Recitation Worksheet Nine

Name: Key UGA ID:

Textbook:
Chemistry & Chemical Reactivity
by John C. Kotz, Paul M. Treichel, John R. Townsend, David Treichel
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Instructions:

- This recitation worksheet covers Ch. 6.6-6.7, 7.1-7.4.
- 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: Dr. Seivert's MyID is mds73312). **Do not use your 81x number**.
- Your completed worksheet has to be submitted to **Gradescope**. You have multiple options for submission:
  - You may use an app to annotate the worksheet by placing your answers in the answer boxes and showing your work when appropriate. Afterward, submit the worksheet to Gradescope. You will not need to upload anything to eLC.
  - You may print out the worksheet, write your answers in the answer boxes, and show your work on it when appropriate. Afterward, convert the worksheet to a PDF and submit to Gradescope. You will not need to upload anything to eLC.
  - If you do not have access to a printer, you may type your answers directly into the worksheet PDF and then submit it to Gradescope. Write your work on separate sheets of paper, convert them to a PDF, and upload to the appropriate dropbox on eLC.
  - There is a Gradescope app available for both iOS and Android devices that allows you to scan and submit your printed work, or you can submit your fillable PDF directly.
- The following criteria **must** be met to be eligible for full credit:
  - You must make sure the pages are in the correct order and have the same layout as the original worksheet when submitting to Gradescope regardless of your submission type.
  - Answers must be written in the corresponding answer boxes.
  - You must show your work when appropriate.
- This worksheet is due no later than **9:00 AM on the Saturday of the recitation week.**
- A periodic table and formula sheet are attached to the end of this worksheet. Please keep these attached to your worksheet in the correct order when submitting to Gradescope.

1. Which of the following are **not** a valid set of quantum numbers? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

C D

A. (114, 3, -3, ½)
B. (1, 0, 0, -½)
C. (2, 2, 2, -½)
D. (2, 1, 1, 1)
E. (4, 2, 0, ½)

2. Which set of quantum numbers describes the highest energy orbital (assume you are dealing with a multi-electron atom unless specified otherwise)?

D

A. (2, 1, 0, ½) 2p
B. (1, 0, 0, ½) 1s
C. (2, 0, 0, -½) 2s
D. (3, 2, 1, ½) 3d
E. (3, 1, -1, -½) 3p

3. Which of the following sets of quantum numbers are **both** valid and degenerate (for all questions about degeneracy, assume you are dealing with a multi-electron atom unless specified otherwise)? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

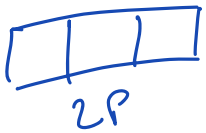
AE

A. (3, 1, 0, ½) 3p
B. (1, 0, 0, -½) 1s
C. (2, 1, 0, 1) → not valid
D. (2, 0, 0, ½) 2s
E. (3, 1, -1, -½) 3p
F. (1, 2, 0, ½) → not valid
G. (2, 1, -1, ½) 2p
H. (3, 0, 0, -½) 3s

4. What is the maximum number of *orbitals* that can be found in the 2p subshell? Answer by using an integer (e.g. 0, 1, etc.).

↳ p → $\ell = 1$

3



orbitals $= 2\ell + 1$
$= 2(1) + 1$
$= 3$

5. What is the maximum number of *electrons* that can be found in the 5d subshell? Answer by using an integer (e.g. 0, 1, etc.).

10

6. Which of the following orbitals has the most total number of nodes?

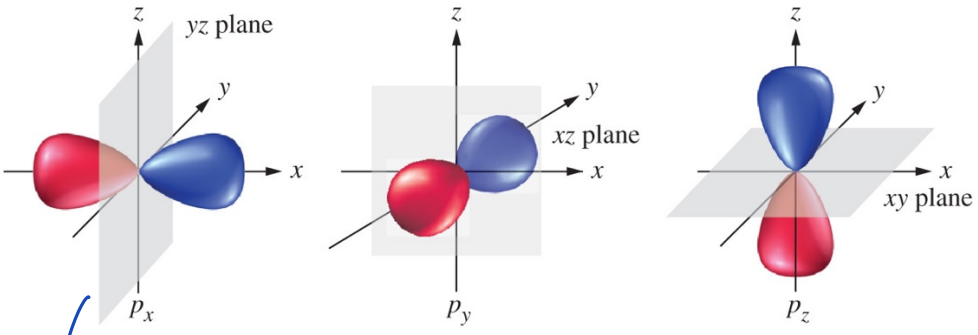
E

nodes $= n - 1$

A. 6s
B. 6p
C. 6d
D. 6f
E. All of these orbitals have the same number of nodes

$n = 6 \rightarrow 5$ nodes

Answer questions 7-9 using the images of the orbitals given below.



↳ node

7. How many total nodes are present in the p_z orbital above? Answer by using an integer (e.g. 0, 1, etc.).

1

8. Which of the following quantum number sets below is **both** valid and may represent any of the three orbitals above? 2P orbitals above

H

A. (2, 1, 2, ½) not valid
B. (3, 2, 0, -½) 3d
C. (4, 1, -1, 1) not valid
D. (5, 1, 0, -½) 5P
E. (1, 1, -1, ½) not valid
F. (3, 0, 0, ½) 3S
G. (4, 1, -2, ½) not valid
H. (2, 1, 0, ½) 2P

9. How many values of (a) n, (b) ℓ, (c) m_ℓ, and (d) m_s are possible in the p_y orbital shown above? Answer by using integers (e.g. 0, 1, etc.).

↳ 2 P_y

(a) | 1 | n = 2 (one value)

(c) | 1 |

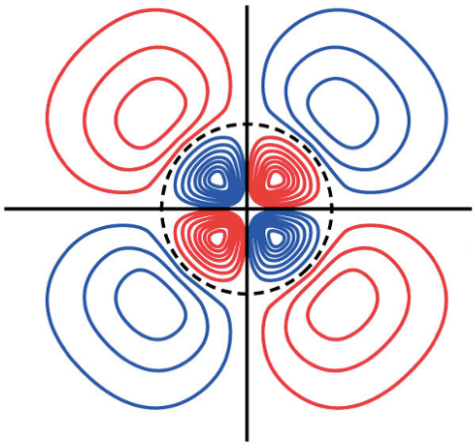
↳ one orientation (P_y)

(b) | 1 | ℓ = 1 (one value)

(d) | 2 |

↳ m_s = +/- 1/2

A 2D illustration of a d orbital is provided below where the nodes are shown using both straight and dashed lines. Answer questions 10-12 using this illustration.



10. How many total nodes are present in this orbital? Answer by using an integer (e.g. 0, 1, etc.).

3

11. Which of the following designations given below correspond to this orbital?

D

$n - l$ = nodes

$n - l = 3$

$n = 4$

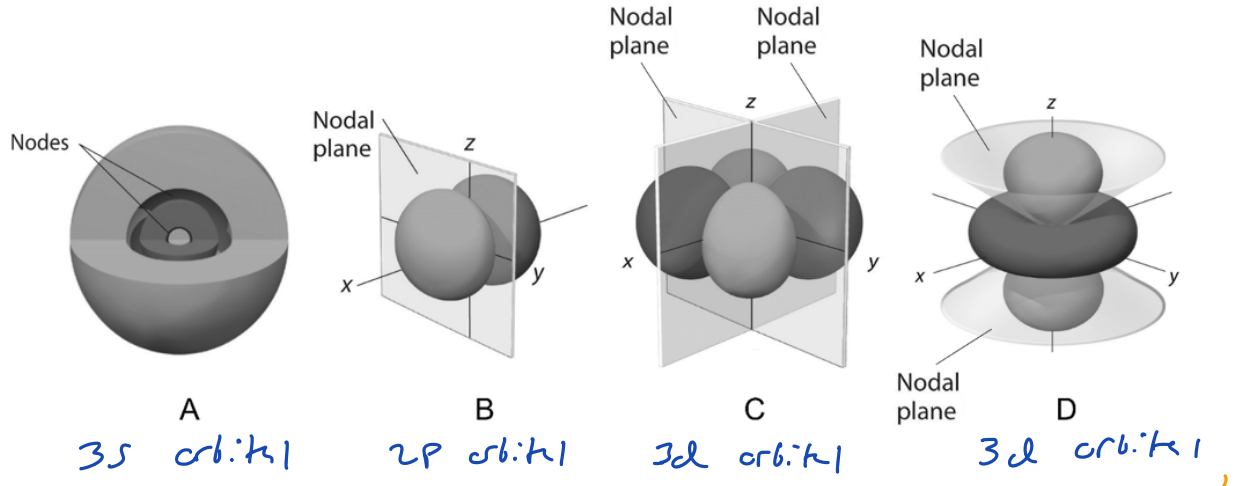
A. 1d
B. 2d
C. 3d
D. 4d
E. 5d
F. 6d
G. More information is needed

12. What is the maximum number of electrons that can occupy this orbital? Answer by using an integer (e.g. 0, 1, etc.).

2

orbitals may only hold a max of 2 electrons

13. 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

degenerate

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

14. 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

15. Which of the following best describes the noble gas electron configuration of the ground state of cobalt?

D

A. [Ar] $4s^2 4d^7$

B. [Ar] $4s^1 4d^8$

C. [Ar] $4d^9$

D. [Ar] $4s^2 3d^7$

E. [Ar] $4s^1 3d^8$

16. Which of the following element and ground state electron configuration (either full or noble gas configuration) pairs below are **incorrect**? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

BCDE

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: $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^4$ → exception!

E. W: [Xe] $6s^2 5d^4$ → missing $4f^{14}$

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

→ exception!

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

18. Which of the following represents an excited state electron configuration of Sn? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

C

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

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

19. Which of the following represents an excited state electron configuration of Ni? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

ABC

ground state: $[Ar]\ 4s^2 3d^8$

A. $[Ar]4s^2 3d^7 8d^1$

B. $[Ar]4s^1 3d^9$

C. $[Ar]4s^1 3d^8 4p^1$

D. $[Ar]4s^2 3d^9$ → extra e^-

E. $[Ar]4s^2 3d^8 4p^1$

20. What ion is roetgenium (Rg) likely to make, if it follows the same filling pattern as the rest of its group? Answer with an integer and sign (e.g. +4, -2).

+1

Expected: $[Rn]\ 7s^1 5f^{14} 6d^{10}$

↳ if treated like one of the exceptions (Au, Cu, etc.)

↳ will lose 7s e^- first, so +1 charge predicted

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

E

O atom → $1s^2 2s^2 2p^4$

O^{2-} ion → $1s^2 2s^2 2p^6$

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

22. Which of the following does *not* correctly have the element matched to a probable charge it would have when forming an ion?

E

Zn → $[Ar] 4s^2 3d^{10}$

Zn^{2+} → $[Ar] 3d^{10}$

Se → $[Ar] 4s^2 3d^{10} 4p^4$

Se^{2-} → $[Ar] 4s^2 3d^{10} 4p^6$ or $[Kr]$

A. Zn: 2+
B. Au: 1+
C. Pb: 4+
D. Se: 2-
E. V: 3+

Au → $[Xe] 6s^1 4f^{14} 5d^{10}$

Au^+ → $[Xe] 4f^{14} 5d^{10}$

V → $[Ar] 4s^2 3d^3$

V^{2+} → $[Ar] 3d^3$

↳ 2+ more probable, or 5+

Pb → $[Xe] 6s^2 4f^{14} 5d^{10} 6p^2$

Pb^{4+} → $[Xe] 4f^{14} 5d^{10}$

23. What ion does the ground state electron configuration [Ar] $3d^2$ belong to? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

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+}: $[Ar]$

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

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

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

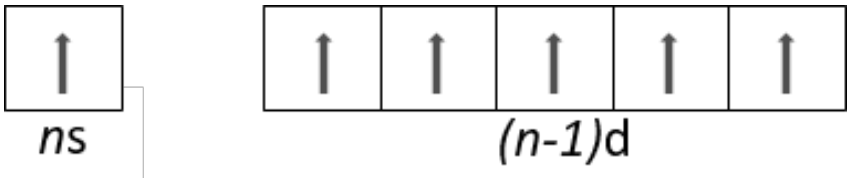
Cr: $[Ar] 4s^1 3d^5$ (exception)

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

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

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

24. Consider the following orbital diagram of valence electrons of certain d block elements. Which element(s) has/have the ground state electron configuration shown below? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).



BE

Cr: $4s^1 3d^5$

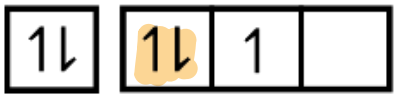
Mo: $5s^1 4d^5$

exceptions:

A. Mn
B. Cr
C. Fe
D. Tc
E. Mo

25. Which of the following orbital diagrams represents a violation of *two* filling rules?

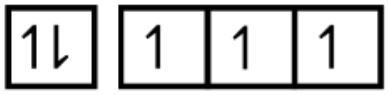
B

A. 

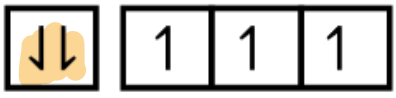
Hund's Rule violation

B. 

Hund's Rule violation
Pauli Exclusion violation

C. 

No violations

D. 

Pauli Exclusion violation

26. How many core electrons are in the elements below? Answer by using integers (e.g. 0, 1, etc.).

(a) Silicon: 10

(4 valence e's)

(b) Fluorine: 2

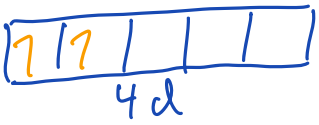
(7 valence e's)

27. How many unpaired electrons are in the following ions below? Answer by using integers (e.g. 0, 1, etc.).

(a) Mo^{4+}: 2

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

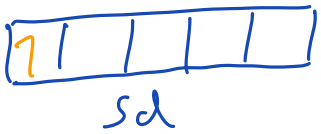
$Mo^{4+}: [Kr]\,4d^2$



(b) Ta^{4+}: 1

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

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



28. Which of the following ions below is paramagnetic?

D

A. Sc^{3+}

B. Zn^{2+}

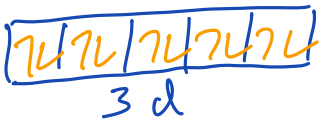
C. Zr^{4+}

D. V^{3+}

E. All of the options given are diamagnetic

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

$Zn^{2+}: [Ar]\,3d^{10}$



$Zr^{4+}: [Kr]$

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

2 unpaired e⁻s

29. Which of the following electrons will have the **lowest** energy in a gold atom?

E

A. (4, 1, -1, ½) 4p
B. (5, 0, 0, -½) 5s
C. (4, 2, 1, ½) 4d
D. (5, 1, 0, ½) 5p
E. (4, 0, 0, -½) 4s

(all valid)

Extra Practice Questions: these questions will not be graded.

1. Which of the following are an **invalid** set of quantum numbers? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

A B D

A. (3, 0, -1, -½)
B. (-1, 1, 0, ½)
C. (15, 2, 1, ½)
D. (6, 0, 0, 2)
E. (5, 1, -1, ½)

2. Which of the following is/are a valid set of quantum numbers? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

D E

A. (2, 1, -2, ½)
B. (3, 0, -1, -½)
C. (3, 0, 0, 0)
D. (2, 1, 0, ½)
E. (2, 1, -1, -½)

3. Which of the following sets of quantum numbers are **both** valid and degenerate (for all questions about degeneracy, assume you are dealing with a multi-electron atom unless specified otherwise)? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

D E

A. (2, 1, -2, ½) → not valid
B. (3, 0, -1, -½) → not valid
C. (3, 0, 0, ½) 3s
D. (2, 1, 0, ½) 2p
E. (2, 1, -1, -½) 2p

4. Which of the following are **not** a valid set of quantum numbers? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

ACF

A. (0, -1, 2, ½)
B. (7, 5, -4, -½)
C. (3, 2, -3, -½)
D. (4, 2, 1, ½)
E. (18, 2, -1, ½)
F. (1, 0, 0, 1)

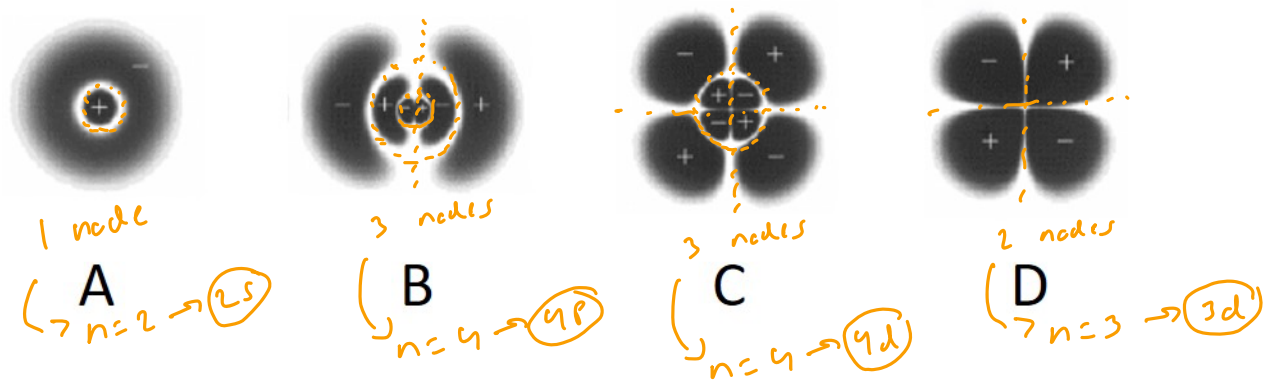
5. Which statement is true about degenerate orbitals in a multi-electron system?

D

A. All orbitals with the same m_s value are degenerate.
B. All orbitals with the same l value are degenerate.
C. All orbitals with the same n value are degenerate.
D. None of the above are true

n and l must be the same

6. Which of the following orbitals would be **highest** in energy?



C

7. What is the ground-state electron configuration for scandium?

D

A. $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3$
B. $1s^2 1p^6 2s^2 2p^6 3d^5$
C. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 4p^1$
D. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^1$
E. $1s^2 2s^2 2p^6 2d^{10} 3s^1$

8. Consider the electron configuration for an element written below. Which of the following statements are true? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

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

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

9. Following the removal of an element's fourth valence electron, the ion's electron configuration is $[Xe]4f^{14}5d^3$. What is the element's atomic symbol?

B

loses two 6s e⁻s
loses two 5d e⁻s

A. W
B. Re → ground → $[Xe]\ 6s^2\ 4f^{14}\ 5d^5$
C. Os
D. Ir

10. How many valence electrons are in the elements below? Answer by using integers (e.g. 0, 1, etc.).

(a) Potassium: [1]

(b) Sulfur: [6]

[Ar] $4s^1$

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

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

[C]

n - l

1s = 0 nodes

3d = 2 nodes

4s = 3 nodes

2p = 1 node

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

12. 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

13. Which of the following **does not** have the correct electron configuration matched to the element in its ground state? Select any that apply and answer using capital letters with no spaces (e.g. ABCDE).

BD

A. Pb: [Xe] $6s^2 4f^{14} 5d^{10} 6p^2$

B. Sn: [Xe] $5s^2 4f^{14} 4d^{10} 5p^2$

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

D. Te: [Kr] $5s^2 5d^{10} 5p^4$

E. Hg: [Xe] $6s^2 4f^{14} 5d^{10}$

14. What is the condensed electron configuration of cadmium(IV) in the ground state?

A

Cd: [Kr] $5s^2 4d^{10}$

Cd^{2+}: [Kr] $4d^{10}$

Cd^{4+}: [Kr] $4d^8$

A. [Kr] $4d^8$

B. [Kr] $5s^2 4d^6$

C. [Kr] $5s^2 5d^6$

D. [Kr] $5d^8$

E. [Xe] $4d^8$

15. How many unpaired electrons are in the following ions below? Answer by using integers (e.g. 0, 1, etc.).

(a) Cr^{3+}: 3

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

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

(b) Ni^{2+}: 2

Ni: [Ar] $4s^2 3d^8$

Ni^{2+}: [Ar] $3d^8$

16. Which of the following options has the highest number of unpaired electrons?

D

A. Ti^{4+}
B. Al
C. O
D. N
E. Se^{2-}

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

Ti^{4+}: $[Ar]$ (0 unpaired e^-s)

Al: $[Ne]\,3s^2\,3p^1$ (1 unpaired e^-s)

O: $[He]\,2s^2\,2p^4$ (2 unpaired e^-s)

N: $[He]\,2s^2\,2p^3$ (3 unpaired e^-s)

Se: $[Ar]\,4s^2\,3d^{10}\,4p^4$

Se^{2-}: $[Ar]\,4s^2\,3d^{10}\,4p^6$ (0 unpaired e^-s)

17. How many electrons can occupy the orbitals that correspond to n = 3? Answer by using an integer (e.g. 0, 1, etc.).

18

$n = 3 \rightarrow 3s, 3p, 3d$

3s 

3p 

3d 

Periodic Table of the Elements

1																	18
1 H 1.01	2											13	14	15	16	17	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	3	4	5	6	7	8	9	10	11	12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.63	33 As 74.92	34 Se 78.97	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.95	43 Tc [97]	44 Ru 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29
37 Cs 132.91	56 Ba 137.33		72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	81 Tl 204.38	82 Pb 207.2	83 Bi 208.98	84 Po [209]	85 At [210]	86 Rn [222]
87 Fr [223]	88 Ra [226]		104 Rf [267]	105 Db [268]	106 Sg [269]	107 Bh [270]	108 Hs [269]	109 Mt [277]	110 Ds [281]	111 Rg [282]	112 Cn [285]	113 Nh [286]	114 Fl [290]	115 Mc [290]	116 Lv [293]	117 Ts [294]	118 Og [294]

57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm [145]	62 Sm 150.36	63 Eu 151.96	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.05	71 Lu 174.97
89 Ac [227]	90 Th 232.04	91 Pa 231.04	92 U 238.03	93 Np [237]	94 Pu [244]	95 Am [243]	96 Cm [247]	97 Bk [247]	98 Cf [251]	99 Es [252]	100 Fm [257]	101 Md [258]	102 No [259]	103 Lr [262]

Formula Sheet

Length
1 kilometer = 0.62137 mile
1 inch = 2.54 centimeters (exactly)
1 Ångstrom = 1×10^{-10} meter

Energy
1 joule = 1 kg·m^2/s^2
1 calorie = 4.184 joules
1 Calorie = 1 kilocalorie = 1000 calories
1 L·atm = 101.325 joules

Pressure
1 pascal = 1 N/m^3 = 1 kg/m·s^2
1 atmosphere = 101.325 kilopascals = 760 mm Hg = 760 torr = 14.70 lb/in^2
1 bar = 1×10^5 Pa (exactly)

Temperature
0 K = −273.15°C
K = °C + 273.15
°C = (5/9)(°F − 32)

Mass
1 kg = 2.205 lbs

Volume
1 mL = 1 cm^3 = 1 cc

Constants
c = 2.998×10^8 m/sec
h = 6.626×10^{-34} J·sec
R = 0.08206 L·atm/mol·K = 8.314 J/mol·K
Specific heat of water = 4.184 J/g·K
Mass of an electron: 9.109 x 10^{-31} kg
Mass of a proton: 1.673 x 10^{-27} kg
RH = 2.18 x 10^{-18} J
Specific heat of water = 4.184 J/g·K
Avogadro's number: 6.022×10^{23}
F = 96485 J/(V·mol e$^-$)
$K_w = 1.0 \times 10^{-14}$ at 25 °C
$k_b = 1.381 \times 10^{-23}$ J/K

Equations
$(P + a(n^2/V^2))\cdot(V - nb) = nRT$
molar mass (M) = mRT/PV
density (d) = MP/RT

$$KE = \frac{3}{2}RT$$

$$\mu_{rms} = \sqrt{\frac{3RT}{M}}$$

$$\frac{Rate\ of\ effusion\ A}{Rate\ of\ effusion\ B} = \sqrt{\frac{MW_B}{MW_A}}$$

$$\Delta E = -2.18 \times 10^{-18} J(\frac{1}{n_f^2} - \frac{1}{n_i^2})$$

$$\ln\left(\frac{P_2}{P_1}\right) = \frac{\Delta H_{vap}}{R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$$

$C_g = kP_g$
$P_{solution} = P_{solvent}\ X_{solvent}$
$P_{solution} = \sum P_j = \sum P_j X_j$
$\pi = MRTi$

Thermodynamic and Electrochemistry

$S = k_b \times \ln(W)$
$\Delta S = q_{rev}/T$
$\Delta G = \Delta G° + RT \cdot \ln Q$
$R = 8.314$ J/mol.K
$\Delta G° = -RT \cdot \ln K$
$\Delta G = -nFE_{cell}$
$E°_{cell} = RT/nF \ln K$
$E°_{cell} = (0.0257/n) \ln K = (0.0592/n) \log K$
$E_{cell} = E°_{cell} - (RT/nF) \ln Q$
$E_{cell} = E°_{cell} - (0.0257/n) \ln Q$
Electrolysis: Q (total charge) = I × t = n × F

Integrated Rate Laws & half-life

$$\ln\frac{[A]}{[A]_0} = -kt$$

$$\frac{1}{[A]} = kt + \frac{1}{[A]_0}$$

$$[A] = -kt + [A]_0$$

$$t_{1/2} = \frac{[A]_0}{2k}$$

$$t_{1/2} = \frac{\ln 2}{k} = \frac{0.693}{k}$$

$$t_{1/2} = \frac{1}{k[A]_0}$$

$$ln\frac{k_2}{k_1} = -\frac{E_a}{R}(\frac{1}{T_2} - \frac{1}{T_1})$$

Equilibrium and Acid / Base

$K_P = K_c \times (RT)^{\Delta n}$

$$ln\frac{K_2}{K_1} = \frac{\Delta H^\circ_{rxn}}{R}(\frac{1}{T_1} - \frac{1}{T_2})$$