

Name Kenz (print) Name \_\_\_\_\_ (sign)

Please show work for partial credit and full credit on the Long Answers and in some of the Short Answer Questions. Multiple choice questions have no partial credit. Please write anything you want graded legibly. If you run out of space, continue on the empty back pages but clearly label where the remaining answer can be found. (If I can't find your answer or cannot read it, I obviously cannot grade it). Return your entire exam including the periodic table. (Please count your exam pages and make sure there are 8 real pages + periodic table assembly)

It is your responsibility to return the entire exam package (with periodic table assembly inside the rest of the exam) directly into Dr. Hahn's hands. If you do not and the exam disappears or sits around for days NOT in Dr. Hahn's possession, that exam will count as an UNEXCUSED missed exam. NOTE: Even if you accidentally come up with the final correct answer, if your work does not lead to your accidentally correct final answer you may lose all points.

**MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2 pts each, 26 pts total)**

- 1) Which reaction below represents the reaction associated with the first electron affinity of Li? 1) B
- A)  $\text{Li(g)} + e^- \rightarrow \text{Li}^-(\text{g})$
  - B)  $\text{Li(g)} + e^- \rightarrow \text{Li}(\text{g})$
  - C)  $\text{Li(g)} \rightarrow \text{Li}^+(\text{g}) + e^-$
  - D)  $\text{Li}^+(\text{g}) + e^- \rightarrow \text{Li(g)}$
  - E)  $\text{Li}^+(\text{g}) \rightarrow \text{Li(g)} + e^-$

- 2) Which one of the following elements is a transition element? 2) E
- A) barium (Ba)
  - B) antimony (Sb)
  - C) selenium (Se)
  - D) potassium (K)
  - E) chromium (Cr)

- 3) Which of the following is a *basic oxide*? (*metal oxides = basic*) 3) E
- A)  $\text{SO}_2$       B)  $\text{CO}_2$       C)  $\text{NO}_2$       D)  $\text{H}_2\text{O}$        E)  $\text{CaO}$

- 4) Which of the following is a useful guideline for the application of formal charges in neutral molecules? 4) B
- A) Lewis structures with large formal charges (e.g., +2,+3 and/or -2,-3) are preferred.
  - B) A Lewis structure in which there are no formal charges is preferred.
  - C) The preferred Lewis structure is one in which positive formal charges are on the most electronegative atoms.

- 5) Which of the elements listed below is most likely to exhibit an expanded octet in its compounds? 5) D
- A) N      B) C      C) Na       D) S      E) O

elements in period 3 & higher

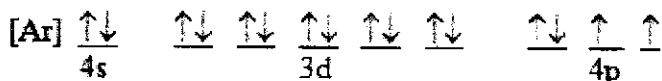
6) Which reaction below represents the reaction associated with the first Ionization Energy of O?

6) B

- A)  $O(g) + e^- \rightarrow O^-(g)$
- B)  $O(g) \rightarrow O^+(g) + e^-$**
- C)  $O(g) \rightarrow O(g) + e^-$
- D)  $O^-(g) + e^- \rightarrow O(g)$
- E)  $O(g) + e^- \rightarrow O^{2-}(g)$

7) Which ground-state atom has an electron configuration described by the following orbital diagram?

7) E



- A) none of these
- B) germanium (Ge)
- C) tellurium (Te)
- D) phosphorus (P)
- E) selenium (Se)**

8) Arrange the following bonds in order of increasing ionic character:

8) A

- C—F
- O—F
- H—F
- Na—F

most ionic opposite side of periodic table

least ionic - close together in periodic table

- A)  $O—F < C—F < H—F < Na—F$**
- B)  $C—F < O—F < H—F < Na—F$
- C)  $H—F < C—F < O—F < Na—F$
- D)  $Na—F < H—F < C—F < O—F$
- E)  $C—F < H—F < O—F < Na—F$

9) Transition metal elements have atoms or ions with partially filled

9) A

- A) d subshells.**
- B) p subshells.
- C) g subshells.
- D) s subshells.
- E) f subshells.

10) Define electronegativity:

10) D

- A) an atoms ability to form double and triple bonds
- B) an atoms ability to donate valence electrons to another atom
- C) an atoms ability to form a cation
- D) an atoms ability to attract electrons that are shared in a chemical bond**
- E) an atoms ability to form an ionic bond with another atom

11) How many electrons does a sulfur atom need to fill its outermost s and p subshells? 11) D  
A) 1                      B) 8                      C) 6                      D) 2                      E) 4

12) What is the total number of electrons possible in the 2p orbitals? to get octet 12) C  
A) Since it depends on the particular atom that has the 2p orbital this cannot be answered without more information.  
B) None of the above

C) 6 ——— p has  $\uparrow\downarrow \uparrow\downarrow \uparrow\downarrow$  3 orbitals with 2 e<sup>-</sup>  
D) 10  
E) 3  
 $p_x \ p_y \ p_z$  in each orbital

13) Which ion is isoelectronic with Ar? 13) D  
A) ~~Ga<sup>3+</sup>~~                      B) F<sup>-</sup>                      C) Fe<sup>2+</sup>                      D) Ca<sup>2+</sup>                      E) Br<sup>-</sup>

In<sup>3+</sup>  
↓  
[Kr]

|  
[Ne]

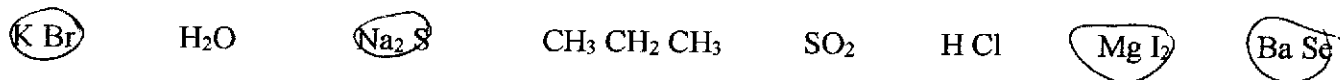
|  
not  
to  
Noble  
gas

[Ar]                      [Kr]

Same e<sup>-</sup> configuration

**Part II: Short Answers** (43 pts) Show work on all questions for partial and full credit even on questions which do not specify. If you do not show work, you will lose points for no work. If you accidentally come up with the final correct answer

1 Given the following compounds, circle all which are ionic compounds. (8 pts)



2. Ionic Bonding (8 pts)

a. Show Lewis dot symbols for the following elements as individual elements. **K** and **Cl** (4 pts)



b. Show the Lewis dot symbol representation for the ionic bond formed between the two elements above by showing the Lewis Dot structure (symbol) of the bonded atoms. (4 pts)



3. Label each of the following as (4 pts)

(a) ionic bonding (b) polar covalent bonding (c) non polar covalent bonding. (letters may be used once, many times or not at all)

If you circle the bonding as ionic or polar covalent, show either full (+ or -) or partial charges (next to the atoms with the full or partial charge. (use a partial charge for the polar covalent and the full charge for the ionic bonding)



3. In each letter circle one of 2 choices (5 pts, 1 pt each)

(a) larger size [(F) or (I)]

(b) higher ionization energy: [(F) or (I)]

(c) higher electronegativity [(Si) or (Cl)]

(d) larger size [(Mg<sup>2+</sup>) or (Mg)]

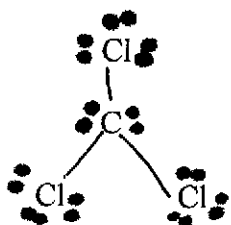
(e) larger size [(S<sup>2-</sup>) or (S)]

4. Are the following Lewis Dot structure allowed? Some of the given structures are absolutely correct. Some of the given structures are absolutely not allowed and impossible (quantum mechanically not allowed). Explain briefly matching one of the following words and using a few of your own words in explanation under each given Lewis Dot structure. (6 pts, 1 pt each)

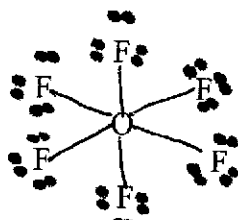
(a) less than octet

(b) more than octet, expanded octet

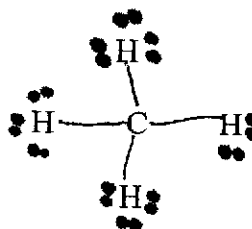
(c) more than duet



[(a) or (b) or (c)]  
(circle one)



[(a) or (b) or (c)]  
(circle one)



[(a) or (b) or (c)]  
(circle one)

Explanation

not allowed

2nd period  
cannot  
expand  
octet

not allowed

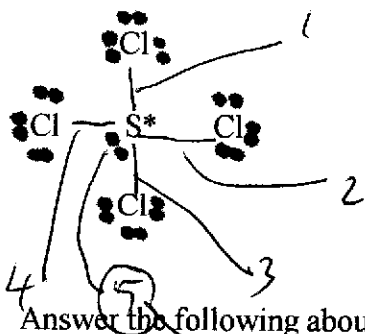
2nd period  
cannot  
expand octet

H with not allowed

octet, duet  
only allowed

6. Given the following Lewis Dot structure, complete the following VSEPR questions.

VSEPR Problem: Answer the following for the following correct Lewis Dot structure at the atom with the \* (12 pts total, 2 pt each)



Answer the following about the atom with the \* in the correct Lewis Dot Structure shown above.

What is the VSEPR # electron pairs ("electron domains") at the atom with the \* 5

How many lone pair does the atom with the \* have? 1 (S is lone pair)

What is the VSEPR geometry of electron pairs? trigonal bipyramidal

What is the VSEPR geometry of the molecule? see saw

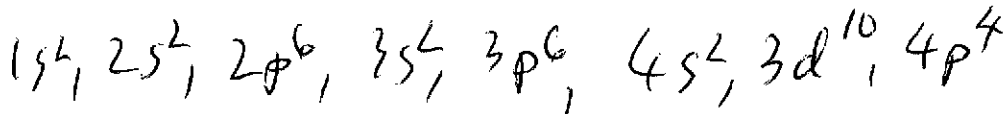
What is the bond angle between Cl—S—Cl? 90°, 120°

What is the hybridization of the atom with the \*? sp<sup>3</sup>d

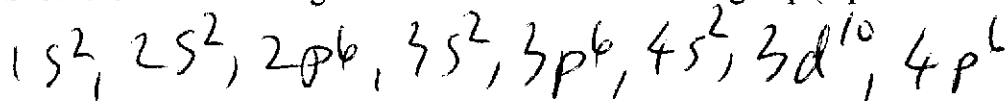
**Part III: Long Answers** (31 pts) Show work on all questions for partial and full credit even on questions which do not specify.

1. Electron Configuration: (16 pts total)

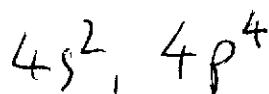
a. Show the electron configuration for the main group (representative element) element Se (4 pts)



b. Show the electron configuration for the ion for the main group (representative element) Se<sup>-2</sup> (2 pts)



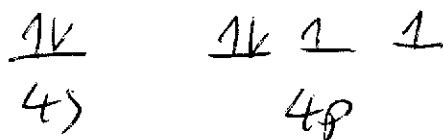
c. Show electron configuration for the valence electrons for the element Se (2 pts)



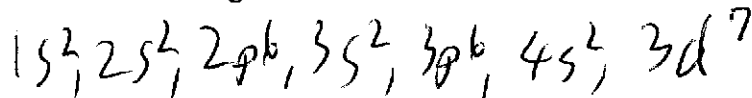
-2 added  
p

d. Give the valence electron configuration diagram for the element Se showing a line for an orbital and up and down arrows for the +1/2 and -1/2 electrons (3 pts)

(format required:  $\begin{array}{c} \uparrow \downarrow \\ 1s \end{array} \begin{array}{c} \uparrow \\ 2s \end{array} \begin{array}{c} \underline{\quad} \quad \underline{\quad} \quad \underline{\quad} \\ 2p \end{array} \dots$ ) (format is not necessarily the answer)

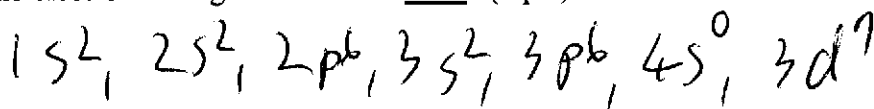


e. Show the electron configuration for the transition metal element Co in the format (1s<sup>2</sup> 2s<sup>2</sup> etc.) (4 pts)



+2 lose e  
lose highest energy e

f. Give the electron configuration of the Co<sup>+2</sup> (2 pts)



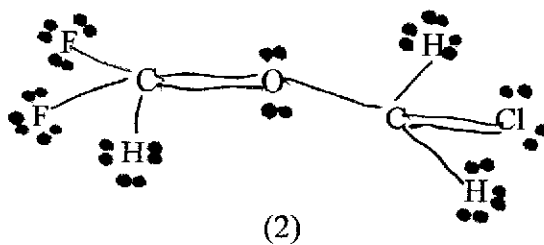
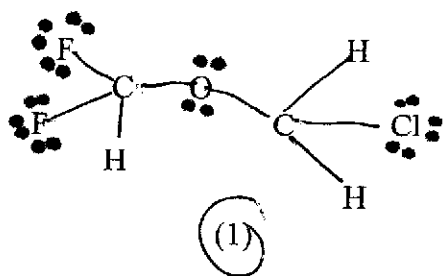
transition metals lose s e before d

2. For the following give the Lewis Dot structure by: (15 pts total)

(a) Show work for valence electron count for the molecule  $C_2O F_2 Cl H_3$  (6 pts)

$$\begin{array}{cccccc} C & O & F & Cl & H & \\ 2(4e) + & 6e + & 2(7e) + & 7e + & 3(1) = & 38 \end{array}$$

(b) Given the following choices circle the number under the correct Lewis Dot structure. (2 pts)



(c) Show your electron count for the Lewis Dot structures above and explain how the electron count effected your choice of correct Lewis Dot structure. (4 pts)

Electron count for structure (1) (show number of electrons pairs and the electron count)

$$19 \times 2 = 38e \text{ matches \# valence } e$$

Electron count for structure (2) (show number of electron pairs and the electron count)

$$29 \times 2 = 58e \text{ too many } e \text{ in trial structure}$$

(d) Explain one thing wrong with the Lewis Dot structure which you chose as incorrect (other than electron count) (3 pt)

OH - more than 8e

② C, O with more than octet - not allowed  
2nd period + lower - no d available



Name Keyz (print) Name \_\_\_\_\_ (sign)

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**MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2 pts each, 26 pts total)**

- 1) Which one of the following elements is a transition element? 1) C
- A) barium (Ba)  
 B) antimony (Sb)  
 C) chromium (Cr)  
 D) selenium (Se)  
 E) potassium (K)

- 2) Which of the following is a *basic oxide*? 2) D
- A) H<sub>2</sub>O      B) NO<sub>2</sub>      C) SO<sub>2</sub>       D) CaO      E) CO<sub>2</sub>

- 3) How many electrons does a sulfur atom need to fill its outermost s and p subshells? 3) A
- A) 2      B) 6      C) 8      D) 4      E) 1

- 4) Which ion is *isoelectronic* with Ar? 4) A
- A) Ca<sup>2+</sup>      B) ~~Ga<sup>3+</sup>~~ <sup>In<sup>3+</sup></sup>      C) F<sup>-</sup>      D) Br<sup>-</sup>      E) Fe<sup>2+</sup>

- 5) Arrange the following bonds in order of increasing *ionic character*: 5) A

C — F  
 O — F  
 H — F  
 Na — F

- A) O — F < C — F < H — F < Na — F  
 B) C — F < H — F < O — F < Na — F  
 C) Na — F < H — F < C — F < O — F  
 D) C — F < O — F < H — F < Na — F  
 E) H — F < C — F < O — F < Na — F

- 6) Which reaction below represents the reaction associated with the first ionization Energy of O? 6) C
- A)  $O(g) + e^- \rightarrow O^-(g)$   
 B)  $O^-(g) + e^- \rightarrow O(g)$   
 C)  $O(g) \rightarrow O^+(g) + e^-$   
 D)  $O(g) + e^- \rightarrow O^{2-}(g)$   
 E)  $O^-(g) \rightarrow O(g) + e^-$
- 7) Which reaction below represents the reaction associated with the first electron affinity of Li? 7) E
- A)  $Li^+(g) + e^- \rightarrow Li(g)$   
 B)  $Li(g) \rightarrow Li^+(g) + e^-$   
 C)  $Li^+(g) \rightarrow Li(g) + e^-$   
 D)  $Li(g) + e^- \rightarrow Li^-(g)$   
 E)  $Li(g) + e^- \rightarrow Li^-(g)$
- 8) Define *electronegativity*: 8) C
- A) an atoms ability to form a cation  
 B) an atoms ability to donate valence electrons to another atom  
 C) an atoms ability to attract electrons that are shared in a chemical bond  
 D) an atoms ability to form double and triple bonds  
 E) an atoms ability to form an ionic bond with another atom
- 9) Transition metal elements have atoms or ions with partially filled 9) E
- A) *p* subshells.  
 B) *f* subshells.  
 C) *g* subshells.  
 D) *s* subshells.  
 E) *d* subshells.
- 10) What is the total number of electrons possible in the 2*p* orbitals? 10) C
- A) None of the above  
 B) 10  
 C) 6  
 D) 3  
 E) Since it depends on the particular atom that has the 2*p* orbital this cannot be answered without more information.
- 11) Which ground-state atom has an electron configuration described by the following orbital diagram? 11) A
- $[Ar] \begin{array}{ccccccccc} \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow\downarrow & \uparrow & \uparrow \\ \underline{4s} & & & \underline{3d} & & & & \underline{4p} & \end{array}$
- A) selenium (Se)  
 B) tellurium (Te)  
 C) none of these  
 D) phosphorus (P)  
 E) germanium (Ge)

- 12) Which of the following is a useful guideline for the application of formal charges in neutral molecules? 12) B
- A) Lewis structures with large formal charges (e.g., +2,+3 and/or -2,-3) are preferred.
  - B) A Lewis structure in which there are no formal charges is preferred.
  - C) The preferred Lewis structure is one in which positive formal charges are on the most electronegative atoms.
- 13) Which of the elements listed below is most likely to exhibit an expanded octet in its compounds? 13) D
- A) Na                      B) O                      C) C                       D) S                      E) N

**Part II: Short Answers** (43 pts) Show work on all questions for partial and full credit even on questions which do not specify. If you do not show work, you will lose points for no work. If you accidentally come up with the final correct answer

1 Given the following compounds, circle all which are covalent compounds. (8 pts)

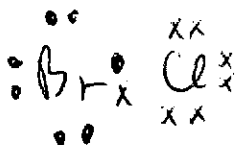


2. Covalent Bonding (8 pts)

a. Show Lewis dot symbols for the following elements as individual elements. **Br** and **Cl** (4 pts)



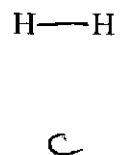
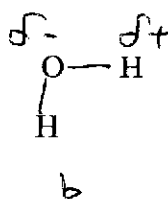
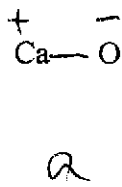
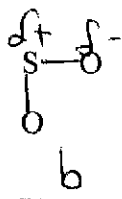
b. Show the Lewis dot symbol representation for the covalent bond formed between the two elements above by showing the Lewis Dot structure (symbol) of the bonded atoms. (4 pts)



3. Label each of the following as: (4 pts)

(a) ionic bonding    (b) polar covalent bonding    (c) non polar covalent bonding. (letters may be used once, many times or not at all)

If your circle the bonding as ionic or polar covalent, show either full (+ or -) or partial charges (next to the atoms with the full or partial charge. (use a partial charge for the polar covalent and the full charge for the ionic bonding)



3. In each letter circle one of 2 choices (5 pts, 1 pt each)

(a) larger size [(B) or (O)]

(b) higher ionization energy: [(B) or (O)]

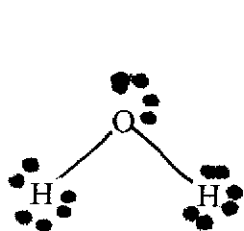
(c) higher electronegativity [(N) or (As)]

(d) larger size [(Fe) or (Fe<sup>3+</sup>)]

(e) larger size [(N) or (N<sup>3-</sup>)]

4. Are the following Lewis Dot structure allowed? Some of the given structures are absolutely correct. Some of the given structures are absolutely not allowed and impossible (quantum mechanically not allowed). Explain briefly matching one of the following words and using a few of your own words in explanation under each given Lewis Dot structure. (6 pts, 1 pt each)

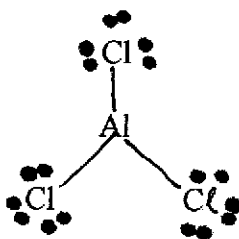
(a) Less than octet (b) more than octet, expanded octet (c) more than duet



[(a) or (b) or (c)]  
(circle one)

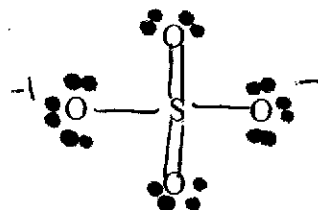
Explanation

It only can  
do duet  
not allowed



[(a) or (b) or (c)]  
(circle one)

allowed  
3rd group  
of ten does  
have less  
than octet

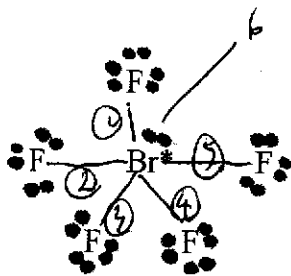


[(a) or (b) or (c)]  
(circle one)

period 3+  
higher  
allowed  
expand  
octet  
(s has 12e)

6. Given the following Lewis Dot structure, complete the following VSEPR questions.

VSEPR Problem: Answer the following for the following correct Lewis Dot structure at the atom with the \* (12 pts total, 2 pt each)



Answer the following about the atom with the \* in the correct Lewis Dot Structure shown above.

What is the VSEPR # electron pairs ("electron domains") 6  
at the atom with the \*

How many lone pair does the atom with the \* have? 1

What is the VSEPR geometry of electron pairs? Octahedral

What is the VSEPR geometry of the molecule? square pyramidal

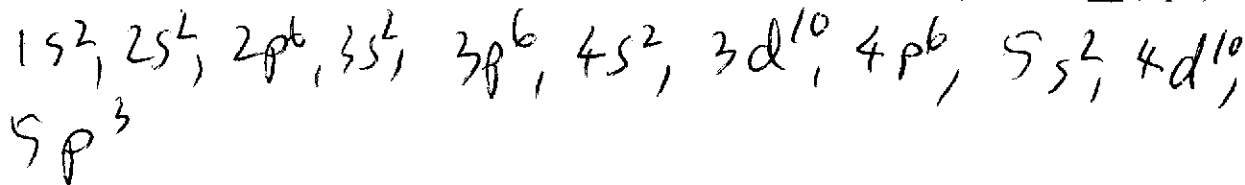
What is the bond angle between F—Br—F? 90°

What is the hybridization of the atom with the \*? sp<sup>3</sup>d<sup>2</sup>

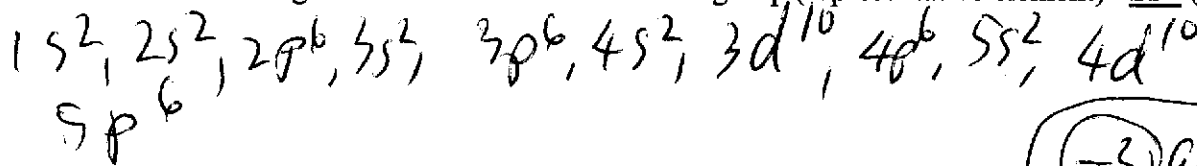
**Part III: Long Answers** (31 pts) Show work on all questions for partial and full credit even on questions which do not specify.

1. Electron Configuration: (16 pts total)

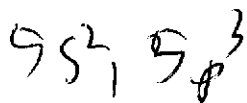
a. Show the electron configuration for the main group (representative element) element **Sb** (4 pts)



b. Show the electron configuration for the ion for the main group (representative element) **Sb<sup>3-</sup>** (2 pts)



c. Show electron configuration for the valence electrons for the element **Sb** (2 pts)



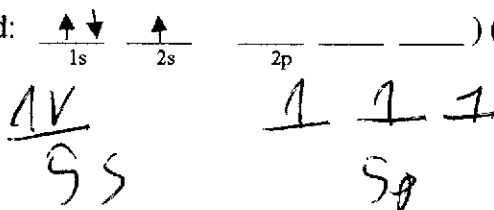
highest period #

-3 add 3e

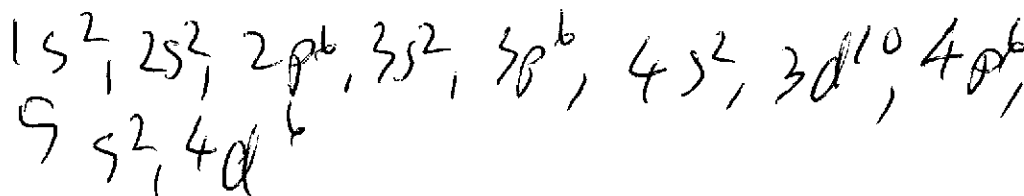
to highest energy orbitals

d. Give the valence electron configuration diagram for the element **Sb** showing a line for an orbital and up and down arrows for the +1/2 and -1/2 electrons (3 pts)

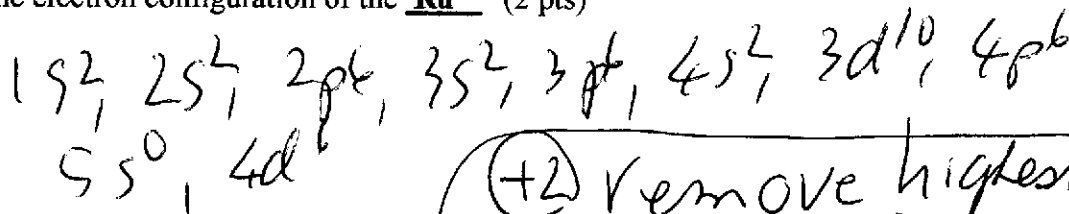
(format required:  $\uparrow \downarrow$   $\uparrow$   $\underline{\hspace{1cm}}$   $\underline{\hspace{1cm}}$  ) (format is not necessarily the answer)



e. Show the electron configuration for the transition metal element **Ru** in the format (1s<sup>2</sup> 2s<sup>2</sup> etc.) (4 pts)



f. Give the electron configuration of the **Ru<sup>+2</sup>** (2 pts)



transition metal

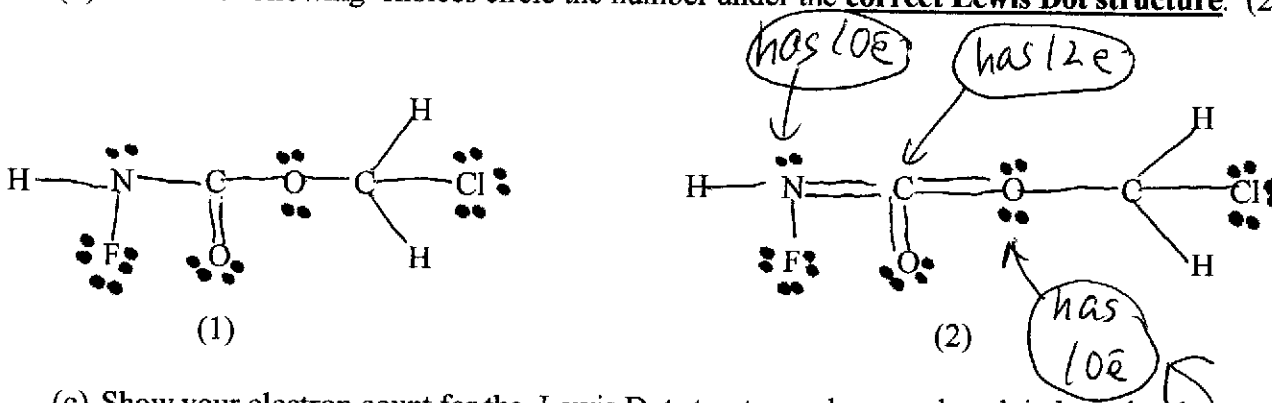
+2 Remove highest energy e from s before d for

2. For the following give the Lewis Dot structure by: (15 pts total)

(a) Show work for valence electron count for the molecule  $C_2 N Cl F O_2 H_3$  (6 pts)

$$\begin{array}{cccccc} C & N & Cl & F & O & H \\ 2(4e) & + & (5e) & + & (7e) & + & (7e) & + & 2(6e) & + & 3(1e) & = & 42e \end{array}$$

(b) Given the following choices circle the number under the **correct Lewis Dot structure**. (2 pts)



(c) Show your electron count for the Lewis Dot structures above and explain how the electron count effected your choice of correct Lewis Dot structure. (4 pts)

Electron count for structure (1) (show number of electrons pairs and the electron count)

$$21 \times 2 = 42e \quad \text{molecule \#} \\ \text{valence } e$$

Electron count for structure (2) (show number of electron pairs and the electron count)

$$23 \times 2 = 46e \quad \text{too many } e$$

(d) Explain one thing wrong with the Lewis Dot structure which you chose as incorrect (other than electron count) (3 pt)

① N, C, O have expanded octet quantum mechanically not allowed