

Ch. 5.3 enthalpy, H

$$\Delta H_{\text{Rx}} = q_p$$

↖
change in
enthalpy
of a rx

↗
heat under constant pressure
conditions

↓
"form of energy"
"moves" from high T to low T

defn
system: Rx happens, here
surrounding: Rx does not happen, here



q enters system
 Rx consumes q
 system gains q
 $q_{sys} > 0$

$\Delta H_{rx} > 0$
 endo thermic Rx

q leaves system
 Rx generates q
 system loses q
 $q_{sys} < 0$

$\Delta H_{rx} < 0$
 exothermic Rx

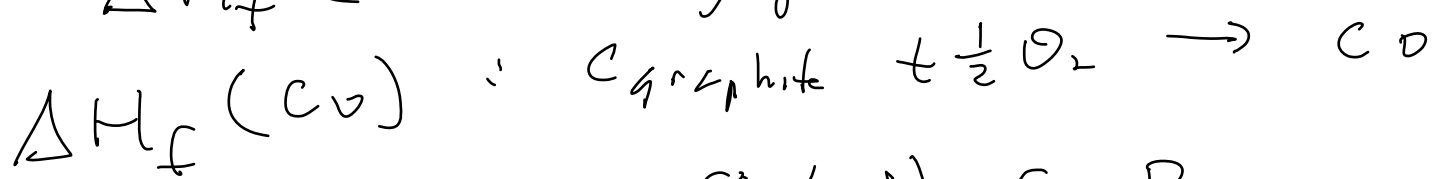
heat leaves "hand" \rightarrow cold
 $\Delta T_{sys} < 0$

heats enter "hand" \rightarrow hot
 $\Delta T_{sys} > 0$

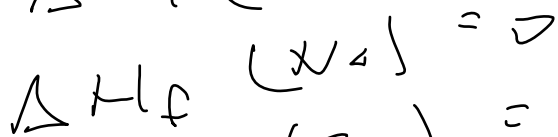
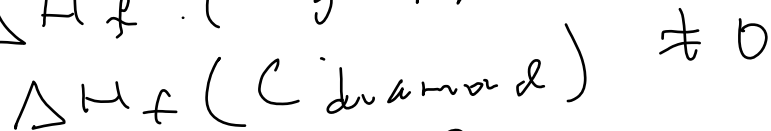
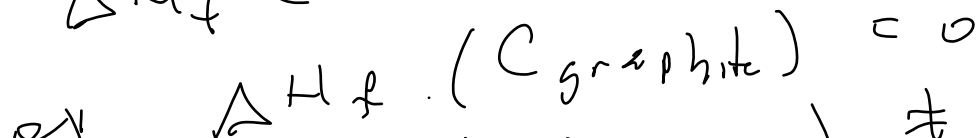
Ch 5.7 $\Delta H_f(\text{chemical}) \neq \Delta H_{rx}$

$\Delta H_f(\text{chemical})$: ΔH_{rx} , where 1 mole of the chemical is formed from the stable form of the atoms in the chemical

\uparrow "formation"



note: ΔH_f (stable form of atom) = 0

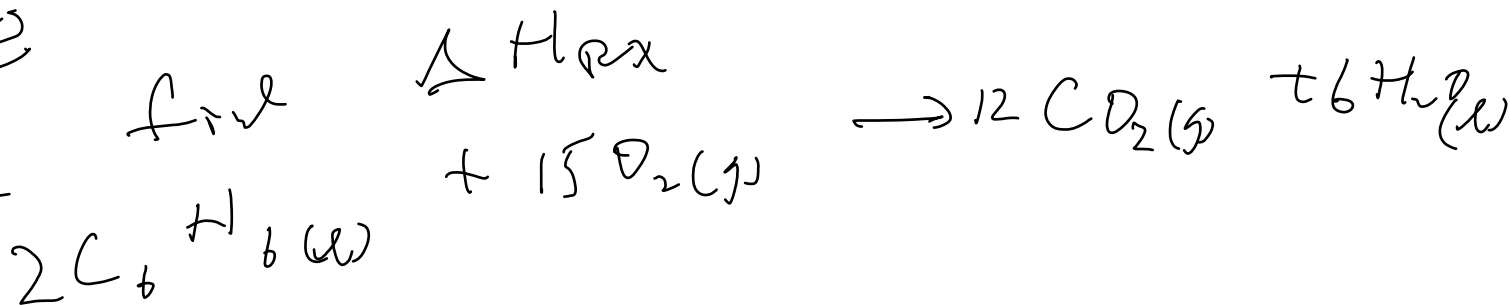


$$\Delta H_{\text{rx}} = \sum a \Delta H_f(\text{products}) - \sum b \Delta H_f(\text{reactants})$$

↑
coefficient of the balanced chemical eq.

problems

①

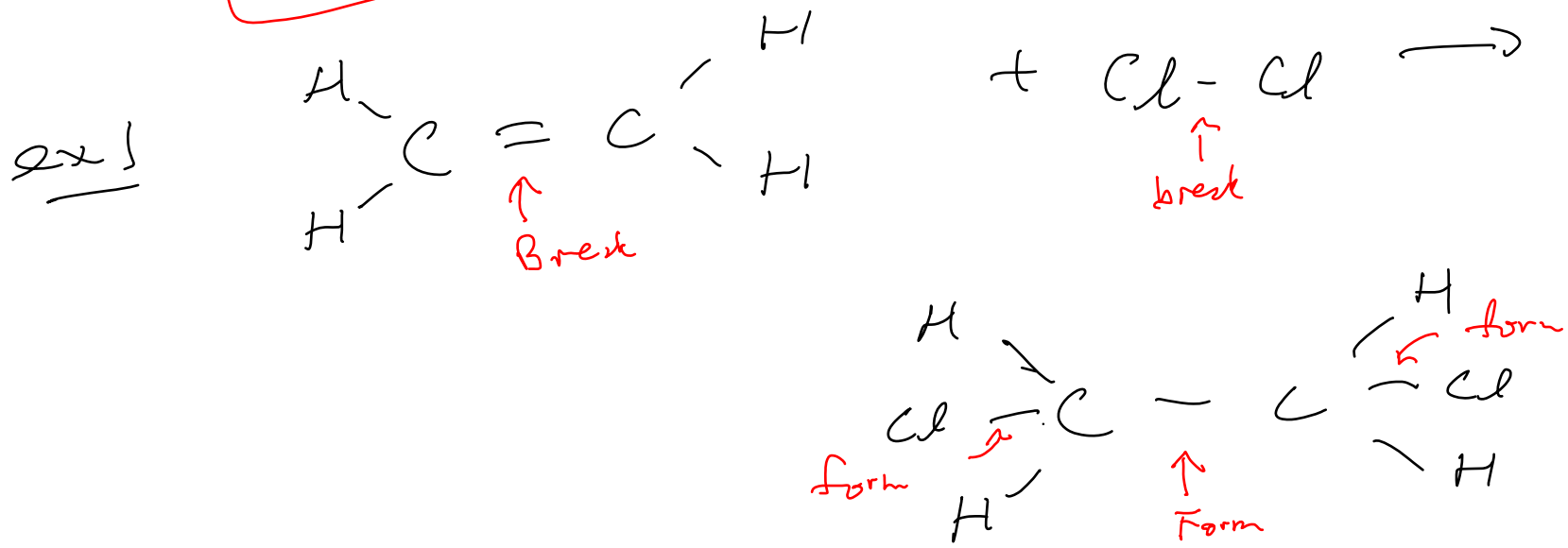


Ch 8.9 bond enthalpy, D

recall: in a chemical rx,
∃ bonds breaking & forming bonds

bond enthalpy: energy to break a bond

$$\Delta H_{rx} = \sum D_{\text{break}} - \sum D_{\text{form}}$$



$$\Delta H_{rx} = \sum D_{\text{break}} - \sum D_{\text{form}}$$
$$= [D(C=C) + D(Cl-Cl)] - [D(C-C) + 2D(C-Cl)]$$

alternative

$$\Delta H_{rx} = \sum \text{break all bond} - \sum \text{form all bond}$$

note as $\Delta H_{rx} = \sum D_{\text{break}} - \sum D_{\text{form}}$

if $\Delta H_{rx} = \sum D_{\text{break}} - \sum D_{\text{form}} > 0$ ~~exothermic~~ ^{endothermic} rx

$$\sum D_{\text{break}} > \sum D_{\text{form}}$$

consume \uparrow $>$ generate \downarrow

$$\uparrow$$
$$\Delta H > 0$$

if $\Delta H_{rx} = \sum D_{\text{break}} - \sum D_{\text{form}} < 0$ exothermic rx

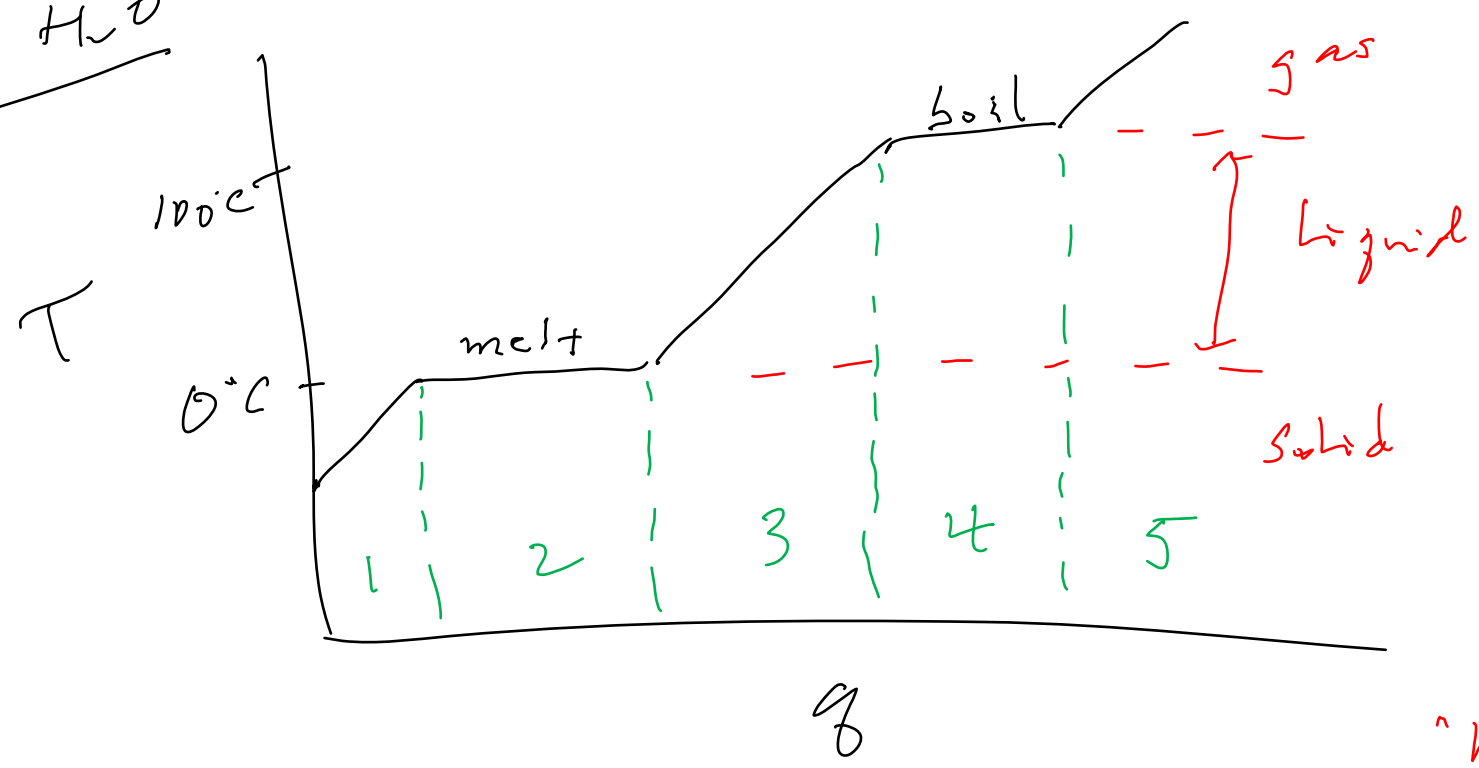
$$\sum D_{\text{break}} < \sum D_{\text{form}}$$

consume \downarrow $<$ generate \uparrow

generate \uparrow $>$ consume \downarrow

ch 11.4 heating curve

for H₂O



for H₂O

$$C_{\text{gas}} = 1.84 \frac{\text{J}}{\text{g} \cdot \text{K}}$$

$$C_{\text{liquid}} = 4.18 \frac{\text{J}}{\text{g} \cdot \text{K}}$$

$$C_{\text{solid}} = 2.09 \frac{\text{J}}{\text{g} \cdot \text{K}}$$

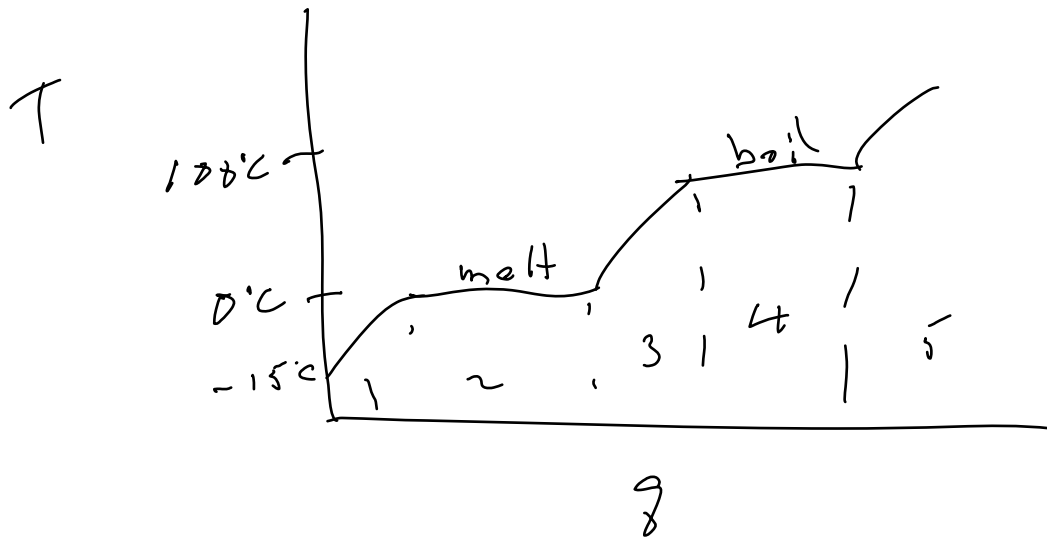
"heat to melt"

$$\Delta H_{\text{fusion}} = \frac{6.01 \text{ kJ}}{\text{mol}}$$

$$\Delta H_{\text{vap}} = \frac{40.67 \text{ kJ}}{\text{mol}}$$

"heat to vaporize"

problem find q for 10g H_2O $-15^\circ C \rightarrow 110^\circ C$



$$q = q_1 + q_2 + q_3 + q_4 + q_5$$

$$q = m c \Delta T$$

specific heat: amount of heat to raise 1g of H_2O by $1^\circ C$ (or 1 K)

$$\begin{aligned} \text{i) } q_1 &= m c_s \Delta T_s \\ &= 10g \left(\frac{2.09 J}{g K} \right) 15 K \\ &= 313 J \end{aligned}$$

note, $\Delta T = T_f - T_i$
 $\Delta T (\text{in } ^\circ C) = \Delta T (\text{in } K)$

ex $0^\circ C \rightarrow -15^\circ C$ $(0 + 273) K - (-15 + 273) K = +15 K$
 $= +15^\circ C$

$$\begin{aligned} \text{ii)} \quad q_2 &= \Delta H_{\text{fus}} m \\ &= \frac{6.01 \text{ kJ}}{\text{mol}} \cdot 10 \text{ g} \cdot \frac{\text{mol}}{18 \text{ g}} = 3.34 \text{ kJ} \end{aligned}$$

$$\begin{aligned} \text{iii)} \quad q_3 &= m c_l \Delta T_l \\ &= 10 \text{ g} \left(\frac{4.18 \text{ J}}{\text{g K}} \right) 100 \text{ K} = 4180 \text{ J} \end{aligned}$$

$$\begin{aligned} \text{iv)} \quad q_4 &= \Delta H_{\text{vap}} m \\ &= \frac{40.6 \text{ kJ}}{\text{mol}} \cdot 10 \text{ g} \cdot \frac{\text{mol}}{18 \text{ g}} = 22.56 \text{ kJ} \end{aligned}$$

$$\begin{aligned} \text{v)} \quad q_5 &= m c_g \Delta T \\ &= 10 \text{ g} \left(\frac{1.84 \text{ J}}{\text{g K}} \right) 10 = 184 \text{ J} \end{aligned}$$

$$\text{vi)} \quad q = \sum_{i=1}^5 q_i = 30.5 \text{ kJ}$$