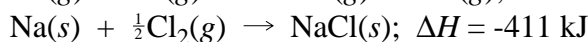
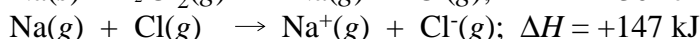
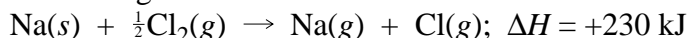
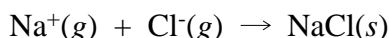


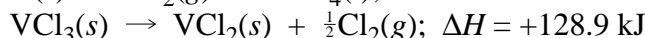
## CHEM 105

## PROBLEM SET 4 THERMOCHEMISTRY

1. Given the following data

calculate  $\Delta H$  for the reaction

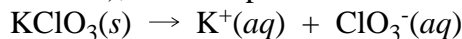
2. Given the following data

calculate  $\Delta H_f^0$  of  $\text{VCl}_3(s)$ .

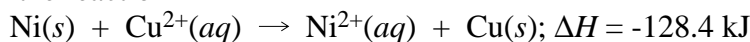
3. Given
- $2\text{Al}_2\text{O}_3(s) \rightarrow 4\text{Al}(s) + 3\text{O}_2(g); \Delta H = +3340 \text{ kJ}$

(a) what is  $\Delta H_f^0$  for  $\text{Al}_2\text{O}_3(s)$ ?(b) what is  $\Delta H$  for the decomposition of 10.0 g of  $\text{Al}_2\text{O}_3$ ?

4. When 3.17 g of
- $\text{KClO}_3$
- is dissolved in 50.0 g of water (
- $\text{SH} = 4.18 \text{ J/g}\cdot^\circ\text{C}$
- ) in a coffee-cup calorimeter (
- $C_{\text{cal}} = 75.0 \text{ J/}^\circ\text{C}$
- ), the temperature fell from
- $25.00^\circ\text{C}$
- to
- $21.18^\circ\text{C}$
- . Calculate
- $\Delta H$
- for the process

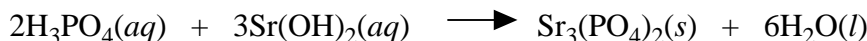


5. Consider the reaction



The reaction is carried out in a coffee-cup calorimeter ( $C_{\text{cal}} = 75.0 \text{ J/}^\circ\text{C}$ ) using 125 mL of the  $\text{Cu}^{2+}$  solution ( $d \approx 1.00 \text{ g/mL}$ ;  $\text{SH} \approx 4.18 \text{ J/g}\cdot^\circ\text{C}$ ) at  $22.50^\circ\text{C}$ . The copper formed weighed 2.48 g. Calculate the final temperature of the calorimeter and contents.

6. When 155 mL of 0.1250 M
- $\text{H}_3\text{PO}_4$
- at
- $24.00^\circ\text{C}$
- was mixed with 260.0 mL of 0.1000 M
- $\text{Sr}(\text{OH})_2$
- at
- $24.00^\circ\text{C}$
- in a calorimeter (calorimeter constant =
- $40.4 \text{ J/}^\circ\text{C}$
- ), the temperature rose to
- $25.54^\circ\text{C}$
- . Calculate
- $\Delta H$
- for the reaction. Specific heat for water =
- $4.184 \text{ J/g}\cdot^\circ\text{C}$
- .



In calculating heat flow, treat the solutions as if they were pure water and ignore the small amount of water formed in the reaction.

7. When a sample of sucrose,
- $\text{C}_{12}\text{H}_{22}\text{O}_{11}(s)$
- , weighing 3.85 g is burned in a bomb calorimeter (
- $C_{\text{cal}} = 3.180 \text{ kJ/}^\circ\text{C}$
- ) containing 6.00 kg of water (
- $\text{SH} = 4.184 \text{ J/g}\cdot^\circ\text{C}$
- ) at
- $23.40^\circ\text{C}$
- , the temperature rose to
- $25.64^\circ\text{C}$
- . Given that
- $\Delta H_f^0$
- for
- $\text{CO}_2(g) = -393.5 \text{ kJ/mol}$
- and
- $\Delta H_f^0$
- for
- $\text{H}_2\text{O}(l) = -285.8 \text{ kJ/mol}$
- , calculate
- $\Delta H_f^0$
- for
- $\text{C}_{12}\text{H}_{22}\text{O}_{11}(s)$
- . HINT: Write the balanced equation for the combustion of
- $\text{C}_{12}\text{H}_{22}\text{O}_{11}(s)$
- to form
- $\text{CO}_2(g)$
- and
- $\text{H}_2\text{O}(l)$
- .

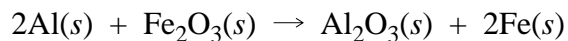
8. When 3.16 g of salicylic acid,  $C_7H_6O_3$ , was burned in a bomb calorimeter ( $C_{cal} = 3.612 \text{ kJ/}^\circ\text{C}$ ) containing 5.00 kg of water at  $23.00^\circ\text{C}$ , 69.3 kJ of heat was given off. Calculate the final temperature.

9. Given:  $\Delta H_f^0$  of  $\text{HI}(g) = 25.9 \text{ kJ/mole}$  and  $\Delta H_{\text{sublimation}}$  of  $\text{I}_2 = 62.4 \text{ kJ/mole}$ .

Calculate  $\Delta H$  for the reaction  $\frac{1}{2}\text{H}_2(g) + \frac{1}{2}\text{I}_2(g) \rightarrow \text{HI}(g)$

10. If 125 g of solid acetic acid ( $\text{CH}_3\text{COOH}$ ) at  $16.7^\circ\text{C}$  is mixed with 755 g of acetic acid at  $33.8^\circ\text{C}$ , what will be the temperature of the system when equilibrium is attained? Assume no heat exchange with the surroundings. The melting point of acetic acid is  $16.7^\circ\text{C}$ , the specific heat ( $S.H.$ ) of liquid acetic acid is  $125 \text{ J/}^\circ\text{C}\cdot\text{mole}$ , and the latent heat of fusion ( $\Delta H_{\text{fusion}}$ ) of acetic acid is  $11.7 \text{ kJ/mole}$ .

11. The thermite reaction, shown below, was once used to weld rails.



- Calculate  $\Delta H$  for this reaction using heat of formation data from Appendix C.
- The specific heats of  $\text{Al}_2\text{O}_3$  and Fe are  $0.79$  and  $0.45 \text{ J/g}\cdot^\circ\text{C}$ , respectively. Calculate the temperature to which the products would be raised, starting at  $25.0^\circ\text{C}$ , by the heat given off in this reaction.
- Will the reaction produce molten iron? ( $\text{mp Fe} = 1535^\circ\text{C}$ ;  $\Delta H_{\text{fus}} = 270 \text{ J/g}$ )