

Name: HEY Section: \_\_\_\_\_**Part I. Multiple Choice: 4 points each**1. For ideal gasses at constant temperature, which of the following is *true*?

- A. The total kinetic energy of the gas particles is a function of the volume.  
 B. The particles are estimated to have no mass.  
 C. The root-mean-squared velocity of the gas particles is independent of temperature.  
 D. The total kinetic energy of the gas particles is independent of mass.  
 E. Ideal gas particles collide only with the walls of the container, not with each other.

2. The orbital that has the quantum numbers  $n=3$ ,  $l=2$ ,  $m_l=0$  is:

- A. 2s  
 B. 3s  
 C. 3p  
 D. 3d  
 E. 4d

3. Which of the following pairs of atoms/ions is isoelectronic?

- A.  $O^{2-}$ ,  $S^{2-}$   
 B. Na,  $Na^{+1}$   
 C.  $Br^{-1}$ , Kr  
 D. Cu, Zn  
 E. none of these

Both have the  $e^{-}$  configuration  
 $[Ar] 4s^2 3d^{10} 4p^6$

4. For a sample of He gas, which statement below is false according to kinetic molecular theory and Graham's law?

- A. At low pressure, there are no attractive forces between He atoms  
 B. At constant temperature, He atoms move faster than Ar atoms  
 C. At constant temperature, He atoms effuse faster than Ar atoms  
 D. At constant temperature, all He atoms move at the same speed  
 E. At low pressure, He atoms occupy negligible volume in a container

5. All halogens have the following number of valence electrons:

- A. 2  
 B. 3  
 C. 5  
 D. 7  
 E. none of these

6. Order the elements S, Cl, and F in terms of increasing atomic radii.

- A. S, Cl, F  
 B. Cl, F, S  
 C. F, S, Cl  
 D. F, Cl, S  
 E. S, F, Cl

F is in row 2 whereas the others are row 3, so F is smallest. Radius decreases across a row, and Cl is to the right of S, so it is smaller. S is the largest radius.

7. Which of the following ionic compounds has the lowest lattice energy?

- A. MgO  
 B. Na<sub>2</sub>O  
 C. NaF  
 D. MgF<sub>2</sub>  
 E. LiF.

Lower lattice energies are observed for ions of lower charge and larger radius. Only NaF and LiF have +1 and -1 charges, so these should have the lowest lattice energy. Of these, Na has the larger size, so NaF should have a lower L.E. than LiF.

8. Circle the correct answer for each of the following:

a) The lowest 2nd ionization energy: Mg, Li, Be

b) The most negative electron affinity: As, Se, Br

Mg and Be have 2e<sup>-</sup> in the valence shell, whereas Li only has 1. Between Mg and Be, Mg is lower in the PTable so it has lower IEs. Gaining an e<sup>-</sup> is most favorable for Br, which attains a noble gas configuration.

**Part II. Short Answers:** Show all your work!

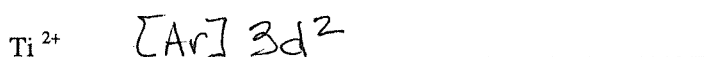
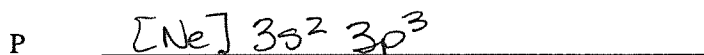
9. What volume of concentrated sulfuric acid (18.0 M) is needed to make 50.0 mL of 2.00 M H<sub>2</sub>SO<sub>4</sub> solution?

10. Provide a balanced equation for the reaction of nitrite ion with aqueous acid to yield gaseous nitric oxide and aqueous nitrate ion.

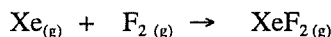
11. In one sentence, clearly explain why the emission spectrum of an element appears as discrete lines as opposed to a continuous spectrum.

Photons are emitted when the electron transitions between energy levels (orbitals); since there are discrete energy levels, only certain values of  $\Delta E$ , which correspond to specific wavelengths of light, are observed.

12. Give the electron configuration for the following atoms and ions (condensed notation is OK).



13. Xenon difluoride can be prepared from elemental xenon and fluorine:



Calculate the enthalpy change,  $\Delta H_f^\circ$ , for this reaction knowing that the bond dissociation energies are 131 kJ/mol for a Xe-F bond and 159 kJ/mol for an F-F bond.

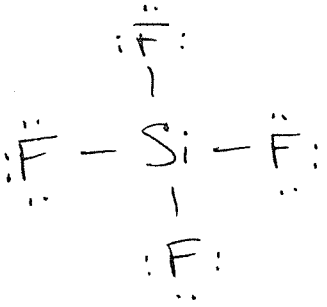
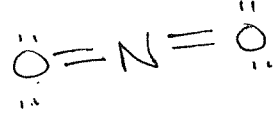
$$\Delta H_f^\circ = \sum \text{bonds broken} - \sum \text{bonds formed}$$

$$\Delta H_f^\circ = -2(131 \text{ kJ/mol}) + 159 \text{ kJ/mol} = -103 \text{ kJ/mol}$$

- 2 Xe-F bonds
+ 1 F<sub>2</sub> bond  
formed
broken



16. Complete the following Table:

<b>Chemical Formula:</b> $\text{SiF}_4$	<b>Chemical Formula:</b> $\text{NO}_2^+$ $16e^-$
<b>Lewis Structure:</b> 	<b>Lewis Structure:</b> (nitrogen is the central atom) 
<b>Molecular Geometry:</b> (words only, you do <u>not</u> have to draw the molecule in three dimensions) tetrahedral 109.5° angles	<b>Molecular Geometry:</b> (words only, you do <u>not</u> have to draw the molecule in three dimensions) linear
<b>Molecular Polarity</b> (yes/no): No	<b>Molecular Polarity</b> (yes/no): No
<b>Hybridization</b> of the Si atom: $sp^3$	<b>Hybridization</b> of the N atom: $sp$
<b>Bond Angle</b> for F-Si-F 109.5°	<b>Bond Angle</b> for O-N-O 180°
<b>Number of <math>\sigma</math> bonds</b> for $\text{SiF}_4$ 4	<b>Number of <math>\sigma</math> bonds</b> for $\text{NO}_2^+$ 2
<b>Number of <math>\pi</math> bonds</b> for $\text{SiF}_4$ 0	<b>Number of <math>\pi</math> bonds</b> for $\text{NO}_2^+$ 2

