proprep

Workbook

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Electronic Structure of Atoms

Atomic Spectra

Questions

1) Calculate the frequency (in Hz) and wavelength (in nm) of the radiation corresponding to n = 6 using the Balmer equation.

2) Determine the value of n corresponding to the Balmer series line at 434 nm.

Answer Key

1) $\upsilon = 7.3 \cdot 10^{14}$ Hz

$\lambda = 411$ nm

2) $n = 5$

Quantum Theory

Questions

1) What is the energy of radiation of frequency $5.36 \cdot 10^{14} S^{-1}$?

a. In $\frac{\text{J}}{\text{photon}}$?

b. In $\frac{\text{kJ}}{\text{mol}}$?

2) Determine the energy of radiation with a wavelength of 470 nm:

a. In $\frac{\text{J}}{\text{photon}}$?

b. In $\frac{\text{kJ}}{\text{mol}}$?

3) Arrange the following wavelengths in order of increasing energy:

a. 7.82 μm

b. 322 nm

c. $6.35 \cdot 10^{-5}$ cm

Answer Key

1) a. $3.55 \cdot 10^{-19} \frac{\text{J}}{\text{photon}}$

b. $213.78 \frac{\text{kJ}}{\text{mol}}$

2) a. $4.23 \cdot 10^{-19} \frac{\text{J}}{\text{photon}}$

b. $254,730.6 \frac{\text{J}}{\text{mol}}$

3) b > c > a

Electron Orbitals

Questions

1) Calculate the energy, in J, corresponding to n = 7 in a hydrogen atom.

2) a. Calculate the energy lost (ΔE) when an electron in a hydrogen atom undergoes,
a transition from n = 4 to n = 2.
b. Calculate the frequency of the emitted photon.

3) Calculate the frequency (in Hz) and wavelength (in nm) of a photon emitted, as a result of an electron transition from n = 7 to n = 3 in a hydrogen atom.

4) A photon of wavelength 2.63 μm is emitted from a hydrogen atom as a result, of an electron transition from n = 6 to nf (n final). Find n_f.

5) $r_n = n^2 a_0 \quad a_0 = 0.53\,\text{Å}$

a. Calculate the radius for the Bohr hydrogen atom corresponding to n = 3.

b. r_n = 2.12 Å , calculate n.

c. Calculate the increase in distance from the nucleus when an electron, is excited from the second to the third orbit in a Bohr hydrogen atom.

6) Write an acceptable value for each of the missing quantum numbers:

a. n = ?, ℓ = 1, m_ℓ = 1, $m_s = +\frac{1}{2}$

b. n = 3, ℓ = 1, m_ℓ = -1, m_s = ?

c. n = 2, ℓ = ?, m_ℓ = 0, $m_s = +\frac{1}{2}$

d. n = 4, ℓ = 1, m_ℓ = ?, m_s = ?

e. n = 4, ℓ = ?, m_ℓ = +3, $m_s = -\frac{1}{2}$

7) What orbital is designated by the following quantum numbers?

a. $n = 4, \ell = 1, m_\ell = 1$
b. $n = 3, \ell = 2, m_\ell = -1$
c. $n = 3, \ell = 0, m_\ell = 0$
d. $n = 5, \ell = 2, m_\ell = 2$

8) How many electrons can have the following quantum numbers?

a. $n = 4, \ell = 3, m_s = +\frac{1}{2}$
b. $n = 2, \ell = 1$
c. $n = 4$
d. $n = 3, m_\ell = 2, m_s = +\frac{1}{2}$
e. $n = 2, \ell = 1, m_s = +\frac{1}{2}$

Answer Key

1) $-4.45 \cdot 10^{-20}\ J$

2) a. $-4.09 \cdot 10^{-19}\ J$

b. $6.17 \cdot 10^{14}\ S^{-1}$

3) $\upsilon = 2.98 \cdot 10^{14}\ S^{-1}$

$\lambda = 1.01\ \mu m$

4) $n_f = 4$

5) a. $4.77\ \mathring{A}$

b. n = 2

c. $2.65\ \mathring{A}$

6) a. $n \geq 2$

b. $m_s = +\frac{1}{2}$ or $m_s = -\frac{1}{2}$

c. $\ell = 0$ or $\ell = 1$

d. $m_\ell = 0$, $m_\ell = 1$ or $m_\ell = -1$ and $m_s = +\frac{1}{2}$ or $m_s = -\frac{1}{2}$

e. $\ell = 3$

7) a. 4p

b. 3d

c. 3s

d. 5d

8) a. 7 electrons

b. 6 electrons

c. 32 electrons

d. 1 electron

e. 3 electrons

Multielectron Atoms

Questions

1) Write the electron configurations of nitrogen, germanium, tungsten and lead.

2) Show the electron configurations of oxygen, silicon, selenium and bismuth, using orbital diagrams.

3) Use the basic rules for electron configurations to indicate:

a. The number of 3d electrons in a Cu atom.
b. The number of 4s electrons in a Sc atom.
c. The number of 3p electrons in a S atom.
d. The number of unpaired electrons in a Cl atom.
e. The number of 4f electrons in a Pb atom.

Answer Key

1) a. N: $1s^2 2s^2 2p^3$

b. Ge: [Ar] $4s^2 3d^{10} 4p^2$

c. Pb: [Xe] $6s^2 4f^{14} 5d^{10} 6p^2$

d. W: [Xe] $6s^2 4f^{14} 5d^4$

2) a. O: $1s^2 2s^2 2p^4$

b. Si: [Ne] $3s^2 3p^6$

c. Se: [Ar] $4s^2 3d^{10} 4p^4$

d. Bi: [Xe] $6s^2 4f^{14} 5d^{10} 6p^3$

3) a. 10 electrons

b. 2 electrons

c. 4 electrons

d. 1 unpaired electron

e. 14 electrons