Enthalpy of formation problems

A selection of practice exam questions, grouped in relation to the main topics of enthalpy of formation, enthalpy of combustion, standard molar enthalpies of formation and other problems relating to the calculation of enthalpy changes for reactions. These calculations are all in the context of the standard states for all substances.

1. (a) Given the following standard enthalpies of formation for carbon dioxide and oxygen (g): 
   \[ \Delta H_f(CO_2) = -393.5 \text{ kJ/mol} \]
   \[ \Delta H_f(O_2) = 0 \text{ kJ/mol} \]
   Calculate the enthalpy of combustion of carbon monoxide (g) using Hess's Law and known enthalpies of formation.

2. (b) Given the following standard enthalpies of formation for ethene and oxygen (g):
   \[ \Delta H_f(C_2H_4) = -126.1 \text{ kJ/mol} \]
   \[ \Delta H_f(O_2) = 0 \text{ kJ/mol} \]
   Calculate the enthalpy of combustion of the reaction:
   \[ C_2H_4 + 3.5O_2 \rightarrow 2CO_2 + 2H_2O \]

3. (c) Given the following standard enthalpies of formation for methane and oxygen (g):
   \[ \Delta H_f(CH_4) = -890.3 \text{ kJ/mol} \]
   \[ \Delta H_f(O_2) = 0 \text{ kJ/mol} \]
   Calculate the enthalpy of combustion of the reaction:
   \[ CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O \]

4. (d) Given the following standard enthalpies of formation for nitrogen and oxygen (g):
   \[ \Delta H_f(N_2) = 0 \text{ kJ/mol} \]
   \[ \Delta H_f(O_2) = 0 \text{ kJ/mol} \]
   Calculate the enthalpy of combustion of the reaction:
   \[ N_2 + 2.5O_2 \rightarrow 2NO \]

5. (e) Given the following standard enthalpies of formation for ammonia and oxygen (g):
   \[ \Delta H_f(NH_3) = -462.2 \text{ kJ/mol} \]
   \[ \Delta H_f(O_2) = 0 \text{ kJ/mol} \]
   Calculate the enthalpy of combustion of the reaction:
   \[ 4NH_3 + 3O_2 \rightarrow 2N_2 + 6H_2O \]

6. (f) Given the following standard enthalpies of formation for dihydrogen and oxygen (g):
   \[ \Delta H_f(H_2) = 0 \text{ kJ/mol} \]
   \[ \Delta H_f(O_2) = 0 \text{ kJ/mol} \]
   Calculate the enthalpy of combustion of the reaction:
   \[ 2H_2 + O_2 \rightarrow 2H_2O \]

7. (g) Given the following standard enthalpies of formation for sulfur trioxide and oxygen (g):
   \[ \Delta H_f(SO_3) = -531.8 \text{ kJ/mol} \]
   \[ \Delta H_f(O_2) = 0 \text{ kJ/mol} \]
   Calculate the enthalpy of combustion of the reaction:
   \[ 2SO_3 + O_2 \rightarrow 2SO_2 + O_2 \]

8. (h) Given the following standard enthalpies of formation for phosphorus pentoxide and oxygen (g):
   \[ \Delta H_f(PO_3) = -181.3 \text{ kJ/mol} \]
   \[ \Delta H_f(O_2) = 0 \text{ kJ/mol} \]
   Calculate the enthalpy of combustion of the reaction:
   \[ PO_3 + O_2 \rightarrow PO_4 \]

9. (i) Given the following standard enthalpies of formation for silicon tetrafluoride and oxygen (g):
   \[ \Delta H_f(SiF_4) = -418.4 \text{ kJ/mol} \]
   \[ \Delta H_f(O_2) = 0 \text{ kJ/mol} \]
   Calculate the enthalpy of combustion of the reaction:
   \[ SiF_4 + O_2 \rightarrow SiOF_2 \]

10. (j) Given the following standard enthalpies of formation for carbon tetrafluoride and oxygen (g):
    \[ \Delta H_f(CF_4) = -381.6 \text{ kJ/mol} \]
    \[ \Delta H_f(O_2) = 0 \text{ kJ/mol} \]
    Calculate the enthalpy of combustion of the reaction:
    \[ CF_4 + O_2 \rightarrow CO_2 + 2HCl \]

11. (k) Given the following standard enthalpies of formation for carbon tetrachloride and oxygen (g):
    \[ \Delta H_f(CCl_4) = -354.7 \text{ kJ/mol} \]
    \[ \Delta H_f(O_2) = 0 \text{ kJ/mol} \]
    Calculate the enthalpy of combustion of the reaction:
    \[ CCl_4 + O_2 \rightarrow CO_2 + 2Cl_2 \]

12. (l) Given the following standard enthalpies of formation for carbon tetrabromide and oxygen (g):
    \[ \Delta H_f(CBr_4) = -330.4 \text{ kJ/mol} \]
    \[ \Delta H_f(O_2) = 0 \text{ kJ/mol} \]
    Calculate the enthalpy of combustion of the reaction:
    \[ CBr_4 + O_2 \rightarrow CO_2 + 2Br_2 \]

13. (m) Given the following standard enthalpies of formation for carbon tetrachloride and oxygen (g):
    \[ \Delta H_f(CCl_4) = -354.7 \text{ kJ/mol} \]
    \[ \Delta H_f(O_2) = 0 \text{ kJ/mol} \]
    Calculate the enthalpy of combustion of the reaction:
    \[ CCl_4 + O_2 \rightarrow CO_2 + 2Cl_2 \]