

Name Key (print) Name \_\_\_\_\_ (sign)

Please show work for partial 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.

NA = not attempted NW = no work

Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2 pts per question, 24 pts total)

1) Calculate the molar mass of H<sub>2</sub>CO<sub>3</sub>. 1) D  
 A) 60.01 g/mol  
 B) 74.04 g/mol  
 C) 61.02 g/mol  
 D) 62.03 g/mol  
 E) 29.02 g/mol

$2(1,01) + 12,01 + 3(16,0) = 62,03$   
H

2) Which of the following is a transition metal element? 2) D  
 A) U                      B) K                      C) Pr                      D) Pd                      E) Sn

3) Which of the following exists as a diatomic molecule in its most stable form? 3) E  
 A) Ne                      B) P                      C) C                      D) Na                      E) N

4) How many Li atoms are contained in 97.9 g of Li? (1 mol Li = 6.94 g Li, 1 mol Li = 6.02 x 10<sup>23</sup> atoms) 4) E  
 A) 5.90 x 10<sup>25</sup> Li atoms  
 B) 7.09 x 10<sup>21</sup> Li atoms  
 C) 4.27 x 10<sup>22</sup> Li atoms  
 D) 4.18 x 10<sup>24</sup> Li atoms  
 E) 8.49 x 10<sup>24</sup> Li atoms

$97,9g \times \frac{mol Li}{6,94g Li} \times \frac{6,02 \times 10^{23}}{mol Li} = 8,49 \times 10^{24} atoms$

5) Identify a substance that is not in its standard state. (standard state has standard enthalpy formation = zero) 5) A  
 A) H<sub>2</sub>                      B) Mn                      C) Ca                      D) O<sub>2</sub>                      E) Ne

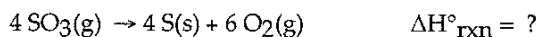
6) For a process at constant pressure, 49,600 calories of heat are released. (1 calorie = 4.184 Joule) This quantity of heat is equivalent to 6) A  
 A) 2.08 x 10<sup>5</sup> J.                      B) 1.24 x 10<sup>4</sup> J.                      C) 4.82 x 10<sup>-6</sup> J.                      D) 1.19 x 10<sup>4</sup> J.

$49,600 calorie \times \frac{4,184 J}{1 calorie} = 207,526.4$   
 $2,08 \times 10^5$

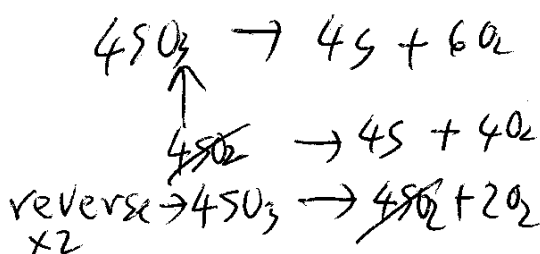
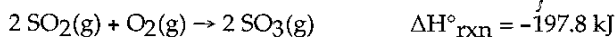
$$395.6 + 1187.2 = 1582.8$$

$$(197.8) \times 2 + (296.8) \times 4 =$$

7) Use the standard reaction enthalpies given below to determine  $\Delta H^\circ_{\text{rxn}}$  for the following reaction: 7) E

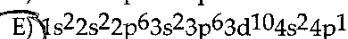
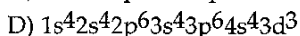
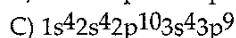
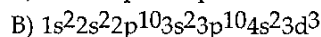
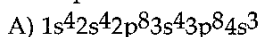


Given:



- A) -494.6 kJ      B) -692.4 kJ      C) -293.0 kJ      D) -791.4 kJ      E) 1583 kJ

8) The complete electron configuration of gallium, element 31, is \_\_\_\_\_ 8) E



9) Determine the specific heat capacity of an alloy that requires 59.3 kJ to raise the temperature of 150.0 g alloy from 298 K to 398 K. 9) E

- A) 1.87 J/g°C      B) 2.29 J/g°C      C) 2.53 J/g°C      D) 4.38 J/g°C      E) 3.95 J/g°C

10) Which of the following has an ionic bond? 10) D

- A) Ne      B) SO<sub>2</sub>      C) O<sub>2</sub>      D) KBr      E) CO

11) Give the symbol for fluorine. 11) A

- A) F      B) Fr      C) Fu      D) Fl      E) Fo

12) Energy that is associated with the position or composition of an object is called 12) A

- A) potential energy      B) thermal energy  
C) chemical energy      D) kinetic energy

$$q = m C \Delta T$$

$$m = 150.0 \text{ g}$$

$$\Delta T = 398 \text{ K} - 298 \text{ K} = 100 \text{ K}$$

$$q = 59.3 \text{ kJ} \times \frac{1000 \text{ J}}{1 \text{ kJ}} = 59300 \text{ J}$$

$$C = \frac{q}{m \Delta T} = \frac{59300 \text{ J}}{(150.0 \text{ g})(100 \text{ K})} = \frac{3.95 \text{ J}}{\text{g}^\circ\text{C}}$$

**Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. (46 pts)**

1. Convert 27.5 milliliters to units of kiloliters. Fill in the parenthesis to do this. (2 pt each, 10 pts total)

*upside down - each*

$$27.5 \text{ mL} \times \left( \frac{1}{1000} \right) \text{ L} \times \left( \frac{1}{1000} \right) \text{ Kilo Liters} = \left( \frac{2.75 \times 10^{-5}}{1000} \right) \text{ Kilo liters}$$

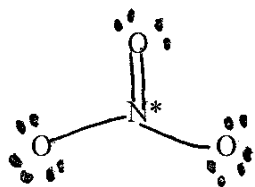
*both inverted  
2.75 x 10<sup>7</sup>*

2. In the periodic table: (15 pts)

- a. What is the elemental symbol for phosphorus? P (2 pt)
- b. How much does one mole of Ba weigh? 137.3 grams (2 pt)
- c. An element symbol for an element which is an Actinide or Lanthanide is Sm (2 pt)
- d. What **group** is the element Cl in? VII A (2 pt)
- e. What **period** is element Se in? 4 (2 pt)
- f. For the element As, the group number is VA (1 pt) and the charge for the ionic form of As is 5 - 8 = (show formula if applicable) (4 pts)

*(-3) ← (NW-1)*

4 The correct Lewis Dot structure for the  $\text{NO}_3^-$  is given below. Answer the following for the Lewis Dot structure shown below. (2 pts each, 8 pts total)



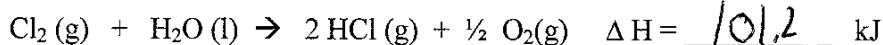
graded  
consistent  
w @ + b

- a. How many electron pairs is around the atom with the \*? 3
- b. How many lone pairs is around the atoms with the \*? 0
- b. The VSEPR geometry of electron pairs is trigonal planar
- c. The VSEPR geometry of the molecule is trigonal planar

5. (9 pts total)

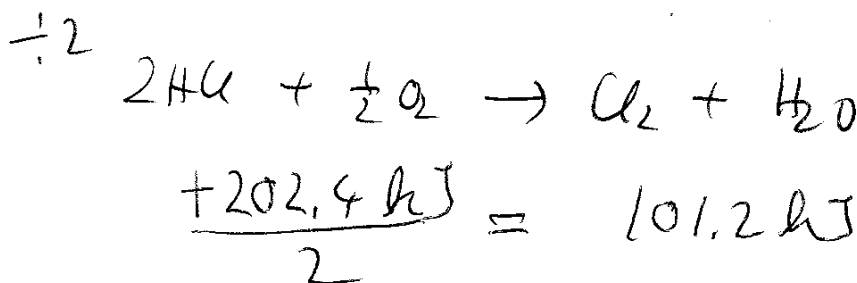
If a system loses energy, the surrounding will [(gain) or (lose)] (circle one) energy. (3 pts) According to the first law of thermodynamics, energy [(can) or (cannot)] (circle one) be created. (3 pts) An endothermic reaction (system is reaction) will have a [(negative) or (positive)] (circle one)  $\Delta H$  (3 pts)

6. For the following reaction & enthalpy, what is the enthalpy for the 2<sup>nd</sup> reaction shown. (Show work) (4 pts)



reverse  
rxn (2pts)

$\div 2$  (2pts)



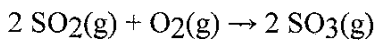
math - 1/2

NW-1

**Part III. Long Answer** Please show work for full credit and to receive partial credit. (## 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. \*\*\*\* (30 pts, 15 pts each)

1. For the following reaction use the following enthalpies of formation to calculate the enthalpy of the reaction. Show all work otherwise you may lose points. (15 pts)

useful equation:  $\{\Delta H^{\circ}_{RXN} = \sum n_{\text{product}} \Delta H^{\circ}_f(\text{product}) - \sum n_{\text{reactant}} \Delta H^{\circ}_f(\text{reactant})\}$



$\Delta H^{\circ}_{RXN} = -197.8 \text{ kJ}$

$\Delta H^{\circ}_f [\text{SO}_2(\text{g})] = -296.8 \text{ kJ/mol}$      $\Delta H^{\circ}_f [\text{SO}_3(\text{g})] = -395.7 \text{ kJ/mol}$

$$\Delta H^{\circ}_{RXN} = 2 \underset{\text{mol SO}_3}{\Delta H^{\circ}_f [\text{SO}_3(\text{g})]} - \left\{ 2 \underset{\text{SO}_2}{\text{mol}} \Delta H^{\circ}_f [\text{SO}_2(\text{g})] \right.$$

$$+ 1 \text{ mol O}_2 \Delta H^{\circ}_f [\text{O}_2(\text{g})] \left. \right\} \text{ math -1}$$

$\Delta H^{\circ}_f [\text{O}_2(\text{g})] = 0$  because most stable form of element

$$\Delta H^{\circ}_{RXN} = \left( \frac{2 \text{ mol}}{\text{SO}_3} \right) \left( -395.7 \frac{\text{kJ}}{\text{mol}} \right) - \left( \frac{2 \text{ mol}}{\text{SO}_2} \right) \left( -296.8 \frac{\text{kJ}}{\text{mol}} \right)$$

$$\Delta H^{\circ}_{RXN} = -791.4 + 593.6 = -197.8 \text{ kJ}$$

2. A reaction of HCl with NaOH is carried out in a water solution in a coffee cup. (Note: I made up these numbers so the value may not fit experimental reality. Assume that the heat lost to the coffee cup, thermometer, and air surrounding the cup are negligible.)  $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

As the reaction occurs, the temperature of the water rises from 22.5 °C to 28.2 °C. The reaction occurs in 102.7 mL of water. What is the  $q_{\text{water solution}}$ ? ( $q_{\text{water solution}} = q_{\text{universe}}$  when we assume that everything other than the water in which the reaction is occurring is negligible). What is the  $q_{\text{reaction}}$ ? ( $q_{\text{system}} = q_{\text{reaction}}$ ) ( $q = m C \Delta T$ ,  $C_{\text{water}} = 4.184 \text{ J/g}^\circ\text{C}$ , for density (water) = 1 gram water / 1 mL water) (15 pts)

$$q = m C \Delta T$$

$$C = 4.184 \text{ J/g}^\circ\text{C}$$

$$\Delta T = T_f - T_i = 28.2^\circ\text{C} - 22.5^\circ\text{C} = 5.7^\circ\text{C}$$

$$m = 102.7 \text{ mL} \times \frac{1 \text{ g H}_2\text{O}}{1 \text{ mL H}_2\text{O}} = 102.7 \text{ g H}_2\text{O}$$

$$q_{\text{H}_2\text{O}} = (102.7 \text{ g}) \left( \frac{4.184 \text{ J}}{\text{g}^\circ\text{C}} \right) (5.7^\circ\text{C})$$

$$q_{\text{H}_2\text{O}} = 2449.3 \text{ J} \rightarrow 2 \text{ sig fig}$$

$$q_{\text{H}_2\text{O}} = 2449.3 \text{ J} \times \frac{\text{kJ}}{1000 \text{ J}} = 2.4 \text{ kJ}$$

$$q_{\text{reaction}} = -2.4 \text{ kJ}$$

did not identify or wrong 2pt.

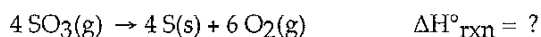
Name \_\_\_\_\_ (print) Name \_\_\_\_\_ (sign)

Please show work for partial 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.

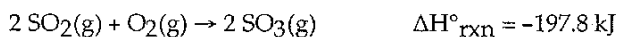
**Part I MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question. (2 pts per question, 24 pts total)**

- 1) Calculate the molar mass of  $\text{H}_2\text{CO}_3$ . 1) \_\_\_\_\_  
 A) 60.01 g/mol  
 B) 74.04 g/mol  
 C) 61.02 g/mol  
 D) 62.03 g/mol  
 E) 29.02 g/mol
- 2) Which of the following is a transition metal element? 2) \_\_\_\_\_  
 A) U B) K C) Pr D) Pd E) Sn
- 3) Which of the following exists as a diatomic molecule in its most stable form? 3) \_\_\_\_\_  
 A) Ne B) P C) C D) Na E) N
- 4) How many Li atoms are contained in 97.9 g of Li? (1 mol Li = 6.94 g Li, 1 mol Li =  $6.02 \times 10^{23}$  atoms) 4) \_\_\_\_\_  
 A)  $5.90 \times 10^{25}$  Li atoms  
 B)  $7.09 \times 10^{21}$  Li atoms  
 C)  $4.27 \times 10^{22}$  Li atoms  
 D)  $4.18 \times 10^{24}$  Li atoms  
 E)  $8.49 \times 10^{24}$  Li atoms
- 5) Identify a substance that is not in its standard state. (standard state has standard enthalpy formation = zero) 5) \_\_\_\_\_  
 A) H B) Mn C) Ca D)  $\text{O}_2$  E) Ne
- 6) For a process at constant pressure, 49,600 calories of heat are released. (1 calorie = 4.184 Joule) This quantity of heat is equivalent to 6) \_\_\_\_\_  
 A)  $2.08 \times 10^5$  J. B)  $1.24 \times 10^4$  J. C)  $4.82 \times 10^{-6}$  J. D)  $1.19 \times 10^4$  J.

7) Use the standard reaction enthalpies given below to determine  $\Delta H^\circ_{\text{rxn}}$  for the following reaction: 7) \_\_\_\_\_



Given:



- A) -494.6 kJ      B) -692.4 kJ      C) -293.0 kJ      D) -791.4 kJ      E) 1583 kJ

8) The complete electron configuration of gallium, element 31, is \_\_\_\_\_ 8) \_\_\_\_\_

- A)  $1s^4 2s^4 2p^8 3s^4 3p^8 4s^3$   
B)  $1s^2 2s^2 2p^{10} 3s^2 3p^{10} 4s^2 3d^3$   
C)  $1s^4 2s^4 2p^{10} 3s^4 3p^9$   
D)  $1s^4 2s^4 2p^6 3s^4 3p^6 4s^4 3d^3$   
E)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^1$

9) Determine the specific heat capacity of an alloy that requires 59.3 kJ to raise the temperature of 150.0 g alloy from 298 K to 398 K. 9) \_\_\_\_\_

- A) 1.87 J/g°C      B) 2.29 J/g°C      C) 2.53 J/g°C      D) 4.38 J/g°C      E) 3.95 J/g°C

10) Which of the following has an ionic bond? 10) \_\_\_\_\_

- A) Ne      B) SO<sub>2</sub>      C) O<sub>2</sub>      D) KBr      E) CO

11) Give the symbol for fluorine. 11) \_\_\_\_\_

- A) F      B) Fr      C) Fu      D) Fl      E) Fo

12) Energy that is associated with the position or composition of an object is called 12) \_\_\_\_\_

- A) potential energy      B) thermal energy  
C) chemical energy      D) kinetic energy



**Part II Short Answer: Write the word or phrase or circle the choice that best completes each statement or answers the question. (46 pts)**

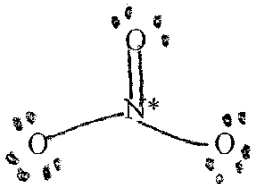
1. Convert 27.5 milliliters to units of kiloliters. Fill in the parenthesis to do this. (2 pt each, 10 pts total)

$$27.5 \text{ mL} \times \left( \frac{\quad}{\quad} \right) \frac{\text{L}}{\text{mL}} \times \left( \frac{\quad}{\quad} \right) \frac{\text{Kilo Liters}}{\text{L}} = \left( \quad \right) \text{Kilo liters}$$

2. In the periodic table: (15 pts)

- a. What is the elemental symbol for phosphorus? \_\_\_\_\_ (2 pt)
- b. How much does one mole of Ba weigh? \_\_\_\_\_ grams (2 pt)
- c. An element symbol for an element which is an Actinide or Lanthanide is \_\_\_\_\_ (2 pt)
- d. What **group** is the element Cl in? \_\_\_\_\_ (2 pt)
- e. What **period** is element Se in? \_\_\_\_\_ (2 pt)
- f. For the element As, the group number is \_\_\_\_\_ (1 pt) and the charge for the ionic form of As is \_\_\_\_\_ (show formula if applicable) (4 pts)

4 The correct Lewis Dot structure for the  $\text{NO}_3^-$  is given below. Answer the following for the Lewis Dot structure shown below. (2 pts each, 8 pts total)

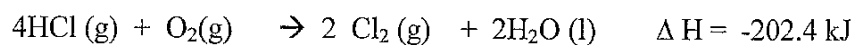


- How many electron pairs is around the atom with the \* ? \_\_\_\_\_
- How many lone pairs is around the atoms with the \* ? \_\_\_\_\_
- The VSEPR geometry of electron pairs is \_\_\_\_\_
- The VSEPR geometry of the molecule is \_\_\_\_\_

5. (9 pts total)

If a system loses energy, the surrounding will [(gain) or (lose)] (circle one) energy. (3 pts) According to the first law of thermodynamics, energy [(can) or (cannot)](circle one) be created. (3 pts) An endothermic reaction (system is reaction) will have a [(negative) or (positive)] (circle one)  $\Delta H$ (3 pts)

6. For the following reaction & enthalpy, what is the enthalpy for the 2<sup>nd</sup> reaction shown. (Show work) (4 pts)

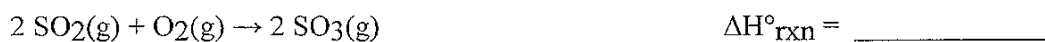


**Part III. Long Answer Please show work for full credit and to receive partial credit. (## pts)**

**\*\*\*\* Please attempt every problem for partial credit. You will get no partial credit if you just rewrite the question with no change in anything.\*\*\*\* (30 pts, 15 pts each)**

1. For the following reaction use the following enthalpies of formation to calculate the enthalpy of the reaction. Show all work otherwise you may lose points. (15 pts)

useful equation:  $\{ \Delta H^{\circ}_{\text{RXN}} = \sum n_{\text{product}} \Delta H^{\circ}_{\text{f}}(\text{product}) - \sum n_{\text{reactant}} \Delta H^{\circ}_{\text{f}}(\text{reactant}) \}$



$$\Delta H^{\circ}_{\text{f}} [\text{SO}_2(\text{g})] = -296.8 \text{ kJ/mol} \quad \Delta H^{\circ}_{\text{f}} [\text{SO}_3(\text{g})] = -395.7 \text{ kJ/mol}$$

2. A reaction of HCl with NaOH is carried out in a water solution in a coffee cup. (Note: I made up these numbers so the value may not fit experimental reality. Assume that the heat lost to the coffee cup, thermometer, and air surrounding the cup are negligible.)  $\text{HCl} + \text{NaOH} \rightarrow \text{NaCl} + \text{H}_2\text{O}$

As the reaction occurs, the temperature of the water rises from 22.5 °C to 28.2 °C. The reaction occurs in 102.7 mL of water. What is the  $q_{\text{water solution}}$ ? ( $q_{\text{water solution}} = q_{\text{universe}}$  when we assume that everything other than the water in which the reaction is occurring is negligible). What is the  $q_{\text{reaction}}$ ? ( $q_{\text{system}} = q_{\text{reaction}}$ ) ( $q = m C \Delta T$ ,  $C_{\text{water}} = 4.184 \text{ J/g}^\circ\text{C}$ , for density (water) = 1 gram water / 1 mL water) (15 pts)