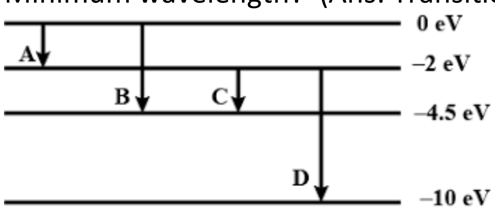
CLASS XII : ASSIGNMENT : CH-12 : ATOMS : PHYSICS

DISTANCE OF CLOSEST APPROACH AND IMPACT PARAMETER

1. Why does the mass of the nucleus not enter the formula for the impact parameter but its charge does?
2. In the Rutherford scattering experiment, if a proton is taken instead of an alpha particle, then for the same distance of closest approach, how much kinetic energy in comparison to the kinetic energy of the alpha particle will be required?
3. Define the distance of the closest approach and impact parameter.
4. What is the impact parameter for the scattering of alpha particles by 180°?
5. For a given impact parameter b, does the angle of deflection increase or decrease with the increase in energy?
6. for the scattering of alpha particles at large angles only the nucleus of the atom is responsible, Explain why?
7. The kinetic energy of alpha particle incident on gold foil is doubled. How does the distance of the closest approach change?
8. Why is an electron supposed to be revolving around the nucleus?
9. In the original experiment, Geiger and Marsden calculated the distance of the closest approach to the gold nucleus (Z= 79)- of a 7.7 MeV α-particle before it comes momentarily to rest and reverses its direction. What is its value? (Ans: 30 fermi)
10. A 4 MeV alpha particle is scattered through 20^o when it approaches a gold nucleus. Calculate the impact parameter if Z for gold is 79. Given tan 10^0= 0.1763 (Ans: 1.61 x 10^{-13} m)
11. In the Geiger- Marsden experiment, calculate the distance of the closest approach to the nucleus of Z = 80 when an α-particle of 8 MeV energy impinges on it before it comes momentarily at rest and reverses its direction. (Ans: 2.82 x 10^{-14} m)
12. Calculate the impact parameter of a 5 MeV alpha particle scattered by 10^o when it approaches a gold nucleus. Take Z = 79 for gold. Given tan 5^o = 0.0875 (Ans: 2.6 x 10^{-13} m)
13. In a Geiger-Marsden experiment, calculate the energy of an alpha-particle whose distance of closest approach to the nucleus of Z = 79 is 2.8 x 10^{-14} m. How will the distance of the closest approach be affected when the kinetic energy of the α-particle is doubled?Ans: E = 1.3 x 10^{-12} J and r_o =1.4 x 10^{-14} m.
14. In a Geiger-Marsden experiment, what is the distance of the closest approach to the gold nucleus of a 7.7 MeV α-particle before it comes to rest momentarily and reverses its direction? Ans: 29.5 fermi

BOHR'S ATOM MODEL, RADIUS OF ORBIT, VELOCITY, AND ENERGY OF ELECTRON, IONISATION POTENTIAL

15. In a hydrogen atom, if the electron is replaced by a particle that is 200 times heavier but has the same charge, how would its radius change?
16. The energy levels of an atom are shown in the figure. Which transition corresponds to the emission of radiation of
    (i) Maximum wavelength
    (ii) Minimum wavelength? (Ans: Transition A and Transition D)



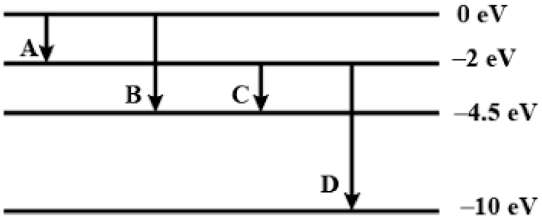
17. Define ionization energy. How would the ionization energy change when an electron in a hydrogen atom is replaced by a particle 200 times heavier than the electron, but having the same charge?

18. The energy of an electron in the ground state of a hydrogen atom is -13.6 eV. How much energy is required to take an electron in this atom from the ground state to the first excited state? (Ans: 10.2 eV)

19. 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's hypothesis of the wave nature of electrons.

20. The electron in the hydrogen atom passes from the n = 4 energy level to the n =1 level. What is the maximum number of photons that can be emitted? And the minimum number?

21. (i) The energy levels of an atom are shown in the figure. Which of them will result in the emission of a photon of wavelength 275 nm?
(ii) Which transition corresponds to the emission of radiation of maximum wavelength? (Ans: E = 4.5 eV, Transition B-275 nm; Transition A- 2eV)



22. The short wavelength limits of the Lyman, Paschen, and Balmer series in the hydrogen spectrum are denoted by λ_L, λ_P, and λ_B respectively. Arrange these wavelengths in increasing order. (Ans: $\lambda_L < \lambda_B < \lambda_P$.)

23. The ground state energy of the hydrogen atom is -13.6 eV. What is the P.E. and K.E. of electrons in this state? (Ans: K = 13.6 eV and V =-27.2 eV)

24. Write an expression for Bohr's radius in the hydrogen atom.

25. Name the spectral series of the hydrogen atom which are in the Infrared region.

26. When is H_α line of the Balmer series in the emission spectrum of hydrogen atoms obtained?

27. In Bohr's theory of the hydrogen atom, what is the implication of the fact that the potential energy is negative and is greater in magnitude than the kinetic energy?

28. What is the energy possessed by an electron for n = ∞? (Ans : 0)

29. What is the ground state energy of an electron in the case of $_3Li^7$? (Ans: -30.4 eV)

30. What is the order of radius of the He atom?

31. What is the order of velocity of electron in a hydrogen atom in the ground state?

32. Name the series of Hydrogen atom which lies in the UV region.

33. What is the ratio of radii of orbits corresponding to the first excited state and ground state in a hydrogen atom?

34. What is the ionization potential of the hydrogen atom?

35. What are the values of the first and second excitation potential of hydrogen atoms?

36. Name the series of hydrogen spectrum which lies in the visible region of the hydrogen spectrum.

37. The wavelength of some of the spectral lines obtained in the hydrogen spectrum are 1216 A°, 6463 A°, and 9546 A°. Which of these wavelengths belongs to the Paschen series?

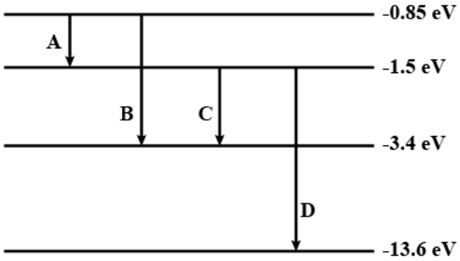
38. The radius of the innermost electron orbit of the hydrogen atom is 5.3 x 10^{-11}m. What is the radius of orbit in the second excited state? (Ans: 4.77 x 10^{-10} m)

39. The energy of the electron in the Hydrogen atom is $E_n = \frac{-13\cdot6}{n^2}$ eV, where n = 1, 2, 3,4……Show that

(i) The electron in a hydrogen atom cannot have an energy of -6.8 eV.

(ii) Spacing between the lines (consecutive energy level) within the given set of observed hydrogen spectrum decreases as n increases.

40. The energy level diagram of an element is given here. Which transition corresponds to the emission of a spectral line of wavelength 102.7 nm? (Ans: Transition D, 12.1 eV)



41. In the ground state of a hydrogen atom, its Bohr's radius is 5.3 x 10^{-11} m. The atom is excited such that the radius becomes 21.2 x 10^{-11}m. Find the value of the principal quantum number and total energy of the atom in the excited state. (Ans: n =2, E = -3.4 eV)

42. In Rutherford's nuclear model of the atom, the nucleus (radius about 10^{-15}m) is analogous to the sun about which the electron moves in orbit (radius about 10^{-10}m) as the earth orbits around the sun. If the dimensions of the solar system had the same properties as those of the atom, would the earth be closer or farther away from the sun than actually it is? The radius of the earth's orbit is 1.5 x 10^{11} m and the radius of the sun is taken as 7 x 10^{8} m.

43. According to the classical electromagnetic theory, Calculate the initial frequency of the light emitted by the electron revolving around a proton in the hydrogen atom. (Ans: 6.6 x 10^{15}Hz)

44. A 10 kg satellite circles the earth once every 2 hours in an orbit having a radius of 8000 Km. Assuming that Bohr's angular momentum postulate applies to a satellite just as it does to an electron in the hydrogen atom, find the quantum number of the orbit of the satellite. (Ans: 5.3 x 10^{45})

45. Using the Rydberg formula, Calculate the wavelengths of the first four spectral lines in the Lyman series of the hydrogen spectrum. (Ans: 1218 A°, 1028A°, 974.3A° and 951.4A°)

46. Which level of the doubly ionized Li^{++} has the same energy as the ground state of the hydrogen atom? Compare the orbital radii of the two levels. (Ans: n =3, r =3)

47. Which level of the triply ionized Be^{+++} has the same orbital radius as that of the ground state of hydrogen? Compare the energies of the two states. (Ans: n =2, E ratio: 4)

48. The ground state energy of the hydrogen atom is -13.6 eV. If an electron makes a transition from an energy level of -0.85 eV to -3.4eV, Calculate the wavelength of the spectral line emitted. To which series of hydrogen spectrum does this wavelength belong? (Ans: 4852 A°, visible region)

49. The total energy of an electron in the first excited state of the hydrogen atom is about -3.4eV.

(i) What is the kinetic energy of an electron in this state?

(ii) What is the potential energy of an electron in this state?

(iii) Which of the answers above would change if the choice of zero of potential energy is changed? (Ans: + 3.4eV, - 6.8 eV, K.E. does not change, P.E. and total energy of the state would change)

50. 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 lines emitted. (Ans: 6.5476 x 10^{-7}m, first line of Balmer series; 3.068 x 10^{-7}m, Lyman series)

51. Calculate the ratio of the frequencies of radiation emitted due to the transition of the electron in a hydrogen atom from its

(i) Second permitted energy level to the first level and

(ii) Highest permitted energy level to second permitted level. (Ans: 10.2 eV, 3.4 eV, ratio:3)