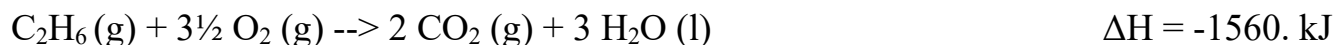
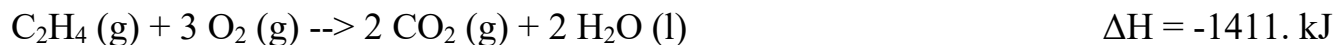


**Hess's Law:**

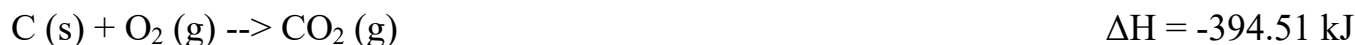
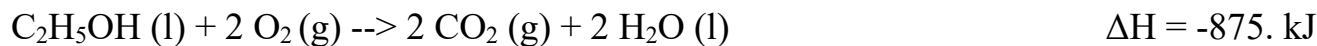
1) Calculate  $\Delta H$  for the reaction:  $C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$ , from the following Data.



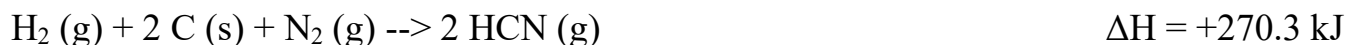
2) Calculate  $\Delta H$  for the reaction  $4 NH_3(g) + 5 O_2(g) \rightarrow 4 NO(g) + 6 H_2O(g)$ , from the following Data.



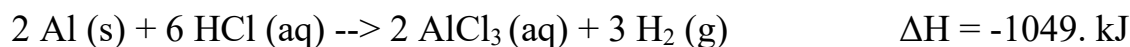
3) Find  $\Delta H^\circ$  for the reaction  $2H_2(g) + 2C(s) + O_2(g) \rightarrow C_2H_5OH(l)$ , using the following thermochemical data.



4) Calculate  $\Delta H$  for the reaction  $\text{CH}_4(\text{g}) + \text{NH}_3(\text{g}) \rightarrow \text{HCN}(\text{g}) + 3 \text{H}_2(\text{g})$ , given:



5) Calculate  $\Delta H$  for the reaction  $2 \text{Al}(\text{s}) + 3 \text{Cl}_2(\text{g}) \rightarrow 2 \text{AlCl}_3(\text{s})$  from the data.



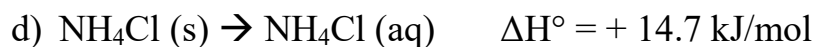
### Endothermic vs. Exothermic

1. What is the sign for  $\Delta H$  for the following reactions? Which of these changes are endothermic? Which are exothermic?

a) Melting of ice

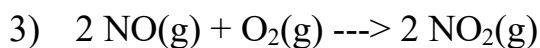
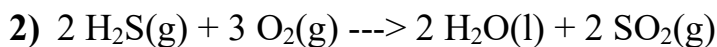
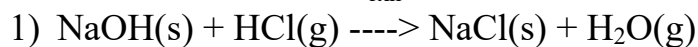


c) Deposition of iodine



e) Calcium oxide solid dissolving in water causes a temperature increase

**Enthalpy of Formation and Reaction:** Use the standard enthalpies of formation table to determine the  $\Delta H_{\text{rxn}}$  for each of these reactions.



| Compound                          | $\Delta H_f$ (kJ/mol) | Compound                  | $\Delta H_f$ (kJ/mol) |
|-----------------------------------|-----------------------|---------------------------|-----------------------|
| $\text{CH}_4\text{(g)}$           | -74.8                 | $\text{HCl(g)}$           | -92.3                 |
| $\text{CO}_2\text{(g)}$           | -393.5                | $\text{H}_2\text{O(g)}$   | -241.8                |
| $\text{CO(g)}$                    | -110.5                | $\text{SO}_2\text{(g)}$   | -296.1                |
| $\text{H}_2\text{O(l)}$           | -285.8                | $\text{NH}_4\text{Cl(s)}$ | -315.4                |
| $\text{H}_2\text{S(g)}$           | -20.1                 | $\text{NO(g)}$            | +90.4                 |
| $\text{H}_2\text{SO}_4\text{(l)}$ | -811.3                | $\text{NO}_2\text{(g)}$   | +33.9                 |
| $\text{MgSO}_4\text{(s)}$         | -1278.2               | $\text{SnCl}_4\text{(l)}$ | -545.2                |
| $\text{MnO(s)}$                   | -384.9                | $\text{SnO(s)}$           | -286.2                |
| $\text{MnO}_2\text{(s)}$          | -519.7                | $\text{SnO}_2\text{(s)}$  | -580.7                |
| $\text{NaCl(s)}$                  | -411.0                | $\text{SO}_2\text{(g)}$   | -296.1                |
| $\text{NaF(s)}$                   | -569.0                | $\text{SO}_3\text{(g)}$   | -395.2                |
| $\text{NaOH(s)}$                  | -426.7                | $\text{ZnO(s)}$           | -348.0                |
| $\text{NH}_3\text{(g)}$           | -46.2                 | $\text{ZnS(s)}$           | -202.9                |

**Other:**

- 1) For the reaction:  $2 \text{C}_4\text{H}_{10}(\text{g}) + 13 \text{O}_2(\text{g}) \rightarrow 8 \text{CO}_2(\text{g}) + 10 \text{H}_2\text{O}(\text{l})$ , the  $\Delta H^\circ_{\text{comb}}$  is  $-2877.4 \text{ kJ}$ .
- What is the  $\Delta H_{\text{comb}}^\circ$  for the combustion of 1 mole of  $\text{C}_4\text{H}_{10}$ ?
  - What is the  $\Delta H_{\text{comb}}^\circ$  for the production of 5 moles of  $\text{H}_2\text{O}$ ?
  - What is the  $\Delta H_{\text{rxn}}^\circ$  for the production of 1 mole of  $\text{C}_4\text{H}_{10}$ ?
- 2) Calculate the mass of a sample of lead ( $C_{\text{Pb}} = 0.160 \text{ J/g}\cdot^\circ\text{C}$ ) when it loses 200. J cooling from  $75.0^\circ\text{C}$  to  $42.0^\circ\text{C}$ .
- 3) Calculate the energy required to take 450.0 g of water from  $27.5^\circ\text{C}$  to  $102.0^\circ\text{C}$ . ( $C_{\text{H}_2\text{O}} = 4.184 \text{ J/g}\cdot^\circ\text{C}$ ,  $C_{\text{steam}} = 2.006 \text{ J/g}$ ,  $H_{\text{vap}} = 2260 \text{ J/g}$ )
- 4) A 28.4 g sample of aluminum is heated to  $39.4^\circ\text{C}$ , and placed in a calorimeter containing 50.0 g of water. The temperature of water increases from  $21.00^\circ\text{C}$  to  $23.00^\circ\text{C}$ . What is the specific heat capacity,  $C$ , of aluminum? (for  $\text{H}_2\text{O}(\text{l})$ ,  $C = 4.184 \text{ J/g}\cdot^\circ\text{C}$ )
- 5) Calculate the heat of formation of ethane,  $\text{C}_2\text{H}_6(\text{g})$ , if its heat of combustion,  $\Delta H^\circ_{\text{comb}}$ , is  $-3120. \text{ kJ}$  as described by the equation is  $2 \text{C}_2\text{H}_6(\text{g}) + 7 \text{O}_2(\text{g}) \rightarrow 6 \text{H}_2\text{O}(\text{l}) + 4 \text{CO}_2(\text{g})$ .

Answers:

- 1) -136.8 kJ
- 2) -1628.2 kJ
- 3) -485.62 kJ
- 4) 255.95 kJ
- 5) -6386.8 kJ

- 1a) endo
- 1b) exo
- 1c) exo
- 1d) endo
- 1e) exo

- 1) -133.8 kJ
- 2) -1123.6 kJ
- 3) -113 kJ

- 1a) -1438.7 kJ
- 1b) -1438.7 kJ
- 1c) +1438.7 kJ
- 2) 37.9 g
- 3) 1,155,308 J = 1155 kJ
- 4) 0.898 J/gC
- 5) -84.4 kJ