

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. (2 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. 1 atm = 760 mm Hg = 760 torr
 $K = ^\circ C + 273.15$ $P_{total} = P_A + P_B + P_C + \dots$ $X = n_A / n_{total} = P_A / P_{total}$ 1 mole of gas = 22.4 Liters

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
No partial credit for MC. (2 pts per question, 22 pts total)

- 1) Give the numbers for m_l for a p subshell ($l = 1$).
A) -1, 0, 1 B) 0, 1 C) -2, -1, 0, 1, 2 D) 1, 2 1) A
- 2) An anion of -2 indicates that an element has
A) lost two protons.
B) lost two neutrons.
C) gained two protons.
D) lost two electrons.
E) gained two electrons. 2) E
- 3) Describe the shape of a s orbital.
A) three balls
B) eight balls
C) spherical 3) C
D) four balls
E) dumbbell shaped
- 4) A triple covalent bond contains _____ of electrons.
A) 2 pairs B) 4 pairs C) 0 pairs D) 3 pairs E) 1 pair 4) D
- 5) Identify the compound with ionic bonding.
A) S B) He C) H₂O D) NaBr E) Na 5) D
- 6) For a wave the distance between adjacent crests is called
A) wavelength 6) A
B) amplitude
C) median
D) area
E) frequency
- 7) Which reaction below represents the electron affinity of Li? 7) E
A) $Li^+(g) + e^- \rightarrow Li(g)$
B) $Li(g) + e^- \rightarrow Li^-(g)$
C) $Li(g) \rightarrow Li^+(g) + e^-$
D) $Li^+(g) \rightarrow Li(g) + e^-$
E) $Li(g) + e^- \rightarrow Li^-(g)$

- 8) No two electrons can have the same four quantum numbers is known as the 8) D
A) Hund's rule
B) Aufbau principle
C) Heisenberg uncertainty principle
D) Pauli exclusion principle
- 9) Which of the following quantum numbers describes the distance of the electron from the nucleus ? 9) D
A) angular momentum quantum number
B) spin quantum number
C) magnetic quantum number
D) principal quantum number
E) Schrödinger quantum number
- 10) How many valence electrons do the noble gases (group VIIIA) possess? 10) D
A) 1
B) 7
C) 6
D) 8
E) 2
- 11) The total pressure of a gas mixture is the sum of the partial pressure of its components is known as 11) C
A) Boyle's Law
B) Charles's Law
C) Dalton's Law
D) Ideal Gas Law
E) Avogadro's Law

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.

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1 a. 1 mole of the gas $\text{H}_2\text{O}(\text{g})$ (6 pts total, 2 pts each)

at STP occupies 22.4 liters.

b. 2.5 moles of the gas $\text{H}_2\text{O}(\text{g})$ at STP occupies 56.0 liters. (show work)

$$\begin{array}{l} 2.5 \text{ mol} \\ \text{gas} \end{array} \times \frac{22.4 \text{ l}}{1 \text{ mol gas}} =$$

c. STP is a pressure of 1.0 atmospheres and 0 °C temperature

2. The equations shown may help you answer the questions which follow ($E=h\nu$ $E=hc/\lambda$, E =energy, h = Planck's constant, c = speed of light, ν = frequency λ = wavelength) (4 pts total, 2 pts each)

a. In general energy (E) [(increases) or (decreases)] (circle one) with higher frequency (ν) of electromagnetic waves.

b. Energy (E) [(increases) or (decreases)] (circle one) with higher wavelength (λ) of electromagnetic waves

3a. How many orbitals are in the **f** subshell? (f is the angular momentum quantum number of $\ell = 3$)

[(0) (1) (3) (5) (7) (14)] (circle one) ^{-3, -2, -1, 0, 1, 2, 3} (4 pts total, 2 pts each this number)

b. How many maximum number of electrons are allowed in the **f** subshell?

[(2) (6) (10) (14)] (circle one) (2 pts)

4. a. In the periodic table the angular momentum quantum number (ℓ) = zero (or s) matches the part of the periodic table in **group** (using the designation from the periodic table attached to your exam) (6 pts total, 2 pts each)

[(IA & IIA) or (IIIA to VIIIA) or (3B to 2B)] (circle one of the parenthesis)

b. In the periodic table when you see elements in the transition metals on your way to the element for which you are trying to do the electron configuration, the d electrons have **period number** of

[(n) or (n-1) or (n-2)] (circle one of the parenthesis)

c. In the periodic table period number matches

[(principal quantum number, n) or (angular momentum quantum number, l) or (magnetic quantum number m_l) or (spin quantum number m_s)] (circle one of the parenthesis)

5. For the symbol $3p^6$ (6 pts total, 2 pts each)

a. 3 means [(period number) or (there are 3 electrons)] (circle one)

b. p means [(electrons are being added to p subshell) or (p is principal quantum number, n)] (circle one)

c. superscript 6 means

[(period number) or (there are 6 electrons in $3p$)] (circle one)

6. Considering periodic properties: (6 pts, 3 pts each)

a. Which atom is bigger? [(B) or (F)] [(circle one)]

→ smaller size

b. Which atom has higher ionization energy [(C) or (F)] (circle one) $IE \rightarrow$ bigger

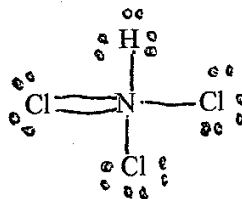
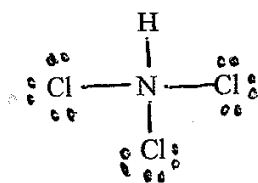
7. Lewis Dot Structure: (11 pts total)

a. For the molecule HNCl_3^+ how many valence electrons are in the molecule? Show work. (5 pts)

$$\begin{array}{cccc} \text{H} & \text{N} & \text{Cl} & \\ 1 & 5 & 7 \times 3 & = 27 - 1 = 26 \end{array}$$

change

b. For the molecule HNCl_3^+ circle the letter under the correct Lewis Dot Structure. (4 pt)



expand orbit

c. Explain in a few words one incorrect thing about the incorrect Lewis Dot Structure. (2 pts)

(b) has too many e, H cannot have more than duet, N in period 2 cannot

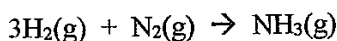
Part III. Long Answer Please show work for full credit and to receive partial credit. (33 pts)
**** Please attempt every problem for partial credit. You will get no partial credit if you just rewrite the question with no change in anything. ****

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1. Stoichiometry of Gases and Dalton's Law question: (12 pts)

(HINT: if you don't know the answer to the earlier question but know how to do the later question, just make up some number and continue with the question. You will get full credit for the later questions if you show correct work even if the answer is totally ridiculous.)

a. For the reaction shown below, how many moles of the gas $\text{NH}_3(\text{g})$ is generated if you start with 2.5 moles of $\text{H}_2(\text{g})$? (show work) (4 pts)



$$2.5 \text{ mol } \underset{\text{H}_2}{\times} \frac{1 \text{ mol } \text{NH}_3}{3 \text{ mol } \text{H}_2} = 0.83 \text{ mol } \text{NH}_3$$

b. If the gas is collected in an enclosed container containing a total of 9.2 moles (n_{total}) of all gases, what is the mole fraction (X_{NH_3}) of the gas $\text{NH}_3(\text{g})$ in the total volume? ($X = n_A/n_{\text{total}} = P_A/P_{\text{total}}$) (show work) (4 pts)

$$X_{\text{NH}_3} = \frac{0.83 \text{ mol } \text{NH}_3}{9.2 \text{ total moles}} = 0.090$$

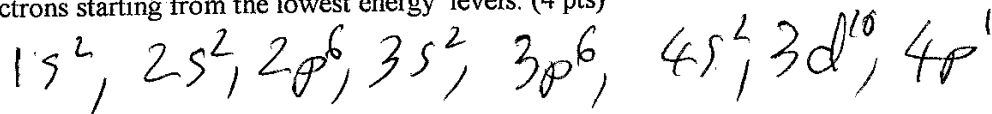
c. If the total pressure (P_{total}) of the gases is 3.5 atm, what is the pressure of the gas (P_{NH_3}) inside the cylinder. (show work) (4 pts)

$$X_{\text{NH}_3} = \frac{P_{\text{NH}_3}}{3.5 \text{ atm}} = 0.090$$

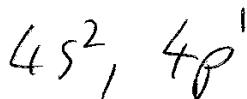
$$P_{\text{NH}_3} = (0.090)(3.5 \text{ atm}) = 0.32 \text{ atm}$$

2. Electron Configuration Problem: (21 pts)

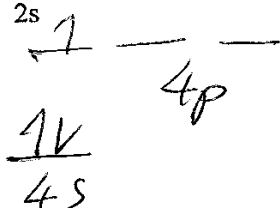
(a). Give the electron configuration for the element Ga using the notation ($1s^2, 2s^2, \dots$). Show all electrons starting from the lowest energy levels. (4 pts)



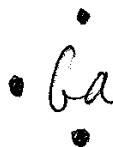
(b). What is the valence electron configuration for the element Ga? use same notation as in (a) above (4 pts)



(c). Give the electron configuration diagram for the valence electrons for the same element Ga. (4 pts) (use the notation $\frac{1 \downarrow}{1s} \frac{1 \downarrow}{2s} \dots$ in which you use arrows to represent electrons)

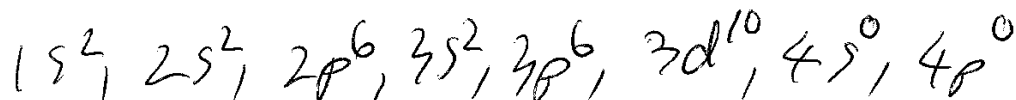


(d) Give the Lewis Dot Symbol for the element Ga (4 pts)



(e) For the ion Ga^{+3} , give the electron configuration in the format $1s^2, 2s^2, \dots$ etc. (5 pts)

remove 3 e



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 $K = ^\circ C + 273.15$ $P_{\text{total}} = P_A + P_B + P_C + \dots$ $X = n_A / n_{\text{total}} = P_A / P_{\text{total}}$ 1 mole of gas = 22.4 Liters

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. No partial credit for MC. (2 pts per question, 22 pts total)

- 1) An anion of -2 indicates that an element has 1) E
 A) lost two electrons.
 B) gained two protons.
 C) lost two neutrons.
 D) lost two protons.
 E) gained two electrons.
- 2) Which of the following quantum numbers describes the distance of the electron from the nucleus ? 2) E
 A) magnetic quantum number
 B) Schrödinger quantum number
 C) angular momentum quantum number
 D) spin quantum number
 E) principal quantum number
- 3) How many valence electrons do the noble gases (group VIIIA) possess? 3) B
 A) 6 B) 8 C) 1 D) 7 E) 2
- 4) For a wave the distance between adjacent crests is called 4) C
 A) area
 B) median
 C) wavelength
 D) frequency
 E) amplitude
- 5) A triple covalent bond contains _____ of electrons. 5) E
 A) 1 pair B) 0 pairs C) 2 pairs D) 4 pairs E) 3 pairs
- 6) No two electrons can have the same four quantum numbers is known as the 6) A
 A) Pauli exclusion principle B) Hund's rule
 C) Aufbau principle D) Heisenberg uncertainty principle

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

7) D

8) Identify the compound with ionic bonding.

- A) NaBr
- B) Na
- C) He
- D) S
- E) H_2O

8) A

9) Give the numbers for m_l for a p subshell ($l = 1$).

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

9) C

10) Describe the shape of a s orbital.

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

10) C

11) The total pressure of a gas mixture is the sum of the partial pressure of its components is known as

- A) Ideal Gas Law
- B) Avogadro's Law
- C) Boyle's Law
- D) Dalton's Law
- E) Charles's Law

11) 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.

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1 a. 1 mole of the gas CO(g) (6 pts total, 2 pts each)

at STP occupies 22.4 liters.

b. 7.2 moles of the gas CO(g) at STP occupies 161 liters. (show work)

$$7.2 \text{ mol CO} \times \frac{22.4 \text{ L}}{1 \text{ mol CO}} =$$

c. STP is a temperature of 0 °C and 1.0 atmospheres pressure

2. The equations shown may help you answer the questions which follow ($E = h\nu$, $E = hc/\lambda$, E =energy, h = Planck's constant, c = speed of light, ν = frequency, λ = wavelength) (4 pts total, 2 pts each)

a. Energy (E) [(increases) or (decreases)] (circle one) with higher wavelength (λ) of electromagnetic waves

b. In general energy (E) [(increases) or (decreases)] (circle one) with higher frequency (ν) of electromagnetic waves.

3a. How many orbitals are in the s subshell? (s is the angular momentum quantum number of $\ell = 0$)

[(0) (1) (3) (5)] (circle one) (4 pts total, 2 pts each this number)

b. How many maximum number of electrons are allowed in the s subshell?

(2) (6) (10) (14)] (circle one) (2 pts)

4. a. In the periodic table **period number** matches (6 pts total, 2 pts each)

(principal quantum number, n) (angular momentum quantum number, ℓ) (magnetic quantum number m_ℓ) (spin quantum number m_s) (circle one)

b. In the periodic table the angular momentum quantum number (ℓ) = one (or p) matches the part of the periodic table in **group** (using the designation from the periodic table attached to your exam)

[(IA & IIA) or (IIIA to VIIIA) or (3B to 2B)] (circle one of the parenthesis)

c. In the periodic table when you see elements in the transition metals on your way to the element for which you are trying to do the electron configuration, the d electrons have period number of

[(n) or (n-1) or (n-2)] (circle one)

5. For the symbol $2p^3$ (6 pts total, 2 pts each)

a. p means [(electrons are being added to the p subshell) or (p is principal quantum number, n)] (circle one)

b. superscript 3 means

[(there are 3 electrons in 2p) (there are 2 electrons in 3rd period)] (circle one)

c. 2 means [(period number) or (there are 2 electrons)] (circle one)

6. Considering periodic properties: (6 pts, 3 pts each)

a. Which atom is bigger? [(Sb) or (N)] (circle one)

↓ bigger size

b. Which atom has higher ionization energy [(F) or (I)] (circle one)

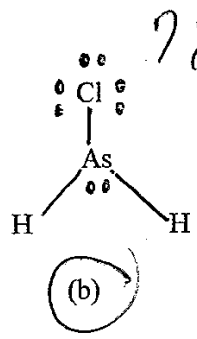
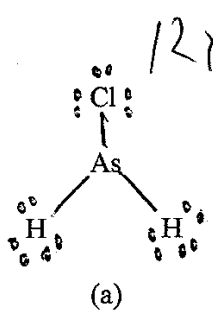
IE opposite ↓ to size smaller

7. Lewis Dot Structure: (11 pts total)

a. For the molecule AsH_2Cl how many valence electrons are in the molecule? Show work. (5 pts)

$$\begin{array}{ccc} As & H & Cl \\ 5 + 2(1) + 7 & = & 14 \end{array}$$

b. For the molecule AsH_2Cl circle the letter under the correct Lewis Dot Structure. (4 pt)



c. Explain in a few words one incorrect thing about the incorrect Lewis Dot Structure. (2 pts)

@ 600 more e⁻, H can only have duet not octet As has less than octet

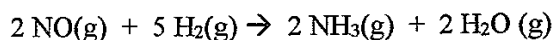
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1. Stoichiometry of Gases and Dalton's Law question: (12 pts)

(HINT: if you don't know the answer to the earlier question but know how to do the later question, just make up some number and continue with the question. You will get full credit for the later questions if you show correct work even if the answer is totally ridiculous.)

a. For the reaction shown below, how many moles of the gas $\text{H}_2\text{O}(\text{g})$ is generated if you start with 0.77 moles of $\text{H}_2(\text{g})$? (show work) (4 pts)



$$0.77 \text{ mol } \underset{\text{H}_2}{\times} \frac{2 \text{ mol H}_2\text{O}}{5 \text{ mol H}_2} = 0.31 \text{ mol H}_2\text{O}$$

b. If the gas is collected in an enclosed container containing a total of 1.5 moles (n_{total}) of all gases, what is the mole fraction ($X_{\text{H}_2\text{O}}$) of the gas $\text{H}_2\text{O}(\text{g})$ in the total volume? ($X = n_A/n_{\text{total}} = P_A/P_{\text{total}}$) (show work) (4 pts)

$$X_{\text{H}_2\text{O}} = \frac{0.31 \text{ mol H}_2\text{O}}{1.5 \text{ mol all gases}} = 0.21$$

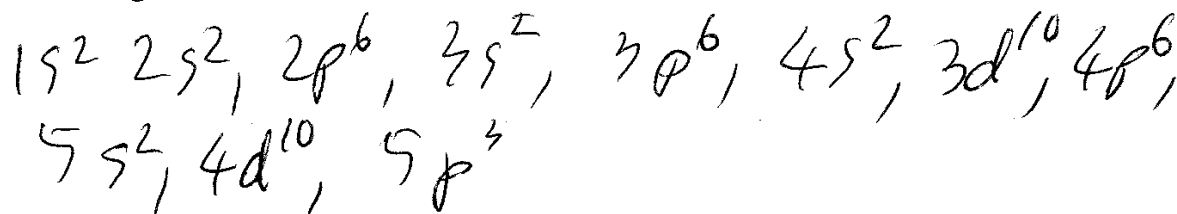
c. If the total pressure (P_{total}) of the gases is 7.2 atm, what is the pressure of the gas ($P_{\text{H}_2\text{O}}$) inside the cylinder. (show work) (4 pts)

$$X_{\text{H}_2\text{O}} = \frac{P_{\text{H}_2\text{O}}}{7.2 \text{ atm}} = 0.21$$

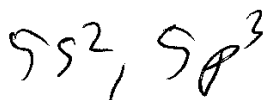
$$P_{\text{H}_2\text{O}} = (0.21)(7.2) = 1.5 \text{ atm}$$

2. Electron Configuration Problem: (21 pts)

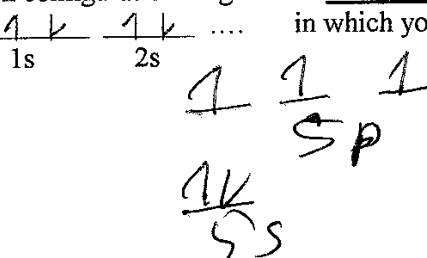
(a). Give the electron configuration for the element **Sb** using the notation ($1s^2, 2s^2, \dots$). Show all electrons starting from the lowest energy levels. (4 pts)



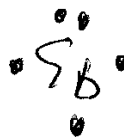
(b). What is the valence electron configuration for the element **Sb**? use same notation as in (a) above (4 pts)



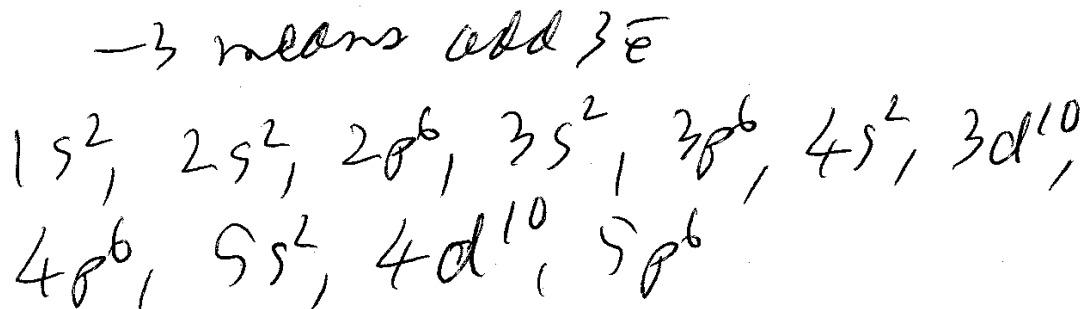
(c). Give the electron configuration diagram for the valence electrons for the same element **Sb** (4 pts) (use the notation $\frac{1 \downarrow}{1s} \frac{1 \downarrow}{2s} \dots$ in which you use arrows to represent electrons)



(d) Give the Lewis Dot Symbol for the element **Sb** (4 pts)



(e) For the ion **Sb³⁻**, give the electron configuration in the format $1s^2, 2s^2, \dots$ etc. (5 pts)



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 $K = ^\circ\text{C} + 273.15$ $P_{\text{total}} = P_A + P_B + P_C + \dots$ $X = n_A / n_{\text{total}} = P_A / P_{\text{total}}$ 1 mole of gas = 22.4 Liters

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. No partial credit for MC. (2 pts per question, 22 pts total)

- 1) Which of the following quantum numbers describes the shape of an subshell? 1) C
 A) magnetic quantum number
 B) spin quantum number
 C) angular momentum quantum number ($l = s, p, d, f$)
 D) Schrödinger quantum number
 E) principal quantum number
- 2) A double covalent bond contains _____ of electrons. 2) A
 A) 2 pairs B) 3 pairs C) 1 pair D) 4 pairs E) 0 pairs
- 3) Identify the compound with covalent bonding. 3) A
 A) H_2O B) He C) NaBr D) S E) Na
- 4) Give the numbers for m_l for a d subshell ($l = 2$). 4) C
 A) 1, 2, 3 B) 0, 1, 2 C) -2, -1, 0, 1, 2 D) -1, 0, 1
- 5) How many valence electrons do the alkali metals (group IA) possess? 5) E
 A) 2 B) 7 C) 6 D) 8 E) 1
- 6) A cation of +2 indicates that an element has 6) C
 A) gained two electrons.
 B) lost two neutrons.
 C) lost two electrons.
 D) lost two protons.
 E) gained two protons.
- 7) Which reaction below represents the first ionization of O? 7) E
 A) $\text{O}(\text{g}) + e^- \rightarrow \text{O}(\text{g})$
 B) $\text{O}(\text{g}) \rightarrow \text{O}(\text{g}) + e^-$
 C) $\text{O}(\text{g}) + e^- \rightarrow \text{O}(\text{g})$
 D) $\text{O}(\text{g}) + e^- \rightarrow \text{O}^{2-}(\text{g})$
 E) $\text{O}(\text{g}) \rightarrow \text{O}(\text{g}) + e^-$

- 8) For a wave the number of cycles that pass through a stationary point is called 8) E
- A) median
 - B) amplitude
 - C) wavelength
 - D) area
 - E) frequency
- 9) Describe the shape of a p orbital. 9) A
- A) dumbbell shaped
 - B) eight balls
 - C) four balls
 - D) spherical
 - E) three balls
- 10) The total pressure of a gas mixture is the sum of the partial pressure of its components is known as 10) D
- A) Boyle's Law
 - B) Ideal Gas Law
 - C) Charles's Law
 - D) Dalton's Law
 - E) Avogadro's Law
- 11) When filling degenerate orbitals, electrons fill them singly first, with parallel spins and then the electrons double up inside the orbitals. This is known as 11) B
- A) Aufbau principle
 - B) Hund's rule
 - C) Pauli exclusion principle
 - D) Heisenberg uncertainty principle

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.

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1 a. 1 mole of the gas $\text{NH}_3(\text{g})$ (6 pts total, 2 pts each)

at STP occupies 22.4 liters.

b. 3.22 moles of the gas $\text{NH}_3(\text{g})$ at STP occupies 72.1 liters. (show work)

$$3.22 \text{ mol } \text{NH}_3 \times \frac{22.4 \text{ L}}{1 \text{ mol}} =$$

c. STP is a temperature of 0 °C and 1.0 atmospheres pressure

2. The equations shown may help you answer the questions which follow ($E = h\nu$ $E = hc/\lambda$, E =energy, h = Planck's constant, c = speed of light, ν = frequency λ = wavelength) (4 pts total, 2 pts each)

a. In general energy (E) [increases] or (decreases)] (circle one) with higher frequency (ν) of electromagnetic waves.

b. Energy (E) [(increases) or decreases] (circle one) with higher wavelength (λ) of electromagnetic waves

3a. How many orbitals are in the p subshell? (p is the angular momentum quantum number $\ell = 1$)

[(0) (1) (3) (5)] (circle one) (4 pts total, 2 pts each this number)

b. How many maximum number of electrons are allowed in the p subshell?

[(2) (6) (10) (14)] (circle one) (2 pts)

4. a. In the periodic table the angular momentum quantum number (ℓ) = two (or d) matches the part of the periodic table in **group** (using the designation from the periodic table attached to your exam) (6 pts total, 2 pts each)

[(IA & IIA) or (IIIA to VIIIA) or (3B to 2B)] (circle one of the parenthesis)

b. In the periodic table **period number** matches

[(principal quantum number, n) (angular momentum quantum number, ℓ) (magnetic quantum number, m_l) (spin quantum number m_s)] (circle one)

c. In the periodic table when you see elements in the transition metals on your way to the element for which you are trying to do the electron configuration, the d electrons have period number of

[(n) or (n-1) or (n-2)] (circle one)

5. For the symbol $4s^2$ (6 pts total, 2 pts each)

a. s means (electrons are being added to the s subshell) (s is principal quantum number, n)] (circle one)

b. 4 means (period number) (there are 4 electrons)] (circle one)

c. superscript 2 means (there are 2 electrons in 4s) (there are 4 electrons in 2 s)] (circle one)

6. Considering periodic properties: (6 pts, 3 pts each)

a. Which atom is bigger? [(Ca) or (K)] [(circle one) \rightarrow smaller size]

b. Which atom has higher ionization energy [(Be) or (Ra)] (circle one) IE opposite \downarrow to size, smaller

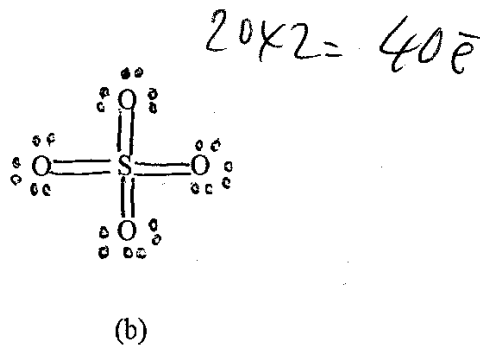
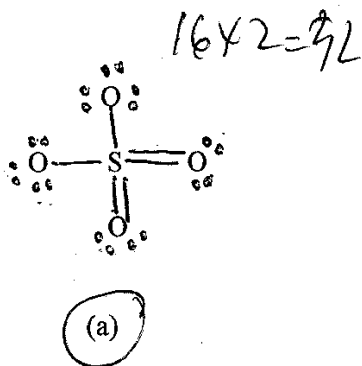
7. Lewis Dot Structure: (11 pts total)

a. For the molecule SO_4^{2-} how many valence electrons are in the molecule? Show work. (5 pts)

$$S \quad O \quad \text{charge}$$

$$6 + (6)4 + 2 = 32 e^-$$

b. For the molecule SO_4^{2-} circle the letter under the correct Lewis Dot Structure. (4 pt)



c. Explain in a few words one incorrect thing about the incorrect Lewis Dot Structure. (2 pts)

(b) has too many e, O has more than octet period 2 not allowed, (S can expand octet)

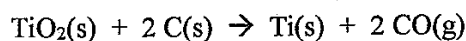
Part III. Long Answer Please show work for full credit and to receive partial credit. (33 pts)
**** Please attempt every problem for partial credit. You will get no partial credit if you just rewrite the question with no change in anything.****

Please show all work on this exam itself. If you are going to show work on the scratch paper and want me to grade it, clearly indicate where I can find your work otherwise, I obviously cannot grade work I cannot find.

1. Stoichiometry of Gases and Dalton's Law question: (12 pts)

(HINT: if you don't know the answer to the earlier question but know how to do the later question, just make up some number and continue with the question. You will get full credit for the later questions if you show correct work even if the answer is totally ridiculous.)

a. For the reaction shown below, how many moles of the gas CO(g) is generated if you start with 1.9 moles of $\text{TiO}_2\text{(s)}$? (show work) (4 pts)



$$1.9 \text{ mol TiO}_2 \times \frac{2 \text{ mol CO}}{1 \text{ mol TiO}_2} = 3.8 \text{ mol CO}$$

b. If the gas is collected in an enclosed container containing a total of 7.7 moles (n_{total}) of all gases, what is the mole fraction (X_{CO}) of the gas CO(g) in the total volume? ($X = n_A/n_{\text{total}} = P_A/P_{\text{total}}$) (show work) (4 pts)

$$X_{\text{CO}} = \frac{3.8 \text{ mol CO}}{7.7 \text{ mol}} = 0.49$$

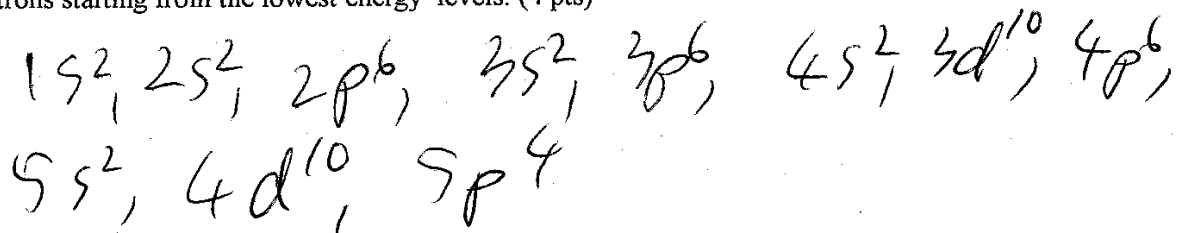
c. If the total pressure (P_{total}) of the gases is 1.2 atm, what is the pressure of the gas (P_{CO}) inside the cylinder. (show work) (4 pts)

$$X_{\text{CO}} = \frac{P_{\text{CO}}}{1.2 \text{ atm}} = 0.49$$

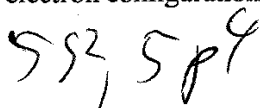
$$P_{\text{CO}} = (0.49)(1.2 \text{ atm}) = 0.59 \text{ atm}$$

2. Electron Configuration Problem: (21 pts)

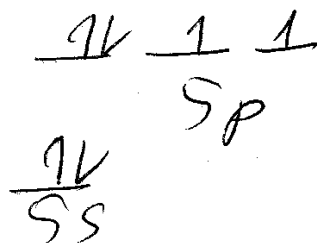
(a). Give the electron configuration for the element Te using the notation ($1s^2, 2s^2, \dots$). Show all electrons starting from the lowest energy levels. (4 pts)



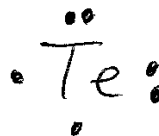
(b). What is the valence electron configuration for the element Te? use same notation as in (a) above (4 pts)



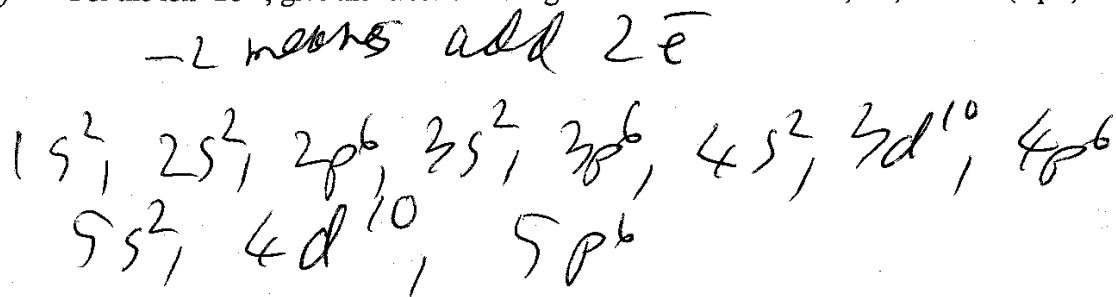
(c). Give the electron configuration diagram for the valence electrons for the same element Te (4 pts) (use the notation $\frac{\uparrow\downarrow}{1s} \frac{\uparrow\downarrow}{2s} \dots$ in which you use arrows to represent electrons)



(d) Give the Lewis Dot Symbol for the element Te (4 pts)



(e) For the ion Te^{2-} , give the electron configuration in the format $1s^2, 2s^2, \dots$ etc. (5 pts)



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. (2 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. 1 atm = 760 mm Hg = 760 torr
 $K = ^\circ\text{C} + 273.15$ $P_{\text{total}} = P_A + P_B + P_C + \dots$ $X = n_A / n_{\text{total}} = P_A / P_{\text{total}}$ 1 mole of gas = 22.4 Liters

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.
 No partial credit for MC. (2 pts per question, 22 pts total)

- 1) A cation of +2 indicates that an element has 1) B
 A) gained two electrons.
 B) lost two electrons.
 C) lost two neutrons.
 D) gained two protons.
 E) lost two protons.
- 2) For a wave the number of cycles that pass through a stationary point is called 2) B
 A) wavelength
 B) frequency
 C) area
 D) median
 E) amplitude
- 3) The total pressure of a gas mixture is the sum of the partial pressure of its components is known as 3) A
 A) Dalton's Law
 B) Boyle's Law
 C) Ideal Gas Law
 D) Avogadro's Law
 E) Charles's Law
- 4) How many valence electrons do the alkali metals (group IA) possess? 4) E
 A) 2 B) 6 C) 7 D) 8 E) 1
- 5) A double covalent bond contains _____ of electrons. 5) D
 A) 3 pairs B) 0 pairs C) 1 pair D) 2 pairs E) 4 pairs
- 6) When filling degenerate orbitals, electrons fill them singly first, with parallel spins and then the electrons double up inside the orbitals. This is known as 6) A
 A) Hund's rule B) Heisenberg uncertainty principle
 C) Pauli exclusion principle D) Aufbau principle
- 7) Identify the compound with covalent bonding. 7) A
 A) H_2O B) Na C) He D) NaBr E) S

- 8) Which of the following quantum numbers describes the shape of an subshell? 8) D
- A) spin quantum number
 - B) principal quantum number
 - C) magnetic quantum number
 - D) angular momentum quantum number ($l = s, p, d, f$)
 - E) Schrödinger quantum number
- 9) Describe the shape of a p orbital. 9) C
- A) three balls
 - B) eight balls
 - C) dumbbell shaped
 - D) spherical
 - E) four balls
- 10) Which reaction below represents the first ionization of O? 10) B
- A) $O(g) + e^- \rightarrow O^{2-}(g)$
 - B) $O(g) \rightarrow O^+(g) + e^-$
 - C) $O^+(g) + e^- \rightarrow O(g)$
 - D) $O(g) \rightarrow O(g) + e^-$
 - E) $O(g) + e^- \rightarrow O^-(g)$
- 11) Give the numbers for m_l for a d subshell ($l = 2$). 11) B
- A) -1, 0, 1
 - B) -2, -1, 0, 1, 2
 - C) 1, 2, 3
 - D) 0, 1, 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.

Please show all work on this exam itself. If you are going to show work on the scratch paper and want me to grade it, clearly indicate where I can find your work. (43 pts)

1 a. 1 mole of the gas $\text{CO}_2(\text{g})$ (6 pts total, 2 pts each)

at STP occupies 22.4 liters.

b. 17.3 moles of the gas $\text{CO}_2(\text{g})$ at STP occupies 385 liters. (show work)

$$17.3 \text{ mol } \text{CO}_2 \times \frac{22.4 \text{ L}}{1 \text{ mol } \text{CO}_2} = 385$$

c. STP is a pressure of 1.0 atmospheres and temperature 0 °C

2. The equations shown may help you answer the questions which follow ($E = h\nu$, $E = hc/\lambda$, E =energy, h = Planck's constant, c = speed of light, ν = frequency, λ = wavelength) (4 pts total, 2 pts each)

a. Energy (E) [(increases) or (decreases)] (circle one) with higher wavelength (λ) of electromagnetic waves

b. In general energy (E) [(increases) or (decreases)] (circle one) with higher frequency (ν) of electromagnetic waves.

3 a. How many orbitals are in the **d** subshell? (d is the angular momentum quantum number of $\ell = 2$)

[(0) (1) (3) (5)] (circle one) (4 pts total, 2 pts each this number)

b. How many maximum number of electrons are allowed in the **d** subshell?

[(2) (6) (10) (14)] (circle one) (2 pts)

4 a. In the periodic table **period number** matches (6 pts total, 2 pts each)

{(principal quantum number, n) (angular momentum quantum number, ℓ) (magnetic quantum number m_ℓ) (spin quantum number m_s)} (circle one parenthesis)

b. In the periodic table the angular momentum quantum number (ℓ) = one (or p) matches the part of the periodic table in **group** (using the designation from the periodic table attached to your exam)

[(IA & IIA) or (IIIA to VIIIA) or (3B to 2B)] (circle one of the parenthesis)

c. In the periodic table when you see elements in the transition metals on your way to the element for which you are trying to do the electron configuration, the d electrons have principal quantum number (period number) of

[(n) or (n-1) or (n-2)] (circle one)

5. For the symbol $5d^4$ (6 pts total, 2 pts each)

a. 5 means [(period number) (there are 5 electrons)] (circle one parenthesis)

b. d means [(electrons are being added to the d subshell) (d is principal quantum number, n)] (circle one parenthesis)

c. superscript 4 means [(period number) or (there are 4 electrons in 5d)] (circle one parenthesis)

6. Considering periodic properties: (6 pts, 3 pts each)

a. Which atom is bigger? [(Ge) or (C)] [(circle one)]

bigger size

b. Which atom has higher ionization energy [(Al) or (Ar)] (circle one)

smaller size
IE bigger

7. Lewis Dot Structure: (11 pts total)

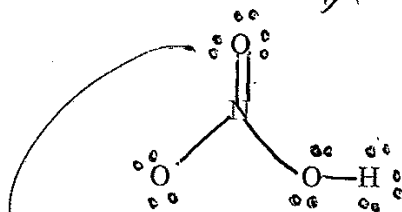
a. For the molecule HNO_3 how many valence electrons are in the molecule? Show work. (5 pts)

$$\begin{array}{ccc} H & N & O \\ 1 + & 5 + & 3(6) = 24 \end{array}$$

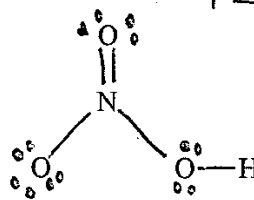
b. For the molecule HNO_3 circle the letter under the correct Lewis Dot Structure. (4 pt)

$$15 \times 2 = 30$$

$$12 \times 2 = 24$$



(a)



(b)

c. Explain in a few words one incorrect thing about the incorrect Lewis Dot Structure. (2 pts)

① H can only have duet ② O has less than octet ③ has more than octet

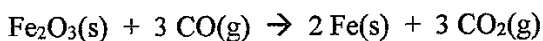
Part III. Long Answer Please show work for full credit and to receive partial credit. (33 pts)
 **** Please attempt every problem for partial credit. You will get no partial credit if you just rewrite the question with no change in anything. ****

Please show all work on this exam itself. If you are going to show work on the scratch paper and want me to grade it, clearly indicate where I can find your work otherwise, I obviously cannot grade work I cannot find.

1. Stoichiometry of Gases and Dalton's Law question: (12 pts)

(HINT: if you don't know the answer to the earlier question but know how to do the later question, just make up some number and continue with the question. You will get full credit for the later questions if you show correct work even if the answer is totally ridiculous.)

a. For the reaction shown below, how many moles of the gas $\text{CO}_2(\text{g})$ is generated if you start with 0.038 moles of $\text{Fe}_2\text{O}_3(\text{s})$? (show work) (4 pts)



$$0.038 \text{ mol Fe}_2\text{O}_3 \times \frac{3 \text{ mol CO}_2}{1 \text{ mol Fe}_2\text{O}_3} = 0.11 \text{ mol CO}_2$$

b. If the gas is collected in an enclosed container containing a total of 0.55 moles (n_{total}) of all gases, what is the mole fraction (X_{CO_2}) of the gas $\text{CO}_2(\text{g})$ in the total volume? ($X = n_A/n_{\text{total}} = P_A/P_{\text{total}}$) (show work) (4 pts)

$$X_{\text{CO}_2} = \frac{0.11 \text{ mol CO}_2}{0.55 \text{ mol all gases}} = 0.20$$

c. If the total pressure (P_{total}) of the gases is 4.3 atm, what is the pressure of the gas (P_{CO_2}) inside the cylinder. (show work) (4 pts)

$$X_{\text{CO}_2} = \frac{P_{\text{CO}_2}}{P_{\text{total}}}$$

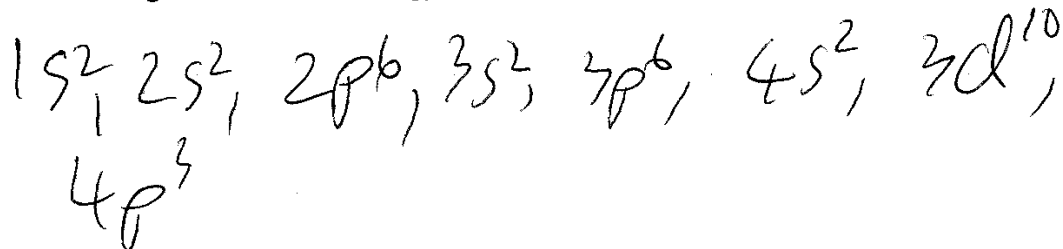
$$0.20 = \frac{P_{\text{CO}_2}}{4.3 \text{ atm}}$$

$$P_{\text{CO}_2} = (0.20)(4.3 \text{ atm})$$

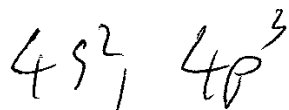
$$P_{\text{CO}_2} = 0.86 \text{ atm}$$

2. **Electron Configuration Problem: (21 pts)**

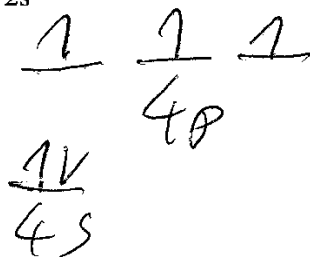
(a). Give the electron configuration for the element **As** using the notation ($1s^2, 2s^2, \dots$). Show all electrons starting from the lowest energy levels. (4 pts)



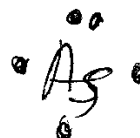
(b). What is the valence electron configuration for the element **As**? use same notation as in (a) above (4 pts)



(c). Give the electron configuration diagram for **the valence electrons** for the same element **As**. (4 pts) (use the notation $\frac{1 \downarrow}{1s} \frac{1 \downarrow}{2s} \dots$ in which you use arrows to represent electrons)



(d) Give the Lewis Dot Symbol for the element **As** (4 pts)



(e) For the ion **As³⁻**, give the electron configuration in the format $1s^2, 2s^2, \dots$ etc. (5 pts)

