CHEMWHIZ QUICK REFERENCE

TOPIC 16

Thermochemistry

Enthalpy, formation reactions, Hess's law, calorimetry, and bond energies.

01 Endothermic vs exothermic — CORE RULE

ΔH > 0 = endothermic (system absorbs heat). ΔH < 0 = exothermic (releases heat). Combustion is always exothermic; report ΔH negative, but report a magnitude when asked 'how much heat is released'.

02 Formation reactions — CORE RULE

Makes exactly 1 mol of compound from elements in their standard states (O_2 g, Br_2 l, C graphite, S rhombic, metals as solids). Fractional coefficients on the reactant side are allowed.

03 ΔH°f of an element — CORE RULE

ΔH°f of any element in its standard reference state = 0 kJ/mol by definition (the zero of the formation-enthalpy scale).

04 ΔH°rxn from formation enthalpies — CORE RULE

ΔH°rxn = Σ n·ΔH°f(products) − Σ n·ΔH°f(reactants), with n the balanced coefficients. Result is in kJ for the reaction as written; divide by a coefficient for a per-mole basis.

05 Heat for a given quantity — METHOD

mass → moles (÷ molar mass) → heat (× ΔH × the mole ratio from the balanced equation). Reverse the chain to find the fuel needed to release a target amount of heat.

06 Hess's law — CORE RULE

ΔH of an overall reaction = sum of ΔH of any steps that add to it. Reverse a step → flip the sign of ΔH; scale a step → scale ΔH. Intermediates must cancel exactly.

07 q = m·s·ΔT — CORE RULE

Q = m·s·ΔT, ΔT = T_final − T_initial. A ΔT in K equals a ΔT in °C (offset cancels).

Water: s = 4.184 J/(g·°C) = 1.000 cal/(g·°C). Use this for 'water' unless told otherwise; use the given value for other substances.

08 Calorimetry — CORE RULE

Heat is conserved: Q_hot + Q_cold + Q_cal = 0. The calorimeter constant C_cal (J/°C) is the whole-device value; negligible for a coffee cup unless stated, always significant for a bomb.

09 Thermal equilibrium (mixing) — CORE RULE

Same substance, no calorimeter: T_eq = (m_hot·T_hot + m_cold·T_cold) / (m_hot + m_cold). Equal masses → the midpoint. Any consistent temperature scale works (no phase change).

10 Bomb calorimetry — CORE RULE

Constant volume: Q = (m_water·s_water + C_cal)·ΔT. Convert mass burned → moles, then |Q| ÷ moles = heat of combustion per mole (negative). C_cal covers bomb + thermometer + stirrer (given).

11 Bond energies (gas phase) — CORE RULE

ΔH ≈ Σ E(bonds broken) − Σ E(bonds formed), E = average bond enthalpy (always positive; breaking is endothermic). Estimate only, gas-phase species only.