Previous Years' Examination Questions

1 Mark Questions

1. The ground state energy of hydrogen atom is −13.6 eV. What are the kinetic and potential energies of electron in this state? **All India 2014C; All India 2010**
2. When is H_α-line of the Balmer series in the emission spectrum of hydrogen atom obtained? **Delhi 2013C**
3. What is the maximum number of spectral lines emitted by a hydrogen atom when it is in the third excited state? **All India 2013C**
4. Why is the classical (Rutherford) model for an atom of electron orbitting around the nucleus not able to explain the atomic structure? **Delhi 2012**
5. What is the ratio of radii of the orbits corresponding to first excited state and ground state, in a hydrogen atom? **Delhi 2010**
6. The radius of innermost electron orbit of a hydrogen atom is 5.3×10^{-11} m. What is the radius of orbit in the second excited state? **Delhi 2010**
7. Write the expression for Bohr's radius in hydrogen atom. **Delhi 2010**
8. State Bohr's quantisation condition for defining stationary orbits. **Foreign 2010**

2 Marks Questions

9. (i) Define the terms impact parameter and distance of closest approach for an α-particle in Geiger-Marsden scattering experiment.
   (ii) What will be the value of the impact parameter for sattering angle (a) $\theta = \theta°$ and (b) $\theta = 180°$?
   CBSE 2022 (Term-II)
10. Write shortcomings of Rutherford atomic model. Explain, how these were overcome by the postulates of Bohr's atomic model. **Delhi 2020**
11. Explain briefly how Rutherford scattering of α-particle by a target nucleus can provide information on the size of the nucleus. **Delhi 2019**
12. Obtain the expression for the ratio of the de-Broglie wavelengths associated with the electron orbiting in the second and third excited states of hydrogen atom. **Delhi 2019**
13. A hydrogen atom in the ground state is excited by an electron beam of 12.5 eV energy. Find out the maximum number of lines emitted by the atom from its excited state .**All India 2019**
14. State Bohr's quantisation condition of angular momentum. Calculate the shortest wavelength of the Brackett series and state to which part of the electro magnetic spectrum does it belong. **Delhi 2019**
15. Calculate the orbital period of the electron in the first excited state of hydrogen atom. **Delhi 2019**
16. Find out the wavelength of the electron orbiting in the ground state of hydrogen atom. **Dehli 2016**

17. Find the wavelength of the electron orbiting in the first excited state in hydrogen atom. **All India 2016**

18. A 12.5 eV electron beam is used to excite a gaseous hydrogen atom at room temperature. Determine the wavelengths and the corresponding series of the lines emitted. **All India 2016**

19. The short wavelength limit for the Lyman series of the hydrogen spectrum is 913.4 Å. Calculate the short wavelength limit for Balmer series of the hydrogen spectrum. **Delhi 2016**

20. The ground state energy of hydrogen atom is –13.6 eV. If an electron makes a transition from an energy level – 1.51 eV to – 3.4 eV, then calculate the wavelength of the spectral line emitted and name the series of hydrogen spectrum to which it belongs. **Delhi 2016**

21. State Bohr postulate of hydrogen atom that gives the relationship for the frequency of emitted photon in a transition. **Foreign 2016**

22. An electron jumps from fourth to first orbit in an atom. How many maximum number of spectral lines can be emitted by the atom? To which series these lines correspond? **Foreign 2016**

23. Calculate the de-Broglie wavelength of the electron orbiting in the $n = 2$ states of hydrogen atom. **All India 2016**

24. Use de-Broglie's hypothesis to write the relation for the nth radius of Bohr orbit in terms of Bohr's quantization condition of orbital angular momentum. **Foreign 2016**

25. An α-particle moving with initial kinetic energy K towards a nucleus of atomic number Z approaches a distance d at which it reverses its direction. Obtain the expression for the distance of closest approach d in terms of the kinetic energy of α-particle K. **All India 2016C**

26. Find the ratio between the wavelengths of the 'most energetic' spectral lines in the Balmer and Paschen series of the hydrogen spectrum. **All India 2016C**

27. Calculate the shortest wavelength of the spectral lines emitted in Balmer series. [Given, Rydberg constant, $R = 10^7\ m^{-1}$] **All India 2015**

28. In the study of Geiger-Marsden experiment on scattering of α-particles by a thin foil of gold, draw the trajectory of α-particles in the coulomb field of target nucleus. Explain briefly how one gets the information on the size of the nucleus from this study. **All India 2015**

29. Show that the radius of the orbit in hydrogen atom varies as n^2, where n is the principal quantum number of the atom. **All India 2015**

30. Calculate the shortest wavelength in the Balmer series of hydrogen atom. In which region (infrared, visible, ultraviolet) of hydrogen spectrum does this wavelength lie? **Delhi 2015**

31. 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? **All India 2014**

32. Using Bohr's postulates of the atomic model, derive the expression for radius of nth electron orbit. Hence, obtain the expression for Bohr's radius. **All India 2014**

33. Define ionisation energy. How would the ionisation energy change when electron in hydrogen atom is replaced by a particle of mass 200 times that of the electron but having the same charge? **All India 2013**

34. In the ground state of hydrogen atom, its Bohr radius is given as 5.3×10^{-11} m.The atom is excited such that the radius becomes 21.2×10^{-11} m. Find (i) the value of the principal quantum number and (ii) the total energy of the atom in this excited state. **Delhi 2013C**

35. Explain, in brief, why Rutherford's model cannot account for the stability of an atom. **Delhi 2010C**

36. Using the relevant Bohr's postulates, derive the expression for the radius of the electron in the nth orbit of the electron in hydrogen atom. **Delhi 2010C**

3 Marks Questions

37. State Bohr's postulate to explain stable orbits in a hydrogen atom. Prove that the speed with which the electron revolves in nth orbit is proportional to $(1/n)$.

CBSE 2022 (Term-II)

38. A narrow beam of protons, each having 4.1 MeV energy is approaching sheet of lead
($Z = 82$). Calculate
(i) the speed of a proton in the beam and
(ii) the distance of its closest approach.

CBSE 2022 (Term-II)

39. Calculate the de-Broglie wavelength associated with the electron in the second excited state of hydrogen atom. The ground state energy of the hydrogen atom is 13.6 eV. **Delhi 2020**

40. A photon emitted during the de-excitation of electron from a state n to the first excited state in a hydrogen atom, irradiates a metallic cathode of work function 2eV, in a photocell, with a stopping potential of 0.55 V. Obtain the value of the quantum number of the state n. **All India 2019**

41. (i) Draw the energy level diagram for the line spectra representing Lyman series and Balmer series in the spectrum of hydrogen atom.
(ii) Using the Rydberg formula for the spectrum of hydrogen atom, calculate the largest and shortest wavelengths of the emission lines of the Balmer series in the spectrum of hydrogen atom.
(Use the value of Rydberg constant, $R = 1.1 \times 10^7\ m^{-1}$) **All India 2019**

42. (i) State Bohr's postulate to define stable orbits in hydrogen atom. How does de-Broglie's hypothesis explain the stability of these orbits?
(ii) A hydrogen atom initially in the ground state absorbs a photon which excites it to the $n = 4$ level. Estimate the frequency of the photon.

All India 2018

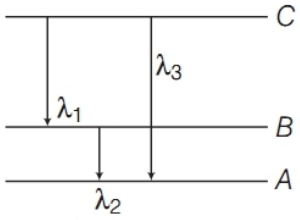
43. Define the distance of closest approach. An α-particle of kinetic energy K is bombarded on a thin gold foil. The distance of the closest approach is r. What will be the distance of closest approach for an α-particle of double the kinetic energy? Write two important limitations of Rutherford nuclear model of the atom.

All India 2016

44. The kinetic energy of the electron orbiting in the first excited state of hydrogen atom is 3.4 eV. Determine the de-Broglie wavelength associated with it. **Foreign 2015**

45. (i) State Bohr's quantisation condition for defining stationary orbits. How does de-Broglie's hypothesis explain the stationary orbits?
(ii) Find the relation between the three wavelengths λ_1, λ_2 and λ_3 from the energy level diagram shown below.

All India 2014



46. (i) Using Bohr's total postulates, derive the expression for the total energy of the electron in the stationary states of hydrogen atom.
(ii) Using Rydberg's formula, calculate the wavelength of spectral lines of the first members of the Lyman series and of the Balmer series.

Foreign 2014

47. The value of ground state energy of hydrogen atom is –13.6 eV.

(i) Find the energy required to move an electron from the ground state to the first excited state of the atom.

(ii) Determine (a) the kinetic energy and (b) orbital radius in the first excited state of the atom.
(Given, the value of Bohr's radius = 0.53 Å) **All India 2014C**

48. (i) The radius of the innermost electron orbit of a hydrogen atom is 5.3×10^{-11} m. Calculate its radius in $n = 3$ orbit.

(ii) The total energy of an electron in the first excited state of the hydrogen atom is –3.4 eV. Find out its (a) kinetic energy and (b) potential energy in this state.
Delhi 2014C

49. 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. **Delhi 2013**

50. 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 $U = -2K$. Hence, deduce the expression for the total energy in the nth energy level of hydrogen atom. **Foreign 2012**

51. (i) Using Bohr's second postulate of quantisation of orbital angular momentum show that the circumference of the electron in the nth orbital state in hydrogen atom is n-times the de-Broglie wavelength associated with it.

(ii) The electron in hydrogen atom is initially in the third excited state. What is the maximum number of spectral lines which can be emitted when it finally moves to the ground state? **Delhi 2012**

52. 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? **All India 2012**

53. 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 to momentarily rest and reverses its direction.

How will the distance of closest approach be affected when the kinetic energy of the α-particle is doubled? **All India 2012**

54. Using the postulates of Bohr's model of hydrogen atom, obtain an expression for the frequency of radiation emitted when the atom makes a transition from the higher energy state with quantum number n_i to the lower energy state with quantum number $n_f (n_f < n_i)$. **Foreign 2011**

55. The electron in a given Bohr orbit has a total energy of – 1.5 eV. Calculate its

(i) kinetic energy

(ii) potential energy

(iii) wavelength of radiation emitted, when this electron makes a transition to the ground state.
[Given, energy in the ground state = – 13.6 eV and Rydberg's constant = 1.09×10^7 m^{-1}] **Delhi 2011C**

56. Using postulates of Bohr's theory of hydrogen atom, show that

(i) radii of orbits increases as n^2 and

(ii) the total energy of electron increases as $\frac{1}{n^2}$, where n is the principal quantum number of the atom.

All India 2011C

57. 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? **Foreign 2010**

58. State the basic assumption of the Rutherford model of the atom. Explain in brief why this model cannot account for the stability of an atom? **Delhi 2010C**

59. Using the relevant Bohr's postulates, derive the expressions for the

(i) speed of the electron in the nth orbit,

(ii) radius of the nth orbit of the electron in hydrogen atom. **Delhi 2010C**

60. State any two postulates of Bohr's theory of hydrogen atom. What is the maximum possible number of spectral lines observed when the hydrogen atom is in its second excited state? Justify your answer. Calculate the ratio of the maximum and minimum wavelengths of the radiations emitted in this process. **All India 2010C**

5 Marks Questions

61. (i) State the postulates of Bohr's model of hydrogen atom and derive the expression for Bohr radius.

(ii) Find the ratio of the longest and the shortest wavelengths amongst the spectral lines of Balmer series in the spectrum of hydrogen atom.

All India 2020

62. 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. **All India 2013**

63. (i) Using postulates of Bohr's theory of hydrogen atom, show that

(a) the radii of orbits increase as n^2 and

(b) the total energy of the electron increases as $1/n^2$, where n is the principal quantum number of the atom.

(ii) Calculate the wavelength of H_α-line in Balmer series of hydrogen atom. Given, Rydberg constant, $R = 1.097 \times 10^7\ m^{-1}$. **All India 2011C**