During Class Invention

Bohr Model

Name(s) with Lab section in Group

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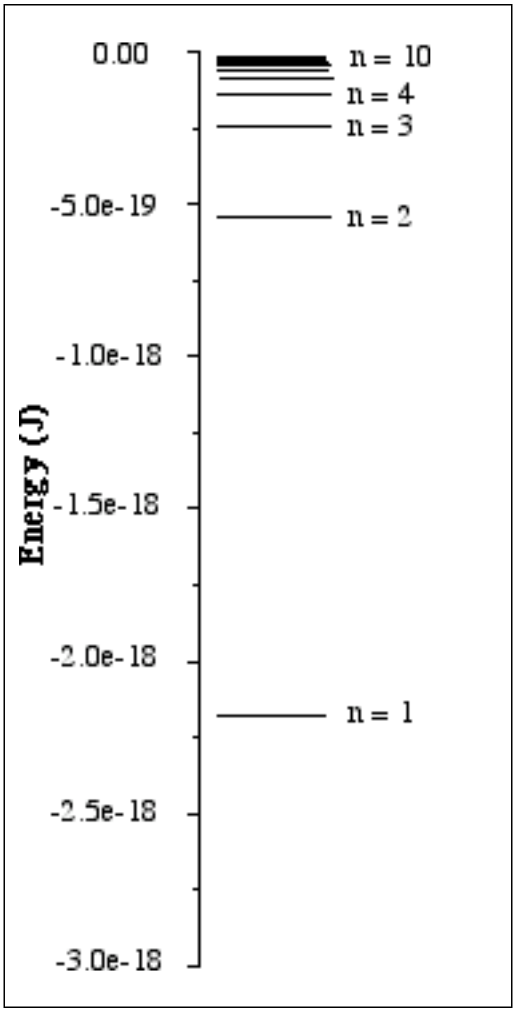
1a. Draw an energy level diagram for the first 5 energy levels in a hydrogen atom that is based on the Bohr model.



2. Calculate the energy for the n = 1 and the n = 2 level (orbits) for an electron in a hydrogen atom.

$$\mathbf{E = -2.18 \times 10^{-18}\ J \left(\frac{1}{n^2}\right)}$$

When n = 1, the energy is,

$$\mathbf{E_1 = -2.18 \times 10^{-18}\ J \left(\frac{1}{1^2}\right) = -2.18 \times 10^{-18}\ J}$$

$$\mathbf{E_2 = -2.18 \times 10^{-18}\ J \left(\frac{1}{2^2}\right) = -5.45 \times 10^{-19}\ J = -0.545 \times 10^{-18}\ J}$$

3. Describes what can happen when a hydrogen atom absorbs a photon of light. When a photon of light is emitted from a hydrogen atom.

When a hydrogen atom absorbs a photon of light, the electron is excited to a higher energy level (n value), or nothing happens. In order for the electron to be excited the energy of the photon must match a ΔE between the two energy levels. If the energy of the photon does not equal a ΔE, the photon does not effect the electron.

When a photon of light is emitted an electron must fall from a higher energy level to a lower energy level. The energy of the photon emitted equals the ΔE between the two energy levels.

4a. Calculate the energy difference between the n = 1 and the n = 4 levels in a hydrogen atom. What is the energy of a photon that would excite an electron from the n = 1 level to the n = 4 level?

$$\mathbf{E = -R_H\left(\frac{1}{n^2}\right)\ ;\quad E_f - E_i = -R_H\left(\frac{1}{n_f^2}\right) - \left(-R_H\left(\frac{1}{n_i^2}\right)\right)\ ;}$$

$$\mathbf{\Delta E = -R_H\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)}$$

$$\mathbf{= -2.18 \times 10^{-18}\ J\left(\frac{1}{4^2} - \frac{1}{1^2}\right)}$$

$$\mathbf{= -2.18 \times 10^{-18}\ J \cdot -0.938 = 2.04 \times 10^{-18}\ J}$$

The photon must have an energy equal to 2.04×10^{-18} J to excite an electron from n = 1 level to the n = 4 level.

5. Calculate the wavelength of a photon of light that would excite an electron in a hydrogen atom from the n = 1 to the n = 4 level.

$$\mathbf{\Delta E = h\frac{c}{\lambda}\quad ;\ \lambda = h\frac{c}{\Delta E}}$$

$$\mathbf{\lambda = (6.626 \times 10^{-34}\ J\ s)\left(\frac{2.9979 \times 10^{8}\ m\ s^{-1}}{2.04 \times 10^{-18}\ J}\right)\left(\frac{10^9\ nm}{1\ m}\right) = 97.4\ nm}$$

6. Calculate the amount of energy required to ionize a hydrogen atom (remove the electron) when the electron is in the n = 1 level.

$$\mathbf{\Delta E = R_H\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right)}\qquad \mathbf{n_f = infinity,\ 1/(infinity)^2 = 0}$$

$$\mathbf{\Delta E = 2.18 \times 10^{-18}\ J\left(\frac{1}{1^2} - \frac{1}{\bullet}\right)}\qquad \mathbf{Note: \frac{1}{\bullet} \rightarrow 0}$$

Ionization energy = 2.18×10^{-18} J

7. Which condition requires more energy to remove an electron:

a) when an electron is close to the nucleus, or when an electron is further from the nucleus? Explain.

It would take more energy to remove an electron that is close to the nucleus compared to an electron that is far from the nucleus. The closer an electron is to the nucleus the great the force of attraction the electron will feel to the nucleus.

b) When the nuclear charge is a +1 or when the nuclear charge is a +5 (assume the electron is the same distance from the nucleus)? Explain.

When the charge is a +5 on the nucleus the electron will feel a greater attraction to the nucleus compared to an electron (that is the same distance from the nucleus) that is attracted to a nucleus with a +1 charge