### Задача №1

$$\begin{array}{lll} {\rm CH_4 + Cl_2 \longrightarrow CH_3Cl + HCl} & \Delta_r H_{298}^\circ \\ {\rm CH_4 + 2\,O_2 \longrightarrow CO_2 + 2\,H_2O_{(liq)}} & \Delta_r H_2^\circ = -890.35 \ \kappa \text{Дэк/моль} \\ {\rm CH_3Cl + \frac{3}{2}\,O_2 \longrightarrow CO_2 + H_2O_{(liq.)} + HCl} & \Delta_r H_3^\circ = -686.20 \ \kappa \text{Дэк/моль} \\ {\rm H_2 + \frac{1}{2}\,O_2 \longrightarrow H_2\,O_{(liq.)}} & \Delta_r H_4^\circ = -285.85 \ \kappa \text{Дэк/моль} \\ {\rm \Delta}_r H_5^\circ = -92.30 \ \kappa \text{Дэк/моль} \\ & \Delta_r H_5^\circ = -92.30 \ \kappa \text{Дэк/моль} \end{array}$$

$$\Delta_r H_{298}^{\circ} = \Delta_r H_1^{\circ} - \Delta_r H_2^{\circ} + 2\Delta_r H_4^{\circ} - \Delta_r H_3^{\circ} = -102.9 \text{ кДж/моль}$$

$$\Delta_r H_{298}^{\circ} = \Delta_f H_{298}^{\circ} (\mathrm{CH_3Cl}) + \Delta_f H_{298}^{\circ} (\mathrm{HCl}) - \Delta_f H_{298}^{\circ} (\mathrm{CH_4}) = -99.45 \text{ кДж/моль}$$

# Задача №2

$$\begin{array}{c} {\rm C}_2{\rm H}_4 + {\rm H}_2 \longrightarrow {\rm C}_2{\rm H}_6 \\ {\rm C}_2{\rm H}_6 + \frac{7}{2}\,{\rm O}_2 \longrightarrow 2\,{\rm CO}_2 + 3\,{\rm H}_2{\rm O} \\ {\rm C} + {\rm O}_2 \longrightarrow {\rm CO}_2 \\ {\rm H}_2 + \frac{1}{2}\,{\rm O}_2 \longrightarrow {\rm H}_2\,{\rm O} \end{array} \qquad \begin{array}{c} \Delta_r H_1^\circ = -136.96 \,\,\kappa \mbox{$\it RJ$cc/моль} \\ \Delta_r H_2^\circ = -1559.88 \,\,\kappa \mbox{$\it RJ$cc/моль} \\ \Delta_r H_3^\circ = -393.51 \,\,\kappa \mbox{$\it RJ$cc/моль} \\ \Delta_r H_4^\circ = -285.84 \,\,\kappa \mbox{$\it RJ$cc/моль} \end{array}$$

$$\Delta_f H_{298}^{\circ}(C_2 H_4) = -\Delta_r H_1^{\circ} - \Delta_r H_2^{\circ} + 2\Delta_r H_3^{\circ} + 3\Delta_r H_4^{\circ} = -55.37 \text{ кДжс/моль}$$
  
 $\Delta_c H_{298}^{\circ}(C_2 H_4) = \Delta_r H_1^{\circ} + \Delta_r H_2^{\circ} - \Delta_r H_4^{\circ} = -1411 \text{ кДжс/моль}$ 

# Задача №3

$$\begin{array}{c} {\rm C_2H_4 + H_2 \longrightarrow C_2H_6} & \Delta_r H_{298}^{\circ} \\ \Delta_f H_{298}^{\circ}({\rm C_2H_6}) = -84.67 \ \kappa \mbox{$\it KJ$} \mbox$$

$$\Delta_r H^\circ = \Delta_c H^\circ_{298}(\mathrm{C_2H_4}) - \Delta_c H^\circ_{298}(\mathrm{H_2}) + \Delta_c H^\circ_{298}(\mathrm{C_2H_6}) = -136.93 \ \text{кДж/моль}$$

$$E(C-C)=348\ \kappa \mbox{Дэс/моль}$$
  $E(C=C)=614\ \kappa \mbox{Дэс/моль}$   $E(C-H)=413\ \kappa \mbox{Дэс/моль}$   $E(H-H)=436\ \kappa \mbox{Дэс/моль}$ 

$$\Delta_r H^{\circ} = E(C-C) + 2E(C-H) - E(C=C) - E(H-H) = 124 \ \text{кДж/моль}$$

### 1 Задача №4

Вещество	$C_p, 298$	$C_p, 400$	$\Delta_f H_{298}^{\circ}$	$\Delta_f H_{349}^{\circ}$
$\mathrm{CH}_4$	35.70	40.63	-74.85	-72.90
CH <sub>3</sub> F	37.48	44.18	-246.9	-244.82
HF	29.14	29.15	-273.30	-271.81
$F_2$	31.30	32.99	0	1.64

$$CH_4 + F_2 \longrightarrow CH_3F + HF$$

$$\Delta_f H_{349}^\circ = \Delta_f H_{298}^\circ + \int_{298}^{349} c_p(T) dT \approx \Delta_f H_{298}^\circ + (c_p^{349} + c_p^{298}) \cdot \frac{\Delta T}{2}$$
 
$$\Delta_r H_{349}^\circ = \Delta_f H_{349}^\circ (\mathrm{CH_3F}) + \Delta_f H_{349}^\circ (\mathrm{HF}) - \Delta_f H_{349}^\circ (\mathrm{CH_4}) - \Delta_f H_{349}^\circ (\mathrm{F_2}) = -445.37 \text{ к.Дэж/моль}$$

 $\Delta_r H_{349}^{\circ}$ 

### 2 Задача №5

$$4 \,\mathrm{HCl} + \mathrm{O}_2 \longrightarrow 2 \,\mathrm{Cl}_2 + 2 \,\mathrm{H}_2\mathrm{O}$$
  $\Delta_r H_T^{\circ}$ 

$$\begin{split} &\Delta_{f}H_{T}^{\circ}(\text{HCl}) = \Delta_{f}H_{298}^{\circ}(\text{HCl}) + \int_{298}^{T} c_{p}(T')dT' = -92310 + 25.53 \cdot T' \bigg|_{298}^{T} + 2.30 \cdot 10^{-3} \cdot (T')^{2} \bigg|_{298}^{T} - 1.09 \cdot 10^{5}(T')^{-1} \bigg|_{298}^{T} \\ &\Delta_{f}H_{T}^{\circ}(\text{O}_{2}) = \Delta_{f}H_{298}^{\circ}(\text{O}_{2}) + \int_{298}^{T} c_{p}(T')dT' = 37.03 \cdot T' \bigg|_{298}^{T} + 0.33 \cdot 10^{-3}(T')^{2} \bigg|_{298}^{T} + 2.85 \cdot 10^{5}(T')^{-1} \bigg|_{298}^{T} \\ &\Delta_{f}H_{T}^{\circ}(\text{Cl}_{2}) = \Delta_{f}H_{298}^{\circ}(\text{Cl}_{2}) + \int_{298}^{T} c_{p}(T')dT' = 31.46 \cdot T' \bigg|_{298}^{T} + 1.69 \cdot 10^{-3}(T')^{2} \bigg|_{298}^{T} + 3.77 \cdot 10^{5}(T')^{-1} \bigg|_{298}^{T} \\ &\Delta_{f}H_{T}^{\circ}(\text{H}_{2}\text{O}) = \Delta_{f}H_{298}^{\circ}(\text{H}_{2}\text{O}) + \int_{298}^{T} c_{p}(T')dT' = -241810 + 30.00 \cdot T' \bigg|_{298}^{T} + 5.35 \cdot 10^{-3}(T')^{2} \bigg|_{298}^{T} - 0.33 \cdot 10^{5}(T')^{-1} \bigg|_{298}^{T} \end{split}$$

$$\Delta_r H_T^{\circ} = -112.763 - 1.623 \cdot 10^{-2} \ T + 4.55 \cdot 10^{-6} \ T^2 + 8.39 \cdot 10^2 (T)^{-1}$$