***Chemistry***

**6: Electronic Structure and Periodic Properties of Elements**

**6.2: The Bohr Model**

17. What does it mean to say that the energy of the electrons in an atom is quantized?

Solution

Quantized energy means that the electrons can possess only certain discrete energy values; values between those quantized values are not permitted.

19. The electron volt (eV) is a convenient unit of energy for expressing atomic-scale energies. It is the amount of energy that an electron gains when subjected to a potential of 1 volt; 1 eV = 1.602 × 10–19 J. Using the Bohr model, determine the energy, in electron volts, of the photon produced when an electron in a hydrogen atom moves from the orbit with *n* = 5 to the orbit with *n* = 2. Show your calculations.

Solution



21. Using the Bohr model, determine the lowest possible energy for the electron in the He+ ion.

Solution

. Since *Z* is the number of protons in the nucleus, *Z* = 2 for He. 

23. Using the Bohr model, determine the energy of an electron with *n* = 8 in a hydrogen atom.

Solution

. Since *Z* is the number of protons in the nucleus, *Z* = 1 for H. 

25. What is the radius, in angstroms, of the orbital of an electron with *n* = 8 in a hydrogen atom?

Solution

. For hydrogen, Z = 1; *a*0 = 0.529 ; *n* = 8.



27. Using the Bohr model, determine the energy in joules of the photon produced when an electron in a Li2+ ion moves from the orbit with *n* = 2 to the orbit with *n* = 1.

Solution



29. How are the Bohr model and the Rutherford model of the atom similar? How are they different?

Solution

Both involve a relatively heavy nucleus with electrons moving around it, although strictly speaking, the Bohr model works only for one-electron atoms or ions. According to classical mechanics, the Rutherford model predicts a miniature “solar system” with electrons moving about the nucleus in circular or elliptical orbits that are confined to planes. If the requirements of classical electromagnetic theory that electrons in such orbits would emit electromagnetic radiation are ignored, such atoms would be stable, having constant energy and angular momentum, but would not emit any visible light (contrary to observation). If classical electromagnetic theory is applied, then the Rutherford atom would emit electromagnetic radiation of continually increasing frequency (contrary to the observed discrete spectra), thereby losing energy until the atom collapsed in an absurdly short time (contrary to the observed long-term stability of atoms). The Bohr model retains the classical mechanics view of circular orbits confined to planes having constant energy and angular momentum, but restricts these to quantized values dependent on a single quantum number, *n*. The orbiting electron in Bohr’s model is assumed not to emit any electromagnetic radiation while moving about the nucleus in its stationary orbits, but the atom can emit or absorb electromagnetic radiation when the electron changes from one orbit to another. Because of the quantized orbits, such “quantum jumps” will produce discrete spectra, in agreement with observations.

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