A couple of extra problems in thermochemistry

1) For liquid C$_3$H$_8$O (isopropyl alcohol), the enthalpy of combustion is $-1986.6$ kJ/mol at 25ºC. Use this value to answer the following questions.
   a) How much heat will be released if 5.00 g of isopropyl alcohol is burned in an open container at 25ºC?
   b) How much heat will be released if 5.00 g of isopropyl alcohol is burned in a closed, rigid container at 25ºC?
   c) If 3.810 g of isopropyl alcohol is burned in an engine at constant pressure and 25ºC, and the engine gives off 96.3 kJ of heat, how much useful work does the engine do?
   d) A 1.268 g sample of isopropyl alcohol is burned in a bomb calorimeter that has a heat capacity of 3962 J/ºC. If the initial temperature of the calorimeter is 19.75ºC, what is the final temperature?
   e) The enthalpies of formation of CO$_2$(g) and H$_2$O(l) are $-393.5$ kJ/mol and $-285.8$ kJ/mol, respectively. Use these values and the information in the problem to calculate the enthalpy of formation of C$_3$H$_8$O(l).
   f) The enthalpy of combustion of liquid C$_3$H$_6$O (acetone) is $-1790.4$ kJ/mol. Use this value and the enthalpy of combustion of isopropyl alcohol to calculate $\Delta H$ for the reaction:

   $2$ C$_3$H$_8$O(l) + O$_2$(g) $\rightarrow$ 2 C$_3$H$_6$O(l) + 2 H$_2$O(l)

2) A chemist puts 486.2 mL of gaseous ethane (C$_2$H$_6$) at 527 torr and 19.27ºC into a bomb calorimeter, along with excess gaseous oxygen. The heat capacity of the calorimeter is 4218 J/ºC. The gases react, and the temperature of the calorimeter rises from 19.27ºC to 24.47ºC.
   a) Calculate $\Delta E$ for the reaction below.

   $2$ C$_2$H$_6$(g) + 7 O$_2$(g) $\rightarrow$ 4 CO$_2$(g) + 6 H$_2$O(l)
   b) Calculate $\Delta H$ for this reaction at 25ºC.
   c) How much heat will be released if 61.33 g of ethane is burned at constant pressure and the reaction is harnessed to do 1250 kJ of useful work?
   d) Calculate the PV work in part c. Be sure to include the correct sign.
   e) Calculate the total work in part c. Be sure to include the correct sign.
Answers

I'll give two answers for most of the questions. The first is rounded to the appropriate number of significant figures. The second has extra digits, to allow you to check your math.

1)  
   a) 165 kJ of heat is released (165.291 kJ)  
   b) 165 kJ of heat is released (164.982 kJ)  
   c) The engine does 29.7 kJ of useful work (29.652 kJ)  
   d) The final temperature is 30.31°C (30.31017°C)  
   e) The enthalpy of formation is –337.1 kJ/mol  
   f) \( \Delta H \) for this reaction is –392.4 kJ

2)  
   a) \( \Delta E = -3.12 \times 10^3 \) kJ (–3121.96 kJ)  
   b) \( \Delta H = -3.13 \times 10^3 \) kJ (–3134.35 kJ)  
   c) 1.95 \times 10^3 \) kJ of heat is released (1946.58 kJ)  
   d) \( w_{\text{PV}} = 12.6 \) kJ (12,636 kJ). Note that this number is positive.  
   e) \( w_{\text{total}} = -1.24 \times 10^3 \) kJ (-1237.36 kJ)