Physics Board Questions

Class: 12

Chapter: Atom

Delhi 2014

1. A 12.5 eV electron beam is used to bombard gaseous hydrogen at room temperature. Up to which energy level the hydrogen atoms would be excited? [E = 12.09eV, n=3]
   Calculate the wavelengths of the first member of Lyman and first member of Balmer series.
   [λ_L = 122nm,λ_B = 656.3nm]
2. A 12.9 eV beam of electrons is used to bombard gaseous hydrogen at room temperature. Up to which energy level the hydrogen atoms would be excited? [E = 12.75eV, n=4]
   Calculate the wavelength of the first member of Paschen series and first member of Balmer series.
   [λ_{Ps} = 1875nm,λ_B = 656nm]
3. A 12.3 eV electron beam is used to bombard gaseous hydrogen at room temperature. Upto which energy level the hydrogen atoms would be excited? [n=3]
   Calculate the wavelengths of the second member of Lyman series and second member of Balmer series.
   [λ_L = 102.5nm,λ_B = 486nm]

All India 2014

1. Using Rutherford model of the atom, derive the expression for the total energy of the electron in hydrogen atom. What is the significance of total negative energy possessed by the electron?
2. Using Bohr's postulates of the atomic model, derive the expression for radius of *n*th electron orbit. Hence obtain the expression for Bohr's radius.

Foreign 2014

1. (*a*) Using Bohr's postulates, derive the expression for the total energy of the electron in the stationary states of the hydrogen atom.
   (*b*) Using Rydberg formula, calculate the wavelengths of the spectral lines of the first member of the Lyman series and of the Balmer series. [λ_L= 4/3R ,λ_B= 36/5R]

Delhi 2013

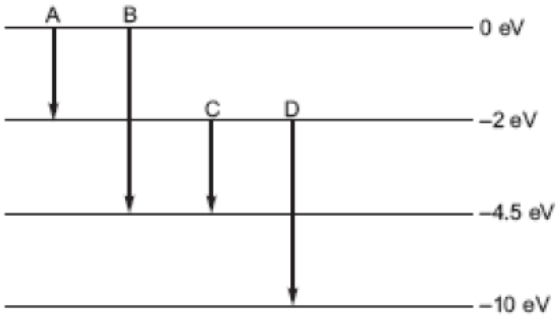
1. Using Bohr's postulates, obtain the expression for the total energy of the electron in the stationary states of the hydrogen atom. Hence draw the energy level diagram showing how the line spectra corresponding to Balmer series occur due to transition between energy levels.
2. Using Bohr's postulates, obtain the expression for (i) kinetic energy and (ii) potential energy of the electron in stationary state of hydrogen atom.
   Draw the energy level diagram showing how the transitions between energy levels result in the appearance of Lyman Series.
3. (*a*) Using Bohr's postulates, obtain expression for the total energy of the electron in the n^{th} orbit of hydrogen atom.
   (*b*) What is the significance of negative sign in the expression for the energy?
   (*c*) Draw the energy level diagram showing how the line spectra corresponding to Paschen series occur due to transition between energy levels.

All India 2013

1. Using Bohr's postulates, derive the expression for the frequency of radiation emitted when electron in hydrogen atom undergoes transition from higher energy state (quantum number n_i) to the lower state, (n_f). When electron in hydrogen atom jumps from energy state n_i =4 to n_f =3, 2,1, identify the spectral series to which the emission lines belong. [Paschen, Balmer, Lyman]

Foreign 2013

1. In an experiment on α–particle scattering by a thin foil of gold, draw a plot showing the number of particles scattered versus the scattering angle θ.
   Why is it that a very small fraction of the particles are scattered at θ > 90º?
   Write 2 important conclusions that can be drawn regarding the structure of atom from the study of this experiment.
2. (a) The energy levels of a hypothetical hydrogen-like atom are shown in the figure. Find out the transition, from the ones shown in the figure, which will result in the emission of a photon of wavelength 275 nm.
   [E = 4.5eV, B]



   (b) Which of these transitions corresponds to the emission of radiation of (i) max. and (ii) min. wavelength?
   [A(ΔE= 2eV), D(ΔE= 10eV)]

Delhi 2012

1. (*a*) Using Bohr's second postulate of quantization of orbital angular momentum show that circumference of the electron in the n^{th} orbital state in hydrogen atom is n times the de Broglie wavelength associated with it.
   (*b*) The electron in hydrogen atom is initially in the third excited state.
   What is the max. no. of spectral lines which can be emitted when it finally moves to the ground state? [6]

All India 2012

1. In a Geiger–Marsden experiment, calculate the distance of closest approach to the nucleus of Z =80, when an α-particle of 8 MeV energy impinges on it before it comes momentarily to rest and reverses its direction. How will the distance of closest approach be affected when the kinetic energy of the α-particle is doubled?
   [$r_0 = 2.88 \times 10^{-14}$, half]
2. The ground state energy of hydrogen atom is – 13.6 eV. If an electron makes a transition from an energy level – 0.85 eV to –3.4 eV, calculate the wavelength of the spectral line emitted. To which series of hydrogen spectrum does this wavelength belong? [Balmer, 4862A°]
3. In a Geiger– Marsden experiment, calculate the distance of closest approach to the nucleus of Z =75, when an α-particle of 5 MeV energy impinges on it before it comes momentarily to rest and reverses its direction. How will the distance of closest approach be affected when the kinetic energy of the α-particle is doubled?
   [$r_0 = 2.7 \times 10^{-14}$, half]

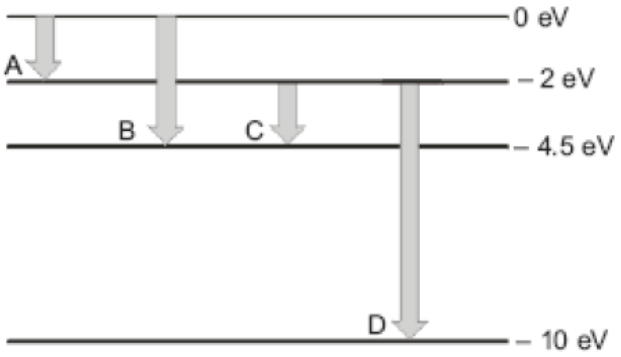
4. The ground state energy of hydrogen atom is –13.6 eV. If an electron makes a transition from an energy level – 0.85 eV to – 1.51 eV, calculate the wavelength of the spectral line emitted. To which series of hydrogen spectrum does this wavelength belong? [Paschen, 1875nm]

Foreign 2012

1. Using Bohr's postulates for hydrogen atom, show that the total energy (E) of the electron in the stationary states can be expressed as the sum of kinetic energy (K) and potential energy (U), where $K = -2U$. Hence deduce the expression for the total energy in the nth energy level of hydrogen atom.

Delhi 2011

1. The energy levels of a hypothetical atom are shown below. Which of the shown transitions will result in the emission of a photon of wavelength 275 nm? [B]
Which of these transitions correspond to emission of radiation of (*i*) max. and (*ii*) min. wavelength? [A,D]



All India 2011

1. (*a*) Using de Broglie's hypothesis, explain with the help of a suitable diagram, Bohr's second postulate of quantization of energy levels in a hydrogen atom.
(*b*) The ground state energy of hydrogen atom is –13.6 eV. What are the kinetic and potential energies of the electron in this state? [13.6eV, -27.2eV]

Foreign 2011

1. Using the postulates of Bohr's model of hydrogen atom, obtain an expression for the frequency of radiation emitted when atom make a transition from the higher energy state with quantum number n_i to the lower energy state with quantum number n_f ($n_f < n_i$).

Delhi 2010

1. What is the ratio of radii of the orbits corresponding to first excited state and ground state in a hydrogen atom? [4:1]
2. The radius of innermost electron orbit of a hydrogen atom is $5{\cdot}3 \times 10^{-11}$ m. What is the radius of orbit in the second excited state? [$r_3 = 3.7 \times 10^{-10}$]
3. Write the expression for Bohr's radius in hydrogen atom

All India 2010

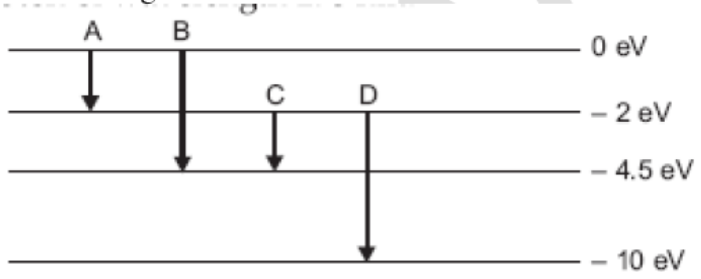
1. Define ionisation energy. What is its value for a hydrogen atom?
2. Find the ratio of energies of photons produced due to transition of an electron of hydrogen atom from its:
   (*i*) second permitted energy level to the first level, and
   (*ii*) the highest permitted energy level to the first permitted level. [3/4]
3. The ground state energy of hydrogen atom is – 13·6 eV. What are the kinetic and potential energies of electron in this state? [13.6eV, -27.2eV]

Foreign 2010

1. State Bohr's quantisation condition for defining stationary orbits.
2. Draw a schematic arrangement of the Geiger – Marsden experiment for studying α-particle scattering by a thin foil of gold. Describe briefly, by drawing trajectories of the scattered α-particles, how this study can be used to estimate the size of the nucleus.

Delhi 2009

1. (a)The energy 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? [B,A]

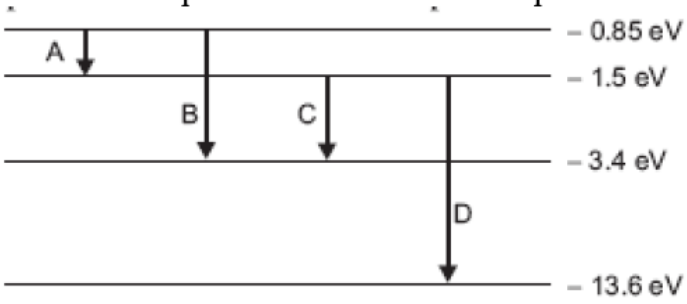
All India 2009

Foreign 2009

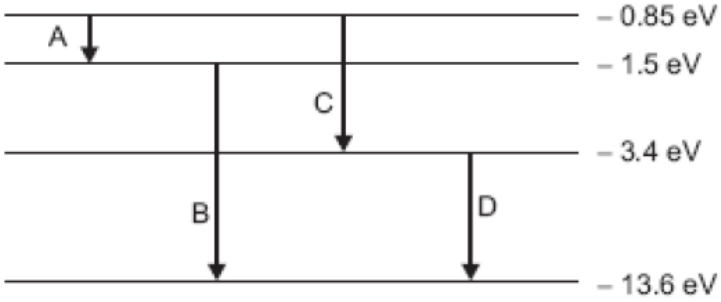
1. In the Rutherford scattering experiment the distance of closest approach for an α-particle is d_0. If α-particle is replaced by a proton, how much kinetic energy in comparison to α-particle will it require to have the same distance of closest approach d_0 ? [half]
2. The energy of the electron in the ground state of hydrogen atom is – 13.6 eV .
   (i) What does the negative sign signify?
   (ii) How much energy is required to take an electron in this atom from the ground state to the first excited state? [10.2eV]

Delhi 2008

1. The energy level diagram of an element is given below. Identify, by doing necessary calculations, which transition corresponds to the emission of a spectral line of wavelength 102·7 nm. [D(ΔE=12.1eV)]



2. The energy levels of an element are given below:



Identify, using necessary calculations, the transition, which corresponds to the emission of a spectral line of wavelength 482 nm. [B(ΔE=2.55eV)]

All India 2008

1. Show that Bohr's second postulate, 'the electron revolves around the nucleus only in certain fixed orbits without radiating energy' can be explained on the basis of de-Broglie hypothesis of wave nature of electron.