Department of Chemistry
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The Hydrogen Atom– Supplemental Worksheet

1. State the significance of the line spectrum of hydrogen.

It indicates that only certain energies are allowed for the electron in the hydrogen atom, or the energy of the electron in the hydrogen atom is quantized.

2. Calculate the energy in each of the following spectral transitions in the hydrogen atom.

$$\Delta E = -2.187 \times 10^{-18} J \left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$$

a. $n = 4 \rightarrow n = 1$ $\Delta E = -2.187 \times 10^{-18} J \left(\frac{1}{1^2} - \frac{1}{4^2}\right) = -2.187 \times 10^{-18} \times 0.9375 = -2.050 \times 10^{-18} J$

b. $n = 3 \rightarrow n = 2$ $\Delta E = -2.187 \times 10^{-18} J \left(\frac{1}{2^2} - \frac{1}{3^2}\right) = -2.187 \times 10^{-18} \times 0.1389 = -3.038 \times 10^{-19} J$

3. What is the minimum uncertainty in the position of an electron (mass = 9.11×10^{-31} kg) traveling at a velocity with an uncertainty of 4.1×10^{7} $m \cdot s^{-1}$?

$$\Delta x \Delta p \geq \frac{h}{4\pi}$$

$$\Delta x (m \Delta v) \geq \frac{h}{4\pi}$$

$$\Delta x \geq \frac{6.626 \times 10^{-34} J \cdot s}{4\pi \times 9.11 \times 10^{-31} kg \times 4.1 \times 10^{7} m \cdot s^{-1}} = 1.42 \times 10^{-12} m$$

4. An electron is excited from the ground state to the *n* = 2 state in a hydrogen atom. Which of the following statements are true? And correct the false statements.

a. It takes less energy to ionize the electron from *n* = 2 than from the ground state. *TRUE.*

b. The electron is closer to the nucleus on average in the *n* = 2 than from the ground state. FALSE. The electron in the ground state is closest to the nucleus.

c. The first excited state corresponds to *n* = 2. TRUE.

d. The wavelength of light emitted when the electron returns to the ground state from *n* =2 is different from the wavelength of light absorbed to go from *n* = 1 to *n* = 2. FALSE. They are the same when going in between the same 2 states.

5. Fill the following chart

n	*l*	Orbital Designation	m_l	Number of Orbitals
1	0	1s	0	1
2	0	2s	0	1
	1	2p	-1, 0, 1	3
3	0	3s	0	1
	1	3p	-1, 0, 1	3
	2	3d	-2, -1, 0, 1, 2	5
4	0	4s	0	1
	1	4p	-1, 0, 1	3
	2	4d	-2, -1, 0, 1, 2	5
	3	4f	-3, -2, -1, 0, 1, 2, 3	7

6. Which of the following sets of quantum numbers are allowed?

a. $n = 3$, $l = 2$, $m_l = -2$ *Allowed*

b. $n = 1$, $l = 1$, $m_l = 0$ *Not Allowed. l must be 0*

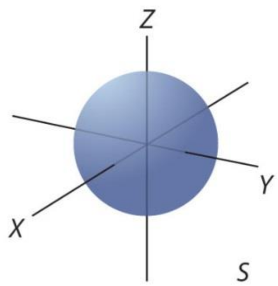
c. $n = 4$, $l = -2$, $m_l = 0$ *Not Allowed. l cannot be negative.*

d. $n = 2$, $l = 1$, $m_l = 1$ *Allowed*

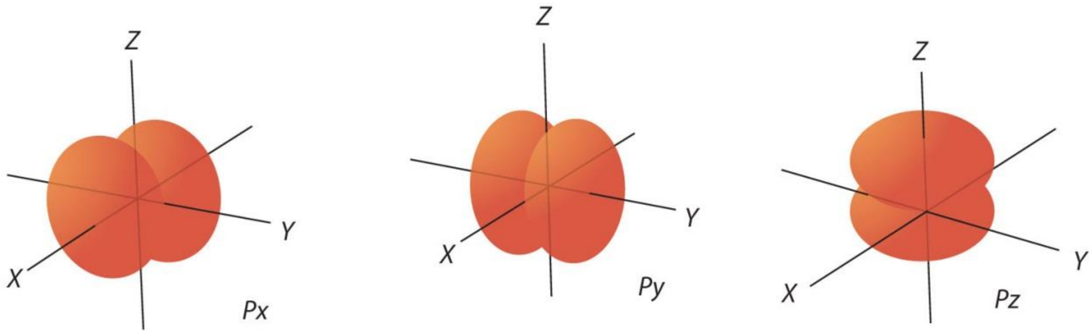
7. What is the maximum number of electrons in the *s, p, d*, and *f* shells?

s = 2, p = 6, d = 10, f = 14

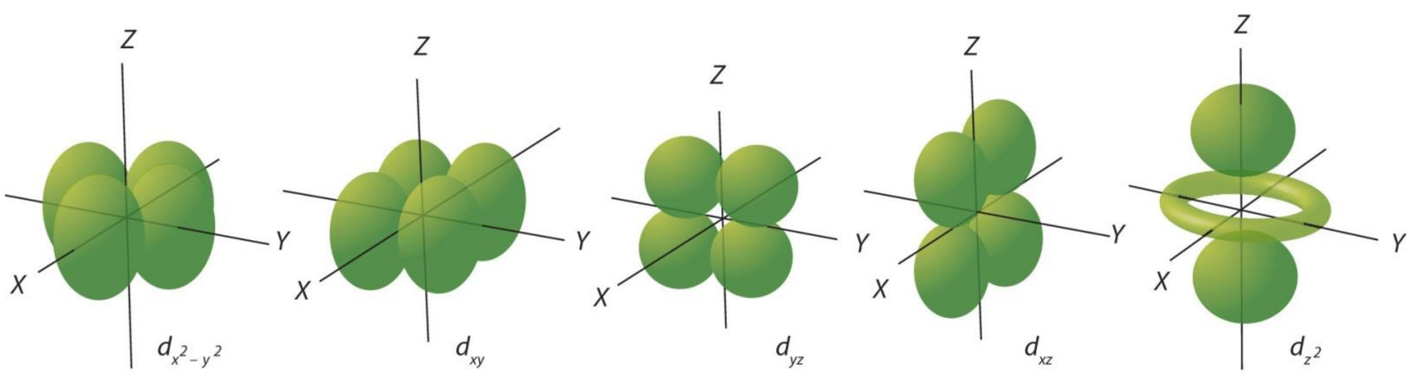
8. Draw the representations of the s, p, and d orbitals.



(a)



(b)



(c)