

PART I (39 pts.) **Multiple Choice.** Choose one correct answer for each of the following 13 questions and mark it on both the attached answer sheet and on the exam. Only the answer sheet will be graded. Each multiple question is worth three (3) points.

- Which of the following has an enthalpy change corresponding to the lattice energy of aluminum fluoride?
 - $\text{Al}^{3+}(\text{g}) + 3\text{F}^{-}(\text{g}) \rightarrow \text{AlF}_3(\text{g})$
 - $\text{Al}(\text{g}) + 3/2 \text{F}_2(\text{g}) \rightarrow \text{AlF}_3(\text{s})$
 - $\text{Al}(\text{s}) + 3/2 \text{F}_2(\text{g}) \rightarrow \text{AlF}_3(\text{s})$
 - $\text{Al}^{3+}(\text{g}) + 3\text{F}^{-}(\text{g}) \rightarrow \text{AlF}_3(\text{s})$
 - none of the above
- Which one of the following is an exothermic process?
 - $\text{S}^{-}(\text{g}) + \text{e}^{-} \rightarrow \text{S}^{2-}(\text{g})$
 - $\text{K}(\text{s}) \rightarrow \text{K}(\text{g})$
 - $\text{K}(\text{g}) \rightarrow \text{K}^{+}(\text{g}) + \text{e}^{-}$
 - $\text{S}(\text{g}) + \text{e}^{-} \rightarrow \text{S}^{-}(\text{g})$
 - more than one of the above reactions
- Which of the above species is paramagnetic?
 - C_2^{2-}
 - N_2^{2+}
 - C_2^{2+}
 - N_2^{2-}
 - more than one of the above
- Which of the following has a N-O bond order that is not an integer (whole number) value? The central N atom is underlined
 - only $\underline{\text{N}}\text{O}_2^{+}$
 - only $\text{Cl}\underline{\text{N}}\text{O}$
 - only $\underline{\text{N}}\text{O}_2^{-}$
 - only $\text{Cl}_3\underline{\text{N}}\text{OH}$ (H is attached to O)
 - two or more of the above
- Of the following four species BF_3 PF_3 $\underline{\text{Si}}\text{F}_5^{-}$ IF_2^{-}
 - four have a molecular dipole moment
 - three have a molecular dipole moment
 - two have a molecular dipole moment
 - one has a molecular dipole moment
 - none has a molecular dipole moment
- The diatomic species with the smallest bond order is (predicted from MO theory)

- A. only Li_2^+
 B. only Be_2^{2-}
 C. only Li_2^-
 D. only Be_2^{2+}
 E. more than one of the above answers
7. The hybrid orbitals utilized for the P-C bond in F_2PCN are
- A. $\text{P}(\text{sp}^3) - \text{C}(\text{sp}^2)$
 B. $\text{P}(\text{sp}^2) - \text{C}(\text{sp})$
 C. $\text{P}(\text{sp}^3) - \text{C}(\text{sp})$
 D. $\text{P}(\text{sp}^2) - \text{C}(\text{sp}^2)$
 E. none of the above
8. Which of the following is not a valid Lewis dot structure for N_2O ?
- A. $\text{N}-\text{N}\equiv\text{O}$
 B. $\text{N}=\text{N}=\text{O}$
 C. $\text{N}\equiv\text{N}-\text{O}$
 D. $\text{N}=\text{N}-\text{O}$
 E. none of the above
9. A possible chemical of a gas with a gas density of 1.82 g/L at a pressure of 1064 torr and 27°C is:
- A. $\text{CH}_4(\text{g})$
 B. $\text{CO}_2(\text{g})$
 C. $\text{CO}(\text{g})$
 D. $\text{O}_2(\text{g})$
 E. none of the above
10. Sulfur dioxide gas, $\text{SO}_2(\text{g})$, effuses through a porous membrane at a root-mean-square speed of 400 m/s. If an unknown gas at the same temperature effuses through the membrane at 284 m/s, determine the molecular weight of the unknown gas.
- A. 45 g/mole
 B. 90 g/mole
 C. 127 g/mole
 D. 32 g/mole
 E. none of the above
11. A real gas mostly closely approaches ideal behavior at:

- A. 1.0 atm and 273 K
- B. 10.0 atm and 546 K
- C. 10.0 atm and 273 K
- D. 0.5 atm and 273 K
- E. 0.5 atm and 546 K

12. Which of the following bonds has the smallest polar character?

- A. N-O
- B. N-P
- C. N-N
- D. N-As
- E. N-Li

13. If 20.4g of Ar(g) are mixed with 1.36g of He(g) in a flask at a given temperature, the total pressure in the flask is found to be 5.0 atmospheres. Determine the partial pressure of He(g) in this flask. Atomic weights are 39.95 g/mol for Ar and 4.00 g/mol for He

- A. 2.0 atm
- B. 0.85 atm
- C. 3.0 atm
- D. 4.15 atm
- E. none of the above

PART IIA (31 pts.)

1. (14 pts.)

A. The common name of ${}_{74}\text{W}$ _____.

B. The common name of ${}_{86}\text{Rn}$ is _____.

C. The name of $\text{Fe}(\text{ClO}_3)_3$ is _____.

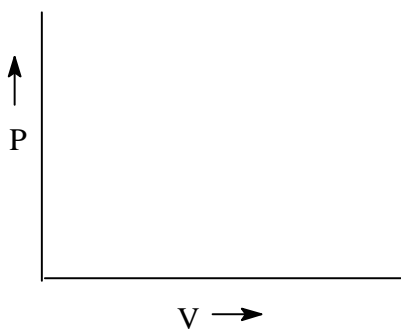
D. The formula of osmium(III) sulfite is _____.

E. An ionic compound containing only calcium and nitrate ions is _____.

F. A homonuclear diatomic species isoelectronic with a CF molecule is _____.

G. The mks units of one joule are _____.

2. (8 pts.) For each of the following two graphs (A. and B.):



A.



B.

A. Draw pressure versus volume curve for an ideal gas. State on graph the variables being held constant.

B. Draw two curves: solid-line curve of relative number of gaseous argon atoms (Ar, at.no.18) in one mole versus their atomic speeds at 25°C and dashed-line curve (on same graph) of relative number of gaseous argon atoms in one mole versus their atomic speeds at 927°C .

3. (9 pts.) Two equal masses (i.e, equal number of grams) of $\text{CO}(\text{g})$ and $\text{CO}_2(\text{g})$ are placed in separate

containers of equal volume and at the same temperature.

A. Which gas has the lowest pressure? Briefly explain why

B. Which gas has the smallest average kinetic energy? Briefly explain why

C. Which gas has the smallest root-mean-square speed? Briefly explain why.

PART IIB (24 pts.)

1. (12 pts.) For each of the following species in which the central atom is underlined answer the following. Describe each geometry in **words** instead of only a **drawing**.

A. $F_2\underline{N}O$ 1) Electron-pair geometry about central N atom _____
 2) Molecular geometry _____
 3) Hybridization at central N atom _____

B. $\underline{P}O_3^{3-}$ 1) Electron-pair geometry about central P atom _____
 2) Molecular geometry _____
 3) Hybridization at central P atom _____

2. (12 pts.) Draw an appropriate Lewis electron dot structure or resonance structures (**showing both the bonding and unshared electron pairs**) for each of the following species and identify the shape (geometry) of the molecule or ion. The underlined atom is the central atom to which each of the other atoms are linked. Describe the molecular geometry in **words** instead of only a **drawing**.

<u>Species</u>	<u>Lewis Structure (resonance structures)</u>	<u>Molecular Geometry</u>
A. $\underline{N}F_4^-$		
B. O_3 (Two O atoms attached to central O atom)		
C. $\underline{Se}F_5^-$		

PART IIC (9 pts.) For each of the following problems show your work with units.

1. (5 pts.) an automobile air bag is filled with nitrogen gas at room temperature (22°C) and a pressure of 850 torr by a gas-producing reaction involving the electric discharge of 200.0 g of solid sodium azide, $\text{NaN}_3(\text{s})$, to completely generate sodium metal and $\text{N}_2(\text{g})$ gas. Determine the resulting volume of gas produced in the air bag. Note that a balanced equation is needed.

answer _____

2. (4 pts.) Calculate the temperature in $^{\circ}\text{C}$ for which the root-mean-speed of oxygen molecules is 4280 m/s.

answer _____