CALORIMETRY LAB PROCEDURES

1. constant volume calorimetry (BOMB)
2. constant pressure calorimetry (COFFEE CUP)
   → open to the air

ΔH_{rxn} ΔH_{NEUT} ΔH_{soln} kJ/mol

BOMB CALORIMETRY (constant V, ΔP $q \neq \Delta H$ but is very close)

→ isolated system

$$q_{rxn} = -[q_{H_2O} + q_{BOMB}]$$
($ms\Delta T$, $C\Delta T$)

1.320g sucrose $C_{12}H_{22}O_{11}$ burned in a bomb calorimeter $C_{BOMB} = 5.430$ kJ/°C ; 957.0g H_2O
$T_i = 25.00°C$, $T_f = 27.31°C$

$\Delta H_{rxn} = ?$ kJ/mol

→ 3.856×10^{-3} mol

$$q_{rxn} = -[(957.0g)(4.184 J/g°C)(2.31°C) + 5430 J/°C(2.31°C)]$$
$$= -[2.179 \times 10^4 J]$$

$$\Delta H_{rxn} = \frac{-21.79 kJ}{3.856 \times 10^{-3} mol}$$ $q_{rxn} = -21.79$ kJ

$\Delta H_{rxn} = ⊖5651$ kJ/mol

$$C_{12}H_{22}O_{11} + 12 O_2 \longrightarrow 12 CO_2 + 11 H_2O + 5651 kJ$$

$$\Delta H_{comb} = -5651 kJ/mol_{rxn}$$

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$\Delta H_{COMB} = -5651$ kJ/mol$_{rxn}$

The enthalpy of combustion of benzoic acid C_6H_5COOH is commonly used as a standard for calibrating constant-volume calorimeters; its value has been accurately determined to be -3226.7 kJ/mol. When 1.9862 g of benzoic acid is burned, the temperature of the calorimeter rises from 21.84°C to 25.67°C. What is the heat capacity of the calorimeter? The calorimeter contains 2.000 kg of H_2O.

$$1.9862\,g \times \frac{1\,mol}{122.13\,g} \times \frac{-3226.7\,kJ}{mol} = -52.476\,kJ \quad \text{"}q_{rxn}\text{"}$$

$$-52476\,J = -\left[(2000\,g)(4.184\,J/g°C)(3.83°C) + C_{BOMB}(3.83°C)\right]$$

$$C_{BOMB} = 5333\,J/°C = 5.333\,kJ/°C$$

"COFFEE CUP" CALORIMETRY constant P ⇒ $\Delta H = \frac{q}{n}$

50.00 mL of 1.000 M HCl @ 25.00°C
+ 50.00 mL of 1.000 M NaOH @ 25.00°C
⟩ $T_f = 32.20°C$

$q = ?$ $\Delta H = \frac{q}{n}$ * negligible heat capacity for calorimeter

$$q_{rxn} = -\left[q_{H_2O}\right]$$

$$= -\left[(100\,g)(4.184\,J/g°C)(7.20°C)\right] = \ominus 3012\,J = -3.012\,kJ$$

$$mol_{HCl} = M \times L = (1.000\,M)(0.05000\,L) = 0.05000\,mol$$

$$\Delta H = \frac{-3.012\,kJ}{0.05000\,mol} = -60.24\,kJ/mol$$