Quantum Numbers, Orbitals, Electron Configurations, Periodic Trends

CH2000: Introduction to General Chemistry, Plymouth State University, Fall 2013

1. Briefly describe in your own terms what each of the quantum numbers mean:

   n (principle q.n.) _____

   ℓ (angular momentum q.n.) _____

   m_ℓ (magnetic q.n.) _____

   m_s (spin magnetic q.n.) _____

2. What are the possible values for each of the quantum numbers?

   n _____

   ℓ _____

   m_ℓ _____

   m_s _____

3. Draw a sketch of an orbital with the given angular momentum quantum number.

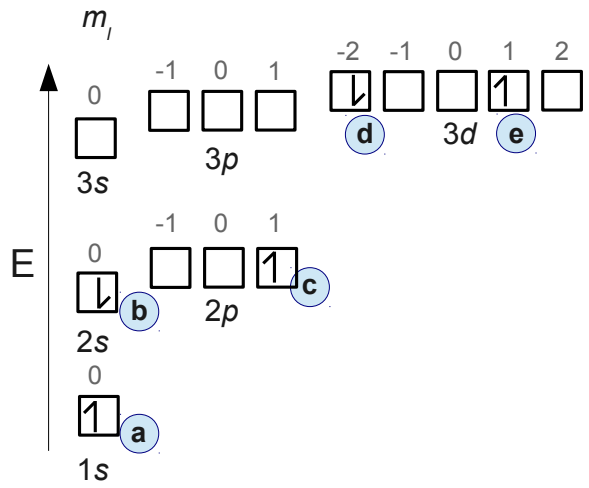
   $\ell = 0$ $\ell = 1$ $\ell = 2$

4. On the energy diagram below, show the relative energy ordering of the orbitals from 1*s* to 4*s*.

5. Each row in the table represents a set of orbitals (e.g., the 2*p* orbitals). Complete the table:

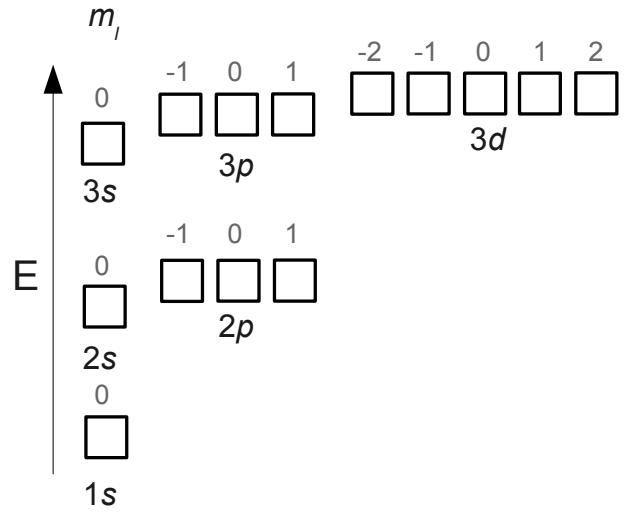
n	***l***	m_ℓ	**Orbital Designation**	**Number of orbitals**
1				1
3		-1, 0, 1		3
4	3			7
5			5*p*	
			2*s*	
3	0			

6. Five electrons have been placed onto the energy diagram below and labeled a-e. In the table to the write, give the values of the four quantum numbers for all 5 electrons.



Electron	***n***	***l***	m_l	m_s
a				
b				
c				
d				
e				

7. Place the electrons with the quantum numbers given in the table onto the energy diagram, labeling each with the appropriate letter. If an electron cannot exist with the given quantum numbers, draw a single line through the row on the table.



Electron	***n***	***l***	m_l	m_s
a	2	0	0	+½
b	2	1	0	+½
c	1	0	0	-½
d	2	0	0	+1
e	3	1	-1	+½
f	3	2	-3	-½
g	3	1	-1	-½

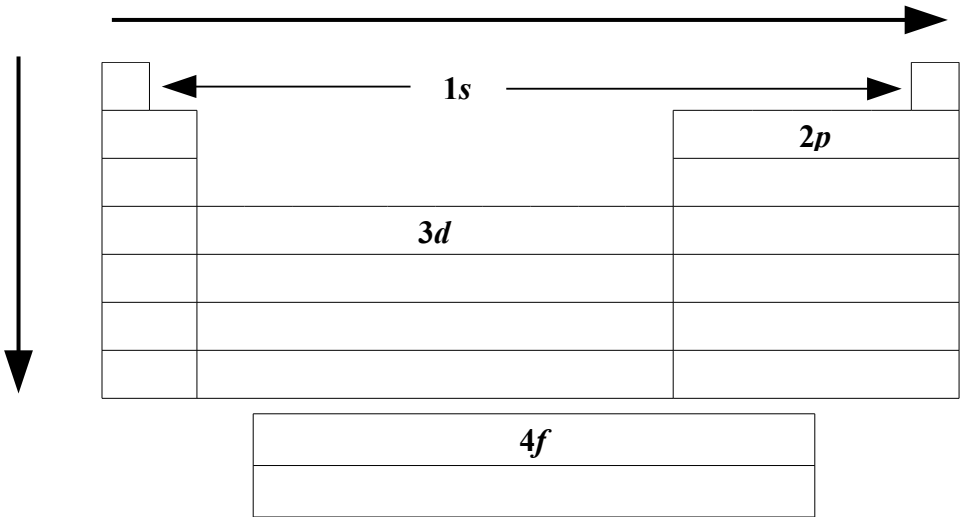
8. DRAW energy level diagrams showing the relative orderings of the orbitals (similar to those in questions 4,6 and 7) and fill them with the correct numbers of electrons to indicate the ground state configurations of the following atoms:

   a) Nitrogen (N)

   b) Sodium (Na)

   c) Argon (Ar)

   d) Scandium (Sc)



9. On the Periodic Table diagram above, fill in the sub-shell label in each box (e.g. '1*s*')

10. The two fundamental atomic properties that can be used to explain most other properties are 'principle quantum number (*n*)' and 'effective nuclear charge (Z_{eff})'. How do these properties trend moving top to bottom and left to right on the Periodic Table? Make note of which property is most important in these two directions and how it changes on the diagram above.

11. How does <u>size</u> of the atoms trend left to right on the Periodic Table? Top to Bottom?

12. How does <u>ionization potential</u> trend left to right on the Periodic Table? Top to Bottom?

13. Give the FULL electron configuration for each of the following atoms (the first is done for you)

a) C $1s^2 2s^2 2p^2$

b) F

c) Mg

d) Ti

e) S

f) Ta

14. Give the electron configuration for each of the following using the Nobel Gas abbreviation (the first is done for you)

a) Ge $[Ar]4s^2 3d^{10} 4p^2$

b) Al

c) Ba

d) V

e) Si

f) I

15. Give the electron configuration for each of the following ions (you may use whichever notation you like; the first is done for you)

a) O^{2-} [He]$2s^2 2p^6$

b) H^+

c) H^-

d) Al^{3+}

e) P

f) Cl^-

g) Ba^{2+}

h) Pb^{2+}

16. Write the reactions showing the first four ionizations for nitrogen (N) and silicon (Si).

N →

Si →

17. Write the electron configurations for the following:

a) N

b) N^+

c) N^{2+}

d) N^{3+}

e) N^{4+}

f) Si

g) Si^+

h) Si^{2+}

i) Si^{3+}

j) Si^{4+}

18. Which element will have the lowest first ionization: N or Si?

19. Which element will have the lowest third ionization: N or Si?

20. Which element will have the higher second ionization: N or Si?

21. Which element is larger in each of the following pairs?

a) Cl or Br

b) As or S

k) Na or Mg

l) Ca or Mg

m) Li or F

n) Al or Ne

22. Which element has the smaller ionization potential in each of the following pairs?

o) Cs or Sr

p) Cl or Si

q) Xe or Ar

r) Rb or K

s) O or Al

t) P or F

Exam Review Questions

1. How many significant figures are in each of the following numbers?
   a) 34.02
   b) 3300
   c) 10.50
   d) 0.00342
   e) 1.2340×10^{7}
   f) 12340000
2. Convert the numbers is questions 1a – 1d into scientific notation.
   a)
   b)
   c)
   d)
3. Convert the following numbers that are in scientific notation into decimal form.
   a) 1.2340×10^{7}
   b) 3.980×10^{2}
   c) 9.23×10^{-5}
   d) 7.0×10^{4}
   e) 5.00134×10^{-4}
   f) 6.626×10^{-34}
4. A box measures 2.56 in × 4.21 in × 12.00 in. What is its volume in liters (L)? (*useful conversion factors*: 1 in ≡ 2.54 cm).

5. An electron is traveling at 1.500×10^{5} m/s. What is its speed in light years per century? (*useful conversion factors*: 1 light-year ≡ $9.460730472580800 \times 10^{15}$ m)

6. The speed of sound in dry air at sea level is 343.2 m/s. The frequency of "middle-C" on a musical instrument is 261.63 Hz. What is the wavelength of the middle-C sound wave?

7. A beam of neutrons with wavelengths of 1.72×10^{-10} m needs to be generated for use in a diffraction experiment. To what speed will the neutrons need to be accelerated? ($m_n = 1.675 \times 10^{-27}$ kg)

