

Workbook



Table of Contents

Electronic Structure of Atoms.....	שגיאה! הסימניה אינה מוגדרת.
Atomic Spectra	שגיאה! הסימניה אינה מוגדרת.
Quantum Theory.....	4
Electron	
Orbitals.....	6
Multielectron	
Atoms.....	9

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

$\lambda = 411$ nm

2) $n = 5$

Quantum Theory

Questions

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

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. $7.82 \mu\text{m}$

b. 322 nm

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

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 $2.63 \mu\text{m}$ is emitted from a hydrogen atom as a result, of an electron transition from $n = 6$ to n_f (n_f final). Find n_f .
- 5) $r_n = n^2 a_0$ $a_0 = 0.53 \text{ \AA}$
 - a. Calculate the radius for the Bohr hydrogen atom corresponding to $n = 3$.
 - b. $r_n = 2.12 \text{ \AA}$, 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. $n = ?$, $\ell = 1$, $m_\ell = 1$, $m_s = +\frac{1}{2}$
 - b. $n = 3$, $\ell = 1$, $m_\ell = -1$, $m_s = ?$
 - c. $n = 2$, $\ell = ?$, $m_\ell = 0$, $m_s = +\frac{1}{2}$
 - d. $n = 4$, $\ell = 1$, $m_\ell = ?$, $m_s = ?$
 - e. $n = 4$, $\ell = ?$, $m_\ell = +3$, $m_s = -\frac{1}{2}$

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

$\lambda = 1.01 \mu m$

4) $n_f = 4$

5) a. 4.77 \AA

b. $n = 2$

c. 2.65 \AA

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: $[\text{Ar}] 4s^2 3d^{10} 4p^2$
c. Pb: $[\text{Xe}] 6s^2 4f^{14} 5d^{10} 6p^2$
d. W: $[\text{Xe}] 6s^2 4f^{14} 5d^4$
- 2) a. O: $1s^2 2s^2 2p^4$
b. Si: $[\text{Ne}] 3s^2 3p^2$
c. Se: $[\text{Ar}] 4s^2 3d^{10} 4p^4$
d. Bi: $[\text{Xe}] 6s^2 4f^{14} 5d^{10} 6p^3$
- 3) a. 10 electrons
b. 2 electrons
c. 4 electrons
d. 1 unpaired electron
e. 14 electrons