PHYSICS

BOOKS - GK PUBLICATIONS PHYSICS (HINGLISH)

ATOMIC PHYSICS

Illustrative Example

1. 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$n = 1(Bohrrediusa_0 = 5.3 \times 10^{-11} m)$?

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2. What is the angular momentum of an electron in Bohr's hydrogen atom whose energy is $-3.4eV$?

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3. The electron in a hydrogen atom makes a transition $n_1 \rightarrow n_2$, where n_1 and n_2 are the principle 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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4. How many time does the electron go round the first bohr orbit of hydrogen atoms in $1s$?

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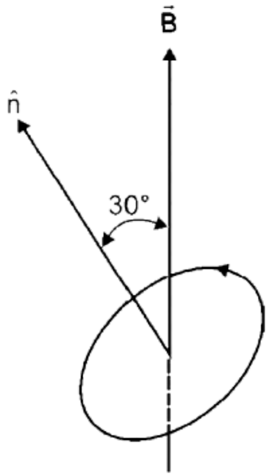
5. An electron in the ground state of hydrogen atom is revolving in anticlock-wise direction in a circular orbit of radius R.

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

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7. If the wavelength of the first member of Balmer series in hydrogen spectrum is 6563 Å, calculate the wavelength of the first member of Lymen series in the same spectrum.

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8. The ratio of ionization energy of Bohr's hydrogen atom and Bohr's hydrogen-like lithium atom is

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9. Electron of energies 10.20 eV and 12.09 eV` can cause radiation to be emitted from hydrogen atoms . Calculate in each case, the principal quantum number of the orbit to which electron in the hydrogen atom is raised and the wavelength of the radiation emitted if it drops back to the ground state.

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10. Determine the wavelength of the first Lymanline,the transition from $n = 2 \text{to} n = 1$.In what region of the electromagnetic spectrum does this line lie ?

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11. Hydrogen atom in its ground state is excited by means of monochromatic radiation of wavelength 970.6Å. How many lines are possible in the resulting emission spectrum ? Calculate the longest wavelength amongst them. You may assume that the ionisation energy for hydrogen atom is 13.6 eV. Given Planck's constant $= 6.6 \times 10^{-34} Js, \quad c = 3 \times 10(8) ms^{-1}$

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12. A hydrogen atom in a state having a binding energy of 0.85 eV makes transition to a state with excitation energy 10.2 eV. The quantum number n of the upper and the lower energy states are

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13. 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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14. 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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15. Estimate the average kinetic energy of hydrogen atoms (or molecules) at room temperature and use the result to explain why nearly all H atom sare in the ground state at room temperature and hence emit no light.

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16. The emission spectrum of hydrogen atoms has two has two lines of Balmer series with wavelength $4102Å$and $4861Å$. To what series does a spectral line belong if its wave nmnber is equal to the difference of wave number is of above two lines ? What is the wavelength of this line? $\left[TakeR = 1.097 \times 10^7 m^{-1}\right]$

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17. 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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18. A hydrogen like atom with 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 ot quantum state n, a photon of energy 40.8 eV is emitted. Find n, Z and the ground state energy (in eV) of this atom. Also calculate the minimum energy (in eV) that can be emitted by this atom during de-excitation. Ground state energy of hydrogen atom is – 13. 6 eV.

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19. 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$47.2 eV$ to excite the electron from the second bohr orbit to the third bohr orbit. Find

(i) The value of Z

(ii) The energy requiredto nucleus 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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20. 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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21. Calculate the separation between the particles of a systemin the ground state, the corresponding binding energy and wavelength of first line in Lyman series of such a system is positronium consisting of an electron and positron revolvin ground their common centre.

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22. A $\mu - meson$ ("charge -e , mass $= 207m$, 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 $0.529 Å$ and $13.6 eV$, repectively. Take $R = 1.67 \times 109678 cm^{-1}$

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23. A particle of charge equal to that of an electron - e, and mass 208 times the mass of electron (called a mu meson) moves in a circular orbit around a nucleus of charge $+3e$ (Take the mass of the nucleus to be infinite) Assuming that the bohr model of the atom is applicable to this system

(i) Derive an expression for the radius of the bohr orbit

(ii) find the value for which the radius is approximately the same as that of the bohr orbit fo the hydrogen atom

(iii) find the wavelength of the radiation emitted when the mu- meson jump from the third orbit of the first orbit

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24. A $\pi - meason$ hydrogen atom is a bound state of negative charged pion (denoted by $\pi^{-}, m_{\pi} = 273 m_e)$ 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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25. 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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26. Calculate difference in binding energy of atomic hydrogen and atomic deuterium.

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

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

b Find the ionization energy of the atom.

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28. Suppose the potential energy between an electron and aproton at a distance r is given by

$-Ke^2/3r^3$. Use Bohr's theory to obtain energy level of such a hypothetical atom.

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

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30. Suppose a moving hydrogen atom makes a head on inelastic collision with a stationary hydrogen atom. Before collision, both atoms are ground state and after collision, they move together. What is the minimum velocity of the moving hydrogen atom if one of the atoms is to be given the minimum excitation energy after the collisions? Take

$m_H = 1.0078 amu. 1 amu = 1.66 \times 10^{-27} kg.$

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31. 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?

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32. 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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33. 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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34. 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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Practice Exercise 1 1

1. The innermost orbit of the hydrogen atom has a diameter of 1.06Å what is the Diameter of the tenth orbit:

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Practice Exercise

1. Which state of triply ionised Beryllium (Be^{+++}) the same orbital radius as that of the ground state hydrogen ?

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2. In (ii), what is the ratio'of the energy state of beryllitim and that of hydrogen? [4]

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3. The orbital speed of the electron in the ground state of hydrogen is v. What will be its orbital speed when it is excited to the enrgy state $-3.4eV$?

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4. Which energy state of doubly ionized lithium Li^{++} has the same energy as that of the ground state of hydrogen?

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5. 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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6. The total energy of the electron in the first excited state of hydrogen is $-3.4eV$. What is the kinetic energy of the electron in this state?

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7. Determine the wavelengh of light emitted when a hydrogen atom makes a transition from the n=6 to the n=2 energy level according to the Bohr model

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

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9. An energy of 68.0 eV is required to excite a hydrogen-like atom in its second Bohr orbit to third. The nuclear charge is Ze. Find the value of Z, the kinetic energy of the electron in the first Bohr orbit and the wavelength of the electronmagnetic radiation required to eject the electron from the first orbit to infinity.

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10. 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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11. A hydrogen like atom (atomic number z) is in a higher excited state of quantum number n. This excited atom can make a transition to the first excited state by successively emitting two photons of energies $10.2eV$ and $17.0eV$ respectively. Alternatively the atom from the same excited state can make a transition to the second excited state by successively emitting 2 photons of energy $4.25eV$ and$5.95eV$ respectively. Determine the value of $(n + z)$

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12. A gas of hydrogen - like ion is perpendicular in such a way that ions are only in the ground state and the first excite state. A monochromatic light of wavelength 1216Å is absorbed by the ions. The

ions are lifted to higher excited state and emit emit radiation of six wavelength , some higher and some lower than the incident wavelength. Find the principal quantum number of the excited state identify the nuclear charge on the ions . Calculate the values of the maximum and minimum wavelengths.

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13. Determine the separation of the first line ofthe Balmer series in a spectrum of ordinary hydrogen and tritium (mass number 3).TakeRydberg's constant R = $10967800m^{-1}$

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14. A photon of energy 5.4852eV liberates an electron from the Li atom initially at rest. The emitted electron moves at right angles to the direction in which photon moves. Find the speed and the direction in which the Li^{2+} ion will move. Ionization potential ofLi atom= 5.3918V.Atomic weight of $Li = 6.94g$,

$N_{Av} = 6.02 \times 10^{23} mol^{-1}$ and $m_e = 9.1 \times 10^{-31} kg$

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15. A neutron moving with a speed v strikes a hydrogen atom in ground state moving toward it with the same speed. Find the minimum speed of the neutron for which ineleastic (completely or partially) collision may take place .The mass of neutron = mass of hydrogen $= 1.67 \times 10^{-27} kg$

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16. A uniform magnetic field B exists in a region. An electrons projected perpendicular to the field goes in a circle. Assuming Bohr's quantization rule for angular momentum, calculate

(a) the smallest possible radius of the electrons

(b) the radius of the nth orbit and

(c) the minimum possible speed of the electron.

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17. A projectile of mass m, charge Z', initial speed v and impact parameter b is scattered by a heavy nucleus of charge Z. Use angular momentum and energy conservation to obtain a formula connecting the minimum distance (s) of the projectile form the nucleus to these parameters .show that for b=0, s reduces to the closest distance of approach r_0.

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

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Practice Exercise 1 2

1. The ratio of minimum to maximum wavelength of radiation that en electron in the gorund stsate can cause in a Bohr's hydrgen atom is:

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Practice Exercise 1 3

1. Show that for large values of principal quantum number, the frequency of an electron rotating in adjacent energy levels of hydrogen atom and the radiated frequency for a transition between these levels all approach the same value.

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Discussion Question

1. Balmer series was observed and analysed before the other series .Can you suggest a reason for such an order?

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2. The excited energy of a He^{+} ion is the same as the ground state energy of hydrogen is it always true that one of the energies of any hydrogen like ion will be the same as the ground state energy of a hydrogen atom?

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3. An atom is in its excited state ,Does the probability of its coming to ground state depend on whether the radiation is already present or not? If you does it also depends on the wavelength of the radiation present?

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4. What while radiation is passed through a sample of hydrogen gas at room temperature , absorption lines are observed in lyman series only Explain

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5. The difference is the frequency of series limit of lyman series and balmer series is equal to the frequency of the first line of the lyman series Explain

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6. When an electron goes fron the valence band to the conduction band in silicon,its energy is increased by 1.1eV.the average energy exchange in a thermal collision is of the order of kT which is only 0.026eV at room tempareture.How is a thermal collision able to take some of the electrons from the valence band to the conduction band ?

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7. The energy required to excite an electron from the ground state of hydrogen atom to the first excited state, is

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8. The total energy of the hydrogen atom is negative. What significance does this have ?

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9. Find out the wavelength of the first line of the $He+$ ion in a spectral series whose frequency width is $\Delta v = 3.3 \times 10^{15} s^{-1}$

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10. In the Bohr model for the hydrogen atom, the closer the electron istobe nucleus, the smaller is the total energy of the atom. Is this also true in the quantum mechanical picture of the hydrogen atom? Justify your answer.

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11. The materials (phosphors) that coat the inside of a fluorescent lamp convert ultravioletradiation (from the mercury- vapor discharge inside the tube) into visible light. Could one alsomake aphosphor that converts visible light to ultraviolet ? Explain.

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12. Which wavelength will be emitting by a sample of atomic hydrogen gas (in ground state) if electron of energy $12.5eV$ collide with the atoms of the gas?

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13. What are the most significant differences between the Bohr model of the hydrogen atom and the Schrodinger analysis of that atom ? What are the similarities?

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14. How many wavelength are emitted by atomic hydrogen in visible range $(380nm - 780nm)$? In the range $50nm \to 100nm$?

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15. What will be the energy corresponding to the first excited state of a hydrogen atom if the potential energy of the atom is taken to be $10eV$ when the electron is widely separated from the proton ? Can be still write $E_0 - E_1 / n^2$, or , $r_n = a_0 n^2$?

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16. The numerical value of ionization in eV equals the ionization potential in volts .Does the equally hold if these quantities are insured in some other units?

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17. How are x- rays produced ? Explain the origin of the line spectra and the continuous spectra .

What limits the minimum size of X - ray wavelengths ?

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Conceptual Mcqs Single Option Correct

1. According to Bohr's theory of the hydrogen atom, the radii of stationary electron orbits are related to the principal quantum number n as :

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

B. $r_n \propto 1/n$

C. $r_n \propto n$

D. $r_n \propto n^2$

Answer:

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2. The wavelength involved in the spectrum of deuterium $\_(1)^2 D$ are slightly different from that of hydrogen spectrum because

A. Size of the two nuclei are different

B. Nuclear forces are different in the two cases

C. Masses of the two nuclei are different

D. Attraction between the electron and the nucleus is different in the two cases

Answer:

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3. The shortest wavelength of the spectrum for transition of an electron to $n = 4$energy level of a hydrogen like atom(atomic number = Z) is the same as the shortest wavelength of the Balmer series of hydrogen atom.The value of Z is:

A. 2

B. 3

C. 4

D. 6

Answer:

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4. Which of the following series in the spectrum of the hydrogen atom lies in the visible region of the electromagnetic spectrum

A. Paschen serie

B. Balmer series

C. Lyman series

D. Brackett series

Answer:

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5. The angular momentum of an electron in an orbit is quantized because it is a necessary condition for the compatibility with:

A. The wave nature of electron

B. Particle nature ofelectron

C. Paulli's exclusion behaviour

D. None of these

Answer:

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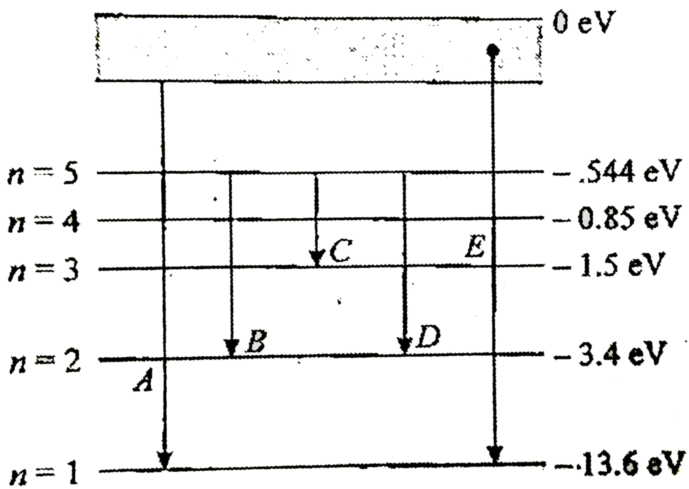
6. In the following figure the energy levels of hydroge atom have been shown along with some transitions marked A, B,C,D and E.The transitionsy A,B and C respectively represent:



A. The first member of Lyman series,third member of Balmer series and second member of Paschen series

B. The ionisation potential of hydrogen, second member of Balmer series and third member of Paschen series

C. The serieslimit of Lyman series, second member of Balmar series and second member of Paschen series

D. The series limit ofLyman series, third member of Balmer series and second member of Paschen series

Answer:

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7. The electron in a hydrogen atom makes a transition from an excited stateto the ground state. Which of the following statements is true ?

A. Its kinetic energy increases and its potential and total energies decreases

B. Its kinetic energy decreases, potential energy increases and its total energy remains the same

C. Its kinetic and total energies decrease and its potential energy increases

D. Its kinetic,potential and total energies decrease

Answer:

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8. In the Bohr's model of hydrogen atom, the ratio of the kinetic energy to the total energy of the electron in n^{th} quantum state is:

A. -1

B. +2

C. -2

D. 2

Answer:

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9. According to Bohr's theory of the hydrogen atom, the speed v_n of the electron in a stable orbit is related to the principal quantum number n as (C is a constant) :

A. $v_n = C / n^2$

B. $v_n = C / n$

C. $v_n = C \times n$

D. $v_n = C \times n^2$

Answer:

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10. In the Bohr model of a hydrogen atom, the centripetal force is furnished by the coulomb attraction between the proton and the electron. If a_0 is the radius of the ground state orbit, m is the mass and e is the chargeon the 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. $\dfrac{e}{\sqrt{4\pi\varepsilon_0 a_0 m}}$

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

Answer:

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11. If elements with principal quantum number $n > 4$ were not allowed in nature, the number of possible elements would be:

A. 60

B. 32

C. 4

D. 64

Answer:

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12. Bohr's atomic model gained acceptance above all other models because it:

A. Is based on quantum hypothesis

B. Explained the constitution of atom

C. Assumed continuous radiation of energy by orbiting electrons

D. Explained hydrogen spectrum

Answer:

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13. Pauli's exclusion principle states that'no&vo electrons in an atom can have identical values for:

A. One of the four quantum numbers

B. Two of the four quantum numbers

C. Three of the four quantum numbers

D. All four quantum numbers

Answer:

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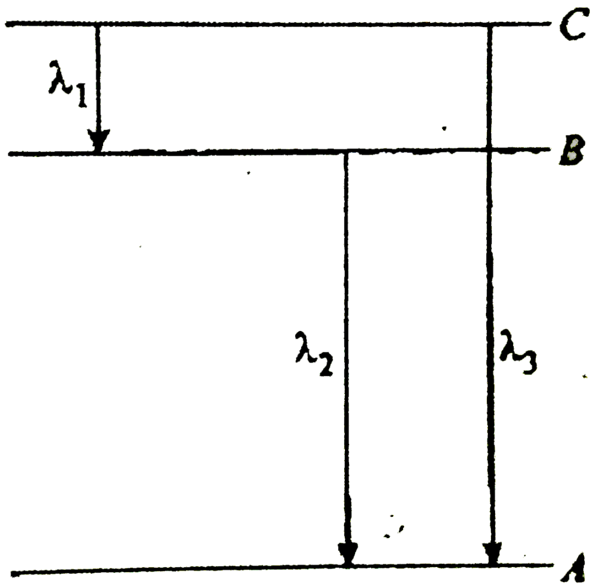
14. Energy levels A,B and C of a certain atom correspond to increasing values of energy i.e. $E_A < E_B < E_C$ .If $\lambda_1, \lambda_2, \lambda_3$ are the wavelengths of radiation corresponding to transition C to B,B to A and C to A respectively, which of the following statements is correct ?



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

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

C. $\lambda_1 + \lambda_2 + \lambda_3 = 0$

D. $\lambda_3 = \sqrt{\lambda_1^2 + \lambda_2^2}$

Answer:

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15. When white light (violet to red) is passed through hydrogen gas at room temperature, absorption lines will be observed in the

A. Lyman series

B. Balmerseries

C. Both (A) and(B)

D. Neither (A) or (B)

Answer:

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16. The difference in angular momentum associated with electron in two successive orbits of hydrogen atom is:

A. $\frac{\lambda}{\pi}$

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

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

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

Answer:

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17. If radiation of all wavelengths from ultraviolet to infrared ispassed through hydrogen gas at room temperature absorption lines will be observed in the

A. Lyman series

B. Balmer series

C. Both (A) and (B)

D. Neither (A) or (B)

Answer:

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18. Which of the following force is responsible for α-particle scattering ?

A. Gravitational

B. Nuclear

C. Coulomb

D. Magnetic

Answer:

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19. A Hydrogen atom and Li^{++} ion are both in the second excited state. If L_H and L_{Li} are their respective 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:

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20. The minimum kinetic energy of an electron,hydrogen ion,helium ion required for ionization of a hydrogen atom is E_1 in case electron is colided with hydrogen atom. It is E_2 if hydrogen ioniscollided and E_3 when helium ioniscollided.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:

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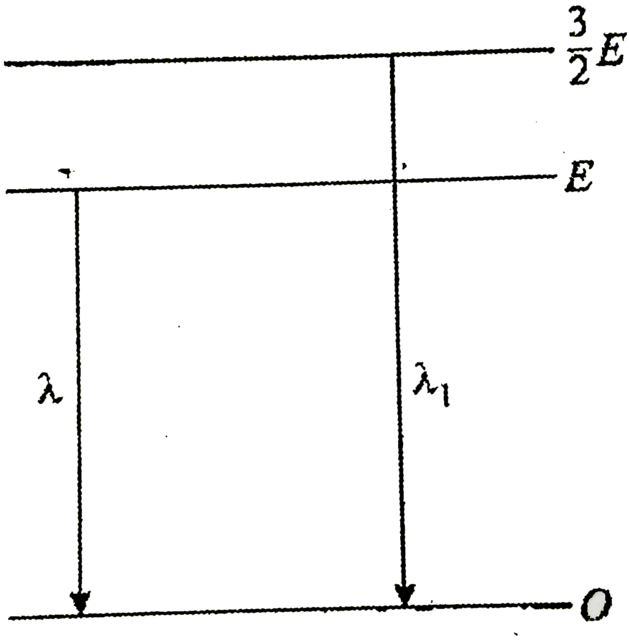
21. The wavelength of radiation emitted due to transition of electron from energy level E to zero is equal to λ. The wavelength of radiation (λ_1)

emitted when electronjumpsfrom energy level $\frac{3E}{2}$ to zero will be :



A. $\frac{2}{3}\lambda$

B. $\frac{3}{2}\lambda$

C. $\frac{4}{9}\lambda$

D. $\frac{9}{4}\lambda$

Answer:

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22. A neutron collies head-on with a stationary hydrogen atom in ground state. Which of the following statements is/are correct ?

A. If kinetic energy of the neutron is less than 13.6eV, collision must be elastic

B. If kinetic energy of the neutron is less than 13.6eV, collision may be inelastic

C. Inelastic collision may take place on when initial kinetic energy of neutron is greater than 13.6 eV

D. Perfectly inelastic collision can not take place

Answer:

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23. An electron in hydrogen atom after absorbing-an energy photon jumps from energy state n_1 to n_2. Then it returns to ground state after emitting six different wavelengths in emission spectrum.'The energy of emitted photons is either equal to, less than or grater than the absorbed photons: Then n_1 and n_2 are:

A. $n_2 = 4. n_1 = 3$

B. $n_2 = 5, n_1 = 3$

C. $n_2 = 4, n_1 = 2$

D. $n_2 = 4, n_1 = 1$

Answer:

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24. Mark correct statements:

A. Bohr's the ry is applicable to hydrogen alone because its nucleus is most light

B. Binding energy of electron (in ground state) of $._1 H^2$ is greater than that of $._1 H$ in ground state

C. All the lines of Balmer series lie in visible spectrum

D. None of these

Answer:

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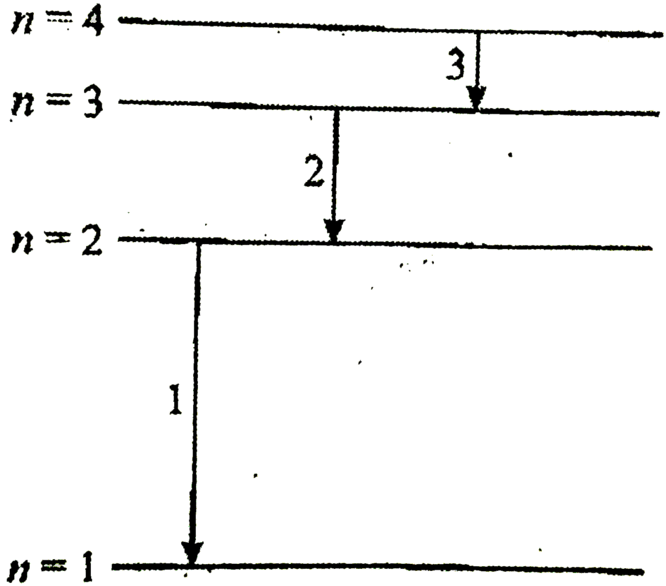
25. Figure represents transitions of electrons from higher to lower state of a hydrogen atom. Which transition represents the line of

Balmerseries:



A. 1

B. 2

C. 3

D. All 1,2,and 3

Answer:

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26. Hydrogen H, deuterium D, singlyionized helium He^{+} and doubly ionized lithium L^{++} all have one electron around the nucleus. Consider $n=2$ and $n=1$ transition. Thewavelengths ofthe emitted radiations are $\lambda_1, \lambda_2, \lambda_3$ and λ_4 respectively. Then approximately:

A. $\lambda-(1)=2\lambda_2=2\sqrt{2}\lambda_3=3\sqrt{2}\lambda_4$

B. $\lambda_1=\lambda_2=2\lambda_3=3\lambda_4$

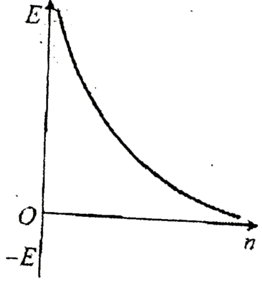
C. $\lambda_1 = \lambda_2 = 4\lambda_3 = 9\lambda_4$

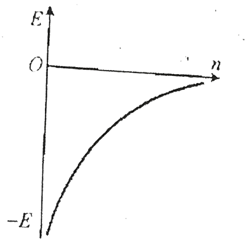
D. $4\lambda_1 = 2\lambda_2 = 2\lambda_3 = \lambda_4$

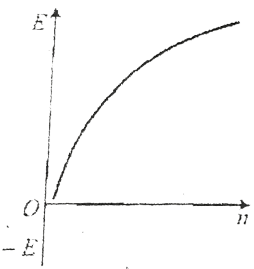
Answer:

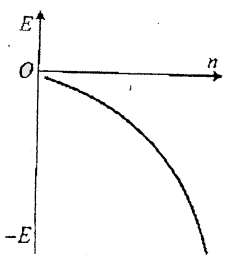
Watch Video Solution

27. Which ofthe following curves may represent the energy of electron in hydrogen atom as a function of principal quantum number n:

A. 

B. 

C. 

D. 

Answer:

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28. A hydrogen atom in ground state absorbs 12.1 eV energy. The orbital angular momentum of electron is increased by:

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

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

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

D. Zero

Answer:

Watch Video Solution

29. Magnetic moment due to the motion of the electron in n^{th} energy state of hydrogen atom is proportional to :

A. n

B. n^0

C. n^5

D. n^3

Answer:

Watch Video Solution

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Numericalmcqssingle Optioriscorrect

1. The energy required to excite a hydrogen atom from $n = 1$ to $n = 2$ energy state 10.2 eV. What is the wavelength of the radiation emitted by the atom when it goes back to Its ground state ?

A. 1024Å

B. 1122Å

C. 1218Å

D. 1324Å

Answer:

Watch Video Solution

2. Consider Bohr's theory for hydrogen atom.The magnitude of angular momentum, orbit radius and frequency of the electron in n^{th} energy statein a hydrogen atom are L,r & f espectively. Find out the value of 'x', if the product f r L is directly proportional to n^{th}:

A. 0

B. 1

C. 2

D. 3

Answer:

Watch Video Solution

3. For the first member of Balmer series of hydrogen spectrum, the wavelength is λ. What is the wavelength of the second member?

A. $\frac{5}{30}\lambda$

B. $\frac{3}{16}\lambda$

C. $\frac{4}{9}\lambda$

D. $\frac{20}{27}\lambda$

Answer:

Watch Video Solution

4. In a new system of units the fundamental quantities are planks constant (h), speed of light (c) and time (7). Then the dimensions of Rydberg's constant will be :

A. $h^1 c^1 T^1$

B. $h^0c^{-1}T^{-1}$

C. $h^1c^0T^{-1}$

D. $h^{-1}cT^0$

Answer:

Watch Video Solution

5. In a hypothetical atom, if transition from $n = 4$ to $n = 3$ produces visible light then the possible transition to obtain infrared radiation is:

A. $n = 5$ to $n = 3$

B. $n = 4$ to $n = 2$

C. $n = 3$ to $n = 1$

D. None of these

Answer:

Watch Video Solution

6. If first excitation potential of a hydrogen like-atom is V electron volt, then the ionization energy of this atom will be:

A. V electron volt

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

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

D. cannot be calculated by given information.

Answer:

Watch Video Solution

7. Ionisatiori energy for hydrogen atom in the ground state is E.What is the ionisation energy of Li^{++} atom in the 2^{nd} excited state?

A. E

B. 3 E

C. 6 E

D. 9 E

Answer:

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8. The different lines in the Lyman series have their wavelengths laying between:

A. Zero to infinite

B. 900Å to 1200Å

C. 1000Å to 1500Å

D. 500Å to 1000Å

Answer:

Watch Video Solution

9. The orbital electron of the hydrogen atom jumps from the ground state to a higher energy state and its orbital velocity is reduced to one third of its initial value. If the radius of the orbit in the ground state is r, then what is the radius of the new orbit ?

A. 2r

B. 3r

C. 3r

D. 9r

Answer:

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10. If we assume that penetrating power of any radiation/particle is inversely proportional to its de-Broglie wavelength of the particle then :

A. a proton and an α-particle after getting accelerated through same potential difference will have equal penetrating power.

B. penetrating power of α-particle will be greater than that of proton which have been accelerated by same potential difference.

C. proton's penetrating power will be less than penetrating power of an electron which has been accelerated by the same potential difference.

D. penetrating powers can not be compared as all these are particles having no wavelength or wave nature.

Answer:

Watch Video Solution

11. According to Bohr's theory the ratio of time taken by electron to complete one revolution in first excited and second excited states of hydrogen will be:

A. 1:8

B. 8:27

C. $8^2 : 27^2$

D. 4:9

Answer:

Watch Video Solution

12. The area of the electron orbit for the ground state of hydrogen atom is A.What will be the area of the electron orbit corresponding to the first excited state ?

A. 4A

B. 8A

C. 16A

D. 32A

Answer:

Watch Video Solution

13. If the wave-number of a spectral line of Brackett series of hydrogen is $\frac{9}{400}$ times the Rydberg constant.What is the state from which the transition has taken place ?

A. n=4

B. n=5

C. n=6

D. n=7

Answer:

Watch Video Solution

14. The ionization potential of H-atom is 13.6 V. The H-atoms in ground state are excited by mono chromatic radiations of photon energy 12.09 ev. Then the number of spectral lines emitted by the excited atoms, will be

A. One

B. Two

C. Three

D. Four

Answer:

Watch Video Solution

15. An electron jumps from the first excited state to the ground stage of hydrogen atom..What will be the percentage change in the speed of electron ?

A. 0.25

B. 0.5

C. 1

D. 2

Answer:

Watch Video Solution

16. An energy of $24.6eV$ is required to remove one of that electrons from a neutal helium atom. The enegy (in eV)required to remove both the electrons from a netural helium atom is

A. 38.2

B. 49.2

C. 51.8

D. 79

Answer:

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17. A neutron beam, in which each neutron has same kinetic energy, is passed through a sample of hydrogen like gas (but not hydrogen) in ground state and at rest. Due to collision of neutrons with the ions of the gas, ions are excited and then they emit photons. Six spectral lines are obtained in which one of the lines is of wavelength (6200/51) nm.Which gas is this?

A. H

B. He^{+}

C. Li^{+2}

D. Bi^{+3}

Answer:

Watch Video Solution

18. In previous questiom what is the minimum possible value of kinetic energy of the neutrons for this to be possible. The mass of neutron and proton can be assumed to be nearly same. Use $hc = 12400 eV Å$

A. 31.875 eV

B. 63.75 eV

C. 127.5 eV

D. 182.5 eV

Answer:

Watch Video Solution

Watch Video Solution

19. In Millikan's oil drop experiment, a charged oil drop of mass $3.2 \times 10^{-14} kg$ is held stationary between two parallel plates 6mm apart by applying a potential difference of $1200V$ between them. How many excess electrons does the oil drop carry? Take $g = 10 ms^{-2}$

A. 7

B. 8

C. 9

D. 10

Answer:

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20. In a hydrogen like atom the energy required to excite the electron from 2^{nd} to 3^{rd} orbit is $47.2eV$ What is atomic number of the atom?

A. 2

B. 3

C. 4

D. 5

Answer:

Watch Video Solution

21. 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:

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22. In a hydrogen atom following the Bohr's postulates the product of linear momentum and angular momentum is proportional to n^x where 'n' is the orbit number. Then 'x' is:

A. 0

B. 2

C. -2

D. 1

Answer:

Watch Video Solution

23. The velocityof an electron in second orbit of tenly ionized sodium atom (atomic number Z= 11) is v. The velocity of an electron in its fifth orbit will be:

A. v

B. $\frac{5}{2}v$

C. $\frac{2}{5}v$

D. $\frac{22}{5}v$

Answer:

Watch Video Solution

24. A positronium consists of an electron and a positron revolving about their common centre of mass. Calculate the separation between the electron and positron in their first excited state:

A. 0.529 A

B. 1.058 A

C. 2.116 A

D. 4.232 A

Answer:

Watch Video Solution

25. A positronium atom consist of an electron and a positron revolving about their common centre of mass . Calculate

Kinetic energy of the electron in ground state

A. 1.51 e V

B. 3.4 e V

C. 6.8 eV

D. 13.6 eV

Answer:

Watch Video Solution

26. A hydrogen atom ia in excited state of principal quantum number n . It emits a photon of wavelength λ when it returnesto the ground state. The value of n is

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

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

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

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

Answer:

Watch Video Solution

27. The ratio of the binding energies of the hydrogen atom in the first and the second excited states is

A. 1:4

B. 4:9

C. 9:4

D. 4:1

Answer:

Watch Video Solution

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28. 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. 975 A

B. 1218 A

C. 2248 A

D. 4316 A

Answer:

Watch Video Solution

29. Out of the following transitions, the frequency of emitted photon will be maximurn for.:

A. $n = 5$ to $n = 3$

B. $n = 6$ to $n = 2$

C. $n = 2$ to $n = 1$

D. $n = 4$ to $n = 2$

Answer:

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30. Imagine a neutral particle of same mass m as electron revolving around a proton of mass M_p only under newton's gravitational force. Assuming Bohr's quantum condition, the radius of electron orbit is given by:

A. $\frac{n^2h^2}{\pi m^2 GM_p}$

B. $\frac{n^2h^2}{4\pi^2 m^2 GM_p}$

C. $\frac{GM_p n^2 h^2}{4\pi^2 m^2}$

D. $\frac{nhGM_p}{4\pi m}$

Answer:

Watch Video Solution

31. Determine the ratio of perimeters in 2^{nd} and 3^{rd} Bohr orbit in He^+ atom:

A. $\frac{9}{4}$

B. $\frac{9}{16}$

C. $\frac{4}{9}$

D. $\frac{16}{9}$

Answer:

Watch Video Solution

32. 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:

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33. An α-particle with a kinetic energy of $2.1eV$ makes a head on collision with a hydrogen atom moving towards it with a kinetic energy of $8.4eV$. The collision

A. must be perfectly elastic

B. may be perfectly inelastic

C. may be inelastic

D. must be perfectly inelastic

Answer:

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34. A hydrogen atom is initially atrest and free to moveis in the second excited state.It comes to ground state by emitting a photon, then the momentum of hydrogen atom will be approximately: (in $kg - m / s$)

A. 12.1×0^{-27}

B. 6.45×10^{-27}

C. 3×10^{-27}

D. 1.5×0^{-27}

Answer:

Watch Video Solution

35. An gas of H-atom in excited state n_2 absorbs a photon of some energy and jump in hiegher energy state n_1. Then it returns to ground state afer emitted six different wavelengths in emission spectrum. The energy of emitted photon is equal, less or greater than the energy of absorbed photon then n_1 and n_2 will be

A. $n_1 = 5, n_2 = 3$

B. $n_1 = 5, n_2 = 2$

C. $n_1 = 4, n_2 = 3$

D. $n_1 = 4, n_2 = 2$

Answer:

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36. Imagine an atom made of a proton and a hypothetical particle of double the mass of the electron but having the same change as the electron. Apply the Bohr atom model and consider all possible transitions of this hypothetical particle of the first excited level. the longest wavelength photon that will be emitted has wavelength [given in terms of the Rydberg constant R for the hydrogen atom] equal to

A. $\frac{Z^2}{3R}$

B. $\frac{1}{3Z^2R}$

C. $\frac{4}{3Z^2R}$

D. $\frac{16}{3Z^2R}$

Answer:

Watch Video Solution

37. One of the lines in the emission spectrum of Li^{2+} has the same wavelength as that of the $2nd$ line of Balmer series in hydrogen spectrum. The electronic transition corresponding to this line is:

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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38. In Bohr's theory the potential energy of an electron at a position is $\frac{Kr^2}{2}$ (where Also is a positive constant), then the quantized energy of the electron in nth orbit is:

A. $\frac{nh}{2\pi}\left(\frac{K}{m}\right)$

B. $\frac{nh}{2\pi}\left(\frac{K}{m}\right)^{1/2}$

C. $nh\left(\frac{K}{m}\right)$

D. $\frac{nh}{2\pi}\left(\frac{m}{K}\right)^{1/2}$

Answer:

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39. If first and second frequencies in transition to orbital are related by the relation $v_1 = kv_2$ then the first frequency in the transition to second orbital will notbe equal to :

A. $v_1\left(\frac{1}{K}-1\right)$

B. $(1-k)v_2$

C. v_2-v_1

D. k^2v_2

Answer:

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40. The ratio of de-Broglie wave length of a photon and an electron of mass 'm' having the same kinetic energy E is: (Speed of light=c)

A. $\sqrt{\frac{2mc^2}{E}}$

B. $\sqrt{\frac{mc^2}{E}}$

C. $\frac{2mc^2}{E}$

D. $\frac{mc^2}{E}$

Answer:

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41. A monochromatic radiation of wavelength λ is incident on a sample containig $He+$. As a result the Helium sample stars radiating. A part of this radiation is allowed to pass through a sample of atomic hydrogen gas in ground state. It is noticed that the hydrogen sample has stared emitting electrons whose maximum kinetic energy is $37.4 eV$.

$\left(hc = 12400 eV \text{Å}\right)$. Then λ is

A. 275Å

B. 243Å

C. 656Å

D. 386Å

Answer:

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42. Of the following transitions in a hydrogen atom, the one which gives an absorption line of highest frequency is

A. $n = 1$ to $n = 2$

B. $n = 3$ to $n = 8$

C. $n = 2$ to $n = 1$

D. $n = 8$ to $n = 3$

Answer:

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43. An electron of the kinetic energy $10eV$ collides with a hydrogen atom in $1st$ excited state. Assuming loss of kinetic energy in the collision be to quantized which of the following statements is correct?

A. The collision may be perfectly inelastic

B. The collision may be inelastic

C. The collision may be elastic

D. The collision must be inelastic

Answer:

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44. If the first orbit of a hydrogen atom the total energy of the electron is $-21.76 \times 10^{-19} J$, then its electric potential energy will be:

A. $-43.52 \times 10^{-19} J$

B. $-21.76 \times 10^{-19} J$

C. $-10.88 \times 10^{-19} J$

D. $-13.6 \times 10^{-19} J$

Answer:

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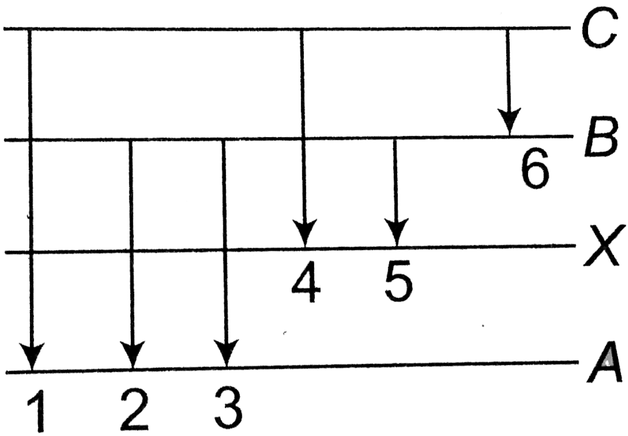
45. In the figure six lines of emission spectrum are shown. Which of them will be absent in the absorption spectrum.



A. 1,2,3

B. 1,4,6

C. 4,5,6

D. 1,2,3,4,5,6

Answer:

Watch Video Solution

46. An orbit electron in the ground state of hydrogen has an angular momentum L_1, and an orbital electron in the first orbit in the ground state of lithium (dounle ionised positively) has an angular momentum L_2. Then :

A. $L_1 = L_2$

B. $L_1 = 3L_2$

C. $L_2 = 3L_1$

D. $L_2 - 9L_1$

Answer:

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47. The ratio of the maximum wavlength of the Lyman series in hydrogen specturm to the maximum wavelength in the Panchen series is

A. $\frac{3}{105}$

B. $\frac{6}{15}$

C. $\frac{52}{7}$

D. $\frac{7}{108}$

Answer:

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48. Consider atoms H, He^{+}, Li^{++} in their ground states. Suppose E_1, E_2 and E_3 are minimum energies required so that the atoms HHe^{+}, Li^{++} can achieve their first excited states respectively, then

A. $E_1 = E_2 = E_3$

B. $E_1 > E_2 > E_3$

C. $E_1 < E_2 < E_3$

D. $E_1 = E_2 = E_3$

Answer:

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49. The radius of first Bohr orbit of hydrogen atom is 0.53Å. Then the radius of first Bohr-orbit of mesnoic atom (negative meson has mass 207 times that of electron but same charge) is:

A. $2.85 \times 10^{-13} m$

B. $1.06 \times 10^{-13} m$

C. $0.53 \times 10^{-10} m$

D. $7.0 \times 10^{-12} m$

Answer:

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Advance Mcqs With One Or More Options Correct

1. The ground state and first excited state energies of hydrogen atom are $-13.6eV$ and $-3.4eV$ respectively. If potential energy in ground state is taken to be zero. Then:

A. potential energy in the first excited state would be $20.4 eV$

B. total energy in the first excited state would be $23.8 eV$

C. Kinetic energy in the first excited state would be $3.4 eV$

D. total energy in the ground state would be $13.6 eV$

Answer:

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2. An electron is excited from a lower energy state to a higher energy state in a hydrogen atom. Which of the following quantity/quantities decreases/decrease in the excitation ?

A. Potential energy

B. Angular speed

C. Kinetic energy

D. Angular momentum

Answer:

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3. The electron in a hydrogen atom makes a transition $n_1 \rightarrow n_2$, where n_1 and n_2 are the principle 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. $n_1 = 6, n_2 = 3$

Answer:

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4. An electron in hydrogen atom first jumps from second excited state to first excited state and then from first excited state to ground state. Let the ratio of wavelength, momentum and energy of photons emitted in these two cases be a, b and c respectively, Then

A. $c = \frac{1}{a}$

B. $a = 9/4$

C. $b = 5/27$

D. $c = 5/27$

Answer:

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5. The magnitude of energy, the magnitude of linear momentum and orbital radius of an electron in a hydrogen atom corresponding to the quantum number n are E, P and r respectively. Then according to Bohr's theory of hydrogen atom:

A. EPr is proportional to $\frac{1}{n}$

B. P/E is proportional to n

C. Er is constant for all orbits

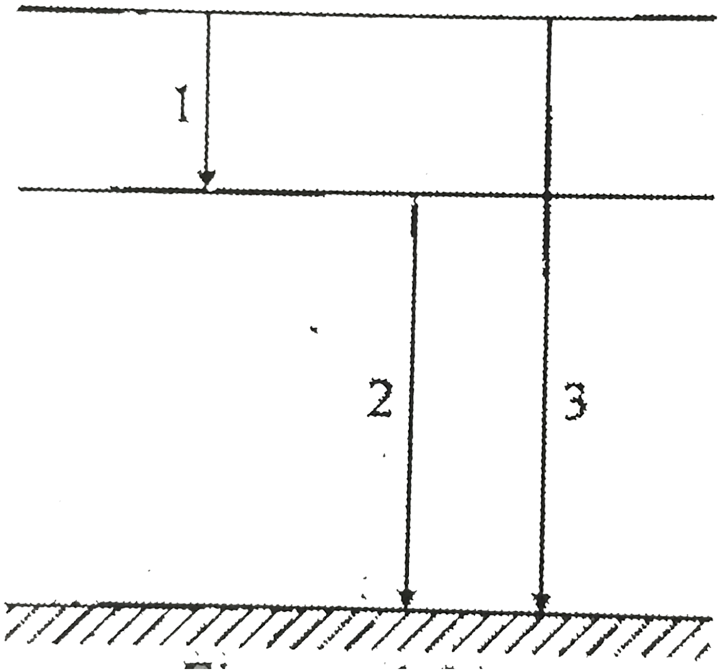
D. Pr is proportional to n

Answer:

Watch Video Solution

6. The wavelengths and frequencies of photons in transition 1,2 and 3 for hydrogen like atom are

λ_1, λ_2, λ_3, v_1, v_2 and v_3 respectively. Then:



A. $v_3 = v_1 + v_2$

B. $v_3 + \frac{v_1 v_2}{v_1 + v_2}$

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

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

Answer:

Watch Video Solution

7. Which of the following transition in He^{+} ion will give rise to a spectral line which has the same wavelength as some spectral line in the hydrogen atom ?

A. $n = 4$ to $n = 2$

B. $n = 6$ to $n = 2$

C. $n = 6$ to $n = 3$

D. $n = 8$ to $n = 4$

Answer:

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

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

Answer:

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9. In an e^{-} transition inside a hydrogen atom, orbital angular momentum may change by (h=Planck's constant)

A. h

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

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

D. $\frac{h}{4\pi}$

Answer:

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10. A beam of ultraviolet light of all wavelength passes through hydrogen gas at room temperature, in the x-direction. Assume that all photons emitted due to electron transitions inside the gas emerge in the y-direction. Let A and B denote the lights emerging from the gas in the x-and y-directions respectively.

(i) Some of the incident wavelengths will be absent in A

(ii) Only those wavelengths will be present in B which are absent in A

(iii) B will contain some visible light

(iv) B will contain some infrared light

A. some of the incident wavelengths will be absent in A

B. Only those wavelengths will be present in B which are absent in A

C. B will contain some visible light

D. B will contain some in frared light

Answer:

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

A. It many emit another photon in the Balmer series

B. It must 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, but the wavelength of this photon cannot be predicted

Answer:

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

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

B. All the lines of Balmer series in visible region

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

D. none of these

Answer:

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13. A neutron collies head-on with a stationary hydrogen atom in ground state. Which of the following statements is/are correct ?

A. if kinetic energy of the neutron is less than $13.6 eV$, collision must be elastic

B. if kinetic energy of the neutron is less than $13.6 eV$, collision may be inelastic

C. inelastic collision may take place only when initial kinetic energy of neutron is greater than $13.6 eV$

D. perfectly inelastic collision cannot take place

Answer:

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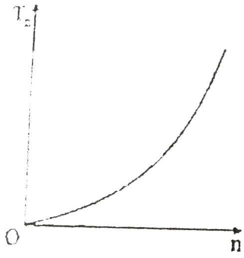
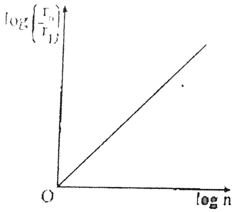
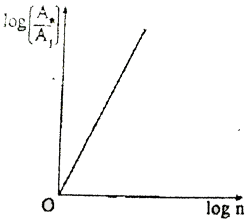
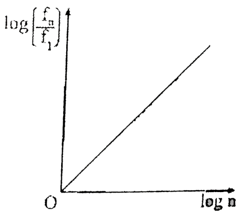
14. If, in a hydrogen atom, radius of nth Bohr orbit is r_n frequency of revolution of electron in nth orbit is f_n and area enclosed by the nth orbit is A_n , then which of the pollowing graphs are correct?

A. 

B. 

C. 

D. 

Answer:

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15. Mark correct statements(s):

Watch Video Solution

16. A photon of energy $10.5eV$ is allowed to interact with a hydrogen atom in its ground state. Then :

A. the photon is completely absorbed by the H-atom

B. the photon cannot excite the H-atom and comes out with energy $10.5eV$

C. the photon transfers $10.2eV$ energy to H-atom exciting it to first excited state

D. none of these

Answer:

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17. When a hydrogen atom is excited from ground state to first excited state then

A. Its kinetic energy increases by $10.2eV$

B. Its kinetic energy decreases by $10.2eV$

C. Its potential energy increase by $20.4eV$

D. Its angular momentum increases by $1.05 \times 10^{-35} J - s$

Answer:

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18. Suppose the potential energy between an electron and a proton at a distance r is given by

$Ke^2/3r^3$. Application of Bohr's theory tohydrogen atom in this case showns that

A. Energy in the nth orbit is proportional to n^3

B. Energy in the nth orbit is proportional to n^6

C. Energy is proportional to m^2 (m: mass of electron)

D. Energy is proportional to m^3 (m: mass of electron)

Answer:

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19. An electron in an hydrogen atom has total energy of $-3.4eV$. Choose the correct statement (s):

A. The kinetic energy of the electron in that orbit is $3.4eV$

B. The potential energy of the electron in the orbit is $-6.8eV$

C. Angular momentum of the electron in that orbit is h / π

D. Angular momentum of the electron for that orbit is $2h / \pi$

Answer:

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20. when Z is doubled in an atom, which of the following statements are consistent with Bohr's theory?

A. Energy of a state is double

B. Radius of an orbit is doubled

C. Velocity of electrons in an orbit is doubled

D. Radius of an orbit is halved

Answer:

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21. The electron in a hydrogen atom jumps back from an excited state to ground state, by emitting a photon of wavelength $\lambda_0 = \frac{16}{15R}$, where R is Rydbergs's constant. In place of emitting one photon, the electron could come back to ground state by

A. Emitting 3 photons of wavelengths λ_1, λ_2 and λ_3 such that $\frac{1}{\lambda_1} + \frac{1}{\lambda_2} + \frac{1}{\lambda_3} = \frac{15R}{16}$

B. Emitting 2 photons of wavelength λ_1 and λ_2 such that $\frac{1}{\lambda_1} + \frac{1}{\lambda_2} = \frac{15R}{16}$

C. Emitting 2 photons of wavelength λ_1 and λ_2 such that $\lambda_1 + \lambda_2 = \frac{16}{15R}$

D. Emitting 3 photons of wavelength λ_1, λ_2 and λ_3 such that $\lambda_1 + \lambda_2 + \lambda_3 = \frac{16}{15R}$

Answer:

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22. 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:

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23. A particular hydrogen like atom has its ground state Binding energy $= 122.4eV$. It is in ground state. Then

A. Its atomic number is 3

B. An electron of 90eV can excite it

C. An electron of kinetic energy nearly 91.8 eV can be brought to almost rest by this atom

D. An electron of kinetic energy 12.6eV may emerge from the atom when electron of kinetic energy 125eV collides with this atom Momentum ratio of photons is

Answer:

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24. If radiation of all wavelengths from ultraviolet to infrared ispassed through hydrogen gas at room temperature absorption lines will be observed in the

A. Lyman series

B. Balmer series

C. Both (A) and (B)

D. Neither (A) or (B)

Answer:

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25. In the hydrogen atom, if the reference level of potential energy is assumed to be zero at the ground state level. Choose the incorrect statement.

A. The total energy of the shell increases with increase in the value of n

B. The total energy of the shell decreases with increase in the value of n

C. The difference in total energy of any two shells remains te same

D. The total energy at the ground state becomes 13.6eV

Answer:

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26. Choose the correct statement (s) for hydrogen and deuterium atoms (considering the motion of nucleus)

A. The radius of first Bohr orbit of deuterium is less than that of hydrogen

B. The speed of electron in first Balmer line of deuterium is more than that of hydrogen

C. The wavelength of first Balmer line of deuterium is more than that of hydrogen

D. The angular momentu of electron in the first Bohr orbit of deuterium is more than that of hydrogen

Answer:

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27. A neutron collies head-on with a stationary hydrogen atom in ground state. Which of the following statements is/are correct ?

A. If kinetic energy of the neutron is less than 20.4eV collision must be elastic

B. If kinetic energy of the neutron is less than 20.4eV collision may be inelastic

C. Inelastic collision may be take place only when initial kinetic energy of neutron is greater than 20.4 eV

D. Perfectly inelastic collision can nto take place

Answer:

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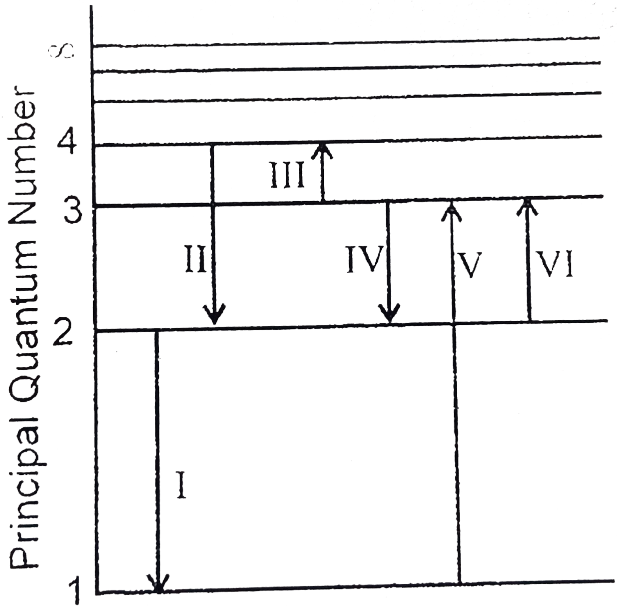
28. The figure shows an energy level diagram for the hydrogen atom. Several transitions are marked as I, II, III,____. The diagram is only indicative and not be scale.



In which transitions is a Balmer photn absorbed?

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29. A hydrogen atom in the $4th$ excited state, then:

A. the maximum number of emitted photons will be 10

B. the maximum number of emitted photons will be 6

C. it can emit three photons in ultraviolet region

D. if an infrared photon is generated, then a visible photon may follow this infrared photon

Answer:

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30. An electron with kinetic energy E collides with a hydrogen atom in the ground state. The collision will be elastic

A. $0 < E < \infty$

B. $0 < E < 10.2eV$

C. $0 < E < 13.6eV$

D. $0 < E < 3.4eV$

Answer:

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Unsolved Numerical Problems

1. A positive ion having just one electron ejected it if a photon of wavelength 228Å or lose is absorbed by it identify the ion

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2. What hydrogen-like ion has the wavelength difference between the first lines of the Balmer Lyman series equal to $59.3nm$?

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3. A beam of ultraviolet radius hacking wavelength between $100nm$ and $200nm$ is inclined on a sample of atomic hydrogen gas. Assuming that the atoms are in ground state which wavelength will have low intensity in the transmitted been? If the energy of a photon is equal to the ground state it hasl arge probability of being observed by on atom in the ground state

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4. A hydrogen atom in state $n = 6$ makes two successive transition and reaches the ground state in the first transition a photon of $1.13eV$ is emitted (a) Find the energy of the photon emitted in the second transition (b) what is the value of n in the intermediate state?

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5. Demonstrate that the frequency ω of a photon emerging when an electron jumps between neighbouring circular orbits of a hydeogen-like ion satisfies the inequality $\omega_n > \omega > \omega_{n+1}$, where ω_n and ω_{n+1} are the frequencies of revolution of that electron around the nucleus along the circular orbits. Make sure that as $n \to \infty$ the frequency of the proton $\omega \to \omega_n$

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6. 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 wave lengths 108.5 and $30.4 nm$.

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7. (a) Find the maximum wavelength λ_0 of light which can ionize a hydrogen atom in its ground (b) light of wavelength λ_0 is inclined on a hydrogen atom which is in its first excited state find the kinetic energy of the electron coming out

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8. A hydrogen atom in ground state absorbs a photon of ultraviolet radiation of wavelength $50nm$ Assuming that the entire photon energy is taken up by the electron with what kinetic energy will the electron be ejected?

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9. Suppose in certine condition only those transition are allowed to hydrogen atoms in which the principal quantum number a changes by2 (a) Find the smaller wavelength emitted by hydrogen (b) list the wavelength emitted by hydrogen in the visible range $(380nm \rightarrow 780nm)$

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10. A particle of mass m moves along a circular orbit in centrosymmetrical potential field $U(r) = kr^2/2$. Using the Bohr quantization condition, find the permissible orbital radii and energy levels to that particle.

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11. A double ionised lithium atom is hydrogen like with atomic number 3

(i)Find the wavelength of the radiation to excite the electron in Li^{++} from the first to the third bohr orbit (Ionisation energy of the hydrogen atom equals $13.6eV$

(ii) How many spectral lines are observed in the emission spectrum of the above excited system ?

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12. A parallel beam, of light of wavelength 100 nm passed through a sample of atomic hydrogen gas in ground state.

(a) Assume that when a phton supplies some of its energy to a hydrogen atom, the rest of the energy appears an another photon moving in the same direction as the incident photon. Neglecting the light emitted by the excited hydrogen atoms in the direction of the incident beam, what wavelengths may be observed in the transmitted beam?

(b) A radition detector is placed near the gas to detect radiation coming perpendicular to the incident beam. Find the wavelength of radiation that may be detected by the detector.

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13. A hydrogen like atom with 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 ot quantum state n, a photon of energy 40.8 eV is emitted. Find n, Z and the ground state energy (in eV) of this atom. Also calculate the minimum energy (in eV) that can be emitted by this atom during de-excitation. Ground state energy of hydrogen atom is – 13. 6 eV.

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14. A stationary helium ion emits a photon corresponding to the first line of Lyman series. That photon liberates a photoelectron form a stationary hydrogen atom in ground state. Find the velocity of photoelectron. Take mass of electron $= 9.11 \times 10^{-31} kg$ and ionisation energy of hydrogen atom=13.6ev.

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15. The evrage kinetic energy of molecules in a gas at temperature T is $1.5KT$find the temperature at which the average kinetic energy of the molecules of hydrogen equals the binding energy of its atoms will hydrogen remain in molecles form at this temperature ? Take $h = 8.62 \times 10^{-6} eVK^{-1}$

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16. A well collimated parallel pencil of cathode rays falls through a potential difference $3kV$ & enters the spacing between two parallel metallic plates, parallel to their length the spacing between the plates being $0.5cm$. The pencil strikes a fluorescent screen, mounted

perpendicular to the length of the plates at the farther end of the plates & produces fluorescent spot. if now a potential difference of 3V is applied across the two plates, calculate the linear deflection of the spot on the screen. Given the length of the plates is 10 cm.

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17. A hydrogen atom in a having a binding of $0.85 eV$ makes transition to a state with excited energy $10.2 eV$ (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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18. A hypothetcal, hydrogen like atom consists of a nucleus of mass m_1 and charge $(+Ze)$ and a nu-meson of mass m_2 and charge (-e). Using Bohr's theory, derive an expression for distance between nucleus and mu-meson for principal quantum number n and derive a relation for energy also. Hence obtain expression for reduced mass.

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19. Whenever a photon is emitted by hydrogen in balmer series it is followed by another in lyman series what wavelength does this latter photon correspond to?

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20. A particular hydrogen like atom with radiation of frequency $2.467 \times 10^{15} Hz$ when it makes transition from $n = 3 \rightarrow n = 1$,What will be the frequency of the radiation emitted in a transition from $n = 3 \rightarrow n = 1$?

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21. 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

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22. A single electron orbits a stationary nucleus of charge $+Ze$, where Z is a constant and e is the magnitude of electronic charge . It requires $47.2eV$ to excite . Find

a the value of Z

b the energy required to excite the electron from the third to the fourth Bohr orbit.

the wavelength of electromagnetic rediation required to remove the electron from the first Bohr orbit to infinity.

d Find the KE, PE, and angular momentum of electron in the first Bohr orbit.

the redius of the first Bohr orbit

[The ionization energy of hydrogen atom $= 13.6 eV$ Bohr radius $= 5.3 \times 10^{-11} m$, "velocity of light" $= 3 \times 10^{-8} jms^{-1}$, Planck's constant $= 6.6 \times 10^{-34} j - s$]

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23. At what minimum kinetic energy must a hydrogen atom move for it's inelastic headon collision with another stationary hydrogen atom so that one of them emits a photon? Both atoms are supposed to be in the ground state prior to the collision.

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24. 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

$E_{\max} = 1.224eV$

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

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25. A hydrogen atom moving at speed v collides with another hydrogen atom kept at rest .Find the minimum value of v for which one of the atoms may get ionized, the mass of a hydrogen atom $= 1.67 \times 10^{-27} kg$

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26. A double ionised lithium atom is hydrogen like with atomic number 3

(i)Find the wavelength of the radiation to excite the electron in Li^{++} from the first to the third bohr orbit (Ionisation energy of the hydrogen atom equals $13.6eV$

(ii) How many spectral lines are observed in the emission spectrum of the above excited system ?

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27. Electron are emitted from an electron gun at almost zero velocity and are accelerated by an electric field E through a distance of $1.0m$ The electron are now scattered by an atomic hydrogen sample in ground state what should be the minimum value of E so that red light of wavelength $656.5nm$ may be emitted by the hydrogen?

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28. A hydrogen like gas emits radiation of wavelengths $460\text{Å}, 828\text{Å}$ and 1035Å, only. Assume thar the atoms have only two excited states and the difference between consecutive energy levels decreases as energy is increased. Taking the energy of the highest energy state to be zero. Find the energies of the ground state and the first excited state.

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29. A gas of hydrogen like ions is prepared in a particular excited state A if emit photons havingwavelength equal to the wavelength of the first line of the lyman series togather with photons of five other wavelength identify the gas and find the principal quantum number of the stateA`

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30. Find the temperature at which the everage thermal kinetic energy is equal to the energy needed to take a hydrogen atom from its ground state $n = 3$ state hydrogen can now emit rod light of wavelength $653.1 nm$because of maxwellan distribution of speeds a hydrogen sample emits red light at temperature much lower than that obtained from this problem Asuume that hydrogen that hydrogen molecules dissociate into atoms

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31. A spectroscopic instrument can resolve two nearly wavelength λ and $\lambda = \Delta\lambda$ if $\lambda / \Delta\lambda$ is smaller than 8000 This is used to study the spectral lines of the belmar series of hydrogen Approxmately how many lines will be resolved by the instrument?

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32. A hydrogen atom in the normal state is located at a distance $r = 2.5cm$ from a long straight conductor carrying a current $I = 10A$. Find the maximum force acting on the atom.

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33. Using Bohr's theory show that when n is very large the frequency of radiation emitted by hydrogen atom due to transition of electrom from n to $(n-1)$ is equal to frequency of revolution of electron in its orbit.

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34. In a hydrogen like ionized atom a single electron is orbiting around the stationary positive charge. If a spectral line of λ equal to 4861Å is observed due to transition from $n = 12$

to $n-6$. What is the wavelength of a spectral line due to transition from $n=9$ to $n=6$ and also identify the element.

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35. The energy of an electron in an excited hydrogen atom is $-3.4eV$. Calculate the angular momentum . Given : Rydbrg's $R=1.09737\times10^{-7}m^{-1}$. Plank's constant $h=6.626176\times10^{-34}J-s$, speed of light`c = 3 xx 10^(8) m s^(-1).

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36. 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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37. 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.

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38. 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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39. A gas of hydrogen - like ion is perpendicular in such a way that ions are only in the ground state and the first excite state. A monochromatic light of wavelength 1216Å is absorbed by the ions. The ions are lifted to higher excited state and emit emit radiation of six wavelength , some higher and some lower than the incident wavelength. Find the principal quantum number of the excited state identify the nuclear charge on the ions . Calculate the values of the maximum and minimum wavelengths.

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