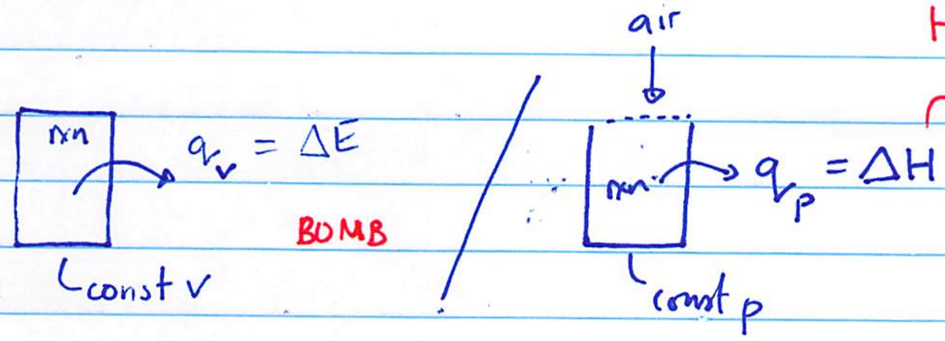
10/25/2019

$H = E + pV$ — enthalpy



Thermochemical eQs

chem eQ + ΔH

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

1 mol C_3H_8 : 3 mol CO_2 (OLD HAT)
1 mol C_3H_8 : −2044 kJ
3 mol CO_2 : −2044 kJ
5 mol O_2 : −2044 kJ

Q: What's q_p if we burn C_3H_8 + form 12.0 g H_2O?

$$12.0\ g\ H_2O \times \frac{1\ mol\ H_2O}{18.02\ g\ H_2O} \times \frac{-2044\ kJ}{4\ mol\ H_2O} = -340.\ kJ$$

(340. kJ of heat were lost/evolved/given off/produced/…)

Q: What mass of C_3H_8 must be burned to make 845 kJ of heat?

$$-845\ kJ \times \frac{1\ mol\ C_3H_8}{-2044\ kJ} \times \frac{44.09\ g\ C_3H_8}{1\ mol\ C_3H_8} = 18.2\ g\ C_3H_8$$

We may need to calculate a <u>new</u> thermochemical eq from known rxns!

3 tricks:

1) If we multiply a thermochem eq. by n, then we multiply ΔH by n.

$$A + 2B \rightarrow C \; ; \; \Delta H = +20 kJ$$

×3 ↓ ×3

$$3A + 6B \rightarrow 3C \; ; \; \Delta H = +60 kJ$$

2) If we reverse eq, reverse sign (×-1) of ΔH.

$$3C \rightarrow 3A + 6B \; ; \; \Delta H = -60 kJ$$

3) Can add up eq's, add up ΔH's (Hess's law)

$$A + 2B \rightarrow C \; ; \; \Delta H = +20 kJ$$

$$\oplus \quad C \rightarrow B + 3D \; ; \; \Delta H = -80 kJ$$

$$A + \cancel{2}B + \cancel{C} \rightarrow \cancel{C} + \cancel{B} + 3D \; ; \; \Delta H = -60 kJ$$

$$A + B \rightarrow 3D \; ; \; \Delta H = -60 kJ$$

ex: $C(s) + H_2O(g) \longrightarrow CO(g) + H_2(g)$; $\Delta H_{rxn} = ?$

(1) $C(s) + O_2(g) \longrightarrow CO_2(g)$; $\Delta H = -393.5\,kJ$ ①

(2) $2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$; $\Delta H = -566.0\,kJ$.

(3) $2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$; $\Delta H = -483.6\,kJ$ — reverse, $\times \frac{1}{2}$

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

$H_2O(g) \longrightarrow H_2(g) + \frac{1}{2}O_2(g)$; $\Delta H = +241.8\,kJ$

reverse
halve

$CO_2(g) \longrightarrow CO(g) + \frac{1}{2}O_2(g)$; $\Delta H = +283.0\,kJ$

(1) $C(s) + O_2(g) \longrightarrow CO_2(g)$; $\Delta H = -393.5\,kJ$

$C(s) + H_2O(g) \longrightarrow CO(g) + H_2(g)$; $\Delta H = +131.3\,kJ$

for you: $3H_2 + O_3 \longrightarrow 3H_2O$; $\Delta H_{rxn} = ?$

1) $2H_2 + O_2 \longrightarrow 2H_2O$; $\Delta H = -483.6\,kJ$

2) $3O_2 \longrightarrow 2O_3$; $\Delta H = +285.4\,kJ$

$\times \frac{3}{2}$

$3H_2 + \frac{3}{2}O_2 \longrightarrow 3H_2O$; $\Delta H = -725.4\,kJ$

reverse
halve

$O_3 \longrightarrow \frac{3}{2}O_2$; $\Delta H = -142.7\,kJ$

$3H_2 + O_3 \longrightarrow 3H_2O$; $\Delta H = -868.1\,kJ$