

Name Key (print) Name green (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 I cannot read your work, I obviously cannot grade it. (1 pts print and sign exam) If you run out of space, please continue on the back page of the exam and clearly tell me where the remaining answer can be found. $PV=nRT$, $R=0.08206 \text{ (L atm)/(mol K)}$, $P_1V_1/P_2V_2 = T_1/T_2$ Avogadro's number = 6.022×10^{23}

If you are a graduating senior, please write graduating senior here _____

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2 pts per question, 44 pts total)

- 1) What is the maximum number of p orbitals that are possible? 1) D
 A) 5 B) 9 C) 7 D) 3 E) 1
- 2) How many valence electrons do the halogens possess? 2) A
A) 7 B) 6 C) 5 D) 1 E) 2
- 3) Identify the species that has the smallest radius (size). 3) B
 A) neutral B) cation
 C) anion D) they are all the same size
- 4) What symbol is used to represent the factor 10^3 ? 4) B
 A) n B) k kilo C) M D) μ
- 5) If the melting point of vanadium metal is 1910°C , what is its melting point in Kelvin? ($K = ^\circ\text{C} + 273.15$) 5) A
 A) 2183 K B) 1637 K C) 3470 K D) 1029 K
 $1910 + 273.15 = 2183.15$
- 6) Identify the compound with covalent bonds. 6) E
 A) KBr B) Kr C) Li D) NaCl E) CH_4
 ionic element element ionic
- 7) Choose the bond below that is least polar. 7) E
 A) C-F B) C-Br C) P-F D) C-I E) Cl-Cl
- 8) The number of cycles that pass through a stationary point is called 8) E
 A) wavelength
 B) median
 C) area
 D) amplitude
 E) frequency

9) Calculate the molar mass for $\text{Mg}(\text{ClO}_4)_2$.

- A) 123.76 g/mol
- B) 75.76 g/mol
- C) 119.52 g/mol
- D) 247.52 g/mol
- E) 223.21 g/mol

$$24.31 + 2 \left[35.5 + 4(16) \right] = 223.3 \text{ g/mol}$$

mg g 0

9) E

10) Which compound has the highest carbon-carbon bond strength?

- A) CH_3CH_3
- B) $\text{HC}\equiv\text{CH}$
- C) $\text{CH}_2=\text{CH}_2$
- D) all bond strengths are the same

10) B

11) What is the empirical formula for $\text{Hg}_2(\text{NO}_3)_2$?

- A) $\text{Hg}_4(\text{NO}_3)_4$
- B) Hg_2NO_3
- C) $\text{Hg}(\text{NO}_3)_2$
- D) $\text{Hg}_2(\text{NO}_3)_2$
- E) HgNO_3

÷ by common denominator
 HgNO_3 (2)

11) E

12) Which reaction below represents the electron affinity of Li?

- A) $\text{Li}(\text{g}) + \text{e}^- \rightarrow \text{Li}^-(\text{g})$
- B) $\text{Li}(\text{g}) \rightarrow \text{Li}^+(\text{g}) + \text{e}^-$
- C) $\text{Li}^+(\text{g}) \rightarrow \text{Li}(\text{g}) + \text{e}^-$
- D) $\text{Li}^+(\text{g}) + \text{e}^- \rightarrow \text{Li}(\text{g})$
- E) $\text{Li}(\text{g}) + \text{e}^- \rightarrow \text{Li}^+(\text{g})$

12) A

13) Ions differ in the number of

- A) neutrons and protons.
- B) neutrons.
- C) electrons.
- D) electrons and protons.
- E) protons.

13) C

14) How many significant figures are in 0.00523980 mL?

- A) 4
- B) 3
- C) 7
- D) 5
- E) 6

14) E

15) Determine the oxidation state of P in PO_3^{3-} .

- A) +3
- B) +2
- C) +6
- D) -3
- E) 0

15) A

16) Identify a cation.

- A) An atom that has lost a proton and a neutron.
- B) An atom that has gained a neutron.
- C) An atom that has lost an electron.
- D) An atom that has gained an electron.

$$\text{P} + 3(-2) = -3$$
$$\text{P} = -3 + 6 = +3$$

16) C

17) Describe the shape of a p orbital.

- A) spherical
- B) dumbbell shaped
- C) three balls
- D) eight balls
- E) four balls

17) B

18) Which of the following solutions will have the highest concentration of chloride ions?

- A) 0.10 M AlCl_3 — $0.10 \times 3 = 0.30$
- B) 0.10 M MgCl_2 — $0.10 \times 2 = 0.20$
- C) 0.10 M LiCl — 0.10
- D) 0.05 M CaCl_2 — $0.05 \times 2 = 0.10$
- E) All of these solutions have the same concentration of chloride ions.

18) A

19) A triple covalent bond contains _____ of electrons.

- A) 2 pairs
- B) 0 pairs
- C) 1 pair
- D) 3 pairs
- E) 4 pairs

19) D

20) Choose the element from the list below.

- A) Na Cl
- B) Fe_2O_3
- C) H_2O_2
- D) H_2O
- E) He

20) E

21) How many H^+ ions can the acid, H_2SO_4 , donate per molecule?

- A) 2
- B) 1
- C) 0
- D) 3

21) A

22) Identify the number of electron groups around a molecule with a trigonal bipyramidal shape.

- A) 5
- B) 4
- C) 2
- D) 1
- E) 3

22) A

Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. Some questions may require that you show work. If you do not show work, you may lose points. Even on questions which do not require work, if you legibly show work, you may get some partial credit. (81 pts)

1. (6 pts total) One mole of the element Mg has 6.02×10^{23} (1 pt) (give a number) of atoms and weighs 24.31 (2 pts) grams

one mole of the molecule Na_2SO_4 has 6.02×10^{23} (1 pt) molecule and weighs 142 (2 pts) grams (show work)

$$2(23.00) + 32.0 + 4(16.0) = 142$$

Na

2. (14 pts total) (1) Match the following words by inputting the letter associated with the word into the parenthesis given. Do not make up your own parenthesis. Each parenthesis should have a single letter matching the parenthesis. You may use each word given one time, many times or not at all. (8 pts, 4 pts each)

- (a) Transition metal element (b) main group element (c) lanthanide / actinides (d) alkali metals (e) alkaline earth metals (f) chalcogen (g) halogen (i) noble gases

Periodic Table of the Elements

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
H	He											B	C	N	O	F	Ne
Li	Be											Al	Si	P	S	Cl	Ar
Na	Mg											Ga	Ge	As	Se	Br	Kr
K	Ca											In	Sn	Sb	Te	I	Xe
Rb	Sr											Tl	Pb	Bi	Po	At	Rn
Cs	Ba											Po	At	Rn			
Fr	Ra																

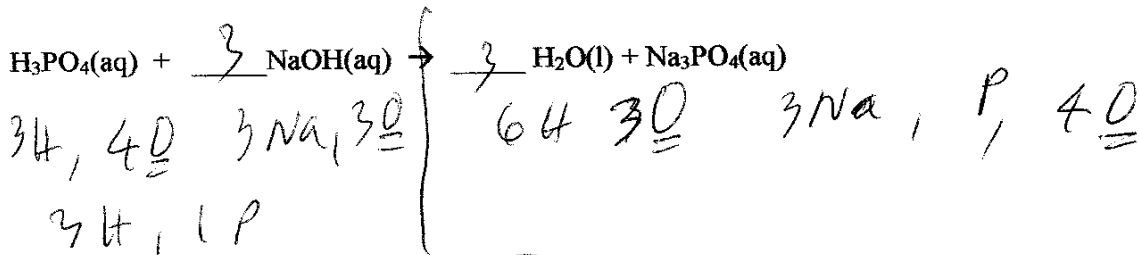
(2) How do you decide which is the more electronegative element? (you would want to say something about across period and down group or something comparable) (3 pts)

F is most electronegative ← less EN ↓ less EN

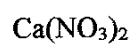
(3) How do you decide which is the larger atom (larger radius atom)? (you would want to say something about across period and down group or something comparable) (3 pts)

→ size decreases ↓ size increases

3. Balance the following reaction by filling in the blank with a number. The number may be the number one or any other number. The parts without a blank do not need any numbers input to balance the equation. (8 pts, 4 pts each)



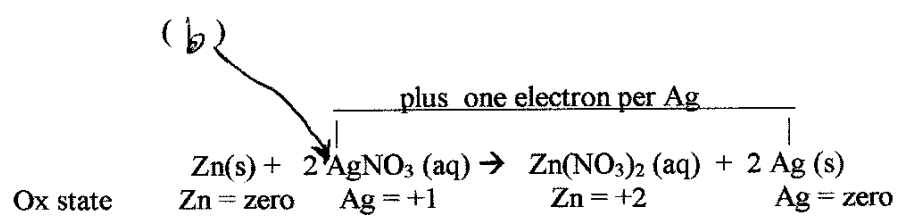
4. (a) The following molecule is [(soluble) or (insoluble)] (circle one) in water. (6 pts)



(b) Give two statements from the solubility chart to explain your answer. (2 pts)

NO_3^- is soluble for all cations
 Ca^{2+} is not an exception for nitrate solubility.

5 For the following redox reaction, fill in the parenthesis by the reagent with either the letter (a) or (b). (a) is being oxidized (b) is being reduced (6 pts)



6 Give the Lewis Dot Symbol for the element As Make sure the dots are clearly visible. (6 pts)

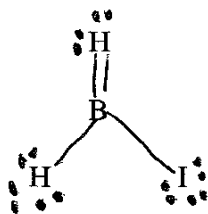


7. Lewis Dot Structure (9 pts total)

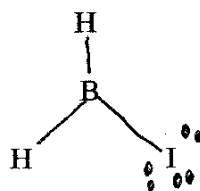
(a) The number of valence electrons in H_2BI is 12 Show work for full credit. (6 pts)

$$\begin{array}{ccc} \text{H} & \text{B} & \text{I} \\ (1)2 + 3 + 7 = 12 \end{array}$$

(b) Which of the two Lewis Dot structures is the correct structure [(1) or (2)] (circle one) (3 pts)



(1)



(2)

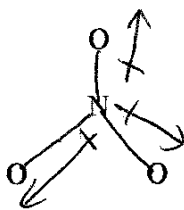
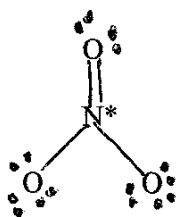
$$12 \times 2 = 24e^-$$

too many e^-

H has more than a duet

$$6 \times 2 = 12e^-$$

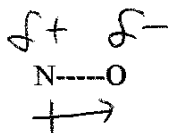
8 Complete the following VSEPR chart for the Lewis Dot structure shown.



line-dash-wedge drawing above

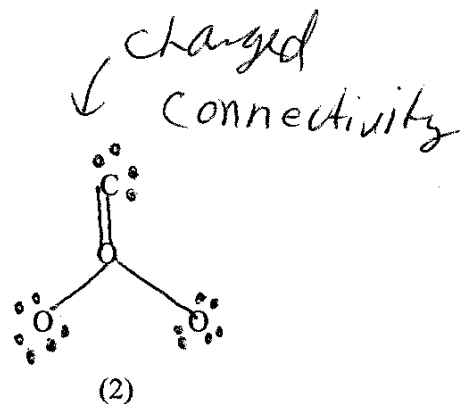
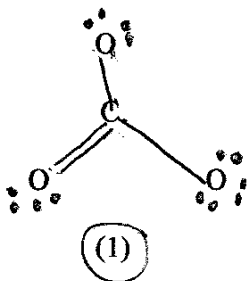
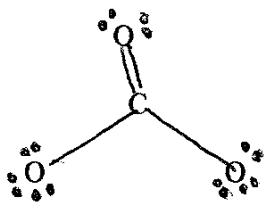
Answer the following questions about the atom with the * (2 pts each, 18 pts)

- a. How many electron pairs 3 b. How many lone pairs 0
- c. What is the geometry of the electron pairs? trigonal pyramidal
- d. What is the geometry of the molecule? trigonal pyramidal
- e. What is the hybridization sp^2 f. What is, are the bond angle 120°
- g. For the bond, show the polarity symbol as an arrow or with the symbol δ



- h. Draw in the vector arrows for the molecule **above** in the line- wedge- dash drawing.
- i. The above molecule as a whole is [(polar) or (nonpolar)] (circle one)

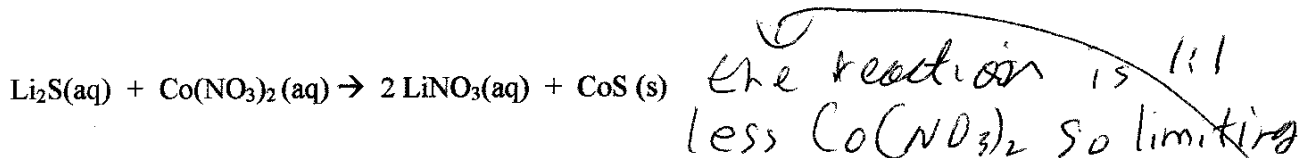
9 For the molecule shown below, which of the two structures is a resonance structure? Circle either [(1) or (2)] (6 pts)



Part III. Long Answer Please show work for full credit and to receive partial credit. (73 pts)

****** Please attempt every problem for partial credit. You will get no partial credit if you just rewrite the question with no change in anything.******

1. Convert the following using dimensional analysis. Show work. If you come up with the final correct numerical answer but show no work, you will lose all points. (25 pts total)



- (a) If you have 0.355 kilograms of Li_2S (molar mass of $\text{Li}_2\text{S} = 45.95 \text{ g/mol}$) and 4.55 moles of reagent $\text{Co}(\text{NO}_3)_2$, which is the limiting reagent?

{ $[\text{Li}_2\text{S}]$ or $[\text{Co}(\text{NO}_3)_2]$ } (circle one) Explain & show work. (5 pts)

$$0.355 \text{ kg Li}_2\text{S} \times \frac{1000 \text{ g Li}_2\text{S}}{1 \text{ kg Li}_2\text{S}} \times \frac{1 \text{ mol Li}_2\text{S}}{45.95 \text{ g Li}_2\text{S}} = \underline{7.73 \text{ mol Li}_2\text{S}}$$

- (b) What is the theoretical yield (based on the mass or moles of the Li_2S regardless of the mass or moles of the limiting reagent) of the LiNO_3 in grams (molar mass of $\text{LiNO}_3 = 68.94 \text{ g/mol}$) ? (20 pts)

$$0.355 \text{ kg Li}_2\text{S} \times \frac{1000 \text{ g Li}_2\text{S}}{1 \text{ kg Li}_2\text{S}} \times \frac{1 \text{ mol Li}_2\text{S}}{45.95 \text{ g Li}_2\text{S}} \times \frac{2 \text{ mol LiNO}_3}{1 \text{ mol Li}_2\text{S}} \times \frac{68.94 \text{ g LiNO}_3}{1 \text{ mol LiNO}_3} =$$

$$1065.23 \text{ g LiNO}_3 \rightarrow 1.07 \times 10^3 \text{ g LiNO}_3$$

w correct sig fig

2. If you have 1.55 moles of a gas at temperature of 303.2 K occupying a volume of 2.82 liters, what is the pressure? [PV = nRT, R=0.08206 (L atm)/(mol K)] (I made up these numbers so the numbers have no relation to reality.) (show work) (20 pts)

$$n = 1.55 \text{ mol}$$

$$T = 303.2 \text{ K}$$

$$V = 2.82 \text{ L}$$

$$PV = nRT \rightarrow P(2.82 \text{ L}) = (1.55 \text{ mol})(0.08206)(303.2 \text{ K})$$

$$P = \frac{nRT}{V}$$

$$P = \frac{(1.55 \text{ mol})(0.08206 \frac{\text{L atm}}{\text{mol K}})(303.2 \text{ K})}{(2.82 \text{ L})}$$

$$P = 13.7 \text{ atm}$$

3. Using the periodic table, for the element (28 pts total, 2 pts each blank) Sn

(a) give: atomic mass 118.71 amu atomic number 50 (4 pts)

(b) number of protons 50 number of electrons 50 number of neutrons 69
(Explain & show work for above in the space below if needed for partial credit) (8 pts)

$$118.7 - 50 = 68.7$$

(c) How many valence electrons does the element have? 4 (4 pts)
Explain how you know.

group # = IV A \rightarrow valence $e^- = 4$

(d) What is the group number for the element IV A (2 pts)
[use the exact number (arabic #, roman #, letter or whatever) given in the periodic table attached to this exam]

(e) What is the charge on the element in its ionic form? +4 or -4 (Explain & show work below if necessary) (4 pts)
If the element forms an ion it would be either +4 or -4 to get an octet

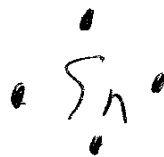
(f) How many **total** electrons does the **ionic** form of the element have? 54 (Explain & show work below) (4 pts)
or 46 e^-

Sn⁻⁴ $\rightarrow 50 + 4 = 54 e^-$ or

Sn⁺⁴ $\rightarrow 50 - 4 = 46 e^-$

50 e^- uncharged

(g) Give the Lewis Dot Symbol for the neutral element. (2 pts)



Name Key (print) Name _____ (sign)

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If you are a **graduating** senior, please write graduating senior here _____

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2 pts per question, 44 pts total)

- 1) How many H⁺ ions can the acid, H₂SO₄, donate per molecule? 1) A
 A) 2 B) 1 C) 0 D) 3

- 2) Which of the following solutions will have the highest concentration of chloride ions? 9 2) A
 A) 0.10 M AlCl₃
 B) 0.10 M LiCl
 C) 0.10 M MgCl₂
 D) 0.05 M CaCl₂
 E) All of these solutions have the same concentration of chloride ions.

- 3) Choose the element from the list below. 3) E
 A) Fe₂O₃ B) H₂O₂ C) H₂O D) Na Cl E) He

- 4) Ions differ in the number of 4) A
 A) electrons.
 B) neutrons.
 C) protons.
 D) neutrons and protons.
 E) electrons and protons.

- 5) Which compound has the highest carbon-carbon bond strength? 5) A
 A) HC≡CH B) CH₃CH₃
 C) CH₂=CH₂ D) all bond strengths are the same

- 6) What symbol is used to represent the factor 10³? 6) D
 A) μ B) n C) M D) k

- 7) If the melting point of vanadium metal is 1910°C, what is its melting point in Kelvin? (K = °C + 273.15) 7) C
 A) 3470 K B) 1637 K C) 2183 K D) 1029 K

- 8) The number of cycles that pass through a stationary point is called 8) A
 A) frequency
 B) wavelength
 C) area
 D) amplitude
 E) median
- 9) Calculate the molar mass for $\text{Mg}(\text{ClO}_4)_2$. 9) D
 A) 123.76 g/mol
 B) 119.52 g/mol
 C) 75.76 g/mol
 D) 223.21 g/mol
 E) 247.52 g/mol
- 10) How many significant figures are in 0.00523980 mL? 10) C
 A) 4
 B) 3
 C) 6
 D) 7
 E) 5
- 11) What is the maximum number of p orbitals that are possible? 11) B
 A) 7
 B) 3
 C) 9
 D) 5
 E) 1
- 12) Identify a cation. 12) A
 A) An atom that has lost an electron.
 B) An atom that has gained an electron.
 C) An atom that has lost a proton and a neutron.
 D) An atom that has gained a neutron.
- 13) A triple covalent bond contains _____ of electrons. 13) A
 A) 3 pairs
 B) 0 pairs
 C) 1 pair
 D) 2 pairs
 E) 4 pairs
- 14) Which reaction below represents the electron affinity of Li? 14) B
 A) $\text{Li}(\text{g}) \rightarrow \text{Li}^+(\text{g}) + \text{e}^-$
 B) $\text{Li}(\text{g}) + \text{e}^- \rightarrow \text{Li}^-(\text{g})$
 C) $\text{Li}(\text{g}) + \text{e}^- \rightarrow \text{Li}^+(\text{g})$
 D) $\text{Li}^+(\text{g}) + \text{e}^- \rightarrow \text{Li}(\text{g})$
 E) $\text{Li}^+(\text{g}) \rightarrow \text{Li}(\text{g}) + \text{e}^-$
- 15) Identify the species that has the smallest radius (size). 15) B
 A) neutral
 B) cation
 C) anion
 D) they are all the same size
- 16) How many valence electrons do the halogens possess? 16) C
 A) 2
 B) 1
 C) 7
 D) 6
 E) 5
- 17) Choose the bond below that is least polar. 17) C
 A) P-F
 B) C-I
 C) $\text{Cl}-\text{Cl}$
 D) C-Br
 E) C-F
- 18) Identify the number of electron groups around a molecule with a trigonal bipyramidal shape. 18) A
 A) 5
 B) 2
 C) 1
 D) 3
 E) 4
- groups
pairs

19) What is the empirical formula for $\text{Hg}_2(\text{NO}_3)_2$?

- A) $\text{Hg}_2(\text{NO}_3)_2$
- B) Hg_2NO_3
- C) $\text{Hg}(\text{NO}_3)_2$
- D) $\text{Hg}_4(\text{NO}_3)_4$
- E) HgNO_3

19) E

20) Identify the compound with covalent bonds.

- A) Kr
- B) KBr
- C) NaCl
- D) Li
- E) CH_4

20) E

21) Determine the oxidation state of P in PO_3^{3-} .

- A) +3
- B) 0
- C) +6
- D) +2
- E) -3

21) A

22) Describe the shape of a p orbital.

- A) spherical
- B) three balls
- C) eight balls
- D) four balls
- E) dumbbell shaped

22) E

Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. Some questions may require that you show work. If you do not show work, you may lose points. Even on questions which do not require work, if you legibly show work, you may get some partial credit. (81 pts)

1. (6 pts total) One mole of the element **Br** has 6.02×10^{23} (1 pt) (give a number) of **atoms** and weighs 79.9 (2 pts) **grams**
 one mole of the molecule **K₃PO₄** has 6.02×10^{23} (1 pt) molecule and weighs 212.27 (2 pts) grams (show work below)

$$\begin{matrix} \text{k} & & \text{P} & & \text{O} \\ (39.10)3 & + & (30.97) & + & (16.00)4 = 212.27 \end{matrix}$$

2. (14 pts total) (1) Match the following words by inputting the letter associated with the word into the parenthesis given. Do not make up your own parenthesis. Each parenthesis should have a single letter matching the parenthesis. You may use each word given one time, many times or not at all. (8 pts, 4 pts each)

(a) Transition metal element (b) main group element (c) lanthanide / actinides (d) alkali metals (e) alkaline earth metals (f) chalcogen (g) halogen (i) noble gases

Periodic Table of the Elements

- (2) How do you decide which is the more electronegative element? (you would want to say something about across period and down group or something comparable) (3 pts)

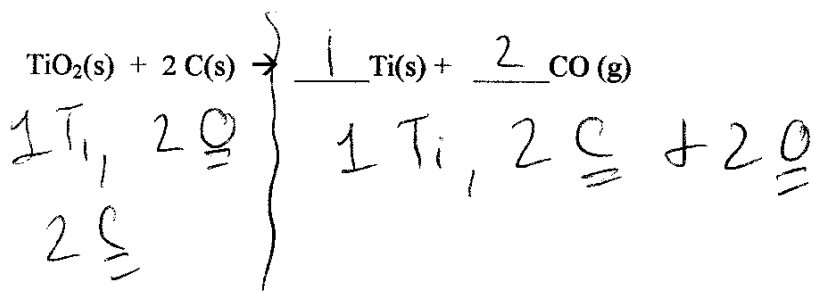
F is most electronegative

← less EN
 ↓ less EN

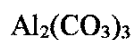
- (3) How do you decide which is the larger atom (larger radius atom)? (you would want to say something about across period and down group or something comparable) (3 pts)

→ size decreases ↓ size increases

3. Balance the following reaction by filling in the blank with a number. The number may be the number one or any other number. The parts without a blank do not need any numbers input to balance the equation. (8 pts, 4 pts each)



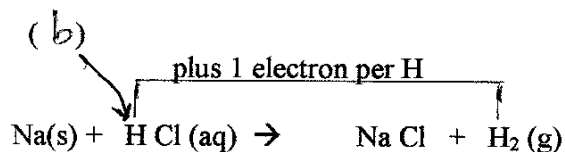
4. (a) The following molecule is [(soluble) or (insoluble)](circle one) in water. (6 pts)



- (b) Give two statements from the solubility chart to explain your answer. (2 pts)

carbonates are insoluble
Al³⁺ is not an exception

5. For the following redox reaction, fill in the parenthesis by the reagent with either the letter (a) or (b). (a) is being oxidized (b) is being reduced (6 pts)



Ox state Na = zero H = +1 Na = +1 H = zero

6 Give the Lewis Dot Symbol for the element **Kr** Make sure the dots are clearly visible. (6 pts)

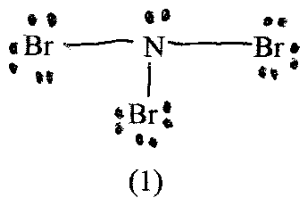


7. Lewis Dot Structure (9 pts total)

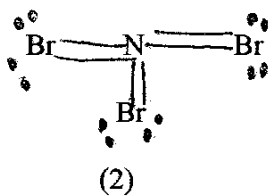
(a) The number of valence electrons in **NBr₃** is 26 Show work for full credit. (6 pts)

$$\begin{array}{c} \text{N} \\ 5 \end{array} + \begin{array}{c} \text{Br} \\ (7) \end{array} 3 = 26$$

(b) Which of the two Lewis Dot structures is the correct structure [(1) or (2)] (circle one) (3 pts)



$$13 \times 2 = 26e^-$$

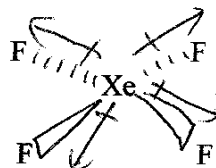
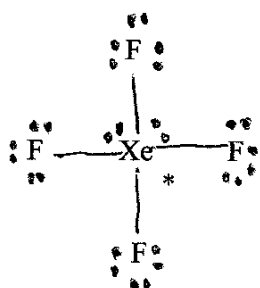


$$12 \times 2 = 24$$

too few e⁻

N cannot expand octet

8 Complete the following VSEPR chart for the Lewis Dot structure shown.

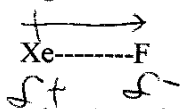


line- wedge- dash drawing above

Answer the following questions about the atom with the * (2 pts each, 18 pts)

- a. How many electron pairs 6 b. How many lone pairs 2
- c. What is the geometry of the electron pairs? Octahedral
- d. What is the geometry of the molecule? Square planar
- e. What is the hybridization sp^3d^2 f. What is, are the bond angle 90°

g. For the bond, show the polarity symbol as an arrow or with the symbol δ

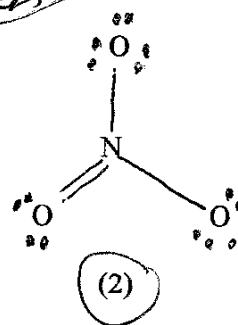
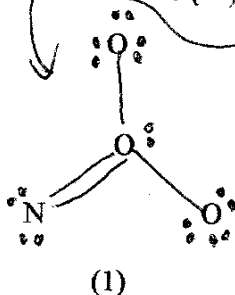
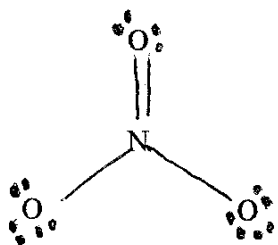


(F is most EN)

h. Draw in the vector arrows for the molecule **above** in the line- wedge- dash drawing.

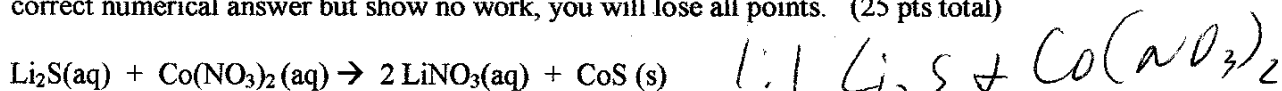
i. The above molecule as a whole is [(polar) or (nonpolar)] (circle one)

9. For the molecule shown below, which of the two structures is a resonance structure? Circle either [(1) or (2)] (6 pts)



Part III. Long Answer Please show work for full credit and to receive partial credit. (73 pts)
****** Please attempt every problem for partial credit. You will get no partial credit if you just rewrite the question with no change in anything.******

1. Convert the following using dimensional analysis. Show work. If you come up with the final correct numerical answer but show no work, you will lose all points. (25 pts total)



less Li_2S moles

(a) If you have 0.355 kilograms of Li_2S (molar mass of $\text{Li}_2\text{S} = 45.95 \text{ g/mol}$) and 8.92 moles of $\text{Co}(\text{NO}_3)_2$, which is the limiting reagent?

{ $[\text{Li}_2\text{S}]$ or $[\text{Co}(\text{NO}_3)_2]$ } (circle one) Explain & show work. (5 pts)

$$0.355 \text{ kg} \underset{\text{Li}_2\text{S}}{\times} \frac{1000 \text{ g Li}_2\text{S}}{1 \text{ kg Li}_2\text{S}} \times \frac{1 \text{ mol Li}_2\text{S}}{45.95 \text{ g Li}_2\text{S}} = 7.73 \text{ mol Li}_2\text{S}$$

(b) What is the theoretical yield (based on the mass or moles of the Li_2S regardless of the mass or moles of the limiting reagent) of the $\text{CoS}(\text{s})$ in grams (molar mass of $\text{CoS} = 91.00 \text{ g/mol}$) ? (20 pts)

$$0.355 \text{ kg} \underset{\text{Li}_2\text{S}}{\times} \frac{1000 \text{ g Li}_2\text{S}}{1 \text{ kg Li}_2\text{S}} \times \frac{1 \text{ mol Li}_2\text{S}}{45.95 \text{ g Li}_2\text{S}}$$

$$\times \frac{1 \text{ mol CoS}}{1 \text{ mol Li}_2\text{S}} \times \frac{91.00 \text{ g CoS}}{1 \text{ mol CoS}} = 703 \text{ g CoS}$$

2. If you have a gas at pressure 3.09 atm at a volume of 0.500 Liters for a 2.0 mole sample of gas, what is the temperature in Kelvin? [PV = nRT, R=0.08206 (L atm)/(mol K)] (I made up these numbers so the numbers have no relation to reality.) (show work) (20 pts)

$$\begin{array}{l} P = 3.09 \text{ atm} \\ V = 0.500 \text{ L} \\ n = 2.0 \text{ mol} \\ T = ? \end{array} \quad (3.09 \text{ atm})(0.500 \text{ L}) = (2.0 \text{ mol})(0.08206) (T)$$

$$PV = nRT$$

$$nRT = PV$$

$$T = \frac{PV}{nR}$$

$$T = \frac{(3.09 \text{ atm})(0.500 \text{ L})}{(2.0 \text{ mol})(0.08206 \frac{\text{L atm}}{\text{mol K}})}$$

$$T = 9.41 \text{ K}$$

3. Using the periodic table, for the element (28 pts total, 2 pts each blank) Se

(a) give: atomic mass 78.96 amu atomic number 34 (4 pts)

(b) number of protons 34 number of electrons 34 number of neutrons 45
(Explain & show work for above in the space below if needed for partial credit) (8 pts)

$$79 - 34 = 45$$

(c) How many valence electrons does the element have? 6 (4 pts)
Explain how you know.

same as group #

(d) What is the group number for the element VI A (2 pts)
[use the exact number (arabic #, roman #, letter or whatever) given in the periodic table attached to this exam]

(e) What is the charge on the element in its ionic form? -2 (Explain & show work below if necessary) (4 pts)

$$6 - 8 = -2$$

(f) How many **total** electrons does the **ionic** form of the element have? 36e⁻ (Explain & show work below) (4 pts)

$$\begin{array}{l} 34e^- \\ \text{neutral} \end{array} + \begin{array}{l} 2e^- \\ \text{charge} \end{array} = 36e^-$$

(g) Give the Lewis Dot Symbol for the neutral element. (2 pts)



Name Key (print) Name Orange - Salmon (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 I cannot read your work, I obviously cannot grade it. (1 pts print and sign exam) If you run out of space, please continue on the back page of the exam and clearly tell me where the remaining answer can be found. $PV=nRT$, $R=0.08206$ (L atm)/(mol K), $P_1V_1/P_2V_2 = T_1/T_2$ Avogadro's number = 6.022×10^{23}

If you are a graduating senior, please write graduating senior here _____

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2 pts per question, 44 pts total)

- 1) Identify the compound with ionic bonds.

A) CO B) H₂O C) N₂ D) Ne E) KBr 1) E
- 2) Which one of the following is **not** an empirical formula?

A) CHO B) C₂H₄O₂ C) CH₂O D) C₂H₄O 2) B
- 3) Which reaction below represents the first ionization of O?

A) O⁺(g) + e⁻ → O(g)
 B) O⁻(g) → O(g) + e⁻
 C) O⁻(g) + e⁻ → O²⁻(g)
 D) O(g) → O⁺(g) + e⁻
 E) O(g) + e⁻ → O⁻(g)

3) D
- 4) Calculate the molar mass of Al(C₂H₃O₂)₃.

A) 204.13 g/mol 27 + 3[(2 × 12) + 3(1) + 2(16)]
 B) 258.09 g/mol
 C) 56.00 g/mol
 D) 139.99 g/mol 204
 E) 86.03 g/mol

4) A
- 5) The factor 10⁻³ corresponds to which prefix?

A) milli B) deka C) centi D) deci 5) A
- 6) Describe the shape of a s orbital.

A) three balls
 B) four balls
 C) dumbbell shaped
 D) eight balls
E) spherical 6) E

- 7) Isotopes differ in the number of
 A) protons.
 B) electrons.
 C) neutrons.
 D) neutrons and protons.
 E) beta particles. 7) C
- 8) Choose the compound from the list below.
 A) Au B) Ne C) He D) CH₄ E) Li 8) D
- 9) What is the maximum number of d orbitals that are possible?
 A) 5 B) 7 C) 9 D) 1 E) 3 9) A
- 10) Identify the shortest bond.
 A) triple covalent bond
 B) single covalent bond
 C) double covalent bond
 D) all of the above bonds are the same length 10) A
- 11) Identify the species that has the smallest radius (size). *- less e⁻, smaller*
 A) N⁻⁵ B) N⁺¹ C) N⁰ D) N⁺³ E) N⁻² 11) D
- 12) Identify a solid.
 A) no definite shape and no definite volume B) no definite shape and definite volume
 C) definite volume and definite shape D) cannot be compressed 12) C
- 13) How many valence electrons do the alkali metals (Gp IA) possess?
 A) 2 B) 7 C) 6 D) 1 E) 8 13) D
- 14) Give the approximate bond angle for a molecule with a tetrahedral shape.
 A) 180° B) 120° C) 90° D) 109.5° E) 105° 14) D
- 15) Determine the oxidation state of C in CO₃⁻². *C + 3(-2) = -2*
 A) -4 B) +6 C) +4 D) +2 E) -2 15) C
- 16) Identify the compound with the smallest dipole moment in the gas phase. *C = -2 + 6 = +4*
 A) Cl₂ B) HF C) LiF D) ClF 16) A
zero dipole
- 17) A double covalent bond contains _____ of electrons.
 A) 1 pair B) 3 pairs C) 4 pairs D) 0 pairs E) 2 pairs 17) E
- 18) Identify a cation. 18) D
 A) An atom that has lost a proton and a neutron.
 B) An atom that has gained a neutron.
 C) An atom that has gained an electron.
 D) An atom that has lost an electron.

19) If a solution has a temperature of 255 K, what is its temperature in degrees celsius? ($K = ^\circ C + 273.15$) 19) D
A) 491°C B) 528°C C) 355°C D) -18°C E) 123.9°C

20) A cation of +2 indicates that an element has 20) E
A) gained two electrons.
B) gained two protons.
C) lost two protons.
D) lost two neutrons.
E) lost two electrons.

Handwritten calculation: $255 - 273.15 = -18.15^\circ C$

21) How many significant figures are in the measurement, 463.090 m? 21) E
A) 3 B) 4 C) 2 D) 5 E) 6

22) How many H⁺ ions can the acid, H₂SO₄, donate per molecule? 22) D
A) 0 B) 1 C) 3 D) 2

Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. Some questions may require that you show work. If you do not show work, you may lose points. Even on questions which do not require work, if you legibly show work, you may get some partial credit. (81 pts)

1. (6 pts total) One mole of the element Ag has 6.022×10^{23} (1 pt) (give a number) of atoms and weighs 107.87 (2 pts) grams
 one mole of the molecule Rb_2CO_3 has 6.022×10^{23} (1 pt) molecule and weighs 230.95 (2 pts) grams (show work)

$$2(\underset{\text{Rb}}{85.47}) + (\underset{\text{C}}{12.01}) + 3(\underset{\text{O}}{16.0}) = 230.95$$

2. (14 pts total) (1) Match the following words by inputting the letter associated with the word into the parenthesis given. Do not make up your own parenthesis. Each parenthesis should have a single letter matching the parenthesis. You may use each word given one time, many times or not at all. (8 pts, 4 pts each)

(a) Transition metal element (b) main group element (c) lanthanide / actinides (d) alkali metals (e) alkaline earth metals (f) chalcogen (g) halogen (i) noble gases

Periodic Table of the Elements

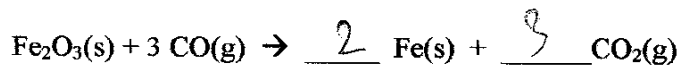
- (2) How do you decide which is the more electronegative element? (you would want to say something about across period and down group or something comparable) (3 pts)

F is most electro negative ← to left
 period less EN. ↓ down group less EN

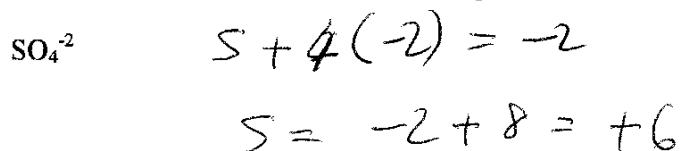
- (3) How do you decide which is the larger atom (larger radius atom)? (you would want to say something about across period and down group or something comparable) (3 pts)

→ across period smaller
 ↓ down group bigger

3. Balance the following reaction by filling in the blank with a number. The number may be the number one or any other number. The parts without a blank do not need any numbers input to balance the equation. (8 pts, 4 pts each)

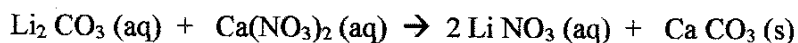


- 4 For the polyatomic ion shown, give the oxidation state of the atom S. Show work. (8 pts)

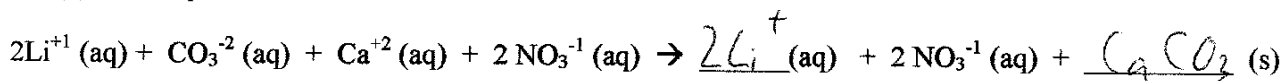


5. Complete the following precipitation reaction by filling in each blank with an ion or molecule. (6 pts, 3 pts each)

(a) molecular equation

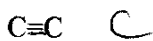
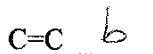
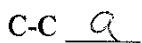


(b) ionic equation



- 6 Place the following bonds in order using the choices below (each letter can only be used one time) (6 pts total, 2 pts each)

(a) longest bond length (b) medium bond length (c) shortest bond length

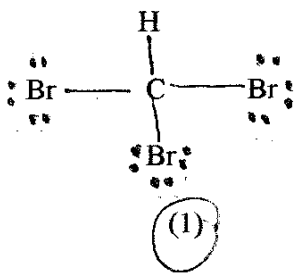


7. Lewis Dot Structure (9 pts total)

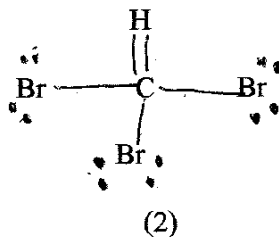
(a) The number of valence electrons in CHBr_3 is 26 Show work for full credit. (6 pts)

$$\begin{array}{c} \text{C} \quad \text{H} \quad \text{Br} \\ 4 + 1 + (7)3 = 26 \end{array}$$

(b) Which of the two Lewis Dot structures is the correct structure [(1) or (2)] (circle one) (3 pts)



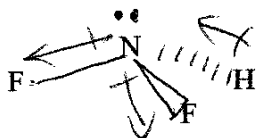
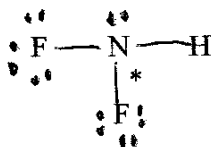
$$13 \times 2 = 26 \bar{e}$$



$$11 \times 2 = 22 \bar{e}$$

too few \bar{e}
 Br less than octet
 H more than duet

8 Complete the following VSEPR chart for the Lewis Dot structure shown.

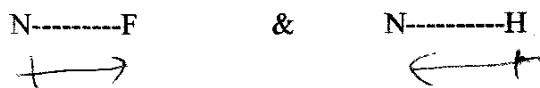


(assume C & H have the same electronegativities)

line- wedge- dash drawing above

Answer the following questions about the atom with the * (2 pts each, 18 pts)

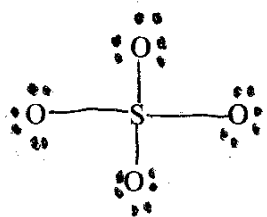
- a. How many electron pairs 4 b. How many lone pairs 1
- c. What is the geometry of the electron pairs? tetrahedral
- d. What is the geometry of the molecule? trigonal pyramidal
- e. What is the hybridization sp³ f. What is, are the bond angle 109.5°
- g. For the bond, show the polarity symbol as an arrow or with the symbol δ



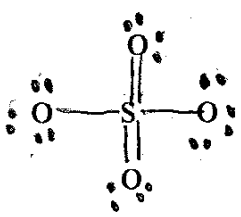
h. Draw in the vector arrows for the molecule **above** in the line- wedge- dash drawing.

i. The above molecule as a whole is [polar] or [nonpolar] (circle one)

9 For the molecule shown below, which of the two structures is a resonance structure? Circle either [(1) or (2)] (6 pts)

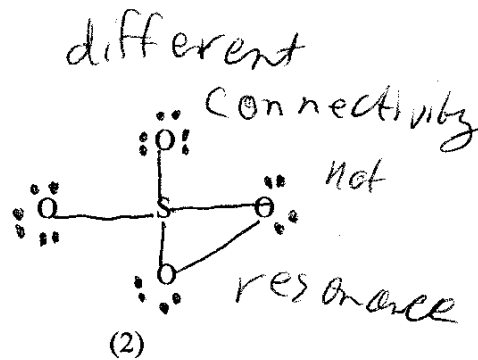


$16 \times 2 = 32$



(1)

$16 \times 2 = 32$

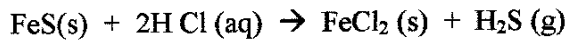


(2)

Part III. Long Answer Please show work for full credit and to receive partial credit. (73 pts)
****** Please attempt every problem for partial credit. You will get no partial credit if you just rewrite the question with no change in anything.******

1. Convert the following using dimensional analysis. Show work. If you come up with the final correct numerical answer but show no work, you will lose all points. (25 pts total)

For the reaction shown below:



a. If you have excess FeS (s) and add 25.0 mL of a 0.125 M HCl solution, how many Liters of H₂S would you generate? (1 mole at STP = 22.4 Liters)(20 pts)

$$25.0 \text{ mL}_{\text{HCl soln}} \times \frac{0.125 \text{ mol HCl}}{1000 \text{ mL HCl soln}} \times \frac{1 \text{ mol H}_2\text{S}}{2 \text{ mol HCl}} \times \frac{22.4 \text{ L}}{1 \text{ mol H}_2\text{S}}$$

$$= 0.035 \text{ L}$$

b. In the reaction above under the conditions shown is the limiting reagent { [FeS(s)] or [HCl] } (circle one) (5 pts)

question states excess FeS

2. You have a mixture of gases with a pressure of 1.09 atm. in a container of volume 3.99 L at 298.2 K. If the new volume is 1.55 Liters at a temperature of 255.2 K, what is the new pressure in atm? ($P_1V_1 / P_2V_2 = T_1/T_2$) (I made up these numbers so that the numbers have no relation to reality.) (show work) (20 pts)

$$P_2 = 1.09 \text{ atm}$$

$$V_2 = 3.99 \text{ L}$$

$$T_2 = 298.2 \text{ K}$$

$$P_1 = ?$$

$$V_1 = 1.55 \text{ L}$$

$$T_1 = 255.2 \text{ K}$$

$$\frac{P_1 V_1}{P_2 V_2} = \frac{T_1}{T_2}$$

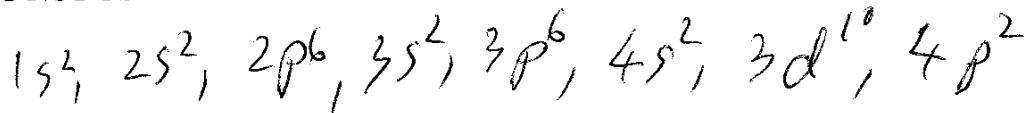
$$P_1 = \left(\frac{T_1}{T_2} \right) \left(\frac{P_2 V_2}{V_1} \right)$$

$$P_1 = \frac{(255.2 \text{ K}) (1.09 \text{ atm}) (3.99 \text{ L})}{(298.2 \text{ K}) (1.55 \text{ L})}$$

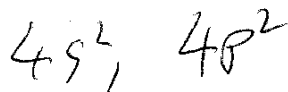
$$P_1 = 2.40 \text{ atm}$$

3. Electron Configuration Question: (28 pts total)

(a). Give the electron configuration for the element **Ge**. You should use the format of $(1s^2, 2s^2, \text{etc})$. This is not me giving the start of your electron configuration but just telling you the format for your answer. **DO NOT USE THE SHORTCUT ELECTRON CONFIGURATION USING THE NOBLE GAS.** (10 pts)

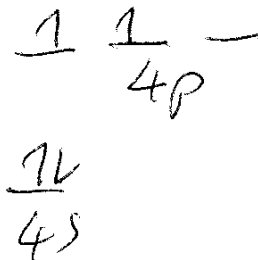


(b) What is the **valence** electron configuration for the same uncharged element **Ge**? Give the valence electron configuration in the form of $(1s^2, 2s^2 \text{ etc.})$. This is not me giving the start of your electron configuration but just telling you the format for your answer) (9 pts)



(c) Give an orbital diagram for the **valence** electron configuration for the element **Ge** using the format with up or down arrows for electrons. (9 pts)

$\uparrow \downarrow \uparrow$ — — — You should show the **lowest energy at the bottom** of this space and the **highest energy at the top** of this space. (I typed the orbitals so that I can draw the thing on one line for ease of typing, you should show any difference in energy by drawing lines on a different level.)



Name Key (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 I cannot read your work, I obviously cannot grade it. (1 pts print and sign exam) If you run out of space, please continue on the back page of the exam and clearly tell me where the remaining answer can be found. $PV=nRT$, $R=0.08206$ (L atm)/(mol K), $P_1V_1/P_2V_2 = T_1/T_2$ Avogadro's number = 6.022×10^{23}

If you are a graduating senior, please write graduating senior here _____

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2 pts per question, 44 pts total)

- 1) Identify the shortest bond. 1) B
 - A) single covalent bond
 - B) triple covalent bond
 - C) double covalent bond
 - D) all of the above bonds are the same length

- 2) Identify a cation. 2) A
 - A) An atom that has lost an electron.
 - B) An atom that has gained an electron.
 - C) An atom that has gained a neutron.
 - D) An atom that has lost a proton and a neutron.

- 3) Isotopes differ in the number of 3) E
 - A) neutrons and protons.
 - B) beta particles.
 - C) electrons.
 - D) protons.
 - E) neutrons.

- 4) Give the approximate bond angle for a molecule with a tetrahedral shape. 4) D
 - A) 105°
 - B) 180°
 - C) 90°
 - D) 109.5°
 - E) 120°

- 5) How many H^+ ions can the acid, H_2SO_4 , donate per molecule? 5) D
 - A) 1
 - B) 0
 - C) 3
 - D) 2

- 6) How many valence electrons do the alkali metals (Gp IA) possess? 6) D
 - A) 6
 - B) 7
 - C) 8
 - D) 1
 - E) 2

- 7) Choose the compound from the list below. 7) D
 - A) Au
 - B) He
 - C) Ne
 - D) CH_4
 - E) Li

- 8) If a solution has a temperature of 255 K, what is its temperature in degrees celsius? ($K = ^\circ C + 273.15$) 8) D
 A) 528°C B) 123.9°C C) 355°C D) -18°C E) 491°C
- 9) Which reaction below represents the first ionization of O? 9) E
 A) $O^-(g) + e^- \rightarrow O^{2-}(g)$
 B) $O(g) + e^- \rightarrow O^-(g)$
 C) $O^-(g) \rightarrow O(g) + e^-$
 D) $O^+(g) + e^- \rightarrow O(g)$
 E) $O(g) \rightarrow O^+(g) + e^-$
- 10) Identify the compound with ionic bonds. 10) A
 A) KBr B) H₂O C) CO D) Ne E) N₂
- 11) The factor 10^{-3} corresponds to which prefix? 11) B
 A) deci B) milli C) centi D) deka
- 12) Identify a solid. 12) B
 A) no definite shape and definite volume B) definite volume and definite shape
 C) cannot be compressed D) no definite shape and no definite volume
- 13) Identify the species that has the smallest radius (size). 13) B
 A) N⁻² B) N⁺³ C) N⁰ D) N⁺¹ E) N⁻⁵
- 14) Which one of the following is **not** an empirical formula? 14) B
 A) CHO B) C₂H₄O₂ C) C₂H₄O D) CH₂O
- 15) A cation of +2 indicates that an element has 15) D
 A) lost two neutrons.
 B) gained two protons.
 C) lost two protons.
 D) lost two electrons.
 E) gained two electrons.
- 16) Identify the compound with the smallest dipole moment in the gas phase. 16) A
 A) Cl₂ B) ClF C) HF D) LiF
- 17) A double covalent bond contains _____ of electrons. 17) C
 A) 0 pairs B) 1 pair C) 2 pairs D) 3 pairs E) 4 pairs
- 18) Calculate the molar mass of Al(C₂H₃O₂)₃. 18) D
 A) 86.03 g/mol
 B) 258.09 g/mol
 C) 139.99 g/mol
 D) 204.13 g/mol
 E) 56.00 g/mol

19) Describe the shape of a s orbital.

- A) eight balls
- B) three balls
- C) spherical
- D) four balls
- E) dumbbell shaped

19) C

20) How many significant figures are in the measurement, 463.090 m?

- A) 3
- B) 4
- C) 6
- D) 2
- E) 5

20) C

21) Determine the oxidation state of C in CO_3^{2-} .

- A) -2
- B) +6
- C) -4
- D) +4
- E) +2

21) D

22) What is the maximum number of d orbitals that are possible?

- A) 1
- B) 7
- C) 9
- D) 5
- E) 3

22) D

Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. Some questions may require that you show work. If you do not show work, you may lose points. Even on questions which do not require work, if you legibly show work, you may get some partial credit. (81 pts)

1. (6 pts total) One mole of the element N has 6.022×10^{23} (1 pt) (give a number) of atoms and weighs 14.01 (2 pts) grams

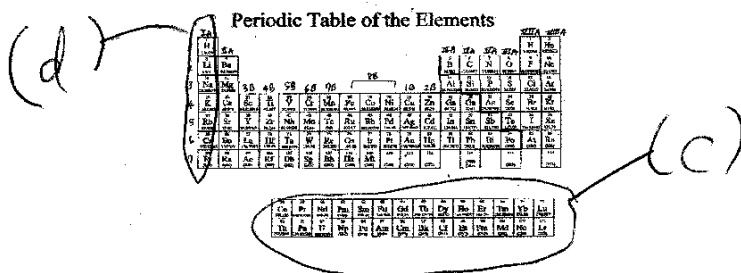
one mole of the molecule Li_2SO_4 has 6.022×10^{23} (1 pt) molecule and weighs 109.95 (2 pts) grams (show work)

$$2(6.94) + 32.07 + 4(16.00) = 109.95$$

Li S

2. (14 pts total) (1) Match the following words by inputting the letter associated with the word into the parenthesis given. Do not make up your own parenthesis. Each parenthesis should have a single letter matching the parenthesis. You may use each word given one time, many times or not at all. (8 pts, 4 pts each)

(a) Transition metal element (b) main group element (c) lanthanide / actinides (d) alkali metals (e) alkaline earth metals (f) chalcogen (g) halogen (i) noble gases

(d) 

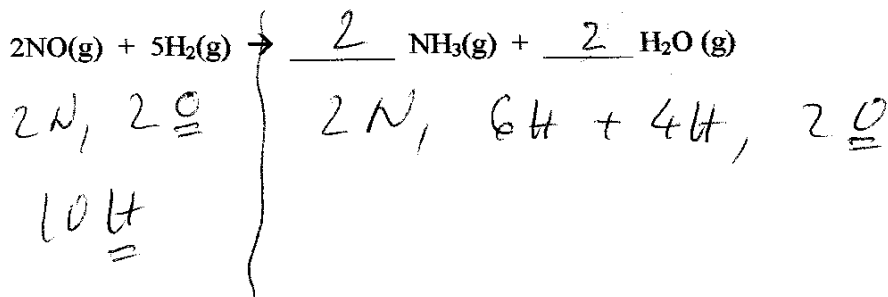
(2) How do you decide which is the more electronegative element? (you would want to say something about across period and down group or something comparable) (3 pts)

F is most electronegative ← less EN
 ↓ less EN

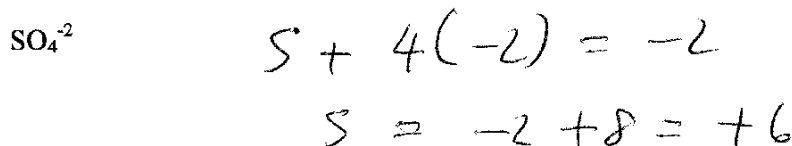
(3) How do you decide which is the larger atom (larger radius atom)? (you would want to say something about across period and down group or something comparable) (3 pts)

→ smaller, ↓ bigger

3. Balance the following reaction by filling in the blank with a number. The number may be the number one or any other number. The parts without a blank do not need any numbers input to balance the equation. (8 pts, 4 pts each)

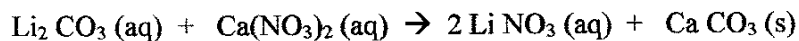


4 For the polyatomic ion shown, give the oxidation state of the atom S. Show work. (8 pts)

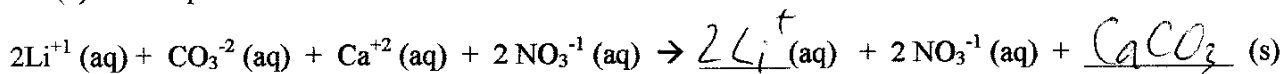


5. Complete the following precipitation reaction by filling in each blank with an ion or molecule. (6 pts, 3 pts each)

(a) molecular equation

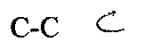
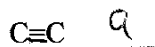


(b) ionic equation



6 Place the following bonds in order using the choices below (each letter can only be used one time) (6 pts total, 2 pts each)

(a) Highest bond strength (b) medium bond strength (c) lowest bond strength

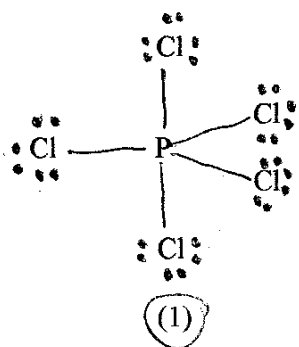


7. Lewis Dot Structure (9 pts total)

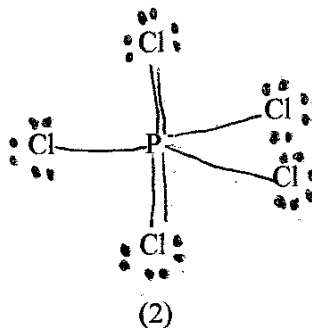
(a) The number of valence electrons in PCl_5 is 40 Show work for full credit. (6 pts)

$$\begin{array}{c} \text{P} \quad \text{Cl} \\ 5 + 5(7) = 40 \end{array}$$

(b) Which of the two Lewis Dot structures is the correct structure [(1) or (2)] (circle one) (3 pts)



$$20 \times 2 = 40 \bar{e}$$

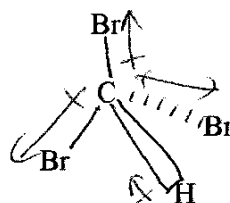
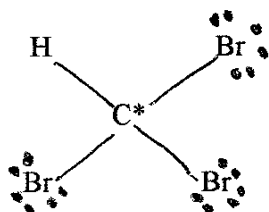


$$22 \times 2 = 44 \bar{e}$$

too many \bar{e}

(P + Cl can expand)
octet

8 Complete the following VSEPR chart for the Lewis Dot structure shown.

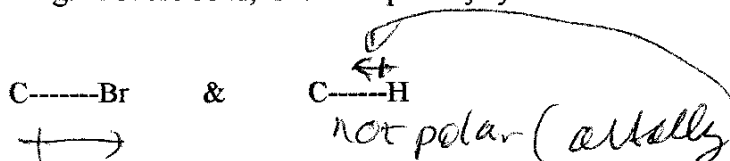


(assume C & H have the same electronegativities)

line- wedge- dash drawing above

Answer the following questions about the atom with the * (2 pts each, 18 pts)

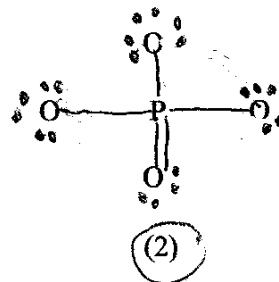
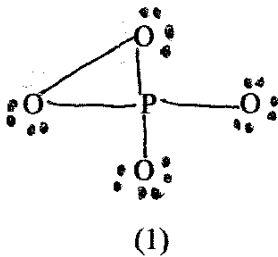
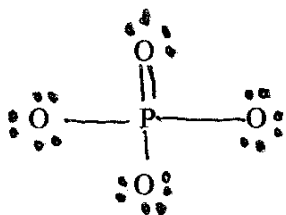
- a. How many electron pairs 4 b. How many lone pairs 0
- c. What is the geometry of the electron pairs? tetrahedral
- d. What is the geometry of the molecule? tetrahedral
- e. What is the hybridization sp³ f. What is, are the bond angle 109.5°
- g. For the bond, show the polarity symbol as an arrow or with the symbol δ



h. Draw in the vector arrows for the molecule above in the line- wedge- dash drawing.

i. The above molecule as a whole is [(polar) or (nonpolar)] (circle one)

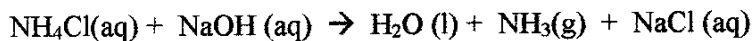
9 For the molecule shown below, which of the two structures is a resonance structure? Circle either [(1) or (2)] (6 pts)



Part III. Long Answer Please show work for full credit and to receive partial credit. (73 pts)

****** Please attempt every problem for partial credit. You will get no partial credit if you just rewrite the question with no change in anything.******

1. Convert the following using dimensional analysis. Show work. If you come up with the final correct numerical answer but show no work, you will lose all points. (25 pts total)



- a. If you have excess $\text{NH}_4\text{Cl}(\text{aq})$ and add 15.0 mL of a 0.500 M NaOH solution, how many Liters of $\text{NH}_3(\text{g})$ would you generate? (1 mole at STP = 22.4 Liters) (20 pts)

$$\begin{aligned} & 15.0 \text{ mL NaOH soln} \times \frac{0.500 \text{ mol NaOH}}{1000 \text{ mL NaOH soln}} \times \frac{1 \text{ mol NH}_3}{1 \text{ mol NaOH}} \times \frac{22.4 \text{ L}}{1 \text{ mol NH}_3} \\ & = 0.168 \text{ L NH}_3 \end{aligned}$$

- b. In the reaction above under the conditions shown is the limiting reagent { $[\text{NH}_4\text{Cl}(\text{aq})]$ or $[\text{NaOH}]$ } (circle one) (5 pts)

states excess NH_4Cl so →

2. You have a mixture of gases in a volume of 1.07 liters at temperature of 275.2 K at an unknown pressure. If the new volume is 3.22 liters at pressure 1.11 atm and temperature of 157.2 K, what is the old unknown pressure? $(P_1V_1)/(P_2V_2) = T_1/T_2$ (I made up these numbers so that the numbers have no relation to reality.) (show work) (20 pts)

$$P_2 = 1.11 \text{ atm}$$

$$T_2 = 157.2 \text{ K}$$

$$V_2 = 3.22 \text{ L}$$

$$P_1 = ?$$

$$T_1 = 275.2 \text{ K}$$

$$V_1 = 1.07 \text{ L}$$

$$\frac{P_1 V_1}{P_2 V_2} = \frac{T_1}{T_2}$$

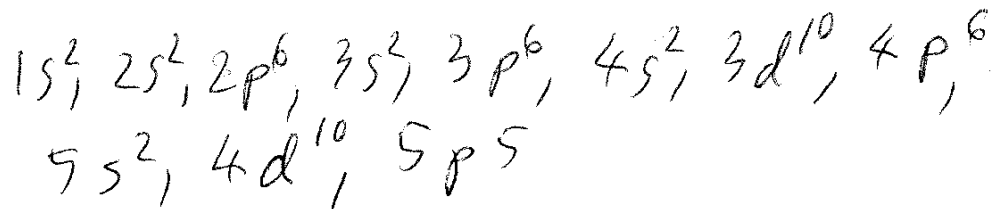
$$P_1 = \left(\frac{T_1}{T_2} \right) \left(\frac{P_2 V_2}{V_1} \right)$$

$$P_1 = \frac{(275.2 \text{ K})(1.11 \text{ atm})(3.22 \text{ L})}{(157.2 \text{ K})(1.07 \text{ L})}$$

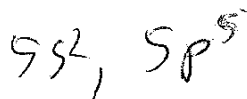
$$P_1 = 5.85 \text{ atm}$$

3. Electron Configuration Question: (28 pts total)

(a) Give the electron configuration for the element **I**. You should use the format of $(1s^2, 2s^2, \text{etc.})$. This is not me giving the start of your electron configuration but just telling you the format for your answer.) DO NOT USE THE SHORTCUT ELECTRON CONFIGURATION USING THE NOBLE GAS. (10 pts)



(b) What is the **valence** electron configuration for the same uncharged element **I**? Give the valence electron configuration in the form of $(1s^2, 2s^2 \text{ etc.})$. This is not me giving the start of your electron configuration but just telling you the format for your answer) (9 pts)



(c) Give an orbital diagram for the **valence** electron configuration for the element **I** using the format with up or down arrows for electrons. (9 pts)

$\begin{array}{c} \underline{1} \downarrow \underline{1} \\ 1s \quad 2s \quad 2p \end{array}$ You should show the **lowest energy at the bottom** of this space and the **highest energy at the top** of this space. (I typed the orbitals so that I can draw the thing on one line for ease of typing, you should show any difference in energy by drawing lines on a different level.)

