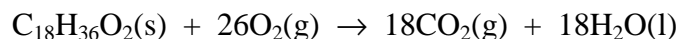


- Stearic acid, $C_{18}H_{36}O_2$, is a fatty acid common in animal fats and vegetable oils and is a valuable energy source for mammals. The net reaction for its metabolism in humans is:



Calculate ΔH° for this reaction given the following heats of formation.

$$\Delta H_f^\circ (C_{18}H_{36}O_2(s)) = -948 \text{ kJ mol}^{-1}, \quad \Delta H_f^\circ (CO_2(g)) = -393 \text{ kJ mol}^{-1} \text{ and}$$

$$\Delta H_f^\circ (H_2O(l)) = -285 \text{ kJ mol}^{-1}$$

Using $\Delta_{\text{rxn}}H^\circ = \sum m\Delta_fH^\circ(\text{products}) - \sum n\Delta_fH^\circ(\text{reactants})$, the heat of the reaction as written is:

$$\begin{aligned} \Delta_{\text{rxn}}H^\circ &= [18\Delta_fH^\circ(CO_2(g)) + 18\Delta_fH^\circ(H_2O(g))] \\ &\quad - [\Delta_fH^\circ(C_{18}H_{36}O_2(s)) + 26\Delta_fH^\circ(O_2(g))] \\ &= [(18 \times -393) + (18 \times -285)] - [(-948) + (26 \times 0)] = -11256 \text{ kJ mol}^{-1} \end{aligned}$$

$\Delta_fH^\circ(O_2(g)) = 0$ for an element already in their standard states.

Answer: **-11256 kJ mol⁻¹**

If the combustion of stearic acid is carried out in air, water is produced as a vapour. Calculate the ΔH° for the combustion of stearic acid in air given that



Energy must be provided to vaporize the water so the enthalpy of combustion is reduced:

$$\Delta_{\text{comb}}H^\circ = -11256 + (18 \times 44) = -10464 \text{ kJ mol}^{-1}$$

Answer: **-10464 kJ mol⁻¹**

Will ΔS be different for the two oxidation reactions? If so, how will it differ and why?

The entropy of $H_2O(g)$ is greater than that of $H_2O(l)$ so ΔS will be greater. In the oxidation reaction which produces $H_2O(l)$, 26 mol of gas are converted into 18 mol of gas so that ΔS will be negative. In the oxidation reaction which produces $H_2O(g)$, 26 mol of gas are converted into $(18 + 18) = 36$ mol of gas and ΔS will be positive.

ANSWER CONTINUES ON THE NEXT PAGE

Calculate the mass of carbon dioxide produced by the complete oxidation of 1.00 g of stearic acid.

The molar mass of stearic acid, $C_{18}H_{36}O_2$, is:

$$18 \times 12.01 \text{ (C)} + 36 \times 1.008 \text{ (H)} + 2 \times 16.00 \text{ (O)} = 284.468$$

1.0 g therefore contains:

$$\text{number of moles of stearic acid} = \frac{\text{mass}}{\text{molar mass}} = \frac{1.00}{284.468} = 0.00352 \text{ mol}$$

As 18 mol of CO_2 are produced for every mole of stearic acid:

$$\text{number of moles of } CO_2 = 18 \times 0.00352 = 0.0633 \text{ mol}$$

The molar mass of CO_2 is $(12.01 \text{ (C)} + 2 \times 16.00 \text{ (O)}) = 44.01$. The mass of CO_2 is thus:

$$\text{mass of } CO_2 = \text{number of moles} \times \text{molar mass} = 0.0633 \times 44.01 = 2.78 \text{ g}$$

Answer: **2.78 g**