Recitation Worksheet Eight

Name: Key

UGA ID:

Instructions:

- Please enter your first and last name as it appears on the eLC roster (do not use a nickname that is not reflected in eLC).
- Your UGA myID is a combination of letters and numbers (example: mine is jmj81738). Do *not* enter your 81x number.
- Download this worksheet and print it if you have a printer. Write the answers in the answer boxes and show your work when appropriate. Using the instructions in the Welcome module on eLC, convert your worksheet to a PDF and then upload it to Gradescope. If you have an iPhone or Android device, you can scan and upload directly through the Gradescope app. The pages must be in the correct order or Gradescope will not be able to read it.
- If you do not have a printer, download the worksheet and type your answers in the answer boxes and upload it to Gradescope. Write your work on separate sheets of paper, convert these pages to a PDF using the instructions in the Welcome module on eLC, then upload them to the dropbox on eLC for this worksheet.
- If you are using an app to annotate the worksheet, make sure the pages are in the correct order and have the same layout as the original or Gradescope will not be able to read it.
- Answers must be written in the corresponding answer box or no credit will be awarded.
- This worksheet is due no later than **11:59 PM on the Friday of the recitation week.**
- The instructions for uploading worksheets to Gradescope can be found in the Content area of eLC in the Welcome Module.
- **You must show your work to receive credit.**

1. Which of the following subshell designations are invalid? Select all that apply.

B C E

A. 1s
B. 1p
C. 1d
D. 2s
E. 2f
F. 3d

2. What is the maximum number of orbitals that can be found in the 3p subshell? Answer with an integer in the box below (e.g. 11).

3

3. What is the maximum number of electrons that can be found in the 4d subshell? Answer with an integer in the box below (e.g. 11).

10

4. Which of the following are an **invalid** set of quantum numbers? Select all that apply.

ACDE

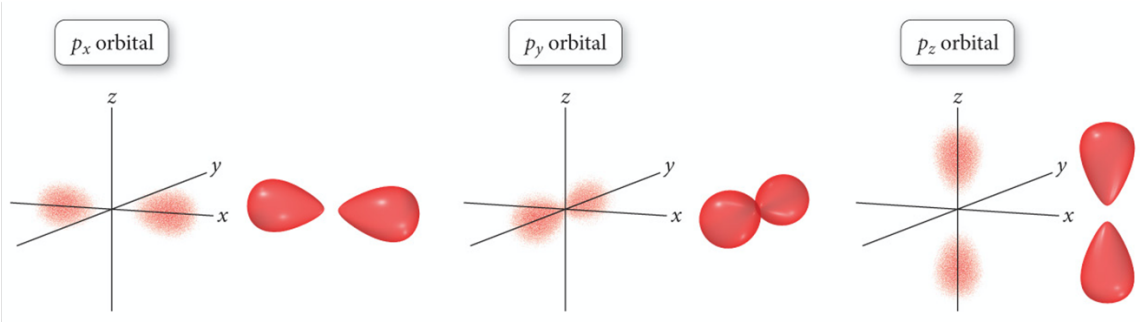
A. (-1, 1, 0, ½)
B. (1, 0, 0, -½)
C. (2, 2, 2, -½)
D. (2, 1, 1, 1)
E. (3, 0, -1, -½)
F. (4, 2, 0, ½)
G. (5, 1, -1, ½)

5. Which of the following statements are **false**? Select all that apply.

ABE

A. The quantum number m_s represents the size of the orbital
B. The quantum number m_ℓ can be zero and represents the energy of the orbital
C. In a one-electron system, the 3s and 3p orbitals are degenerate
D. In a multi-electron system, the quantum numbers (2, 1, 0, -½) and (2, 1, 1, ½) are valid and degenerate
E. A $3d_{xy}$ orbital is degenerate with a $3d_{xz}$ orbital in a multi-electron system but not in a single electron system

Answer questions 6-8 using the images of the orbitals given below. The images below are only **general illustrations, and the nodes are not shown below**.



6. Which of the following quantum numbers below represent the *x*, *y*, and *z* subscripts in the orbitals above?

orientations

C

A. n
B. ℓ
C. m_ℓ
D. m_s
E. None of the quantum numbers provide this information

7. Which of the following sets of quantum numbers below are valid and may represent any of the three orbitals above? Select all that apply. $\ell = 1$

C E

A. (2, 1, 2, ½) invalid
B. (3, 2, 0, -½) $\ell = 2$
C. (4, 1, -1, ½)
D. (5, 0, 0, -½) $\ell = 0$
E. (6, 1, 0, ½)
F. (3, 0, 0, ½) $\ell = 0$
G. (1, 1, -1, ½) $\ell \neq 1$ here b/c $n = 1$
H. (4, 2, -2, ½) $\ell = 2$

8. If one of the orbitals given above is the $3p_y$ orbital, how many values of (a) n, (b) ℓ, (c) m_ℓ, and (d) m_s are possible? Answer with integers in the boxes below (e.g. 11).

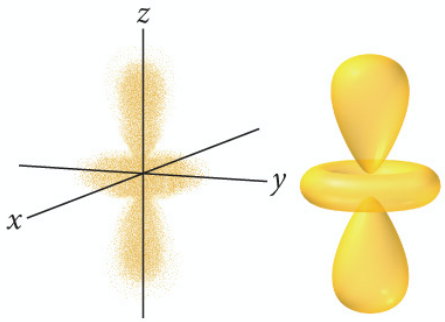
(a) 1 $n = 3$

(c) 1 m_ℓ = are orientation (p_y)

(b) 1 $\ell = 1$

(d) 2 $m_s = +1/2$ or $-1/2$

9. Consider the image of the orbital given below, **which is only a general illustration of that particular orbital type**. If the orbital were to contain 5 total nodes, which of the following subshells would correspond to this orbital?



d orbital

nodes = n − 1

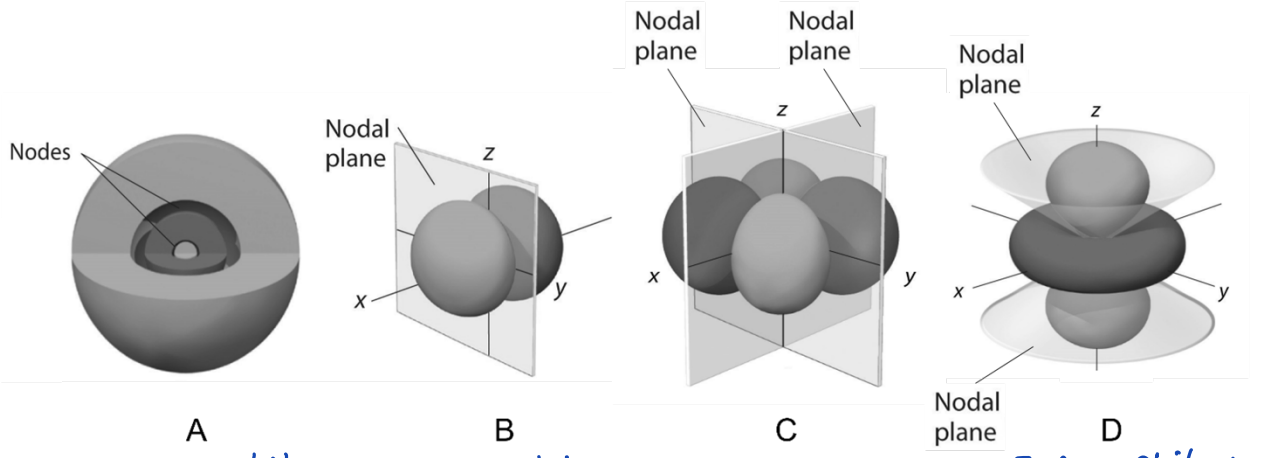
5 nodes = n − 1

n = 6

F

A. 4p
B. 5p
C. 6p
D. 4d
E. 5d
F. 6d
G. 4f
H. 5f
I. 6f

10. Which of the following options has the energy of orbitals pictured below ranked correctly from lowest energy to highest energy?



3s orbital

2p orbital

3d orbital

3d orbital

equal energy

E

A. B < A < C < D
B. A < B < C = D
C. A < B = D < C
D. B = D < A < C
E. B < A < C = D

11. In a multi-electron system, an orbital in a 4s subshell fills before an orbital in a 3d subshell despite a higher quantum number n. Which of the following statements best explain this behavior?

D

A. A 3d orbital experiences less shielding than a 4s orbital
B. The 3d subshell is able to hold more electrons than a 4s orbital which subsequently results in a lower energy
C. There are more nodes in a 3d orbital than a 4s orbital causing an increase in energy
D. A 4s orbital experiences more penetration than a 3d orbital
E. The number of possible orientations for the 3d orbitals are higher than 4s orbitals resulting in a higher energy

12. Which of the following element and ground state electron configuration (either full or noble gas configuration) pairs below are **incorrect**? Select all that apply.

B C E

A. Y: [Kr] $5s^2 4d^1$
B. Al: $1s^2 2s^2 2p^6 3s^2 2p^1$
C. K: [Ne] $4s^1$
D. Mo: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^4$
E. W: [Xe] $6s^2 5d^4$ → missing $4f^{14}$

13. The electron configuration [Xe] $6s^1 4f^{14} 5d^{10}$ corresponds to which of the following options below?

C

A. Pt
B. Pt in an excited state
C. Au
D. Au in an excited state
E. Hg
F. Hg in an excited state
G. None of the above; the electron configuration given is invalid

14. Which of the following represents an excited state electron configuration of Sn? Select all that apply.

ground state: $[Kr]5s^2 4d^{10} 5p^2$

C

A. $[Kr]\ 5s^2 4d^9 5p^2$ → missing e^-; not excited state

B. $[Kr]\ 5s^2 4d^{10} 5p^2$ → ground state

C. $[Kr]\ 5s^1 4d^{10} 5p^3$

D. $[Kr]\ 5s^2 4d^{10} 5p^2 6p^1$ → extra e^-

E. $[Kr]\ 5s^2 4d^{10} 5p^1$ → missing e^-; not excited state

15. Which of the following is the correct ground state electron configuration for an oxide ion in the ground state?

O atom → $1s^2 2s^2 2p^4$

O^{2-} ion → $1s^2 2s^2 2p^6$

E

A. $1s^2 2s^2 2p^2$

B. $1s^2 2s^2 2p^3$

C. $1s^2 2s^2 2p^4$

D. $1s^2 2s^2 2p^5$

E. $1s^2 2s^2 2p^6$

16. What ion does the ground state electron configuration [Ar] $3d^2$ belong to? (select all that apply)

AD

A. Ti^{2+}

B. Sc^{3+}

C. Cr^{2+}

D. Mn^{5+}

E. Fe^{3+}

Ti: $[Ar]\ 4s^2 3d^2$

Ti^{2+}: $[Ar]\ 3d^2$

Sc: $[Ar]\ 4s^2 3d^1$

Sc^{3+}: $[Ar]$

Cr: $[Ar]\ 4s^1 3d^5$

Cr^{2+}: $[Ar]\ 3d^4$

Mn: $[Ar]\ 4s^2 3d^5$

Mn^{2+}: $[Ar]\ 3d^5$

Mn^{5+}: $[Ar]\ 3d^2$

Fe: $[Ar]\ 4s^2 3d^6$

Fe^{2+}: $[Ar]\ 3d^6$

Fe^{3+}: $[Ar]\ 3d^5$

17. Consider a hypothetical transition metal with the noble gas electron configuration below. What is the most probable charge that will form from this element? A hypothetical noble gas "Ng" is given in the brackets below. Enter your answer as an integer and charge (e.g. +/- 1, 2, 3, etc.).

[Ng] $10s^1 9d^{10}$ → neutral

+1

ion (+1 charge): [Ng] $5d^{10}$

18. Heisenberg's uncertainty principle states that...

C

A. matter and energy are really the same thing
B. it is impossible to know anything with certainty
C. it is impossible to know both the exact position and momentum of an electron
D. there can only be one uncertain digit in a reported number
E. it is impossible to know how many electrons there are in an atom

19. How many core electrons are in the elements below? Answer with integers in the boxes below (e.g. 11).

(a) Silicon: 10

(b) Fluorine: 2

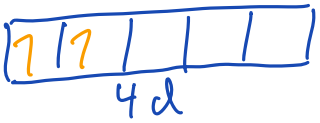
20. How many unpaired electrons are in the following ions below? Answer with integers in the boxes below (e.g. 11).

(a) Mo^{4+}: 2

(b) Ta^{4+}: 1

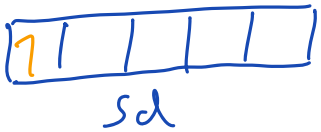
Mo: [Kr] $5s^1 4d^5$

Mo^{4+}: [Kr] $4d^2$



Ta: [Xe] $6s^2 4f^{14} 5d^3$

Ta^{4+}: [Xe] $4f^{14} 5d^1$



21. Which electron orbital diagram(s) below for an element in its ground state does not have any violations? Which violate the Aufbau principle? Hund's rule? Pauli exclusion principle? Write the corresponding letter(s) in the boxes below. Hint: each option may or may not be used more than once.

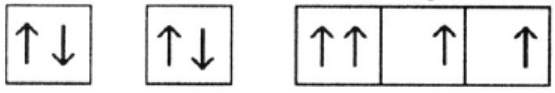
(a) No violations: E

(b) Aufbau principle violation: C D

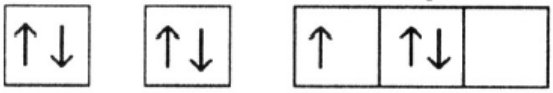
(c) Hund's rule violation: B C

(d) Pauli exclusion principle violation: A

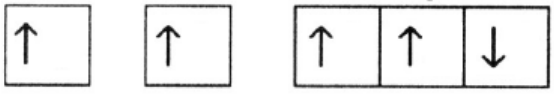
A.



B.

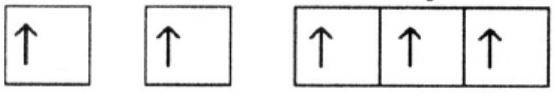


C.



→ Aufbau + Hund's rule violation

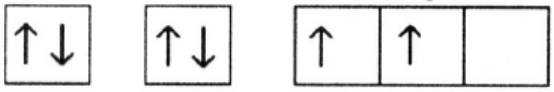
D.



↓

singly occupied e's in degenerate orbitals must be parallel (same spin)

E.



22. Which of the following ions below is paramagnetic?

D

A. Sc^{3+}

B. Zn^{2+}

C. Zr^{4+}

D. V^{3+}

E. All of the options given are diamagnetic

Sc^{3+} : [Ar]

Zn^{2+} : [Ar] $3d^{10}$ ↑↓ ↑↓ ↑↓ ↑↓ ↑↓ (3d)

Zr^{4+} : [Kr]

V^{3+} : [Ar] $3d^{2}$ ↑ ↑ | | | (3d) unpaired e⁻s

Extra Practice Questions: these questions will not be graded.

1. Which of the following options are valid quantum numbers for the orbital illustrated below? Select all that apply.

p orbital
$\ell = 1$

BF

A. (1, 1, 0, ½) → not valid

B. (2, 1, -1, -½)

C. (4, 2, -1, ½) → $\ell = 2$ valid

D. (2, 1, 2, ½) → not valid

E. (4, 1, -1, 0) → not valid

F. (2, 1, 1, ½)

2. Consider the electron configuration for an element written below. Which of the following statements are true? Select all that apply.

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

C

A. The electron configuration belongs to the element Ga
B. The electron configuration illustrates an element in its ground state
C. The electron configuration illustrates an element in its excited state
D. The electron configuration belongs to the element Ge in an excited state
E. As written, the element has 18 valence electrons

3. How many valence electrons are in the elements below? Answer with integers in the boxes below (e.g. 11).

(a) Potassium: 1

(b) Sulfur: 6

[Ar] $4s^1$

[Ne] $3s^2 3p^4$

4. Which of the following orbitals has the most total nodes?

C

$n-1$

A. 1s
B. 3d
C. 4s
D. 2p

1s = 0 nodes

3d = 2 nodes

4s = 3 nodes

2p = 1 node

5. Which of the following does **not** have the element paired with its correct ground state electron configuration?

D

A. As: $[Ar]4s^2 3d^{10} 4p^3$

B. Re: $[Xe]6s^2 4f^{14} 5d^5$

C. S: $[Ne]3s^2 3p^4$

D. Y: $[Kr]5s^2 5d^1$ (4)

E. All of the elements above are paired with the correct ground state electron configuration