α} X-ray emitted from a sample has an energy of `7.46 ke V. Of which element is the sample made?

A. Calucium $(Ca, Z = 20)$

B. Cobalt $(Co, Z = 27)$

C. Cadmium $(Cd, Z = 48)$

D. Nickel $(Ni, Z = 28)$

Answer: D

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166. 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 state of the atoms is $n = 4$

B. the initial state of the atoms may be $n = 2$

C. the initial state of the atoms may be $n = 3$

D. there are three transitions belonging to Lyman series

Answer: A::B::D

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167. Energy liberated in the de-excitation of hydrogen atom from the third level falls on a photo-cathode. Later when the same photo-cathode is exposed to a spectrum of some unknown - like gas, excited to the second energy level , it is found that the de Broglie wavelength of the fastest photoelectrons now ejected has decreased by a factor of 3. For this new gas, difference of energies of the second Lyman line and the first balmer line is found to be 3 times the ionization potential of the hydrogen atom. Select the correct statement (s):

A. The gas is lithium.

B. The gas is helium.

C. The work function of photo-cathode is $8.5eV$.

D. The work function of photo-cathode is $5.5eV$.

Answer: B::C

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168. Which of the following products, in a hydrogen atom , are independent of the principal quantum number n ? The symbels have their usual meanings.

A. $\omega^2 r$

B. $\frac{E}{v^2}$

C. $v^2 r$

D. $\frac{E}{c}$

Answer: B::C

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169. According to Bohr's theory of hydrogen atom , for the electron in the nth premissible orbit

A. Linear momentum $\propto \frac{1}{n}$

B. radius of orbit $\propto n$

C. Kinetic energy $\propto \frac{1}{n^2}$

D. angular momentum $\propto n$

Answer: A::C::D

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170. When a hydrogen atom is excited from ground state to first excited state, then a)its kinetic energy increased by 20 eV b)its kinetic energy decreased by 10.2 eV c)its potential energy increased by 20.4 eV d)its angular momentum increased by $1.05 \times 10^{-34} Js$

A. Not correct

B. Correct

C. Correct

D. Correct

Answer: B::C::D

Watch Video Solution

171. In an X-ray tube, the voltage applied is $20kV$. The energy required to remove an electron from $Lshellis19.9keV$ In the X-rays emitted by the tube.

A. minimum wavelength will be $62.1nm$.

B. energy of the characteristic x-rays will be equal to oe less than $19.9keV$.

C. L_{α} X-ray may be emitted.

D. L_{α} X-ray will have energy $19.9keV$.

Answer: A::B::C

Watch Video Solution

172. Supose the potential energy between electron and proton at a distance r is given by $-\frac{Ke^2}{3r^3}$. Applicatiojn of Bohr's theroy of hydrogen atom in this case shows that

A. energy in the nth orbit is proportional to n^6

B. energy is proportional to m^{-3} $(m = \text{mass of electron})$

C. energy in the nth orbit is proportional to n^{-2}

D. energy is proportional to m^3 (m = "mass of electron")`

Answer: A::B

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173. Let A_n be the area enclosed by the nth orbit in a hydrogen atom. The graph of in $(A_n \mid A_1)$ against In (n)

A. will pass through origin

B. will be a straight line with slop 4

C. will be a monotonically increasing nonlinear curve

D. will be a circle

Answer: A::B

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174. Mark out the correct statement(s).

A. Line spectra contain information about atoms only.

B. Line spectra contain information about both atoms and molecules.

C. Band spectra contain information about both atoms and molecules.

D. Bamd spectra contain information about molecules only.

Answer: B::D

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175. A hydrogen atom having kinetic energy E collides with a stationary hydrogen atom. Assume all motions are taking place along the line of motion of the moving hydrogen atom. For this situation, mark out the correct statement (s).

A. For $E \geq 20.4 eV$ only, collision would be elastic.

B. For $E \geq 20.4eV$ only, collision would be inelastic.

C. For $E = 2.4eV$ only, collision would be perfectly inelastic.

D. For $E = 18eV$ the KE of initially moving hydrogen atom after collisition is zero.

Answer: B::C::D

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176. In Bohr's model of hydrogen atom ,

A. the radius of nth orbit is proportional to n^2

B. the total energy of electron in nth orbit is proportional to n

C. the amgular momentum of the electron in an orbit is an integral multiple of $h/2\pi$

D. the magnitude of the potential energy of an electron in any orbit is greater than its kinetic energy

Answer: A::C::D

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177. Which of the following are in the ascending order of wavelength?

A. $H_{\alpha}, H_{\beta}, H_{\gamma}$,.... Lines in the Balmer series of hydrogen atom

B. Lyman limit, Balmer limit, and Paschen limit in the hydrogen spectrum

C. Violet, blue, yellow, and red colour in solar spectrum.

D. None of above.

Answer: B::C

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178. Continuous spectrum is produced by

A. incandesent electric bulb

B. sum

C. hydrogen molecules

D. sodium vapor lamp

Answer: A::B

Watch Video Solution

179. A gas of monoatomic hydrogen is bombarded with a stream of electrons that have been accelerated from rest through a potential difference of $12.75V$. In the emission spectrum, one can observe lines of

A. Lyman series

B. Balmer series

C. Paschen series

D. Pfund series

Answer: A::B::C

Watch Video Solution

180. If the potential energy of the electron in the first allowed orbit in hydrogen atom is E: its

A. ionization potential is E: its

B. kinetic energy is $-E/2$

C. total energy is $E/2$

D. none of these

Answer: A::B::C

Watch Video Solution

181. According to Bohr's theory of hydrogen atom , for the electron in the nth premissible orbit

A. the linear momentum is propotional to $(1/n)$

B. the radius is propotional to (n)

C. the kinetic energy is propotional to $(1/n^2)$

D. the angular momentum is propotional to (n)

Answer: A::C::D

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182. Whenever a hydrogen atom emitsa photon in the Balmer series .

A. It may emit another photon in the Balmer series

B. It must emit another photon in the lyman series

C. the second photon, if emitted, will have a wavelength of about $122 nm$

D. It may emit a second photon, the wavelength of this photon cannot be predicted

Answer: B::C

Watch Video Solution

183. Let $\lambda_{\alpha}, \lambda_{\beta}, \text{ and } \lambda'_{\alpha}$ denote the wavelength of the X-ray of the $K_{\alpha}, K_{\beta}, \text{ and } L_{\alpha}$ lines in the characteristic X-rays for a metal. Then.

A. $\lambda_{\alpha} > \lambda_{\alpha} > \lambda_{\beta}$

B. $\lambda_{\alpha} > \lambda_{\beta} > \lambda_{\alpha}$

C. $\frac{1}{\lambda_{\beta}} = \frac{1}{\lambda_{\alpha}} + \frac{1}{\lambda'_{\alpha}}$

D. $\frac{1}{\lambda_\alpha} = \frac{1}{\lambda_\beta} + \frac{1}{\lambda_\alpha}$

Answer: A::C

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184. Which of the following statements are correct for an X-ray tube?

A. On increasing potential difference between the filament and target, photon flux of X-rays increase.

B. On increasing potential difference between the filament and target, frequency of X-rays increases.

C. On increasing filament current, cut-off wavelength increases.

D. On increasing filament current, intensity of X-ray increases.

Answer: B::D

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185. Suppose frequency of emitted photon is f_0 when the electron of a stationary hydrogen atom jumps from a higher state m to a lower state n. If the atom is moving with a velocity $v(< < c)$ and emits a photon of frequency f during the same transition, then which of the following statement are possible?

A. f may be equal to f_0

B. f may be greater than f_0

C. f may be less than f_0

D. f cannot be equal to f_0

Answer: A::B::C

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186. Which of the following statements about hydrogen spectrum are correct?

A. All the lines of Lyman series lie in ultraviolet regien.

B. All the lines of Balmer series lie in visible regien.

C. All the lines of Paschen series lie in infrared regien.

D.

Answer: A::C

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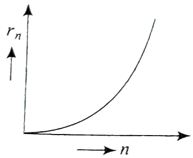
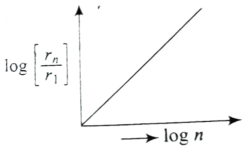
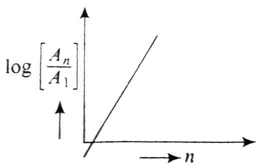
187. If, in a hydrogen atom, radius of nth Bohr orbit is r_n frequency of revolution of electron in nth orbit is f_n

and area enclosed by the nth orbit is A_n , then which of the pollowing graphs are correct?

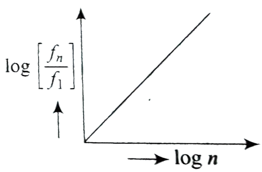
A. 

B. 

b.

C. 

c.

D. 

d.

Answer: A::B::C

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Multiple Correct

1. Which of the following statements are true?

A. The shortest wavelength of X-rays emitted from an X-ray tube depends on the corrent in the tube.

B. Characteristic X-ray spectra is simple as compared to optical spectra.

C. X-ray cannot be different by means of an ordianary grating.

D. Three exist a sharp limit on the short wavelength side for each continous X-ray spectrum

Answer: B::C::D

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2. An X-ray tube is operated at $6.6kV$. In the continuous spectrum of the emitted X-rays, which of the following frequency will be missing?

A. $10^{18} Hz$

B. $1.5 \times 10^{18} Hz$

C. $2 \times 10^{18} Hz$

D. $2.5 \times 10^{18} Hz$

Answer: C::D

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3. Which of the following statements are correct?

A. If angular momentum the Earth due to its motion around the Sun were quantized according to Bohr's ralation $L = nh/2\pi$, then the quantum number$n$ would be the order of 10^{74}

B. If element with principal quantum number > 4 were not allowed in nature , then the number number of possible element would be 64.

C. Rydberg's constant varies with mass number of the elment.

D. The ratio of the wave number of H_a lines of Balmer series for hydrogen and that of H_a line of Balmer series for singly ionized helium is excatly4

Answer: A::C

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4. According to Einstein's theory of relativity, mass can be converted into energy and vice-versa. The lightest elementary partical, taken to be the electron, has a mass equivalent to $0.51MeV$ of energ. Then, we can say that

A. the minimum amount of energy avalible through conversition of mass into energy is $1.2 MeV$

B. the least energy of a λray photon that can be converted into mass is $1.02 MeV$

C. whereas the minimum energy released by conversion of mass into energy is $1.02 MeV$, it is only a λ- ray photon of energy $0.51 MeV$ and above that can be converted into mass

D. whereas the minimum energy released by conversion of mass into energy is $0.51 MeV$, it is only a λ- ray photon of energy $1.01 MeV$ and above that can be converted into mass

Answer: A::B

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5. X-ray from a tube with a target A of atomic number Z shows strong K lines for target A and weak$K$ lines for impurities. The wavelength og K_α lines is λ_z for target A and λ_1 and λ_2 for two impurities.

$$\frac{\lambda_z}{\lambda_1} = 4 \text{ and } \frac{\lambda_z}{\lambda_2} = \frac{1}{4}$$

Assuming the screeining contant of K_α lines to be unity select the correct statement(s).

A. The atomic number of first impurity is $2z - 1$.

B. The atomic number of first impurity is $2z + 1$.

C. The atomic number of second impurity is $\frac{(z+1)}{2}$

.

D. The atomic number of second impurity is $\frac{z}{2}+1.$

Answer: A::C

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6. 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. $\frac{T}{R}$

D. $\frac{V}{E}$

Answer: A::C::D

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7. An X-ray tube is operated at $50kV$ and $20mA$. The target material of the tube has mass of $1kg$ and specific heat $495Jkg^{-1}$^(@)C^(-1)`. One perent of applied electric power is converted into X-rays and the remaining energy goes into heating the target. Then,

A. a suitable target metrial must have hight melting temprature.

B. a suitable target metrial must have low thermal conductivity.

C. the average rate of rice of temprature of the target would be $2^\circ Cs^{-1}$

D. the minimum wavelength of X-rays emitted is about $0.25 \times 10^{-10} m$

Answer: A::C

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8. For a cartain metal, the K obsorption edge is at 0.72Å. The wavelength of $K_{\alpha}, K_{\beta}. And K_{\gamma}$ lines of of K series are $0.210\text{Å}, 0.192\text{Å}, \text{ and } 0.180\text{Å}, respectively. Thee \neg giesof$ K, L and M $\text{ or } bitare$E_(K), E_(L) and E_(M)`, respectively. Then

A. $E_K = -13.04keV$

B. $E_L = -7.52keV$

C. $E_M = -3.21keV$

D. $E_K = -13.04keV$

Answer: A::B::C

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9. The third line of the Balmer series spectrum of a hydrogen-like ion of atomic number Z equals to $108.5nm$. The binding energy of the electron in the ground state of these ions is E_n. Then

A. $Z = 2$

B. $E_B = 54.4eV$

C. $Z = 3$

D. $E_B = 122.4eV$

Answer: A::B

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10. Assertion: In a hydrogen atom energy of emitted photon corresponding to transition from $n = 2$ to $n = 1$ is such greater as compared to transition from $n = \infty$ to $n = 2$.

Reason: Wavelength of photon is directly proportional to the energy of emitted photon.

A. Statement I is True , Statement II is True , Statement II is a correct explanation for Statement I.

B. Statement I is True , Statement II is True , Statement II is NOT a correct explanation for Statement I.

C. Statement I is True , Statement II is False.

D. Statement I is False , Statement II is True.

Answer: C

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11. Statement I: In an X-ray tube , if the energy with which an electron strickes the metal target increases , then the wavelength of the characteristic X-rays also changes.

Statement II : Wavelength of the characteristic X-rays depends only on the initial and final energy levels.

A. Statement I is True , Statement II is True , Statement II is a correct explanation for Statement I.

B. Statement I is True , Statement II is True , Statement II is NOT a correct explanation for Statement I.

C. Statement I is True , Statement II is False.

D. Statement I is False , Statement II is True.

Answer: D

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12. Statement I : The energy of a He^{+} ion for a given n is almost exactly four times that of H atom for the same n.

Statement II : Photon emitted during transition between corresponds pair of levels in He^{+} and H have the same energy E and the same wavelength $\lambda = hc/E$.

A. Statement I is True , Statement II is True , Statement II is a correct explanation for Statement I.

B. Statement I is True , Statement II is True , Statement II is NOT a correct explanation for

Statement I.

C. Statement I is True , Statement II is False.

D. Statement I is False , Statement II is True.

Answer: A

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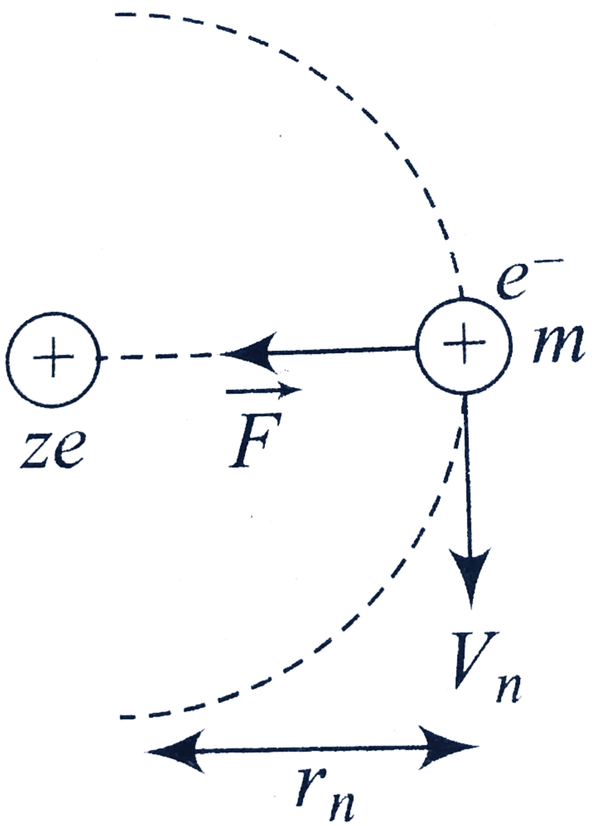
13. Hydrogen is the simplest atom of nature. There is one proton in its nucleus and an electron moves around the nucleus in a circular orbit. According to Niels Bohr's, this electron moves in a stationary orbit, if emits no electromagnetic radiation. The angular momentum of the electron is quantized , i.e., $mvr = (nh/2\pi)$, where

$m =$ mass of the electron , $v =$ velocity of the electron in the orbit , $r =$ radius of the orbit , and $n = 1, 2, 3....$

When transition takes place from Kth orbit to Jth orbit, energy photon is emitted. If the wavelength of the emitted photon is λ.



we find that $\dfrac{1}{\lambda} = R\left[\dfrac{1}{J^2} - \dfrac{1}{K^2}\right]$, where R is

Rydberg's constant.

On a different planed, the hydrogen atom's structure was somewhat different from ours. The angular momentum of electron was $P = 2n(h/2\pi)$. i.e., an even multipal of $(h/2\pi)$.

Answer the following questions regarding the other planet based on above passage:

The minimum permissible radius of the orbit will be

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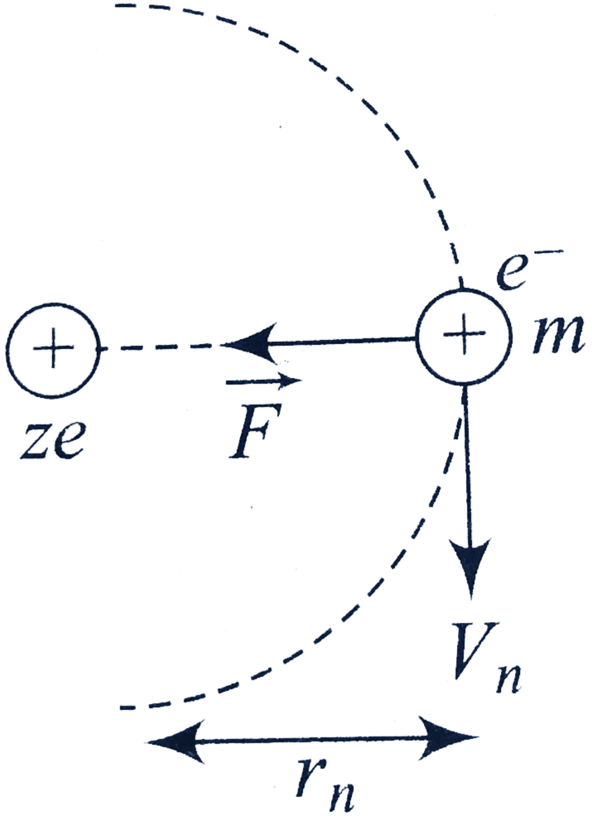
Linked Comprehension

1. Hydrogen is the simplest atom of nature. There is one proton in its nucleus and an electron moves around the nucleus in a circular orbit. According to Niels Bohr's, this electron moves in a stationary orbit, if emits no electromagnetic radiation. The angular momentum of the electron is quantized , i.e., $mvr = (nh/2\pi)$, where $m =$ mass of the electron , $v =$ velocity of the electron in the orbit , $r =$ radius of the orbit , and $n = 1, 2, 3$.... When transition takes place from Kth orbit to Jth orbit, energy photon is emitted. If the wavelength of the emitted photon is λ.



we find that $\frac{1}{\lambda} = R\left[\frac{1}{J^2} - \frac{1}{K^2}\right]$, where R is Rydberg's constant.

On a different planed, the hydrogen atom's structure was somewhat different from ours. The angular momentum of electron was $P = 2n(h/2\pi)$. i.e., an even multipal of $(h/2\pi)$.

Answer the following questions regarding the other planet based on above passage:

In our world, the velocity of electron is v_0 when the hydrogen atom is in the ground state on the other planet should be

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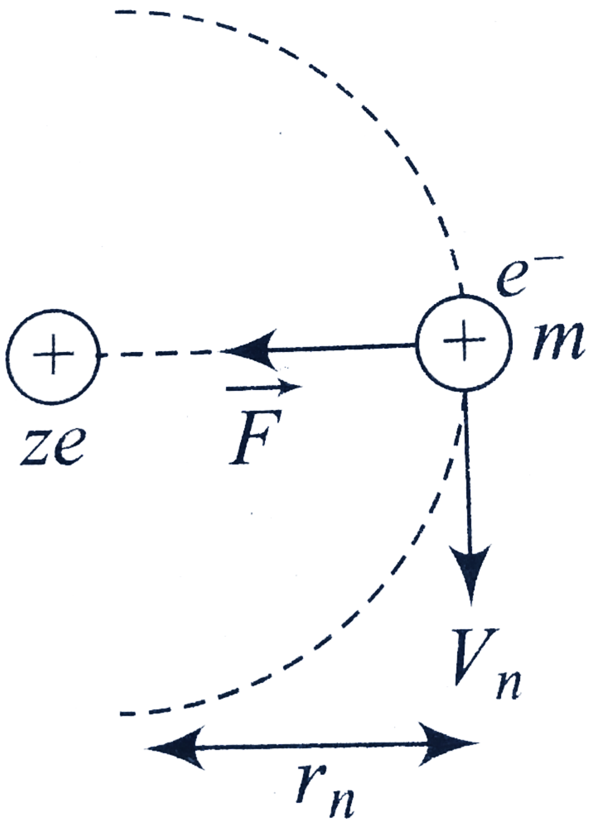
2. Hydrogen is the simplest atom of nature. There is one proton in its nucleus and an electron moves around the nucleus in a circular orbit. According to Niels Bohr's, this electron moves in a stationary orbit, if emits no electromagnetic radiation. The angular momentum of the electron is quantized , i.e., $mvr = (nh / 2\pi)$, where $m =$ mass of the electron , $v =$ velocity of the electron in the orbit , r = radius of the orbit , and $n = 1, 2, 3....$

When transition takes place from Kth orbit to Jth orbit, energy photon is emitted. If the wavelength of the emitted photon is λ.



we find that $\dfrac{1}{\lambda} = R\left[\dfrac{1}{J^2} - \dfrac{1}{K^2}\right]$, where R is Rydberg's constant.

On a different planet, the hydrogen atom's structure was somewhat different from ours. The angular momentum of electron was $P = 2n(h/2\pi)$. i.e., an even multiple of $(h/2\pi)$.

Answer the following questions regarding the other planet based on above passage:

In our world, the ionization potential energy of a hydrogen atom is $13.6eV$. On the other planet, this ionization potential energy will be

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3. In an ordianary atom, as a first approximation, the motion of the nucleus can be ignored. In a positronium atom a positronreplaces the proton of hydrogen atom.

The electron and positron masses are equal and , therefore , the motion of the positron cannot be ignored. One must consider the motion of both electron and positron about their center of mass. A detailed analyasis shows that formulae of Bohr's model apply to positronium atom provided that we replace m_e by what is known reduced mass is $m_e/2$.

The orbital radius of the first excited level of postronium atom is

A. $4a_0$

B. $a_0/2$

C. $8a_0$

D. $2a_0$

Answer: C

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4. In an ordianary atom, as a first approximation, the motion of the nucleus can be ignored. In a positronium atom a positronreplaces the proton of hydrogen atom. The electron and positron masses are equal and , therefore , the motion of the positron cannot be ignored. One must consider the motion of both electron and positron about their center of mass. A detailed analyasis shows that formulae of Bohr's model apply to positronium atom provided that we replace m_e by what is known reduced mass is $m_e / 2$.

If the Rydberg constant for hydrogen atom is R , then the Rydberg constant for positronium atom is

A. $2R$

B. R

C. $R/2$

D. $4R$

Answer: C

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5. In an ordianary atom, as a first approximation, the motion of the nucleus can be ignored. In a positronium atom a positronreplaces the proton of hydrogen atom. The electron and positron masses are equal and , therefore , the motion of the positron cannot be ignored. One must consider the motion of both electron and positron about their center of mass. A detailed analaysis shows that formulae of Bohr's model apply to positronium atom provided that we replace m_e by what is known reduced mass is $m_e / 2$.

When system de-excites from its first excited state to ground state, the wavelngth of radiation is

A. $1217 Å$

B. $2431 Å$

C. $608 Å$

D. none of these

Answer: B

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6. The electrons in a H- atom kept at rest , jumps from the mth shell to the nth shell $(m > n)$. Suppose instead of emitting electromagnetic wave, the energy released is converted into kinetic energy of the atom. Assuming Bohr's model and conservation of angular momentum are valid. Now , answer the following questions:

What principal is violated of inertia

A. Laws of motion

B. Energy conservation

C. Nothing is violated

D. Cannot be decided

Answer: A

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7. The electrons in a H- atom kept at rest , jumps from the mth shell to the nth shell $(m > n)$. Suppose instead of emitting electromagnetic wave, the energy released is converted into kinetic energy of the atom. Assuming Bohr's model and conservation of angular momentum are valid. Now , answer the following questions:

Calculate the angular velocity of the atom about the nucleus if l is the momentum of inertia

A. $\frac{(m+n)}{6.28}\frac{h}{l}$

B. $\frac{(m+n)}{1.57}\frac{h}{l}$

C. $\frac{(m-n)}{6.28}\frac{h}{l}$

D. $\frac{(m-n)}{1.57}\frac{h}{l}$

Answer: C

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8. The electrons in a H- atom kept at rest , jumps from the mth shell to the nth shell $(m > n)$. Suppose instead of emitting electromagnetic wave, the energy released is converted into kinetic energy of the atom. Assuming Bohr's model and conservation of angular momentum are valid. Now , answer the following questions:

If the above comprehension be true , ehat is not valid here?

A. $F = ma$

B. $\tau = 1\alpha$

C. $F = dp/dt$

D. All of them

Answer: D

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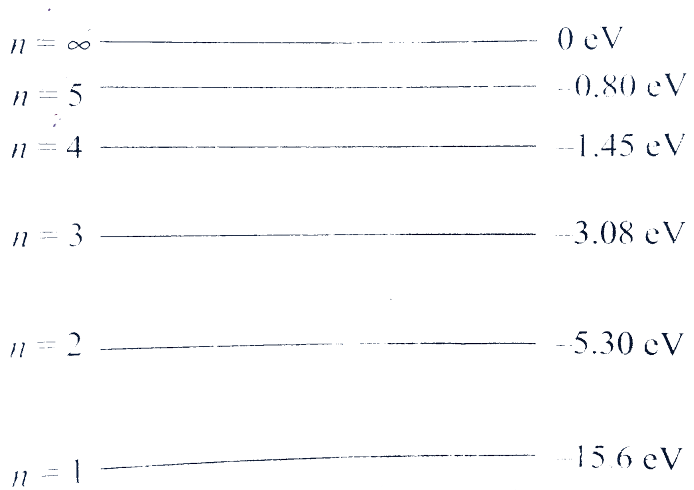
9. The energy levels of a hypothetical one electron atom are shown in figure



Find the ionization potential of the atom.

A. $11.2eV$

B. $13.5eV$

C. $15.6eV$

D. $12.6eV$

Answer: C

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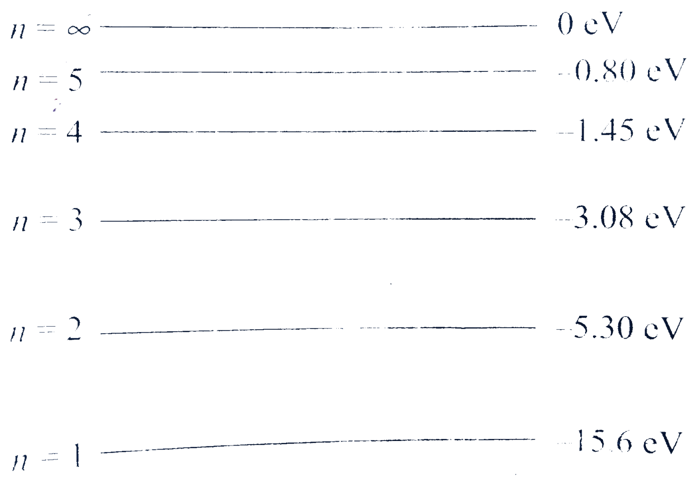
10. The energy levels of a hypothetical one electron atom are shown in figure



Find the short wavelength limit of the series terminating at $n = 2$.

A. 3256Å

B. 2339Å

C. 2509Å

D. 3494Å

Answer: B

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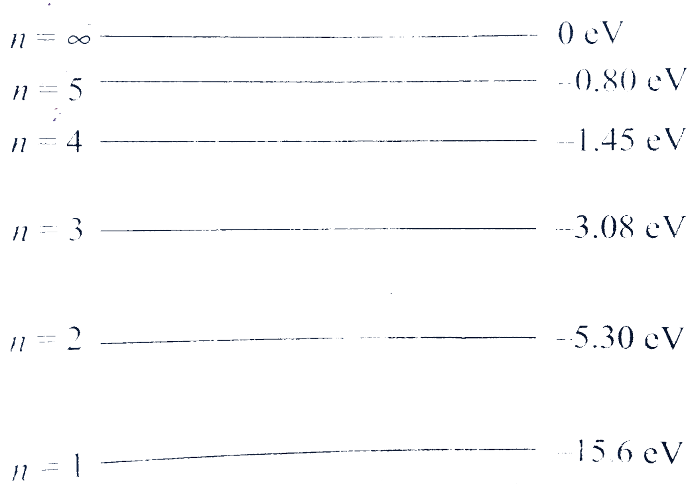
11. The energy levels of a hypothetical one electron atom are shown in figure



Find the excitation potential for the state $n = 3$.

A. $14.64eV$

B. $9.93eV$

C. $12.52eV$

D. $10.04 eV$

Answer: C

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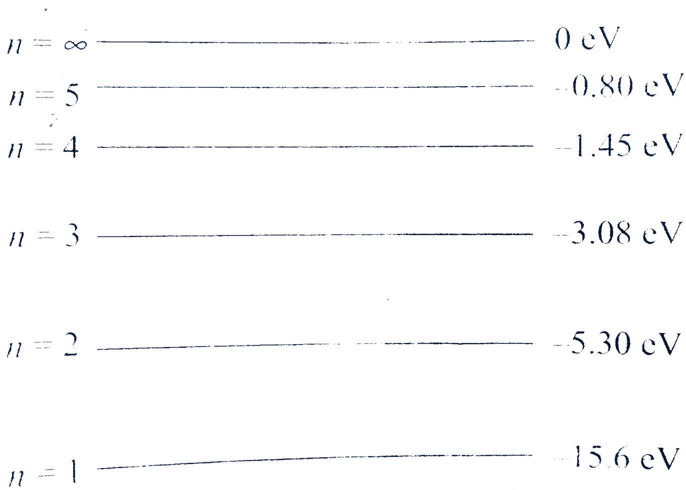
12. The energy levels of a hypotherical one electron atom are shown in figure



Find the wave number of the photon emitted for the transition $n = 3 \rightarrow n = 1$

A. $2.23 \times 10^7 m^{-1}$

B. $1.009 \times 10^7 m^{-1}$

C. $3.005 \times 10^6 m^{-1}$

D. $0.432 \times 10^6 m^{-1}$

Answer: B

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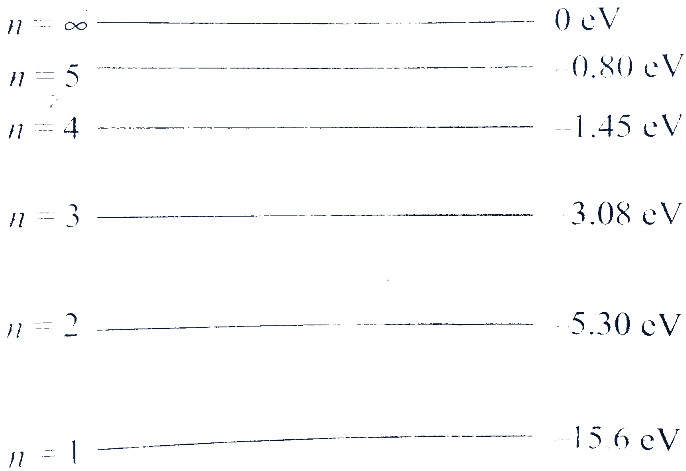
13. The energy levels of a hypothetical one electron atom are shown in figure



If an electron with initial kinetic energy $6eV$ is to interact with this hypothetical atom , what minimum energy will this electron carry after interaction?

A. $2eV$

B. $3eV$

C. $6eV$

D. $0eV$

Answer: C

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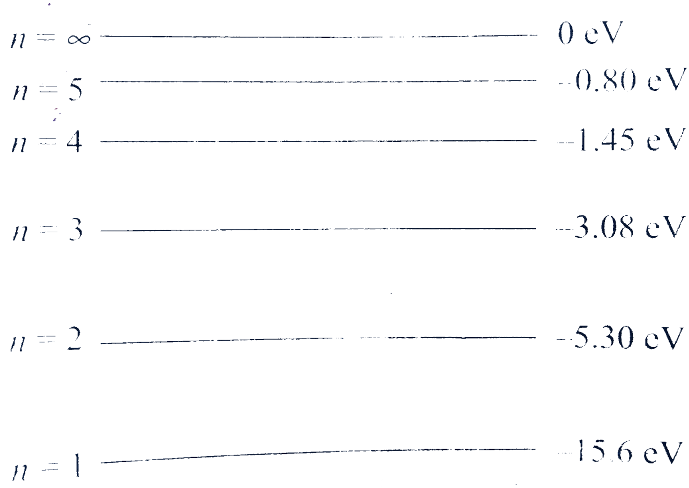
14. The energy levels of a hypothetical one electron atom are shown in figure



The initial kinetic energy of an electron is $11eV$ and it interact with the above said hypothetical one electron atom , the minimum energy carried by the electron after interaction is

A. $0.7eV$

B. $0.3eV$

C. $0.9eV$

D. $1eV$

Answer: A

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15. The electron in a hydrogen atom at rest makes a transition from $n=2$ energy state to the $n=1$ ground state.

find the energy (eV) of the emitted photon.

A. $5.8eV$

B. $8.3eV$

C. $10.2eV$

D. $12.7eV$

Answer: C

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16. The electron in a hydrogen atom at rest makes a transition from $n=2$ energy state to the $n=1$ ground state.

Assuming that all of the energy corresponding to transition from $n=2 \rightarrow n=1$ is carried off by the photon. By setting the momentum of the system (atom + photon) equal to zero after the emission and assuming that the recoil energy of the atom is smaller compared with the $n = 2 \rightarrow n = 1$ energy level separation , find the energy of the recoiling hydrogen atom.

A. $2.75 \times 10^{-7} eV$

B. $5.54 \times 10^{-8} eV$

C. $8.11 \times 10^{-8} eV$

D. $10.36 \times 10^{-7} eV$

Answer: B

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17. For a certain hypothetical one electron atom, the wavelength $(\in \text{Å})$ 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 of this element?

A. 1800Å

B. 1500Å

C. 1300Å

D. 1650Å

Answer: B

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18. 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 of this element?

A. $3.96V$

B. $9.23V$

C. $6.34V$

D. $8.28V$

Answer: D

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19. A sample of hydrogen gas in its ground state is irradiated with photons of $10.02eV$ energies. The radiation from the above sample is used to irradiate two other sample of excited ionized He^{+} and excited ionized Li^{2+}, repectively. Both the ionized samples absorb the incident radiation.

How many spectral lines are obtained in the spectra of Li^{2+}?

A. 10

B. 15

C. 20

D. 17

Answer: B

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20. A sample of hydrogen gas in its ground state is irradiated with photons of $10.2eV$ energies. The radiation from the above sample is used to irradiate two other sample of excited ionized He^{+} and excited ionized Li^{2+}, repectively. Both the ionized samples absorb the incident radiation.

What is the smallest wavelength that will be observed in spectra of He^{+} ion ?

A. $24.4nm$

B. $28.8nm$

C. $22.2nm$

D. $30.6nm$

Answer: A

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21. A sample of hydrogen gas in its ground state is irradiated with photons of $10.2 eV$ energies. The radiation from the above sample is used to irradiate two other sample of excited ionized He^{+} and excited ionized Li^{2+}, repectively. Both the ionized samples absorb the incident radiation.

How many spectral lines are obtained in the spectra of He^{+} ion?

A. 2

B. 4

C. 6

D. 8

Answer: C

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22. A sample of hydrogen gas in its ground state is irradiated with photons of $10.2eV$ energies. The radiation from the above sample is used to irradiate two other sample of excited ionized He^{+} and excited ionized Li^{2+}, repectively. Both the ionized samples absorb the incident radiation.

Which is the smallest wavelength that will be observed in spectra of Li^{2+} ?

A. $8.6nm$

B. $10.4nm$

C. $12.8nm$

D. $14.6nm$

Answer: B

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23. A neutron of kinetic $65eV$ collides inelastically with a singly ionized helium atom at rest. It is scattered at an angle 90° with respect to its original direction.

Find the minimum allowed value of energy of the neutron.

A. $0.39eV$

B. $0.32eV$

C. $0.25eV$

D. $0.43eV$

Answer: B

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24. A neutron of kinetic $6.5eV$ collides inelastically with a singly ionized helium atom at rest. It is scattered at an angle 90° with respect to its original direction.

Find the maximum allowed value of energy of the He atom?

A. $13.68eV$

B. $19.88eV$

C. $15.26eV$

D. $17.84eV$

Answer: D

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25. Soppose potential energy between electronand proton at seperation r is given by $U = k \log r, wherek$ is a constant. For such a hypothetical hydrogen atom , calculate the radins of nth Bohr and its energy level

A. $\frac{2nh}{\pi\sqrt{mk}}$

B. $\frac{nh}{2\pi\sqrt{2mk}}$

C. $\frac{nh}{2\pi\sqrt{mk}}$

D. $\frac{nh}{4\pi\sqrt{mk}}$

Answer: C

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26. Soppose potential energy between electronand proton at seperation r is given by $U = k \log r, wherek$ is a constant. For such a hypothetical hydrogen atom , calculate the radins of nth Bohr and its energy level

A. (k)/(2) [1 + log (n^(2) h^(2))/(4 pi^(2)mk)]`

B. $2k\left[2+\frac{\log(n^2h^2)}{4\pi^2mk}\right]$

C. $k\left[2+\frac{\log(n^2h^2)}{4\pi^2mk}\right]$

D. (k)/(2) [1 + log (n^(2) h^(2))/(2 pi^(2)mk)]`

Answer: A

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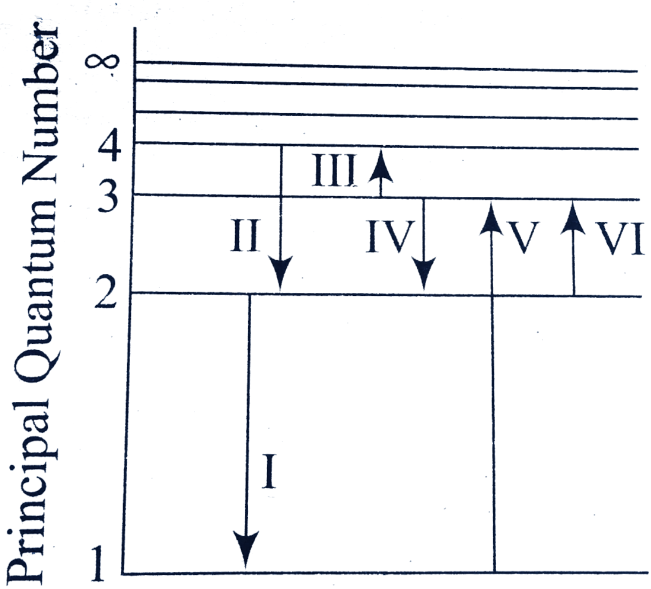
27. Pertain to the following statement and figure



The figure above shown level diagram of the hydrogen atom. Serveral transition are market as I, II, III, ... The diagram is only indicative and not to scale.

In which transition ia a Balmer series photon absorbed?

A. II

B. III

C. IV

D. VI

Answer: D

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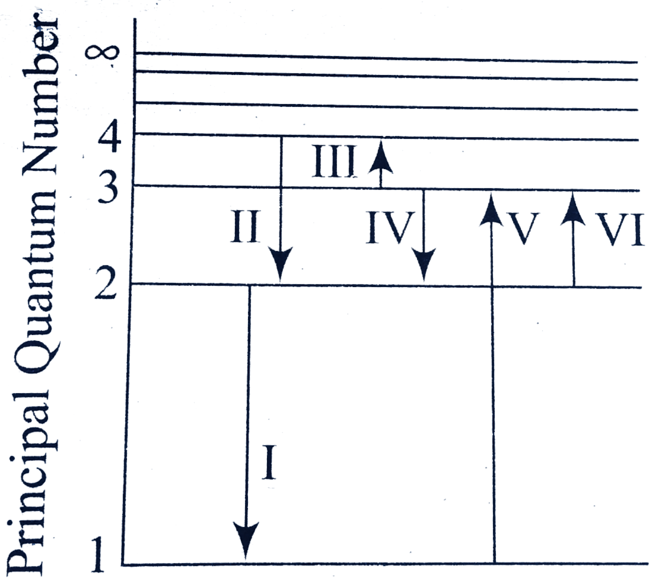
28. Pertain to the following statement and figure



The figure above shown level diagram of the hydrogen atom. Serveral transition are market as I, II, III, ... The diagram is only indicative and not to scale.

The wavelength of the radiation involved in transition II is:

A. $291nm$

B. $364nm$

C. $487nm$

D. $652nm$

Answer: C

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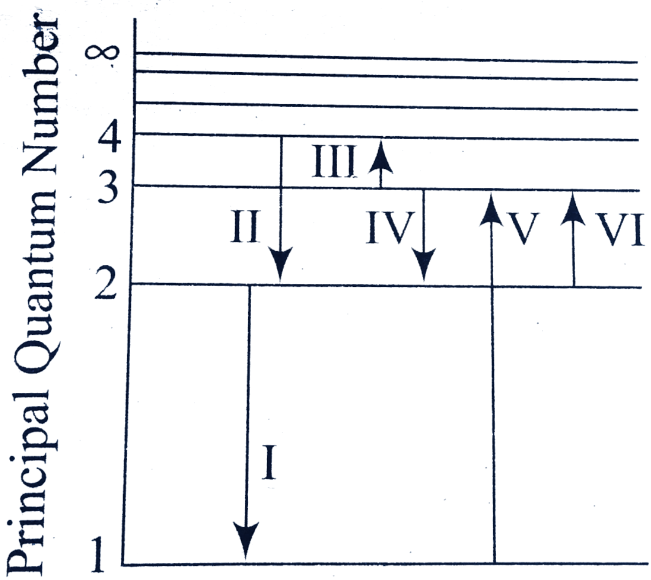
29. Pertain to the following statement and figure



The figure above shown level diagram of the hydrogen atom. Serveral transition are market as I, II, III, ... The diagram is only indicative and not to scale.

Which transition will occur when a hydrogen atom is irradiated with radiation of wavelength $103nm$?

A. I

B. III

C. IV

D. V

Answer: D

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30. A certain species of ionized atoms produces emission line spectral accorduing to the Bohr's model. A group of lines in the spectrum is forming a series in which in the shortest wavelength is $22.79nm$ and the longest wavelength is $41.02nm$. The atomic number of atom is Z.

Based on above information, answer the following question:

The series belongs to

A. 2

B. 3

C. 4

D. 5

Answer: C

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31. A certain species of ionized atoms produces emission line spectral accorduing to the Bohr's model. A group of lines in the spectrum is forming a series in which in the shortest wavelength is $22.79nm$ and the longest wavelength is $41.02nm$. The atomic number of atom is Z.

Based on above information, answer the following question:

The series belongs to

A. Lyman

B. Balmer

C. Paschen

D. Brackett

Answer: B

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32. A certain species of ionized atoms produces emission line spectral accorduing to the Bohr's model. A group of lines in the spectrum is forming a series in which in the shortest wavelength is $22.79nm$ and the longest wavelength is $41.02nm$. The atomic number of atom is Z.

Based on above information, answer the following question:

The next to longest wavelength in the series of lines is

A. $35.62nm$

B. $30.47nm$

C. $25.68nm$

D. $12.64nm$

Answer: B

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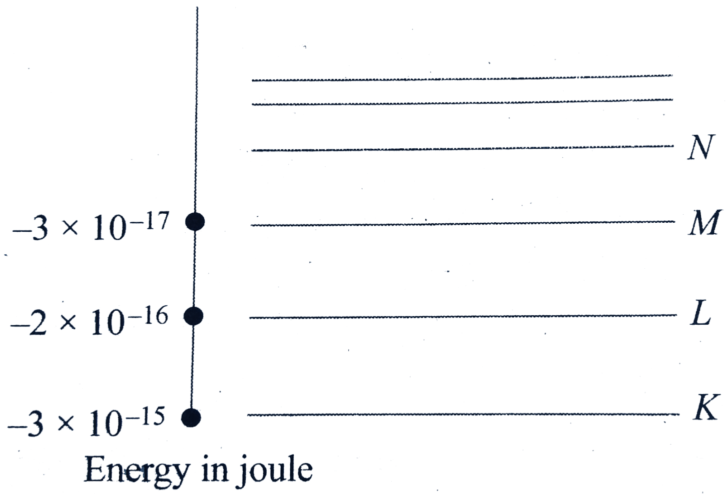
33. Simplified model of electron energy levels for a cartain atom is shown in figure. The atom is bombarded will fast moving electrons. The impact of one of these electrons can cause the removal of electron from K-level , thus, creating a vacancy in the K-level. This vacancy in K-level is filled by an electron from l-level and the energy reased in this transition can either appear as electromagnetic waves or may all be used knock out an electron from M-level of the atom.



Based on above information, answer the following question:

The minimum potential difference through which bombarding electron beam must be acclerated from rest to cause the ejection of electron from K-level is.

A. $18750V$

B. $400kV$

C. $16kV$

D. $21.6kV$

Answer: A

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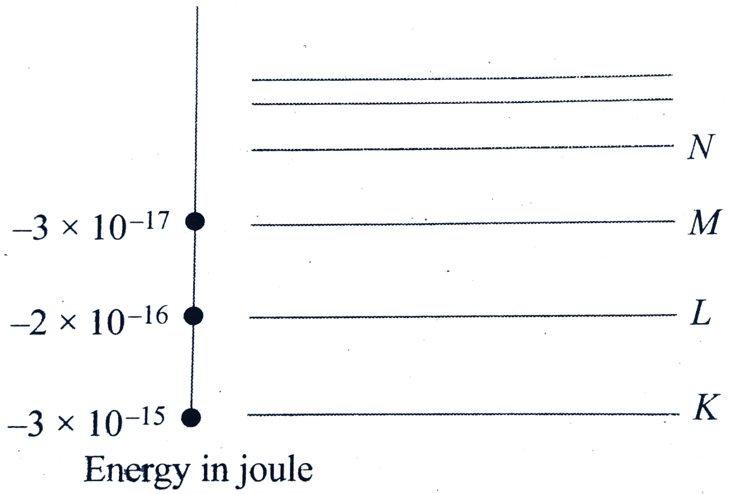
34. Simplified model of electron energy levels for a cartain atom is shown in figure. The atom is bombarded will fast moving electrons. The impact of one of these electrons can cause the removal of electron from K-level , thus, creating a vacancy in the K-level. This vacancy in K-level is filled by an electron from l-level and the energy reased in this transition can either appear as electromagnetic waves or may all be used knock out an electron from M-level of the atom.



Based on above information, answer the following question:

Wavelength of the electromagnetic waves emitted due to transition from L to K-level is

A. $8 \times 10^{-10} m$

B. $7.104 \times 10^{-11} m$

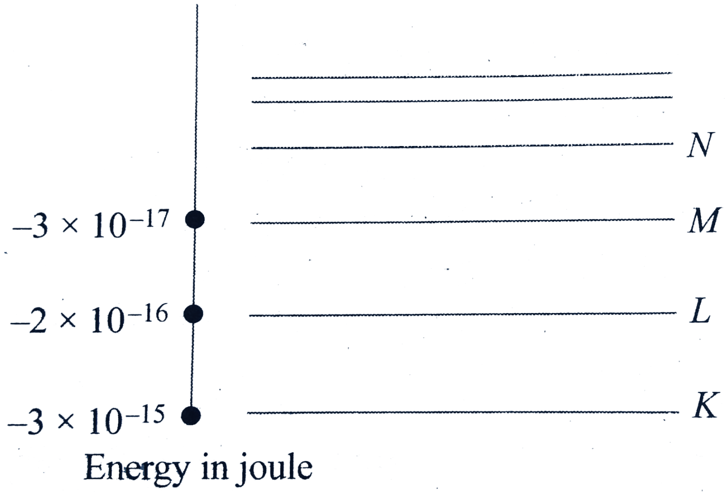
C. $22.46nm$

D. $142.6 \times 10^{-8} m$

Answer: B

Watch Video Solution

35. Simplified model of electron energy levels for a cartain atom is shown in figure. The atom is bombarded will fast moving electrons. The impact of one of these electrons can cause the removal of electron from K-level , thus, creating a vacancy in the K-level. This vacancy in K-level is filled by an electron from l-level and the energy reased in this transition can either appear as electromagnetic waves or may all be used knock out an electron from M-level of the atom.



Based on above information, answer the following question:

The KE of the emitted electron from M-level is

A. $260 \times 10^{-17} J$

B. $2 \times 10^{-18} J$

C. $280 \times 10^{-17} J$

D. $227 \times 10^{-17} J$

Answer: D

Watch Video Solution

36. A monochromatic beam of light having photon energy $12.5eV$ is incident on a simple A of atomic hydrogen gas in which all almost are in the ground state. The emission spectra obtained from this sample is incident on another sample B of atomic hydrogen gas in which all atoms are in the first excited state.

Based on above information, answer the following question:

The atoms of sample A after passing of light through it

A. may be in the first excited state

B. may be in the second excited state

C. may be in both first and second excited state

D. None of above.

Answer: D

Watch Video Solution

37. A monochromatic beam of light having photon energy $12.5eV$ is incident on a simple A of atomic hydrogen gas in which all almost are in the ground state. The emission spectra obtained from this sample is incident on another sample B of atomic hydrogen gas in which all atoms are in the first excited state.

Based on above information, answer the following question:

The emission spectra of sample A

A. must have 3 lines

B. must have 2 lines

C. may have 2 lines

D. it is not formed

Answer: D

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38. A monochromatic beam of light having photon energy $12.5eV$ is incident on a simple A of atomic hydrogen gas in which all almost are in the ground state. The emission spectra obtained from this sample is incident on another sample B of atomic hydrogen gas in which all atoms are in the first excited state.

Based on above information, answer the following question:

The atoms of sample B

A. will ionize when emission spectra of A is incident on B

B. may ionize when emission spectra of A is incident on B

C. will be excited to some higher state but won't ionize

D. None of above.

Answer: D

Watch Video Solution

39. A single electron orbit around a stationary nucleus of charge $+Ze$ where Z is a constant and e is the magnitude of the electronic charge. It requires$47.2eV$ to excite the electron from the second bohr orbit to the third bohr orbit. Find

(i) The value of Z

(ii) The energy required by nucleus to excite the electron from the third to the fourth bohr orbit

(iii) The wavelength of the electronmagnetic radiation required to remove the electron from the first bohr orbit to inlinity

(iv) The energy potential energy potential energy and the angular momentum of the electron in the first bohr orbit

(v) The radius of the first bohr orbit (The ionization energy of hydrogen atom $= 13.6 eV$ bohr radius $= 5.3 \times 10^{-11} matre$ velocity of light $= 3 \times 10^{8} m/\sec$ planks 's constant $= 6.6 \times 10^{-34}$ jules - sec)

A. 5

B. 4

C. 3

D. 2

Answer: A

Watch Video Solution

40. A single electron orbit around a stationary nucleus of charge $+Ze$ where Z is a constant and e is the magnitude of the electronic charge. It requires$47.2eV$ to excite the electron from the second bohr orbit to the third bohr orbit. Find

(i) The value of Z

(ii) The energy required by nucleus to excite the electron from the third to the fourth bohr orbit

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A. $0.529 \times 10^{-10} m$

B. $0.106 \times 10^{-10} m$

C. $0.318 \times 10^{-10} m$

D. none of these

Answer: B

Watch Video Solution

41. A single electron orbit around a stationary nucleus of charge $+Ze$ where Z is a constant and e is the magnitude of the electronic charge. It requires $47.2eV$ to excite the electron from the second bohr orbit to the third bohr orbit. Find

(i) The value of Z

(ii) The energy required by nucleus to excite the electron from the third to the fourth bohr orbit

(iii) The wavelength of the electronmagnetic radiation required to remove the electron from the first bohr orbit to inlinity

(iv) The energy potential energy potential energy and the angular momentum of the electron in the first bohr orbit

(v) The radius of the first bohr orbit (The ionization energy of hydrogen atom $= 13.6 eV$ bohr radius $= 5.3 \times 10^{-11} matre$ velocity of light $= 3 \times 10^{8} m / \sec$ planks 's constant $= 6.6 \times 10^{-34}$ jules - sec)

A. $0.105 \times 10^{-13} Js$

B. $2.10 \times 10^{-13} Js$

C. $3.15 \times 10^{-13} Js$

D. Can be (a) or (b)

Answer: A

Watch Video Solution

42. When high energetic electron beam , (i.e., cathode rays) strike the heavier metal, then X-ray are produced. Spectrum of X-ray are classified into two categories: (i) continous spectrum, and (ii) characteristic depends only on the potential difference across the electrode. But wavelength of characteristic spectrum depends on the atomic number (z).

The production of characteristic X-ray is due to the

A. continuous acceleration of incident electrons towards the nucleus

B. continuous ratardation of incident electrons towards the nucleus

C. electron transition between inner shells of the target atom

D. electron transition between outer shells of the target atom

Answer: C

Watch Video Solution

43. When high energetic electron beam , (i.e., cathode rays) strike the heavier metal, then X-ray are produced. Spectrum of X-ray are classified into two categories: (i) continous spectrum, and (ii) characteristic depends only on the potential difference across the electrode. But wavelength of characteristic spectrum depends on the atomic number (z).

The production of continuous X-ray is due to the

A. acceleration of incident electrons by the the nucleus of the target atom

B. electron transition between inner shells of the target atom

C. electron transition between outer shells of the target atom

D. annibilation of the mass of incident electrons

Answer: A

Watch Video Solution

44. 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 quantum 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.)

A. $2.55eV$

B. $0.73eV$

C. $1.82eV$

D. information insufficient

Answer: A

Watch Video Solution

45. 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 quantum 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.)

A. $4 \rightarrow 2$

B. $3 \rightarrow 1$

C. $3 \rightarrow 2$

D. $4 \rightarrow 3$

Answer: A

Watch Video Solution

46. 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 quantum 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.)

A. $\frac{2h}{\pi}$

B. $\frac{h}{2\pi}$

C. $\frac{h}{\pi}$

D. $\frac{h}{4\pi}$

Answer: C

Watch Video Solution

47. The electron in a Li^{++} ion is the nth shell , n being very large. One of the K-electron in another matallic atom has been knocked out. The second matel has four orbits. Now, we take two sample one of Li^{++} ion and the other of the second mateillic ions. Suppose the probability of electronic transition from higher to lower energy level is directly proportional to the energy difference between the two shells. Take $hc = 1224 eV nm$, where h is Planck's constant and c the velocity of light in vacuum. It is found that major electromagnetic wavws emitted from the two sample are identical. Now , answer the following questions:

What is the X-ray having least intensity emitted by the second sample?

A. K_{papha}

B. L_{papha}

C. M_{papha}

D. data insufficient

Answer: A

Watch Video Solution

48. The electron in a Li^{++} ion is the nth shell , n being very large. One of the K-electron in another matallic atom has been knocked out. The second matel has four orbits. Now, we take two sample one of Li^{++} ion and the other of the second mateillic ions. Suppose the probability of electronic transition from higher to lower energy level is directly proportional to the energy difference between the two shells. Take $hc = 1224 eV nm$, where h is Planck's constant and c the velocity of light in vacuum. It is found that major electromagnetic wavws emitted from the two sample are identical. Now , answer the following questions:

What is the major X-ray emitted by the sample?

A. K_{papha}

B. K_{β}

C. K_{γ}

D. K_{δ}

Answer: C

Watch Video Solution

49. The electron in a Li^{++} ion is the nth shell , n being very large. One of the K-electron in another matallic atom has been knocked out. The second matel has four orbits. Now, we take two sample one of Li^{++} ion and the other of the second mateillic ions. Suppose the probability of electronic transition from higher to lower energy level is directly proportional to the energy difference between the two shells. Take $hc = 1224 eV nm$, where h is Planck's constant and c the velocity of light in vacuum. It is found that major electromagnetic wavws emitted from the two sample are identical. Now , answer the following questions:

The wavelength of this major X-ray is

A. $0.90 Å$

B. $1.0 Å$

C. $1.1 Å$

D. none of these

Answer: D

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50. Two hydrogen-like atoms A and B are of different masses and each atom contains equal numbers of protons and neutrons. The difference in the energies between the first Balmer lines emitted by A and B , is $5.667eV$. When atom atoms A and B moving with the same velocity , strike a heavy target , they rebound with the same velocity in the process, atom B imparts twice the momentum to the target than that A imparts. Identify the atom A and B.

A. $\_(1)^{1}H$

B. $\_(1)^{2}H$

C. $\_(3)^6 Li$

D. $\_(2)^4 Li$

Answer: B

Watch Video Solution

51. Two hydrogen-like atoms A and B are of different masses and each atom contains equal numbers of protons and neutrons. The difference in the energies between the first Balmer lines emitted by A and B, is $5.667 eV$. When atom atoms A and B moving with the same velocity , strike a heavy target , they rebound with the same velocity in the process, atom B imparts twice the momentum to the target than that A imparts. Identify the atom A and B.

A. $12.1eV$

B. $13.6eV$

C. $14.3eV$

D. $15.1eV$

Answer: D

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52. $1.8g$ of hydrogen is excite by irradiation. The study of spectra indicated that 27% of the atoms are in the first excite state, 15% of the aton in the second excited, and the rest in the ground state. The ground stat, ionization energy of hydrogen atom is 21.4×10^{-12}ergs.

The number of atoms present in the second excited state is

A. 1.61×10^{23}

B. 0.805×10^{23}

C. 2.92×10^{23}

D. 1.46×10^{23}

Answer: C

Watch Video Solution

53. $1.8g$ of hydrogen is excite by irradiation. The study of spectra indicated that 27% of the atoms are in the first excite state, 15% of the aton in the second excited, and the rest in the ground state. The ground stat, ionization energy of hydrogen atom is 21.4×10^{-12} ergs.

The total amount of energy that would be evolved when all the atoms returns to the ground state is

A. $782kJ$

B. $978kJ$

C. $19.63 \times 10^{11} erg$

D. $97.87 \times 10^{11} erg$

Answer: A

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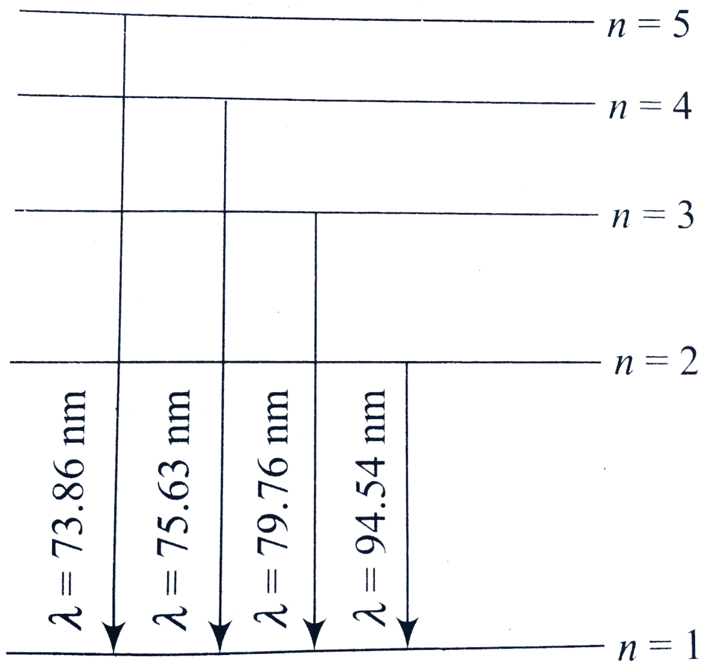
54. In a set of experiment on a hydrogen on a hypotherical one-electron atom, the wavelength of the photons emitted from transition ending in the ground state $(n = 1)$ are shown in the energy level diagram



$\lambda_{5 \rightarrow 1} = 73.86nm$

$\lambda_{4 \rightarrow 1} = 75.63nm$

$\lambda_{3 \rightarrow 1} = 79.76nm$

$\lambda_{2 \rightarrow 1} = 94.54nm$

The energy of the atom in level $n = 1$ is nearly

A. $13.14eV$

B. $15.57eV$

C. $17.52eV$

D. $16.42eV$

Answer: D

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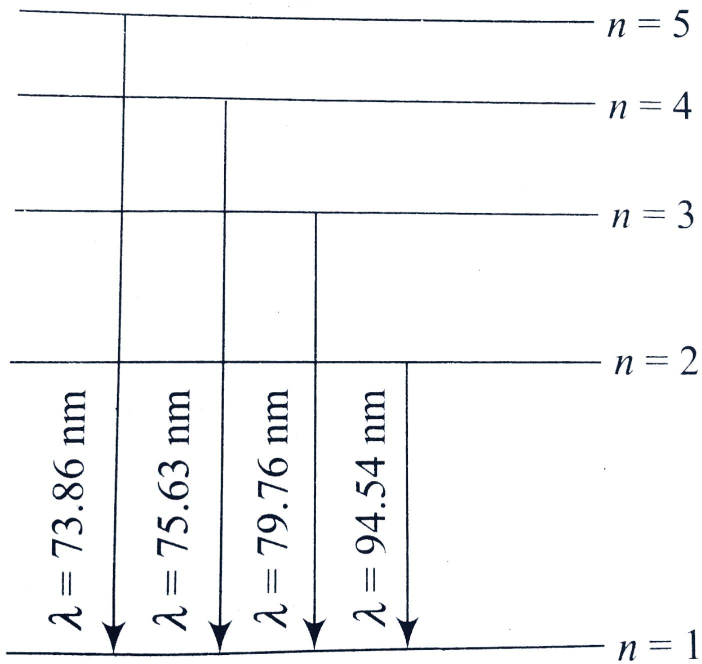
55. In a set of experiment on a hydrogen on a hypotherical one-electron atom, the wavelength of the photons emitted from transition ending in the ground state $(n = 1)$ are shown in the energy level diagram



$\lambda_{5 \to 1} = 73.86nm$

$\lambda_{4 \to 1} = 75.63nm$

$\lambda_{3 \to 1} = 79.76nm$

$\lambda_{2 \to 1} = 94.54nm$

If an electron made a transition from `n = 4 to n = 2 level, the wavelength of the light that it would emit is nearly

A. $380nm$

B. $190nm$

C. $76nm$

D. $510nm$

Answer: A

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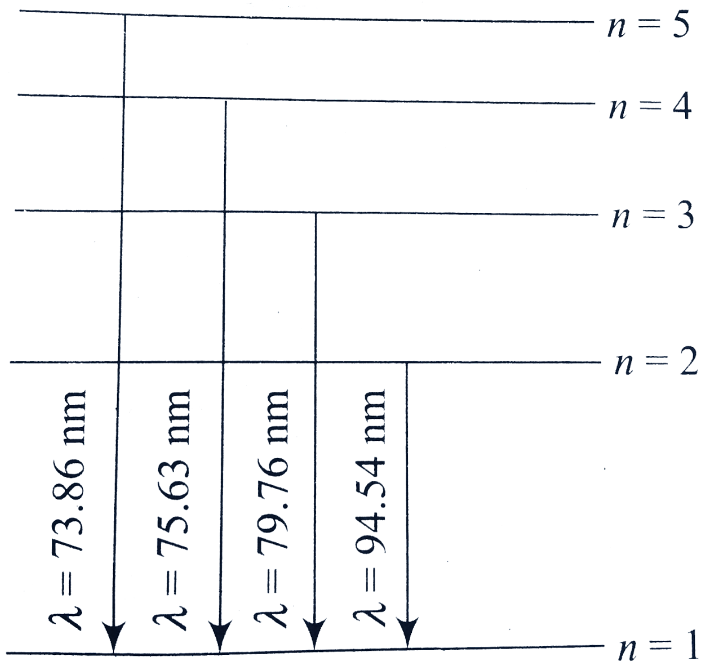
56. In a set of experiment on a hydrogen on a hypotherical one-electron atom, the wavelength of the photons emitted from transition ending in the ground state $(n = 1)$ are shown in the energy level diagram



$\lambda_{5\rightarrow1} = 73.86nm$

$\lambda_{4\rightarrow1} = 75.63nm$

$\lambda_{3\rightarrow1} = 79.76nm$

$\lambda_{2\rightarrow1} = 94.54nm$

The possible energy of the atom in $n = 3$ cannot be

A. $-19.5eV$

B. $-0.4875eV$

C. $-0.121 eV$

D. $-7.8 eV$

Answer: D

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57. 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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58. 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.

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59. In a hydrogen atom, the electron is in nth excited it comes down to first excited state by emitting ten different wavlength . The value of n is

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60. The shortest wavelength of the Brackett series of hydrogen like atom (atomic number =Z) is the same as the shortest wavelength of the Blamer series of hydrgeon atom . The value ofn Z is

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61. Heat at the rate of 200 W is produced in an X-ray tube operating at 20 kV. Find the current in the circuit. Assume that only a small fraction of the kinetic energy of electron is converted into X-rays.

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62. An electron in an H-atom kept at rest , jumps from the mth shell to the nth shell $(m > n)$. Suppose instead of emitting electromagnetic wave, the energy reased is converted into the kinetic energy of the atom. Assume the Bohr model and conservation of angular momentum are valid. If I is the moment of inertia the angular velocity of the atom about the nucleus is $4(m-n)h/kI$. Calculate k

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Integer

1. In the spectrum of singly ionized helium , the wavelength of a line observed is almost the same as the first line of Balmer series of hydrogen . It is due to transition of electron from $n_1 = 6 \rightarrow n_2 = ^{''*''}$. What is the value of $('' * '')$.

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2. A Bohr's hydrogen atom undergoes a transition $n = 5 \rightarrow n = 4$ and emits a photon of frequency f. Frequency of circular motion of electron in $n = 4 \text{ or } bitis f_4$. The ratio f / f_4 is found to be $18 / 5m$. State the value of m.

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3. The average lifetime for the $n = 3$ excited state of a hydrogen-like atom is $4.8 \times 10^{-8} s$ and that for the $n = 2 stateis 12.8 \times 10^{-8} s$. The ratio of average number of revolution made in the $n = 3$ sate before any transition can take place from these state is.

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4. An electron in a hydrogen atom makes a trsnsition $n_1 \rightarrow n_2$ where n_1 and n_2 are principal quantum numbers of the two states. Assume the Bohr model to be valid. The time period of the electron in the initial state is eight times that in the final state. The possible values of n_1 and n_2 are

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Fill In The Blanks

1. To produce characteristic X - rays using a Tungsten target in an X - ray generator , the accelerating should be greater than .... Volts and the energy of the characterization is ...... eV .

(The binding energy of the intermost electron in Tungsten is - 40keV).

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2. When the number of electron striking the anode of an X - ray tube is increase , the .... of the emitted X - ray increases , while when the speed of the electrons the anode are increased , the cut - off wavelength of the emitted X - ray ....

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3. The wavelength of the characteristic X-ray K_{α} line emitted by a hydrogen-like element is 0.32Å. Calculate the wavelength of K_{β} line emitted by a same element.

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4. The Bohr radius of the fifth Valence electron of phosphorous atom (atomic number = 15) acting as a dopant in silicon (relative dielectric constant = 12) is .... Å

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5. In an X- ray tube , electrons accelerated through a potential difference of 15000 volts strike a copper target . The speed of the emitted X - ray inside the tube is .... m/s

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6. In the Bohr model of the hydrogen atom, the ratio of the kinetic energy to the total energy of the electron in a quantum state n is ....

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7. The wavlength of K_{α}, X-rays produced by an X-ray tube 0.76Å . The atomic number of the anode material of the tube is

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8. Find recoil speed (approximately in ms^{-1}) when a hydrogen atom emits a photon during the transition from $n = 5 \rightarrow n = 1$

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Single correct answer type

1. The shorted wavelength of X- rays emitted from an X-rays tube depends on

A. the current in the tube

B. the voltage applied to the tube

C. the nature of the gas in the tube

D. the atomic number of the target meterial

Answer: A

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2. If element with particle quantum number $n > 4$ were not allowed in nature , the number of possible element would be

A. 60

B. 32

C. 4

D. 64

Answer: D

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3. 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

A. hydrogen atom

B. deuterium atom

C. singly ionization helium

D. doubly ionized lithium

Answer: D

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4. The X-ray beam coming from an X-ray tube

A. monochromatic

B. having all wavelength smaller then a certain maximum wavelength

C. having all wavelength larger then a certain maximum wavelength

D. having all wavelength lying between a minimum ans a maximum wavelength

Answer: A

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5. The K_{α} X-ray emission line of lungsten accurs at $\lambda = 0.021 nm$. What is the energy difference between $K$and L levels in the atom?

A. $0.51 meV$

B. $1.2 meV$

C. $59 meV$

D. $13.6 meV$

Answer: A

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6. 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. 1.51

B. 13.6

C. 40.8

D. 122.4

Answer: B

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7. 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) $0 \rightarrow \infty$

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

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

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

A. $0 \text{ and } \infty$

B. $\lambda_{\min} \rightarrow \infty, where \lambda_{\min} > 0.$

C. $0 \rightarrow \lambda_{\max}, where \lambda_{\max} < \infty.$

D. $\lambda_{\min} \rightarrow \lambda_{\max}, where 0 < \lambda_{\min} < \infty.$

Answer: A

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8. Imagine an atom made up of proton and a hypothetical particle of double the mass of the electron but havign the same charge as the electron. Apply the Bhor atom model and consider all possible transitions of this hypothetical particle to the first excited level. The longest wavelength photon that will be emitted has wavelength λ (given in terms of the Rydberg constant R for the hydrogen atom) equal to (a) $9/5R$ (b) $\frac{36}{5}R$ (c) $18/5R$ (d) $4/R$

A. $9/(5R)$

B. $36/(5R)$

C. $18/(5R)$

D. $4/R$

Answer: D

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9. The electron in a hydrogen atom makes a transition from an excited state to the ground state. Which of the following statements is true?

A. Its kinetic energy increases and its potential and total energies decrease.

B. Its kinetic energy decreases, potential increases and its total energy remain tha same

C. Its kinetic energy and total energies decrease, and its potential, energy increases.

D. Its kinetic potential and total energies decrease.

Answer: A

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10. Electrons with energy 80 ke V are incident on the tungsten

target of on X-ray tube. K-shell electrons of tungsten have 72.5 ke V energy.

X-ray emitted by the tube contain only

(a) a continuous X-ray spectrum (Bremsstrahlung) with a minimum wavelength of

$\approx 0.155 \text{Å}$. (b) a continuos X-ray spectrum (Bremsstrahlung) with all wavelegths

(c) the characteristic X-ray spectrum of tungsten

(d) a continuous X-ray spectrum (Bremsstrahlung) witha minimum wavelength of

$\approx 0.155\text{Å}$ and the characteristic X-ray spectrum of tungsten.

A. a continuos X-ray spectrum (Bremsstrablung) with a minimum wavelength of -0.155Å

B. continuos X-ray spectrum (Bremsstrablung) with all wavelengths

C. the characteristic X-ray spectrum of tungsten.

D. a continuos X-ray spectrum (Bremsstrablung) with a minimum wavelength of -0.155Å and the charateristic X-ray spectrum of tungsten

Answer: A

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11. The transition from the state $n = 4$ to $n = 3$ in a hydrogen like atom results in ultraviolet radiation Infrared radiation will be obtained in the transition from

A. $2 \rightarrow 1$

B. $3 \rightarrow 1$

C. $4 \rightarrow 2$

D. $5 \rightarrow$

Answer: B

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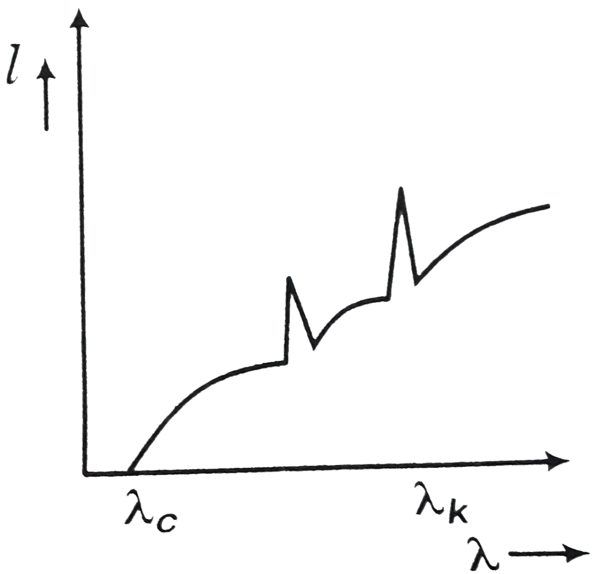
12. The intensity of X-rays from a coolidge tube is plotted against wavelength as shown in the figure . The minimum wavelegth found is λ_c and the wavelength of the K_α line is λ_k. As the accelerating voltage is increased



A. $\lambda_K - \lambda_C$ increases

B. $\lambda_K - \lambda_C$decreases

C. λ_K increases

D. λ_K increases

Answer: A

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13. 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}

Answer: B

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14. A hydrogen atom and a Li^{++} ion are both in the second excited state. If l_H and l_Li are the 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 $|E_H| < |E_{LI}|$

Answer: B

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15. The electirc potential between a proton and an electron is given by $V = V_0 \ln\left(\frac{r}{r_0}\right)$, 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)$r_n \propto \frac{1}{n^2}$

A. $r_n \propto n$

B. $r_n \propto 1/n$

C. $r_n \propto n^2$

D. $r_n \propto 1/n^2$

Answer: A::C::D

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16. If the atom($\_100)Fm^{257}$ follows the Bohr model the radius of $\_(100)Fm^{257}$ is n time the Bohr radius , then find n .

A. 100

B. 200

C. 4

D. 1/4

Answer: C::D

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17. 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. $Z = 44$

Answer: C::D

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18. 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

A. one photon of energy $10.2eV$ and an electron of energy $1.4eV$.

B. Two photon of energy $1.4eV$

C. Two photon of energy $10.2eV$

D. one photon of energy $10.2eV$ and another photon of $1.4eV$.

Answer: A::D

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19. 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) $802nm$ (b) $823nm$

(c) $1882nm$ (d) $1648nm$.

A. $802nm$

B. $823nm$

C. $1882nm$

D. $1648nm$

Answer: B

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20. Electrons of mass m with de-Broglie wavelength λ fall on the target in an X-ray tube. The cut-off wavelength (λ_0) of the emitted X-ray is

A. $\lambda_0 = \frac{2mc\lambda^2}{h}$

B. $\lambda_0 = \frac{2h}{mc}$

C. $\lambda_0 = \frac{2m^2c^2\lambda^2}{h^2}$

D. $\lambda_0 = \lambda$

Answer: C

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

A. wavelength of characteristic X-rays decreases when the atomic number of the target increases.

B. Cut-off wavelength of the continuous X-rays depends on the atomic number of the target.

C. Intensity of the characteristic X-rays depend on the electric power given to the X-ray tube.

D. Cut-off wavelength of the continuous X-rays depends on the energy of the electrons in the X-ray tube.

Answer: C

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22. The wavelength of the first spectral line in the Balmer series of hydrogen atom is $6561A^{\circ}$. The wavelength of the second spectral line in the Balmer series of singly - ionized helium atom is

A. 1215Å

B. 1640Å

C. 2430Å

D. 4687Å

Answer: A

Watch Video Solution

Maltiple correct answers type

1. In the Bohr model of the hydrogen atgom

A. the radius of nth orbit is proportional to n^2

B. the total energy of electron in nth orbit is proportional to n

C. the angular momentum of the electron in an orbit is integral multiple of $h/2\lambda$

D. the angular momentum of the electron in an orbit is greater than KE

Answer: D

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2. The mass number of a nucleus is

A. always less then its atomic number

B. always more then its atomic number

C. sometimes equal to its atomic number

D. sometimes more than and sometimes equal to its atomic number

Answer: A

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3. The potential difference applied to an X-ray tube is increased. As a result, in the emitted radiation,

A. the intensity increases

B. the minimum wavelength increases

C. the intensity remains unchanged

D. the minimum wavelength decreases

Answer: C

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4. An electron in a hydrogen atom makes a trsnsition $n_1 \to n_2$ where n_1 and n_2 are principal quantum numbers of the two states. Assume the Bohr model to be valid. The time period of the electron in the initial state is eight times that in the final state. The possible values of n_1 and n_2 are

A. $n_1 = 4, n_2 = 2$

B. $n_1 = 8, n_2 = 2$

C. $n_1 = 8, n_2 = 1$

D. $n_1 = 6, n_2 = 3$

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Assertion-reasoning type

1. In each of the questions, assertion(A) is given by corresponding statement of reason (R) of the statemens. Mark the correct answer.

Q. Statement I: If the accelerating potential in an X-ray tube is increased, the wavelentghs of the characteristic X-rays do not energy.

Statement II: When an electron beam strikes the target in an X-ray tube, part of the kinetic energy is converted into X-ray energy.

A. If both Statement I and Statement II are true , Statement II is correct explaination of the Statement I.

B. If both Statement I and Statement II are true , Statement II is not the correct explaination of the Statement I.

C. If Statement I is true , statement II is false.

D. If Statement I is false , statement II is true.

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Linked comprehension type

1. In a mixture of $H - He^{+}$ gas ($He+$ is singly ionized He atom), H atom and $He+$ ions are excited to their respective first excited state. Subsequently H atoms transfer their total excitation energy to $He+$ ions (by collisions) Assume that the bohr model of atom is exactly valid.

The quantum number n of the state finally populated in He^{+} inos is -

A. 2

B. 3

C. 4

D. 5

Watch Video Solution

2. In a mixture of $H - He^{+}$ gas ($He +$ is singly ionized He atom), H atom and $He +$ ions are excited to their respective first excited state. Subsequently H atoms transfer their total excitation energy to $He +$ ions (by collisions) Assume that the bohr model of atom is exactly valid.

The wavelength of light emitted in the visible region by $He +$ Ions after collisions with H atoms is -

A. $6.5 \times 10^{-7} m$

B. $5.6 \times 10^{-7} m$

C. $4.8 \times 10^{-7} m$

D. $4.0 \times 10^{-7} m$

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3. In a mixture of $H - He^{+}$ gas ($He +$ is singly ionized He atom), H atom and $He +$ ions are excited to their respective first excited state. Subsequently H atoms transfer their total excitation energy to $He +$ ions (by collisions) Assume that the bohr model of atom is exactly valid.

The ratio of the kinetic energy of the $n = 2$ electron for the H atom to the of He^{+} Ion is -

A. $\frac{1}{4}$

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

C. 1

D. 2

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4. The key feature of Bohr's spectrum of hydrogen atom is the quantization of angular momentum when an electron is revolving around a proton. We will extend this to a general rotational motion to find quantized rotational energy of a diatomic molecule assuming it to be rigid.The rule to be applied is Bohr's quantization condition.

A diatomic molecule has moment of inertia I. By Bohr's quantization condition its rotational energy in the n^{th} level ($n = 0$ is not allowed) is

A. $\frac{1}{n^2}\left(\frac{h^2}{8\pi^2 I}\right)$

B. $\frac{1}{n}\left(\frac{h^2}{8\pi^2 I}\right)$

C. $n\left(\frac{h^2}{8\pi^2 I}\right)$

D. $n^2\left(\frac{h^2}{8\pi^2 I}\right)$

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5. The key feature of Bohr's spectrum of hydrogen atom is the quantization of angular momentum when an electron is revolving around a proton. We will extend this to a general rotational motion to find quantized rotational energy of a diatomic molecule assuming it to be rigid.The rule to be applied is Bohr's quantization condition.

it is found that the excitation from ground to the first excited state of rotation for the CO molecule is close to $\frac{4}{\pi} \times 10^{11} Hz$ then the moment of inertia of CO molecule about its center of mass is close to

$\left(Take h = 2\pi \times 10^{-34} Js\right)$

A. $2.76 \times 10^{-46} kgm^2$

B. $1.87 \times 10^{-46} kgm^2$

C. $4.67 \times 10^{-47} kgm^2$

D. $1.17 \times 10^{-47} kgm^2$

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6. The key feature of Bohr's spectrum of hydrogen atom is the quantization of angular momentum when an electron is revolving around a proton. We will extend this to a general rotational motion to find quantized rotational energy of a diatomic molecule assuming it to be rigid.The rule to be applied is Bohr's quantization condition.

In a CO molecule, the distance between $C(mass = 12a.m.u)$ and $O(mass = 16a.m.u)$ where $1a.m.u = \frac{5}{3} \times 10^{-27} kg$, is close to

A. $2.4 \times 10^{-10} m$

B. $1.9 \times 10^{-10} m$

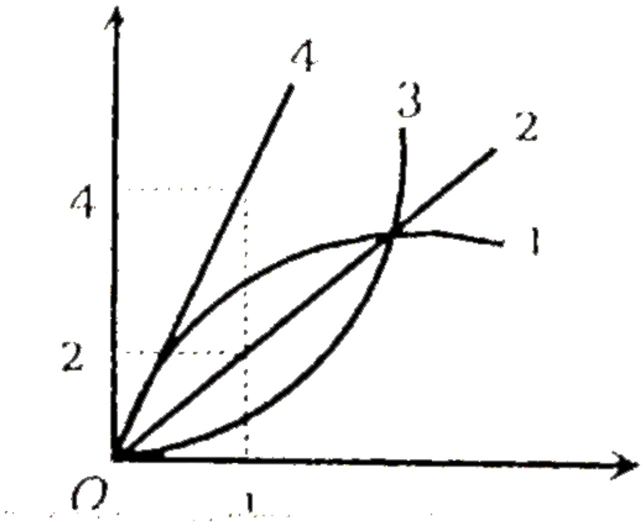
C. $1.3 \times 10^{-10} m$

D. $4.4 \times 10^{-10} m$

Watch Video Solution

dpp-4.1

1. The figure shows a graph between $1n\left|\frac{A_n}{A_1}\right|$ and $1n|n|$, where A_n is the area enclosed by the n^{th} orbit in a hydrogen like atom. The correct curve is



A. 4

B. 3

C. 2

D. 1

Answer: A

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2. The force acting on the electron in a hydrogen atom depends on the principal quantum number as

A. $F \propto 1/n^2$

B. $F \propto 1/n^4$

C. $F \propto 1/n^5$

D. Does not depend on n+

Answer: B

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3. Ionization potential of hydrogen atom is $13.6eV$. Hydrogen atoms in the ground state are excited by monochromatic radiation of photon energy $12.1eV$. According to bohr's theory , the spectral lines emitted by hydrogen will be

A. One

B. Two

C. Three

D. Four

Answer: C

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4. Find the ratio of ionization energy of bohr 's hydrogen atom doubly liothium ion (Li^2)

A. $1:1$

B. $1:3$

C. $1:9$

D. None of these

Answer: C

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5. What is the angular momentum of an electron in Bohr's hydrogen atom whose energy is $-0.544eV$?

A. $\frac{h}{\pi}$

B. $\frac{2h}{\pi}$

C. $\frac{5h}{2\pi}$

D. $\frac{7h}{2\pi}$

Answer: C

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6. The ratio between total acceleration of the electron in singly ionized helium atom and hydrogen atom(both in ground state) is

A. 1

B. 8

C. 4

D. 16

Answer: B

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7. A hydrogen atom in ground state absorbs $10.2eV$ of energy .The orbital angular momentum of the electron is increases by

A. 1.05×10^{-34} J-sec

B. 3.36×10^{-34} J-sec

C. 2.11×10^{-34} J-sec

D. 4.22×10^{-34} J-sec

Answer: A

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8. Thr ratio of the speed of the electron in the ground state of hydrogen atom to the speed of light in vacuum is

A. 43467

B. 2/137

C. 1/137

D. 1/237

Answer: C

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9. Minimum excitation potential of Bohr's first orbit hydrogen atom is

A. 13.6 V

B. 3.4 V

C. 10.2 V

D. 3.6 V

Answer: C

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10. Which of the following statement is true regarding Bohr's model of hydrogen atom?

(i) Orbiting speed of an electron decreases as it falls to discete orbits away from the nucleus.

(ii) Ratio of allowed orbits of electrons sre proportional to the principal quantum number.

(iii) Frequency with which electrons orbit around the nucleus in discrete orbits is inversely proportional to the cube of principal quantum number.

(iv) Binding force with which the electron is bound to the nucleus increase as it shift to auter orbits.

Select the correct answer using the codes given below:

A. I and III

B. II and IV

C. I,II and III

D. II,III and IV

Answer: A

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11. The de- broglie wavelength of an electron in the first bohr orbit is

A. equal to one-fourth the circumference of the first orbit

B. equal to half the circumference of the first orbit

C. equal to twice the circumference of the first orbit

D. equal to the circumference of the first orbit

Answer: D

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12. In a hypothetical Bohr hydrogen, the mass of the electron is doubled. The energy E_0 and radius r_0 of the first orbit will be (a_0 is the Bohr radius)

A. $E_0 = -27.2eV, r_0 = a_0/2$

B. $E_0 = -27.2eV, r_0 = a_0$

C. $E_0 = -13.6eV, r_0 = a_0/2$

D. $E_0 = -13.6eV, r_0 = a_0$

Answer: A

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13. Which of the following transitions gives photon of maximum energy?

A. n=1 to n=2

B. n=2 to n=1

C. n=2 to n=6

D. n=6 to n=2

Answer: A

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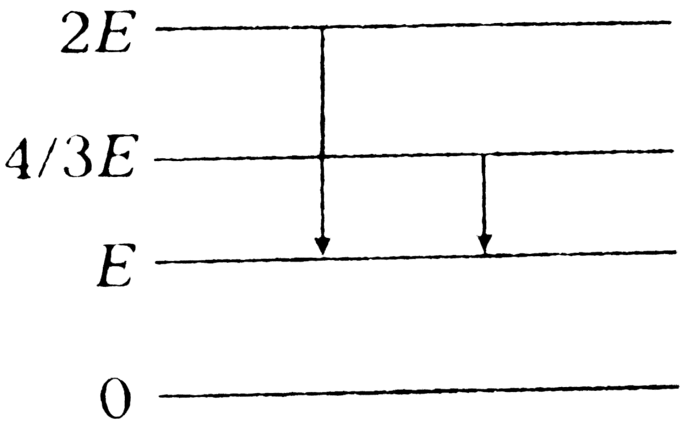
14. The energy levels of a certain atom are represented in adjoining figure. During the transition from 2E to E level, a photon of wavelength λ is emitted. The wavelength of photon produced during transition from

$\frac{4}{3}$ E level to E will be



A. $\lambda/3$

B. $3\lambda/4$

C. $4\lambda/3$

D. 3λ

Answer: D

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15. 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 the first to the third Bohr orbit (ionization energy of the hydrogen atom equals 13.6 eV).

A. 182.24 Å

B. 177.17 Å

C. 142.25 Å

D. 113.74 Å

Answer: D

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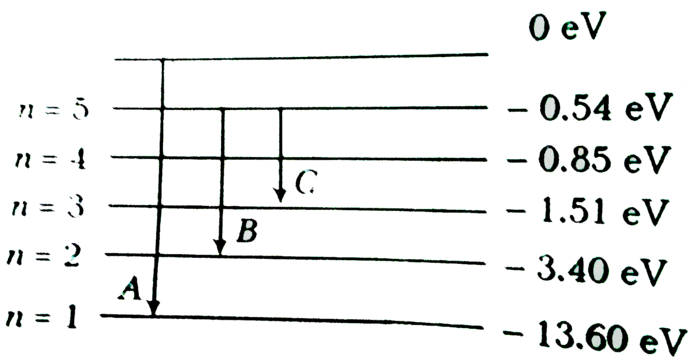
dpp 4.2

1. In figure the energy levels of the hydrogen atom have been shown along with some transitions marking A,B,C. The trantions A,B, and C respectively represents



A. First member of Lyman series, third spectral line of Balmar series and the second spectral line of Paschen series

B. Ionization potential of hydrogen, second special line of Balmer series and third spectral line of Paschen series

C. Series limit of Lyman series, third spectral line of Balmer series and second spectral line of Paschen series

D. Series limit of Lyman series, second spectral line of Balmer series and third spectral line of Paschen series

Answer: C

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2. In the figure of previous problem, D and E respectively represent

A. Absorption line of Balmer series and the ionisation potential of hydrogen

B. Absorption line of Balmer series and the wavelength lesser than lowest of the Lyman series

C. Spectral line of Balmer series and the maximum wavelegth of Lyman series

D. Spectral line of Lyman series and the absorption to greater wavelength of limiting value of Paschen series

Answer: A

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3. if the wavelength of the first line of the balmer series of hydrogen is 6561Å, the wavelength of the second line of the series should be

A. 13122Å

B. 3280Å

C. 4860Å

D. 2187Å

Answer: C

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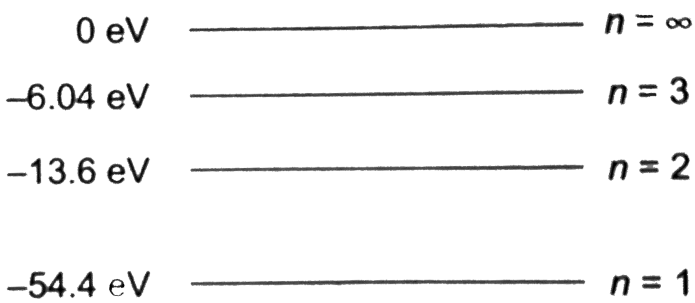
4. The enegry level diagram for an hydrogen-like atom is shown in the figure. The radius of its first Bohr orbit is



A. 0.265 Å

B. 0.53 Å

C. 0.132 Å

D. None of these

Answer: A

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5. If the series limit of Lyman series for Hydrogen atom is equal to the series limit Balmer series for a hydorgen like atom, then atomic number of this hydrogen-like atom will be

A. 1

B. 2

C. 3

D. 4

Answer: B

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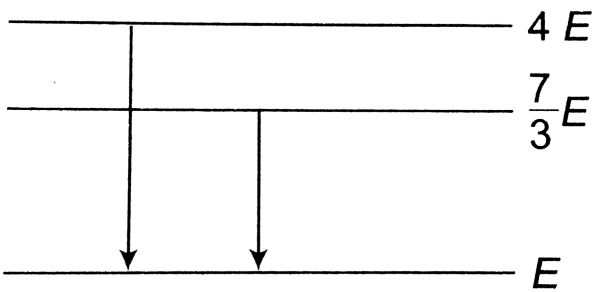
6. The following diagram indicates the energy levels of a certain atom when the system moves from $4E$ level to E. A photon of wavelength λ_1 is emitted. The wavelength of photon produced during its transition from $\frac{7}{3}E$ level to E is λ_2. the ratio $\frac{\lambda_1}{\lambda_2}$ will be



A. $\frac{9}{4}$

B. $\frac{4}{9}$

C. $\frac{3}{2}$

D. $\frac{7}{3}$

Answer: B

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7. A hydrogen atom emits a photon corresponding to an electron transition from $n = 5$ to $n = 1$. The recoil speed of hydrogen atom is almost (mass of proton $\approx 1.6 \times 10^{-27} kg$).

A. $10 ms^{-1}$

B. `2xx10^(-2) ms^(-1)

C. $4ms^{-1}$

D. $8 \times 10^2 ms^{-1}$

Answer: C

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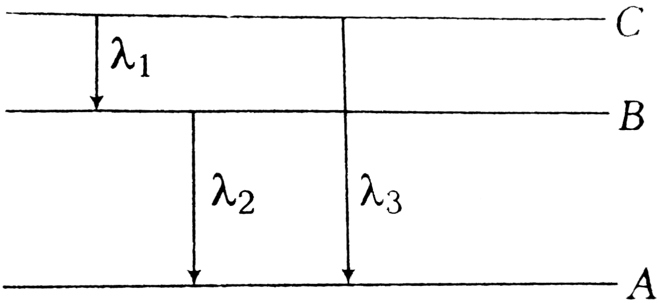
8. Energy levels A, B and C of a certain atom corresponding to increasesing values of energy i.e., $E_A < E_B < E_C$. If λ_1, λ_2 and λ_3 are the wavelength of radiations corresponding to the transitions C to B,B to A and C to A respectively, which of the followoing statements is correct ?



A. $\lambda_3 = \lambda_1 + \lambda_2$

B. $\lambda_3 = \dfrac{\lambda_1 \lambda_2}{\lambda_1 + \lambda_2}$

C. $\lambda_1 + \lambda_2 + \lambda_3 = 0$

D. $\lambda_3^2 = \lambda_1^2 + \lambda_2^2$

Answer: B

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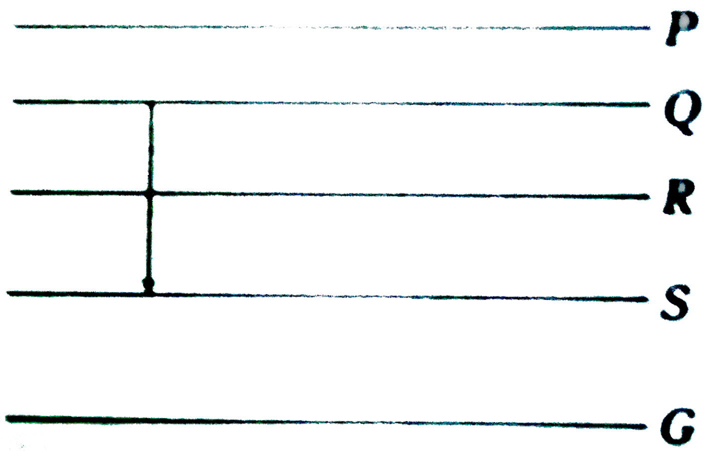
9. Figure shows the energy levesl P.Q,R,S and G of an atom where G is the ground state . A red line in the emission spectrum fo the atom can be obtained by an energy level change from Q to S. A blue line can be obtained by following energy level change



A. $P \text{to} Q$

B. $Q \text{to} R$

C. $R \text{to} S$

D. $R \text{to} G$

Answer: D

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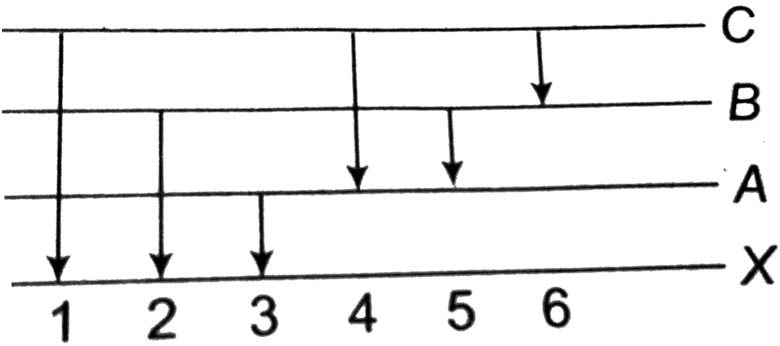
10. The figure indicates the enegry level diagram of an atom and the origin of six spectral lines in emission (e.g. line no.5 series from the transition from level B to A). The following spectral lines will also occur in the absorption spectrum



A. 1,4,6

B. 4,5,6

C. 1,2,3

D. 1,2,3,4,5,6

Answer: C

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11. A hydrogen like atom of atomic 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 to 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(eV) that can be emitted by this atom during de - excitation. Ground state energy of hydrogen atom is -13.6 eV

A. 1

B. 2

C. 3

D. 4

Answer: B

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12. The energy, the magnitude of linear momentum, magnitude of angular momentum and orbital radius of an electron in a hydrogen atom corresponding to the quantum number n are E, p, L and r respectively. Then according to Bohr's theory of hydrogen atom, match the expressions in column I with statement in column II.

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13. A single electron orbit around a stationary nucleus of charge $+Ze$ where Z is a constant and e is the magnitude of the electronic charge. It requires$47.2eV$ to excite the electron from the second bohr orbit to the third bohr orbit. Find

(i) The value of Z

(ii) The energy required by nucleus to excite the electron from the third to the fourth bohr orbit

(iii) The wavelength of the electronmagnetic radiation required to remove the electron from the first bohr orbit to inlinity

(iv) The energy potential energy potential energy and the angular momentum of the electron in the first bohr orbit

(v) The radius of the first bohr orbit (The ionization energy of hydrogen atom $= 13.6eV$ bohr radius $= 5.3 \times 10^{-11} matre$ velocity of light $= 3 \times 10^{8} m / \sec$ planks 's constant $= 6.6 \times 10^{-34}$ jules - sec)

A. 5

B. 4

C. 2

D. 3

Answer: A

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14. A single electron orbit around a stationary nucleus of charge $+Ze$ where Z is a constant and e is the magnitude of the electronic charge. It requires$47.2eV$ to excite the electron from the second bohr orbit to the third bohr orbit. Find

(i) The value of Z

(ii) The energy required by nucleus to excite the electron from the third to the fourth bohr orbit

(iii) The wavelength of the electronmagnetic radiation required to remove the electron from the first bohr orbit to inlinity

(iv) The energy potential energy potential energy and the angular momentum of the electron in the first bohr orbit

(v) The radius of the first bohr orbit (The ionization energy of hydrogen atom $= 13.6 eV$ bohr radius $= 5.3 \times 10^{-11} matre$ velocity of light $= 3 \times 10^{8} m / \sec$ planks 's constant $= 6.6 \times 10^{-34}$ jules - sec)

A. 13.6 eV

B. 16.53 eV

C. 47.2 eV

D. 27.2 eV

Answer: B

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15. A single electron orbit around a stationary nucleus of charge $+Ze$ where Z is a constant and e is the magnitude of the electronic charge. It requires$47.2eV$ to excite the electron from the second bohr orbit to the third bohr orbit. Find

(i) The value of Z

(ii) The energy required by nucleus to excite the electron from the third to the fourth bohr orbit

(iii) The wavelength of the electronmagnetic radiation required to remove the electron from the first bohr orbit to inlinity

(iv) The energy potential energy potential energy and the angular momentum of the electron in the first bohr orbit

(v) The radius of the first bohr orbit (The ionization energy of hydrogen atom $= 13.6eV$ bohr radius $= 5.3 \times 10^{-11} matre$ velocity of light $= 3 \times 10^8 m/\sec$ planks 's constant $= 6.6 \times 10^{-34}$ jules - sec)

A. 340 eV

B. $-340eV$

C. 680 eV

D. $-680eV$

Answer: A

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ddp.4.3

1. The continuous x - ray spectrum obtained from a Coolidge tube is of the form

A.

B.

C.

D.

Answer: A

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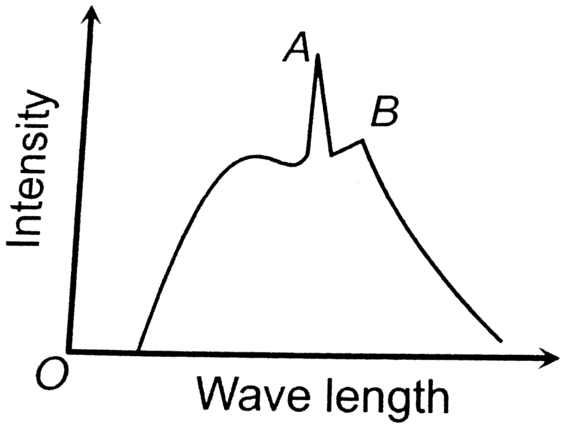
2. The figure represents the observed intensity of X - rays emitted by an X - ray tube as a function of wavelength . The sharp peaks A and B denote



A. band spectrum

B. continuous spectrum

C. characteristic radiations

D. white radiations

Answer: C

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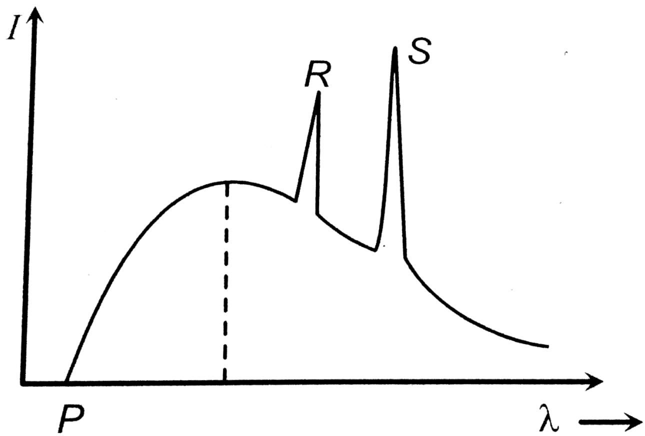
3. If the potential difference between the anode and cathode of the X - ray tube is increases



A. the peaks at R and S would move to shorter wavelength

B. the peaks at R and S would remain at the same wavelength

C. the cut- off wavelength at P would decrease

D. (b) and (c) both are correct

Answer: D

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4. One increasing the operating voltage in a x-ray tube by 1.5 times, the shortest wavelength decreases by 26pm. Find the original value of operating voltage.

A. $\approx 10kV$

B. $\approx 16kV$

C. $\approx 50kV$

D. $\approx 75kV$

Answer: B

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5. In X-ray tube when the accelerating voltage V is halved.the difference between the wavelength of K_α line and minimum wavelength of continuous X-ray spectrum

A. romains contant

B. becomes more than two times

C. becomes half

D. becomes less than two times

Answer: D

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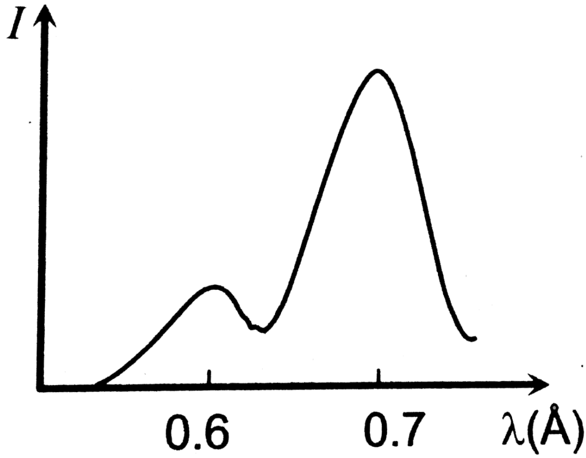
6. In the diagram a graph between the intensity of X-rays emitted by a molybdenum target and the wavelength is shown , when electrons of $30keV$ are incident on the target. In the graph one peak is of K_{α}

line and the other peak is of K_β line



A. first peak is of K_α line at 0.6Å

B. highest peak is of K_α line at 0.7Å

C. if the energy of incident particle is increased, then the peak will shift toward left

D. If the energy of incident particle is increased then the paak will shift toward right

Answer: B

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7. Let $\lambda_{\alpha}{'}, \lambda_{\beta}, \text{ and } \lambda'_{\alpha}$ denote the wavelength of the X-ray of the $K_{\alpha}, K_{\beta}, \text{ and } L_{\alpha}$ lines in the characteristic X-rays for a metal. Then.

A. $\lambda_{\alpha} > \lambda_{\alpha} > \lambda_{\beta}$

B. $\lambda_{\alpha} > \lambda_{\beta}\lambda_{\alpha}$

C. $\frac{1}{\lambda_{\beta}} = \frac{1}{\lambda_{\alpha}} + \frac{1}{\lambda_{\alpha}}$

D. $\frac{1}{\lambda_{\beta}} + \frac{1}{\lambda_{\alpha}} = \frac{1}{\lambda_{\alpha}}$

Answer: C

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8. The graph that correctly represents the relation of frequency v of a particular characteristic X - ray with the atomic number Z of the material is

A.

B.

C.

D.

Answer: C

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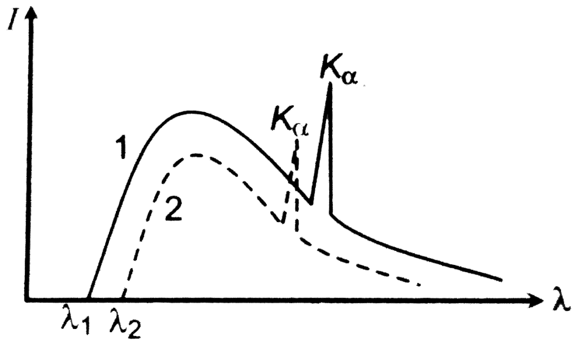
9. The intensity distribution of X - rays from two Coolidge tubes operated on different voltages V_1 and V_2 and using is shown in the figure . Which one of the following inequalities is true ?



A. $V_1 > V_2, Z_1 < Z_2$

B. $V_1 > V_2, Z_1 < Z_2$

C. $V_1 < V_2, Z_1 > Z_2$

D. $V_1 l = V_2, Z_1 < Z_2$

Answer: A

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10. The X- ray wavelength of L_{α} line of platinum $(Z = 78)$ is 1.30Å. The X - ray wavelength of L_{α} line of Molybdenum $(Z = 42)$ is

A. 5.41Å

B. 4.20Å

C. 2.70Å

D. 1.35Å

Answer: A

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11. The K_{α} X - rays arising from a cobalt $(z = 27)$ target have a wavelength of 179 pm. The K_{α} X - rays arising from a nickel target $(z = 28)$ is

A. $> 179\text{pm}$

B. $< 179\text{pm}$

C. $= 179\text{pm}$

D. None of these

Answer: B

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12. For characteristic X-ray, choose, the correct option.

A. $E(K_\gamma) < E(K_\beta) < E(K_\alpha)$

B. $E(K_\alpha) < E(L_\alpha) < E(M_\alpha)$

C. $\lambda(K_\gamma) < \lambda(K_\beta) < \lambda(K_\alpha)$

D. $\lambda(M_\gamma) < \lambda(L_\beta) < \gamma(K_\alpha)$

Answer: C

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13. The wavlength of K_α, X-rays produced by an X-ray tube 0.76Å . The atomic number of the anode material of the tube is

A. 82

B. 41

C. 20

D. 10

Answer: B

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14. The wavelength of K_{α} line for an element of atomic number $43 is \lambda$. Then the wavelength of K_{α} line for an element of atomic number 29 is

A. $\frac{43}{29}\lambda$

B. $\frac{42}{28}\lambda$

C. $\frac{9}{4}\lambda$

D. $\frac{4}{9}\lambda$

Answer: C

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15. The potential difference applied to an X-ray tube is increased. As a result, in the emitted radiation,

A. the intensity increases

B. the minimum wavelength increases

C. the intensity remains unchanged

D. the minimum wavelength decreases

Answer: A::D

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