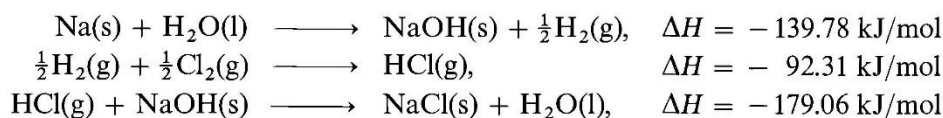


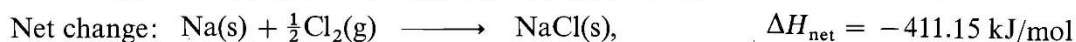
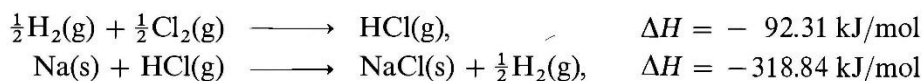
### SEQUENCES OF REACTIONS; HESS'S LAW

The change in state of a system produced by a specified chemical reaction is definite. The corresponding enthalpy change is definite, since the enthalpy is a function of the state. Thus, if we transform a specified set of reactants to a specified set of products by more than one sequence of reactions, the total enthalpy change must be the same for every sequence. This rule, which is a consequence of the first law of thermodynamics, was originally known as Hess's law of constant heat summation. Suppose that we compare two different methods of synthesizing sodium chloride from sodium and chlorine.

#### Method 1.



#### Method 2.



#### Relación entre $\Delta H_r$ y $\Delta U_r$

$$H = U + PV$$

$$\Delta H_r = \Delta U_r + \Delta n_{(\text{gases})}RT$$

$$\Delta H_r = \Delta U_r + \Delta(PV)$$

$$\Delta n_{(\text{gases})} = n_{\text{prod}} - n_{\text{react}}$$

para los gases ideales;  $\Delta(PV) = \Delta(nRT)$

$$\Delta U_{r298.15K}^0 = \Delta H_{r298.15}^0 - \Delta n_{(\text{gases})}RT$$

$$\Delta H_r = \Delta U_r + \Delta(nRT)$$

Usando el ejemplo de la combustión del ácido benzoico (ver ecuación balanceada):

asumiendo que  $T = \text{cte}$

$$\Delta n_{(\text{gases})} = 7 \text{ mol} - \frac{15}{2} \text{ mol} = -\frac{1}{2} \text{ mol}$$

$$\Delta U_{r298.15}^0 = -3227260 \text{ J/mol} - \left(-\frac{1}{2}\right)(8.314 \text{ J/mol})(298.15 \text{ K})$$

$$\Delta U_{r298.15}^0 = -3226020 \text{ J/mol}$$

$$\Delta U_{r298.15}^0 = (-3226020 \text{ J/mol}) \left(\frac{1 \text{ cal}}{4.184 \text{ J}}\right) \left(\frac{1 \text{ mol}}{122 \text{ g}}\right) = -6319.97 \frac{\text{cal}}{\text{g}}$$



**Relación entre la entalpía de reacción y la temperatura**

Si  $C_p$  varía con la temperatura, por ejemplo:  $C_p = a + bT + \frac{c}{T^2}$

$$dH = C_p dT = \left( a + bT + \frac{c}{T^2} \right)$$

$$\int_{H(T_1)}^{H(T_2)} dH = \int_{T_1}^{T_2} \left( a + bT + \frac{c}{T^2} \right)$$

$$\int_{H(T_1)}^{H(T_2)} dH = a(T_2 - T_1) + \frac{b}{2}(T_2^2 - T_1^2) - c\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$H(T_2) = H(T_1) + \left[ a(T_2 - T_1) + \frac{b}{2}(T_2^2 - T_1^2) - c\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \right]$$

