

Quantum Numbers, Orbitals, and Exam Review
CH2000: Introduction to General Chemistry, Plymouth State University

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.

$\ell = 0$

$\ell = 1$

$\ell = 2$

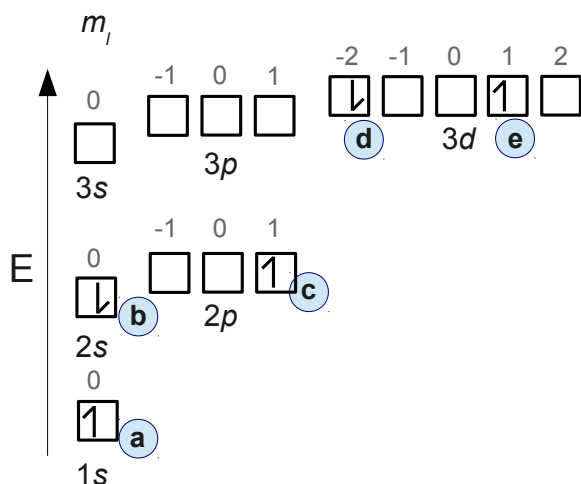
4. On the energy diagram below, show the relative energy ordering of the orbitals from 1s to 4s.



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

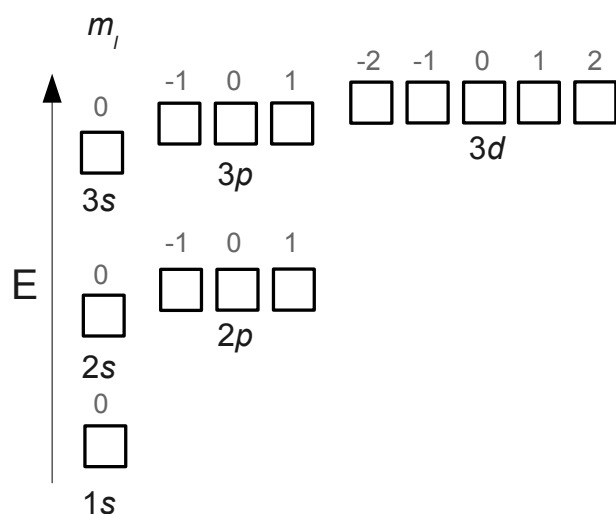
| n | l | m_l | Orbital Designation | Number of orbitals |
|-----|-----|----------|---------------------|--------------------|
| 1 | | | | 1 |
| 3 | | -1, 0, 1 | | 3 |
| 4 | 3 | | | 7 |
| 5 | | | $5p$ | |
| | | | $2s$ | |
| 3 | 0 | | | |
| | | | | |

6. Five electrons have been placed onto the energy diagram below and labeled a-e. In the table to the right, 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 | $+\frac{1}{2}$ |
| b | 2 | 1 | 0 | $+\frac{1}{2}$ |
| c | 1 | 0 | 0 | $-\frac{1}{2}$ |
| d | 2 | 0 | 0 | +1 |
| e | 3 | 1 | -1 | $+\frac{1}{2}$ |
| f | 3 | 2 | -3 | $-\frac{1}{2}$ |
| g | 3 | 1 | -1 | $-\frac{1}{2}$ |

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)

Exam Review Questions

9. How many significant figures are in each of the following numbers?
- a) 34.02 c) 10.50 e) 1.2340×10^7
b) 3300 d) 0.00342 f) 12340000
10. Convert the numbers in questions 9a – 9d into scientific notation.
- a) c)
b) d)
11. Convert the following numbers that are in scientific notation into decimal form.
- a) 1.2340×10^7 d) 7.0×10^4
b) 3.980×10^2 e) 5.00134×10^{-4}
c) 9.23×10^{-5} f) 6.626×10^{-34}
12. A box measures 2.56 in \times 4.21 in \times 12.00 in. What is its volume in liters (L)? (*useful conversion factors: 1 in \equiv 2.54 cm.*)
13. 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 \equiv $9.460730472580800 \times 10^{15}$ m*)
14. 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?
15. 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)