

**Chem 115**  
**Practice Problems for Test 2**

1. A 1.45-g sample of acetic acid (m.w. = 60.06 u) was burned in excess oxygen in the bomb of a calorimeter with a heat capacity of 5.81 kJ/°C. The temperature of the calorimeter and its contents rose from 24.32 °C to 27.95 °C. From this experiment, what is the molar heat of combustion of acetic acid?

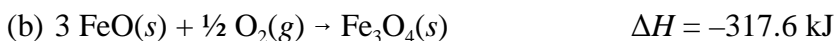
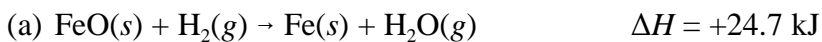
Solution:

$$\Delta T = (27.95 - 24.32) \text{ }^\circ\text{C} = 3.63 \text{ }^\circ\text{C}$$

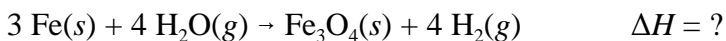
$$q_{\text{cal}} = (5.81 \text{ kJ/}^\circ\text{C})(3.63 \text{ }^\circ\text{C}) = 21.0_9 \text{ kJ}$$

$$q_{\text{rxn}} = \left( \frac{-21.0_9 \text{ kJ}}{1.45 \text{ g}} \right) \left( \frac{60.06 \text{ g}}{\text{mol}} \right) = -873.57 \text{ kJ/mol} = -874 \text{ kJ/mol}$$

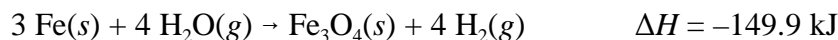
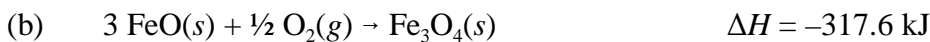
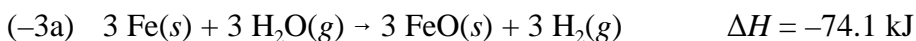
2. Given:



Calculate the value of  $\Delta H$  for the reaction



Solution:



3. The combustion of hydrazine,  $\text{N}_2\text{H}_4(l)$  in excess oxygen produces  $\text{N}_2(g)$  and  $\text{H}_2\text{O}(l)$ . The standard enthalpy of combustion of  $\text{N}_2\text{H}_4(l)$  is  $-622.4$  kJ, and the standard enthalpy of formation of  $\text{H}_2\text{O}(l)$  is  $-285.9$  kJ. From this information, calculate the standard enthalpy of formation of  $\text{N}_2\text{H}_4(l)$ .

Solution:



$$\Delta H^\circ_c = 2 \Delta H^\circ_f(\text{H}_2\text{O}) - \Delta H^\circ_f(\text{N}_2\text{H}_4)$$

$$\Delta H^\circ_f(\text{N}_2\text{H}_4) = 2 \Delta H^\circ_f(\text{H}_2\text{O}) - \Delta H^\circ_c = (2)(-285.9 \text{ kJ}) - (-622.4 \text{ kJ}) = +50.6 \text{ kJ}$$

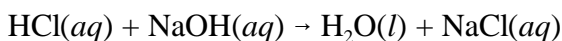
4. (a) How many grams of NaOH (f.w. = 40.00 u) are needed to prepare exactly 250 mL of a 1.25 M solution of NaOH(aq)?

$$\text{g NaOH} = (0.250 \text{ L}) \left( \frac{1.25 \text{ mol}}{\text{L}} \right) \left( \frac{40.00 \text{ g}}{\text{mol}} \right) = 12.5 \text{ g}$$

- (b) How many milliliters of 1.25 M NaOH solution are need to prepare exactly 500 mL of  $3.50 \times 10^{-3}$  M NaOH solution?

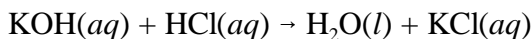
$$V = \frac{(500 \text{ mL})(3.50 \times 10^{-3} \text{ M})}{1.25 \text{ M}} = 1.40 \text{ mL}$$

- (c) A 25.0-mL sample of  $3.50 \times 10^{-3}$  M NaOH solution is titrated with  $5.00 \times 10^{-3}$  M HCl solution. How many milliliters of the acid solution are needed to reach the equivalence point?



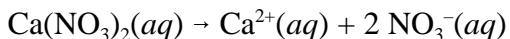
$$V_{\text{HCl}} = \frac{M_{\text{NaOH}} V_{\text{NaOH}}}{M_{\text{HCl}}} = \frac{(3.50 \times 10^{-3} \text{ M})(25.00 \text{ mL})}{5.00 \times 10^{-3} \text{ M}} = 17.5 \text{ mL}$$

- (d) If titration of a 25.0-mL sample of a solution of KOH of unknown concentration requires 32.5 mL of 0.100 M HCl solution to reach the equivalence point, what is the concentration of the KOH solution?

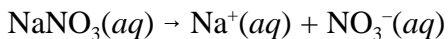


$$M_{\text{KOH}} = \frac{V_{\text{HCl}} M_{\text{HCl}}}{V_{\text{KOH}}} = \frac{(32.5 \text{ mL})(0.100 \text{ M})}{25.0 \text{ mL}} = 0.130 \text{ M}$$

- (e) What is the nitrate ion concentration in a solution prepared by mixing 40.0 mL of 0.100 M  $\text{Ca}(\text{NO}_3)_2(aq)$  with 30.0 mL of 0.200 M  $\text{NaNO}_3(aq)$ ?



$$\text{mmol NO}_3^- = 2 \times \text{mmol Ca}(\text{NO}_3)_2 = (2)(40.0 \text{ mL})(0.100 \text{ M}) = 8.00 \text{ mmol}$$



$$\text{mmol NO}_3^- = \text{mmol NaNO}_3 = (30.0 \text{ mL})(0.200 \text{ M}) = 6.00 \text{ mmol}$$

$$[\text{NO}_3^-] = \frac{8.00 \text{ mmol} + 6.00 \text{ mmol}}{70.0 \text{ mL}} = 0.200 \text{ M}$$

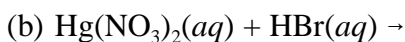
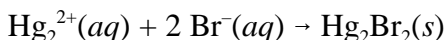
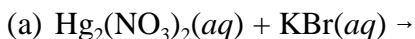
5. Indicate whether the following ionic compounds are soluble or insoluble in water. If sparingly soluble, write soluble.

$\text{PbSO}_4$	insoluble	$\text{BaCO}_3$	insoluble
$\text{BaS}$	soluble	$\text{Cs}_3\text{PO}_4$	soluble
$\text{Al}(\text{OH})_3$	insoluble	$\text{AgC}_2\text{H}_3\text{O}_2$	soluble

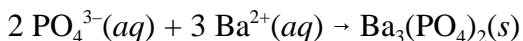
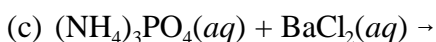
6. Indicate whether the following are strong electrolytes, weak electrolytes, or non-electrolytes.

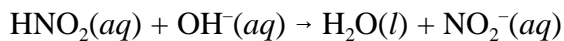
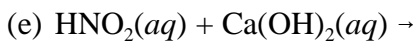
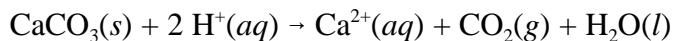
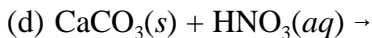
$\text{H}_3\text{PO}_4(aq)$	weak electrolyte	$\text{NaNO}_3(aq)$	strong electrolyte
$\text{PbS}(s)$	strong electrolyte	$\text{C}_2\text{H}_5\text{NH}_2(aq)$	weak electrolyte
$\text{HClO}_4(aq)$	strong electrolyte	$\text{C}_2\text{H}_5\text{OH}(aq)$	non-electrolyte

7. Write net ionic equations for each of the following, if a metathetical reaction occurs. If no reaction occurs, write "n. r."



n.r.





8. Consider light with a wavelength of 625.6 nm. (speed of light =  $2.998 \times 10^8 \text{ m}\cdot\text{s}^{-1}$ ; Planck's constant =  $6.626 \times 10^{-34} \text{ J}\cdot\text{s}$ )

- (a) What is the frequency?

$$\nu = \frac{c}{\lambda} = \frac{2.998 \times 10^8 \text{ m}\cdot\text{s}^{-1}}{625.6 \times 10^{-9} \text{ m}} = 4.792 \times 10^{14} \text{ s}^{-1}$$

- (b) What is the energy of one photon of this light?

$$E = h\nu = (6.626 \times 10^{-34} \text{ J}\cdot\text{s})(4.792 \times 10^{14} \text{ s}^{-1}) = 3.175 \times 10^{-19} \text{ J}$$

- (c) How many photons would supply exactly 100 kJ of energy?

$$\text{photons} = (100 \text{ kJ}) \left( \frac{\text{photon}}{3.175 \times 10^{-19} \text{ J}} \right) \left( \frac{10^3 \text{ J}}{\text{kJ}} \right) = 3.149 \times 10^{23} \text{ photons}$$