Quantum Number and Energy Level Worksheet

1. Draw energy level diagrams for:
   a) F b) Ca c) Co d) Yb e) N^{3-}

2. Write the short form electron configuration for:
   a) F b) Ca c) Co d) Yb

3. Identify the orbital corresponding to the following quantum numbers:

   a) $n = 3, l = 2, m_l = 1, m_s = \pm ½$

   b) $n = 5, l = 3, m_l = -3, m_s = \pm ½$

   c) $n = 4, l = 1, m_l = -1, m_s = \pm ½$

   d) $n = 2, l = 1, m_l = 0, m_s = \pm ½$

   e) $n = 4, l = 2, m_l = -2, m_s = \pm ½$

4. Which of the following designations are orbitals that are not possible in wave mechanics?

   1*d*, 4*f*, 1*p*, 6*d*, 2*f*

5. Which of the following are sets of quantum numbers for orbitals which are possible in wave mechanics?

   a) $n = 1, l = 1, m_l = 1, m_s = \pm ½$

   b) $n = 2, l = 1, m_l = 2, m_s = \pm ½$

   c) $n = 2, l = 0, m_l = 0, m_s = \pm ½$

   d) $n = 3, l = 3, m_l = 1, m_s = \pm ½$

   e) $n = 3, l = 2, m_l = -2, m_s = \pm ½$

   f) $n = 4, l = 3, m_l = 2, m_s = \pm ½$

6. Write the quantum numbers for the two electrons in a 3*s* orbital.

7. The actual electron configuration of chromium is $[Ar]4s^1 3d^5$. Do some research and explain why chromium has an anomalous electron arrangement.

8. Use electron configurations to explain the common ion charges for antimony; i.e. Sb^{3+} and Sb^{5+}

9. Predict the electron configuration for the gallium ion, Ga^{3+}, provide your reasoning.

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Name:
Date:

Quantum Number and Energy Level Worksheet - ANSWERS

1. Draw energy level diagrams for:
   a) F b) Ca c) Co d) Yb e) N^{3-}
   Talk to the teacher if you are not sure about these ones.

2. Write the short form electron configuration for:
   a) F F: $[He]2s^2 2p^5$
   b) Ca Ca: $[Ar]4s^2$
   c) Co Co: $[Ar]4s^2 3d^7$
   d) Yb Yb: $[Xe]6s^2 4f^{14}$

3. Identify the orbital corresponding to the following quantum numbers:

   a) $n = 3, l = 2, m_l = 1, m_s = \pm ½$ 3d

   b) $n = 5, l = 3, m_l = -3, m_s = \pm ½$ 5f

   c) $n = 4, l = 1, m_l = -1, m_s = \pm ½$ $4p_z$

   d) $n = 2, l = 1, m_l = 0, m_s = \pm ½$ $2p_y$

   e) $n = 4, l = 2, m_l = -2, m_s = \pm ½$ 4d

4. Which of the following designations are orbitals that are not possible in wave mechanics?

   1*d*, 4*f*, 1*p*, 6*d*, 2*f* 1d, 1p, 2f are not possible

5. Which of the following are sets of quantum numbers for orbitals which are possible in wave mechanics?

   a) $n = 1, l = 1, m_l = 1, m_s = \pm ½$
   Not possible
   b) $n = 2, l = 1, m_l = 2, m_s = \pm ½$
   Not possible
   c) $n = 2, l = 0, m_l = 0, m_s = \pm ½$
   Possible
   d) $n = 3, l = 3, m_l = 1, m_s = \pm ½$
   Not possible
   e) $n = 3, l = 2, m_l = -2, m_s = \pm ½$
   Possible
   f) $n = 4, l = 3, m_l = 2, m_s = \pm ½$
   Possible

6. Write the quantum numbers for the two electrons in a 3*s* orbital.
   $n = 3, l = 0, m_l = 0, m_s = + ½$
   $n = 3, l = 0, m_l = 0, m_s = - ½$

7. The actual electron configuration of chromium is $[Ar]4s^1 3d^5$. Do some research and explain why chromium has an anomalous electron arrangement.

Because of electron-electron repulsion and the fact that energetically the 4s and 3d are so close in energy the atom is more stable when one of the 4s electrons moves to the 3d orbital giving all orbitals a half-full arrangement.

8. Use electron configurations to explain the common ion charges for antimony; i.e. Sb^{3+} and Sb^{5+}

Sb: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^3$

Sb^{3+}: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10}$ - this ion loses the three electrons from the 5p orbitals leaving a stable ion with the 5s orbital full.

Sb^{5+}: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 4d^{10}$ - this ion loses the three electrons from the 5p orbitals as well as the 2 electrons in the 5s orbital creating a stable ion.

9. Predict the electron configuration for the gallium ion, Ga^{3+}, provide your reasoning.

Ga: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^1$

Ga^{3+}: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$

Gallium will lose the electrons from the fourth energy level first. That means the electron in the 4p is removed as well as the 2 electrons in the 4s. By doing this all remaining orbitals are completely occupied increasing the stability of this ion.