Multiple Choice: (4 points each. Put answers in left margin as capital letters.)

1. How many significant figures are in the answer to the following problem: $\dfrac{2.511 - 2.311}{2736}$?

    A) 1   B) 2   C) 3   D) 4   E) 5

2. What is the concentration of a sodium chloride (NaCl) solution after 40 mL of water is added to 60 mL of a solution that is initially 2.00 M?

    A) 0.67 M B) 0.80 M C) 1.20 M D) 1.33 M E) 2.00 M

3. Which of the following ionic compounds has the lowest water solubility?

    A) $CaSO_4$ B) $CoCO_3$ C) KCl   D) $(NH_4)_2S$ E) $Ni(NO_3)_2$

4. Which of the following is a precipitation reaction?

    A) $Cu(OH)_{2\,(aq)} + 2\,HNO_{3\,(aq)} \rightarrow Cu(NO_3)_{2\,(aq)} + 2\,H_2O_{(\ell)}$
    B) $H_2SO_{4\,(aq)} + 2\,NH_{3\,(aq)} \rightarrow (NH_4)_2SO_{4\,(aq)}$
    C) $FeCl_{3\,(s)} + 3\,AgNO_{3\,(g)} \rightarrow 3\,AgCl_{(s)} + 3\,Fe(NO)_{3\,(aq)}$
    D) $2\,SrS_{(s)} + 2\,HCl_{(aq)} \rightarrow SrCl_{2\,(aq)} + H_2S_{(g)}$
    E) None is a precipitation reaction.

5. What is the oxidation number of the phosphorus atom in $Mg_3(PO_4)_2$?

    A) -1   B) +1   C) +3   D) +5   E) +7

6. Which of the following is a formation reaction?

    A) $2\,Al_{(s)} + 3\,O_{(g)} \rightarrow Al_2O_{3\,(s)}$ D) $2\,Al_{(g)} + \frac{3}{2}\,O_{2\,(g)} \rightarrow Al_2O_{3\,(s)}$
    B) $2\,Al_{(s)} + \frac{3}{2}\,O_{2\,(g)} \rightarrow Al_2O_{3\,(s)}$ E) None of the above.
    C) $4\,Al_{(g)} + 3\,O_{2\,(g)} \rightarrow 2\,Al_2O_{3\,(s)}$

7. Which of the following processes is endothermic?

    A) Water freezing.   C) The reaction of sodium and water   E) A block resting on a table
    B) Coal burning.   D) A light bulb emitting light

8. What is ΔH for the net reaction below?

    $H_{2\,(g)} + F_{2(g)} \longrightarrow 2\,HF_{(g)}$ ΔH = -537 kJ
    $C_{(s)} + 2\,F_{2\,(g)} \longrightarrow CF_{4\,(g)}$ ΔH = -680 kJ
    $\underline{2\,C_{(s)} + 2\,H_{2\,(g)} \longrightarrow C_2H_{4\,(g)}}$ $\underline{ΔH = \quad 52.3\ kJ}$
    $C_2H_{4\,(g)} + 6\,F_{2\,(g)} \rightarrow 2\,CF_{4\,(g)} + 4\,HF_{(g)}$ ΔH = ?

   A) -2,486 kJ   B) -1,702 kJ   C) -1,165 kJ   D) 234 kJ   E) 1,165 kJ

9. Which of the following is a statement of the first law of thermodynamics?

   A) Energy can be freely exchanged between the system and the surroundings only in an open container.
   B) The enthalpy of a reaction is independent of the number of steps taken.
   C) Energy can be neither created nor destroyed.
   D) It is possible to measure the exact energy of a substance only at absolute zero (0 K).
   E) The heat of reaction of any spontaneous process must be negative.

Discussion Questions: (Show your work to receive credit.)

1. A solution of $CaCl_2$ in water forms a mixture that is 22.0% calcium chloride by mass. If the total mass of the solution is 166.1 g, what masses of $CaCl_2$ and water were used? What is the $CaCl_2$ molar concentration? Assume the solution density is 1.00 g/mL. (10 points)

2. Propane burns according to the reaction: $C_3H_{8\,(g)} + 5\,O_{2\,(g)} \rightarrow 3\,CO_{2\,(g)} + 4\,H_2O_{(\ell)}$

   If 10.0 g of propane is reacted with 15.00 g of oxygen, which of the reactants is limiting?

   What is the maximum mass of carbon dioxide that can be produced? What is the percent yield if 10.0 g of CO_2 is made?   (15 points)

3. Complete the following: (10 points)

   ___ $ClO_{2\,(g)}$ + ___ $O_{3\,(g)} \rightarrow$ ___ $Cl_2O_{6\,(g)}$ + ___ $O_{2\,(g)}$
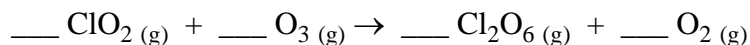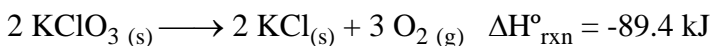
   Solid nickel(II) hydroxide reacts with aqueous hydrobromic acid to produce aqueous nickel(II) bromide and water.

4. What are standard conditions in thermochemistry? (4 points)

5. A researcher studying the nutritional value of a new candy places a 6.40 g sample of the candy inside a bomb calorimeter and combusts it in excess oxygen. The observed temperature increase is 2.11 °C. If the heat capacity of the calorimeter is 42.90 kJ•K^{-1}, how many kilojoules are there per gram of candy? (5 points)

6. Is the following process exothermic, endothermic, or neither? Explain. (10 points)

   a) $CO_{2\,(s)} \rightarrow CO_{2\,(g)}$

   b) $2\ I_{(g)} \rightarrow I_{2(g)}$
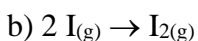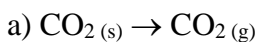
7. From the following data: (10 points)

   $2\ KClO_{3\,(s)} \longrightarrow 2\ KCl_{(s)} + 3\ O_{2\,(g)}$ $\Delta H°_{rxn} = -89.4\ kJ$

   a) Is the reaction endothermic or exothermic?
   b) How much energy would be absorbed or released if 10.75 g of potassium chloride formed?
   c) If an unknown quantity of potassium chlorate is burned with a heat change of -325 kJ, what mass of potassium chlorate burned?