11/5/2018

last time...

$\Delta E = q_v$ (const vol heat, not useful)

$\Delta E \neq q_p$ (const pressure heat, VERY useful!)

Can define a stat fxn, enthalpy: $H = E + pV$

$\Delta H = q_p$ (very useful!!)

ΔH: changes in stat fxn: doesn't depend on path!

$R \rightarrow P$
(i) (f)

ΔH = -ve : rxn loses heat: exothermic (feels hot to touch)

ΔH = +ve : rxn gains heat: endothermic (feels cold to touch)

Stoichiometry involving ΔH: Thermochemical equation

chem eq + ΔH $K = 10^3$

ex: $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$; $\Delta H_{rxn} = -2044\,kJ$

Ratios $1\,mol\,C_3H_8 : 5\,mol\,O_2 : 3\,mol\,CO_2 : 4\,mol\,H_2O : -2044\,kJ$

ex: What's q_{rxn} (const p) if we burn C_3H_8 + end up w/ 12.0 g H_2O

$$12.0\,g\,H_2O \times \frac{1\,mol\,H_2O}{18.02\,g\,H_2O} \times \frac{-2044\,kJ}{4\,mol\,H_2O} = -511\,kJ$$

511 kJ of heat is released

Relationships involving ΔH_{rxn}

if we change rxn, we change ΔH_{rxn} in a well-defined way

(1) rxn × x , ΔH_{rxn} × x

ex: $A \longrightarrow 2B$; $\Delta H_{rxn} = -10\,kJ$

×3 → $3A \longrightarrow 6B$; $\Delta H_{rxn} = -30\,kJ$ ← ×3

(2) if we reverse rxn, we reverse sign of ΔH_{rxn}.

ex: $A \rightarrow 2B$; $\Delta H_{rxn} = -10\,kJ$

reverse → $2B \rightarrow A$; $\Delta H_{rxn} = +10\,kJ$ ← reverse sign $+ \leftrightarrow -$

(3) If we add-up rxns, we add-up ΔH_{rxn}

"Hess's law"

ex: $A \longrightarrow 2B$; $\Delta H_{rxn} = -10\,kJ$

$B \longrightarrow C$; $\Delta H_{rxn} = +30\,kJ$

(+)

$A + \cancel{B} \longrightarrow \overset{1}{\cancel{2}}B + C$; $\Delta H_{rxn} = +20\,kJ$

$A \rightarrow B + C$; $\Delta H_{rxn} = +20\,kJ$

ex:

given (1) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$; $\Delta H = -483.6\,kJ$

(2) $3O_2(g) \rightarrow 2O_3(g)$; $\Delta H = +285.8\,kJ$

what is ΔH_{rxn} for: $3H_2(g) + O_3(g) \rightarrow 3H_2O(g)$?

reverse (2)

$2O_3(g) \rightarrow 3O_2(g)$; $\Delta H = -285.8\,kJ$ $\times \frac{1}{2}$

$O_3(g) \rightarrow \frac{3}{2}O_2(g)$; $\Delta H = -142.9\,kJ$

$\frac{3}{2} \times$ (1) $3H_2(g) + \frac{3}{2}O_2(g) \rightarrow 3H_2O(g)$; $\Delta H = -725.4\,kJ$ $\times \frac{3}{2}$

(+)

$O_3(g) + 3H_2(g) + \cancel{\frac{3}{2}O_2(g)} \rightarrow \cancel{\frac{3}{2}O_2(g)} + 3H_2O(g)$; $\Delta H = -868.3\,kJ$

✓

What's ΔH_{rxn} : $CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$

given: (1) $Ca(s) + CO_2(g) + \frac{1}{2}O_2(g) \rightarrow CaCO_3(s)$; $\Delta H = -812.8\,kJ$

(2) $2Ca(s) + O_2(g) \rightarrow 2CaO(s)$; $\Delta H = -1269.8\,kJ$

reverse $\times\frac{1}{2}$ $\times(-1)$ $\times\frac{1}{2}$

$CaO(s) \rightarrow Ca(s) + \frac{1}{2}O_2(g)$; $\Delta H = +634.9\,kJ$

(1) $Ca(s) + CO_2(g) + \frac{1}{2}O_2(g) \rightarrow CaCO_3(s)$; $\Delta H = -812.8\,kJ$

$CaO(s) + CO_2(g) \rightarrow CaCO_3(s)$; $\Delta H = -177.9\,kJ$

MAS439.