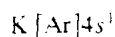


or in terms of the argon core abbreviation.



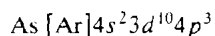
Chang ST Atom Structure

EXAMPLE 7.11 Orbital Diagrams

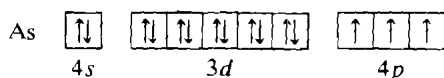
- Write the electron configuration for arsenic.
- Draw its orbital diagram.
- Are As atoms diamagnetic or paramagnetic?

METHOD OF SOLUTION

- From the atomic number of As we see there are 33 electrons per arsenic atom. From Figure 7.29 in the text, the order of filling orbitals is $1s$, $2s$, $2p$, $3s$, $3p$, $4s$, and so on. Placing electrons in the lowest energy orbitals until they are filled, we find that the first 18 electrons are arranged $1s^2 2s^2 2p^6 3s^2 3p^6$, which corresponds to an Ar core. The next 2 enter the $4s$, and the next 10 enter the $3d$. This leaves 3 electrons for the $4p$ subshell. *Answer:* The electron configuration of As is



- All of the orbitals are filled except for the $4p$ orbitals. The electrons must be placed into the $4p$ orbitals in accordance with Hund's rule. The orbital diagram for the outer orbitals is



- Answer:* Arsenic atoms are paramagnetic because they contain 3 unpaired electrons.

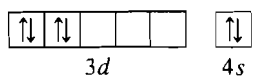
Self Test C-GAChang

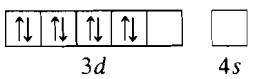
TRUE-FALSE QUESTIONS

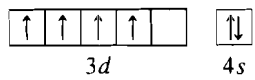
- The greater the frequency of light, the faster the speed of light.
- The energy of a photon is inversely proportional to the wavelength of the radiation.
- Bohr postulated that radiation is emitted when an electron transition occurs from a lower to a higher energy orbit.
- The quantum mechanical model of the H atom confirms that Bohr's orbits are reasonable but shows that the energies of the principal energy levels are wrong.
- The value of the magnetic quantum number depends on ℓ .
- An orbital for which $\ell = 2$ is a d orbital.
- The m_ℓ quantum number can have only one of two possible values, $-\frac{1}{2}$ or $+\frac{1}{2}$.
- No two electrons in an atom can have the same set of four quantum numbers.
- The d subshell consists of a set of six orbitals.
- In a many-electron atom the energies of the p_x , p_y , and p_z orbitals are not the same.

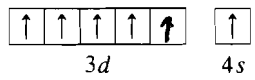
11. The electron configuration for nitrogen can be written as $1s^2 2s^2 2p^3$ or $1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$.
12. The configuration $1s^2 2s^2 2p^5 3s^2$ would be an excited state of sodium.

SELF-TEST A

- 1. A certain AM radio station broadcasts at a frequency of 600 kHz. What is the wavelength of these radio waves in meters?
 - 2. How long would it take a radio wave of frequency 5.5×10^5 Hz to travel from the planet Venus to Earth (28 million miles)?
 - 3. Calculate the energy required to remove an electron from a hydrogen atom in the ground state.
 - 4. Which of the following has the greatest ionization energy?
a. H b. He⁻ c. Li²⁺
 - 5. The average kinetic energy of a neutron at 25°C is 6.2×10^{-21} J. What is its de Broglie wavelength? The mass of a neutron is 1.008 amu. *Hint:* kinetic energy = $\frac{1}{2}mu^2 = (mu)^2/2m$.
 - 6. Deduce the possible sets of four quantum numbers for an electron that arise when $n = 2$.
 - 7. What is the maximum number of electrons that can occupy an $n = 3$ energy level? The $n = 4$ energy level?
 - 8. Which of the following subshells has a capacity of 10 electrons?
a. 5s b. 2p c. 4p d. 3d e. 6s
 - 9. How many orbitals are occupied by one or more electrons in a germanium atom?
 - 10. Complete the sentence: An electron with $\ell = 2$ must
a. Have $m_\ell = -2$
b. Be in an $n = 3$ energy level
c. Be in a p orbital
d. Be in a d orbital
 - 11. Write quantum numbers for
a. An electron in a 2s orbital
b. The outermost electrons in Ge
 - 12. Write the electron configuration for the following atoms: Ar, Se, and Ag.
 - 13. How many electrons are represented by the abbreviation [Kr]?
 - 14. Which of the following is the correct orbital diagram for chromium?
- a. 

c. 

b. 

d. 
- 15. Which of the following atoms has the greatest number of unpaired electrons?
a. Ti b. Ag c. O d. P e. K

GENERAL PROBLEMS

- 16. If the energy required to ionize 1 mol of H atoms were used to raise the temperature of water, what mass of water could have its temperature increased by 50°C?
- 17. If 5% of the energy supplied to an incandescent light bulb is radiated as visible light, how many "visible" photons per second are emitted by a 100-watt bulb? Assume the wavelength of all visible light to be 560 nm. Given: 1 watt = 1 J/s.
- 18. The light-sensitive compound in most photographic films is silver bromide (AgBr). Assume, when film is exposed, that the light energy absorbed dissociates the molecule into atoms. (The actual process is more complex.) If the energy of dissociation of AgBr is 100 kJ/mol, find the wavelength of light that is just able to dissociate AgBr.

SELF-TEST B1

1. What is the wavelength of electromagnetic radiation with frequency $5.0 \times 10^{14} \text{ s}^{-1}$?
2. What is the energy of a photon of radiation having a frequency of $6.2 \times 10^{14} \text{ s}^{-1}$?
3. The red line in the spectrum of lithium occurs at 670.8 nm. What is the energy of a photon of this light? What is the energy of 1 mol of these photons?
4. What wavelength of radiation will be emitted when an electron in a hydrogen atom jumps from the $n = 5$ to the $n = 1$ principal energy level? Name the region of the electromagnetic spectrum corresponding to this wavelength.
5. Which of the following sets of quantum numbers are not allowed for describing an electron in an orbital in a hydrogen atom?

	n	ℓ	m_ℓ	m_s
a.	3	2	-3	$-\frac{1}{2}$
b.	2	3	0	$-\frac{1}{2}$
c.	2	1	0	$-\frac{1}{2}$

6. Which choice is a possible set of quantum numbers for the last electron added to make up an atom of gallium (Ga) in its ground state?

	n	ℓ	m_ℓ	m_s
a.	4	2	0	$-\frac{1}{2}$
b.	4	1	0	$-\frac{1}{2}$
c.	4	2	-2	$-\frac{1}{2}$
d.	3	1	+1	$-\frac{1}{2}$
e.	3	0	0	$-\frac{1}{2}$

7. Write the electron configuration for the following atoms: Sb, V, and Pb.
8. How many unpaired electrons do nitrogen atoms have?