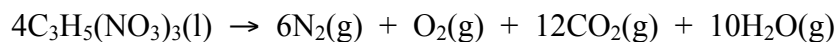


- Nitroglycerine,  $C_3H_5(NO_3)_3$ , decomposes to form  $N_2$ ,  $O_2$ ,  $CO_2$  and  $H_2O$  according to the following equation.



If 15.6 kJ of energy is evolved by the decomposition of 2.50 g of nitroglycerine at 1 atm and 25 °C, calculate the enthalpy change,  $\Delta H^\circ$ , for the decomposition of 1.00 mol of this compound under standard conditions.

**Marks**  
**4**

**The molar mass of  $C_3H_5(NO_3)_3$  is:**

$$(3 \times 12.01 \text{ (C)} + 5 \times 1.008 \text{ (H)} + 3 \times 14.01 \text{ (N)} + 9 \times 16.00 \text{ (O)}) \text{ g mol}^{-1} \\ = 227.1 \text{ g mol}^{-1}$$

**2.50 g therefore corresponds to:**

$$\text{number of moles} = \frac{\text{mass}}{\text{molar mass}} = \frac{2.50 \text{ g}}{227.1 \text{ g mol}^{-1}} = 0.0110 \text{ mol}$$

**As this amount leads to 15.6 kJ being evolved, the enthalpy change for the decomposition of 1.00 mol is:**

$$\Delta H^\circ = 15.6 \text{ kJ} / 0.0110 \text{ mol} = -1420 \text{ kJ mol}^{-1}$$

Answer:  $-1420 \text{ kJ mol}^{-1}$

Hence calculate the enthalpy of formation of nitroglycerine under standard conditions.

Data:	$\Delta_f H^\circ$ (kJ mol <sup>-1</sup> )
H <sub>2</sub> O(g)	-242
CO <sub>2</sub> (g)	-394

**The balanced reaction above is for the decomposition of 4 mol of nitroglycerine. Hence,  $\Delta_{\text{rxn}} H^\circ = 4 \times -1420 \text{ kJ mol}^{-1} = -5680 \text{ kJ mol}^{-1}$ .**

**Using  $\Delta_{\text{rxn}} H^\circ = \sum m \Delta_f H^\circ(\text{products}) - \sum n \Delta_f H^\circ(\text{reactants})$ , the enthalpy change for the above reaction is:**

$$\Delta_{\text{rxn}} H^\circ = [12\Delta_f H^\circ(\text{CO}_2(\text{g})) + 10\Delta_f H^\circ(\text{H}_2\text{O}(\text{g}))] - [4\Delta_f H^\circ(\text{C}_3\text{H}_5(\text{NO}_3)_3(\text{l}))]$$

**Hence:**

$$-5680 \text{ kJ mol}^{-1} = [(12 \times -394 + 10 \times -242) \text{ kJ mol}^{-1}] - [4\Delta_f H^\circ(\text{C}_3\text{H}_5(\text{NO}_3)_3(\text{l}))]$$

$$\Delta_f H^\circ(\text{C}_3\text{H}_5(\text{NO}_3)_3(\text{l})) = -367 \text{ kJ mol}^{-1}$$

Answer:  $-367 \text{ kJ mol}^{-1}$