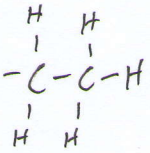
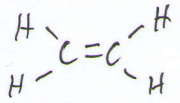
Study Guide for Enthalpy Quiz – Answers

1. a) ethane (C_2H_6)



ethene (C_2H_4)



ethyne (C_2H_2) $H-C\equiv C-H$

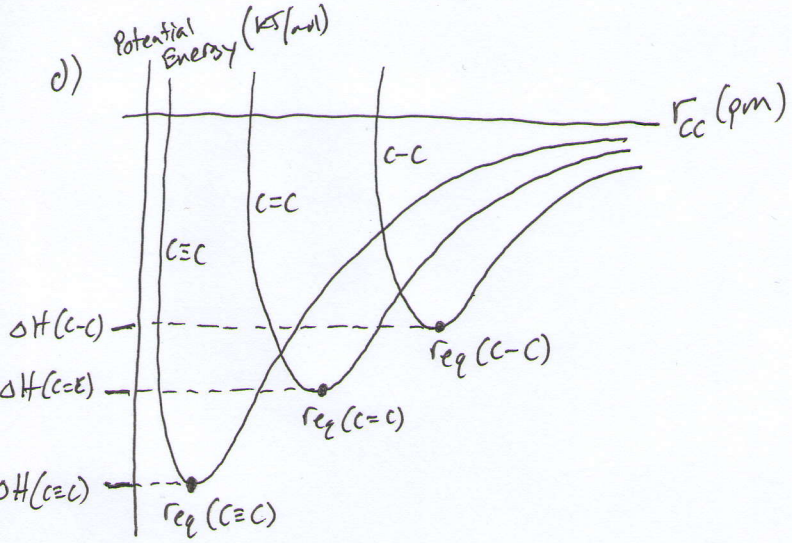
b) $C\equiv C < C=C < C-C$

Shortest longest

c) $C-C < C=C < C\equiv C$

Weakest strongest

d)



e)

Formation

$2C_{(s,\text{graphite})} + 3H_{2(g)} \rightarrow C_2H_{6(g)}$

$2C_{(s,\text{graphite})} + 2H_{2(g)} \rightarrow C_2H_{4(g)}$

$2C_{(s,\text{graphite})} + H_{2(g)} \rightarrow C_2H_{2(g)}$

Combustion

$C_2H_{6(g)} + \frac{7}{2}O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(g)}$

$C_2H_{4(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O_{(g)}$

$C_2H_{2(g)} + \frac{5}{2}O_{2(g)} \rightarrow 2CO_{2(g)} + H_2O_{(g)}$

f) (i) ΔH_c (ethane) $= \Delta H(C-C) + 6\Delta H(C-H) + \frac{7}{2}\Delta H(O=O) - 4\Delta H(C=O) - 6\Delta H(O-H)$

ΔH_c (ethene) $= \Delta H(C=C) + 4\Delta H(C-H) + 3\Delta H(O=O) - 4\Delta H(C=O) - 4\Delta H(O-H)$

ΔH_c (ethyne) $= \Delta H(C\equiv C) + 2\Delta H(C-H) + \frac{5}{2}\Delta H(O=O) - 4\Delta H(C=O) - 2\Delta H(O-H)$

(ii) ΔH_c (ethane) $= 2\Delta H_f(CO_2) + 3\Delta H_f(H_2O) - \Delta H_f(C_2H_6) - \frac{7}{2}\Delta H_f(O_2)$

ΔH_c (ethene) $= 2\Delta H_f(CO_2) + 2\Delta H_f(H_2O) - \Delta H_f(C_2H_4) - 3\Delta H_f(O_2)$

ΔH_c (ethyne) $= 2\Delta H_f(CO_2) + \Delta H_f(H_2O) - \Delta H_f(C_2H_2) - \frac{5}{2}\Delta H_f(O_2)$

g) (i) $C_2H_6 \rightarrow C_2H_2 + 2H_2$

$\Delta H_{rxn} = \Delta H(C-C) + 6\Delta H(C-H) - \Delta H(C\equiv C) - 2\Delta H(C-H) - 2\Delta H(H-H)$

$= (347) + 6(414) - (812) - 2(414) - 2(436)$

$\Delta H_{rxn} = 319$ kJ/mol

(ii) $C_2H_4 + H_2 \rightarrow C_2H_6$

$\Delta H_{rxn} = \Delta H(C=C) + 4\Delta H(C-H) + \Delta H(H-H) - \Delta H(C-C) - 6\Delta H(C-H)$

$= (620) + 4(414) + (436) - (347) - 6(414)$

$\Delta H_{rxn} = -119$ kJ/mol

(iii) $C_2H_2 + H_2 \rightarrow C_2H_4$

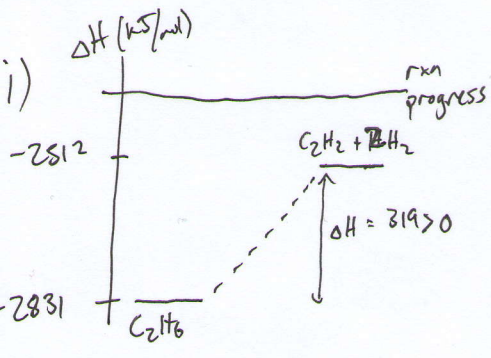
$\Delta H_{rxn} = \Delta H(C\equiv C) + 2\Delta H(C-H) + \Delta H(H-H) - \Delta H(C=C) - 4\Delta H(C-H)$

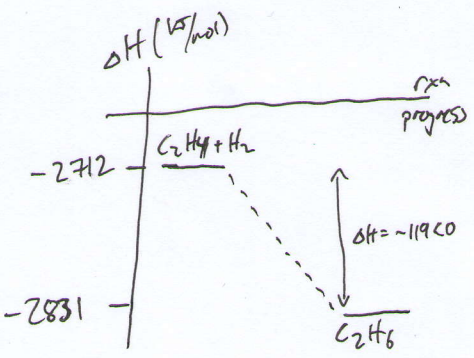
$= (812) + 2(414) + (436) - (620) - 4(414)$

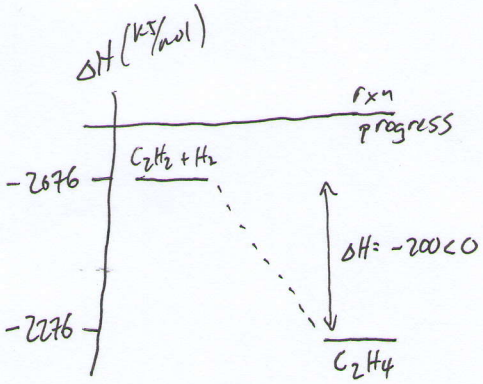
$= -200$ kJ/mol

h) (i) endothermic (ii) exothermic (iii) exothermic

i)







2.

① $H_{2(g)} \rightarrow 2H_{(g)}$ $\quad \Delta H_{rxn,1} = 436.4$ kJ/mol

② $Br_{2(g)} \rightarrow 2Br_{(g)}$ $\quad \Delta H_{rxn,2} = 192.5$

③ $H_{2(g)} + Br_{2(g)} \rightarrow 2HBr_{(g)}$ $\quad \Delta H_{rxn,3} = -72.4$

$-\frac{1}{2}$① $\quad H_{(g)} \rightarrow \frac{1}{2}H_{2(g)}$ $\quad \Delta H_{rxn} = -\frac{1}{2}\Delta H_{rxn,1} = -\frac{1}{2}(436.4)$

$-\frac{1}{2}$② $\quad Br_{(g)} \rightarrow \frac{1}{2}Br_{2(g)}$ $\quad \Delta H_{rxn} = -\frac{1}{2}\Delta H_{rxn,2} = -\frac{1}{2}(192.5)$

$\frac{1}{2}$③ $\quad \frac{1}{2}H_{2(g)} + \frac{1}{2}Br_{2(g)} \rightarrow HBr_{(g)}$ $\quad \Delta H_{rxn} = \frac{1}{2}\Delta H_{rxn,3} = \frac{1}{2}(-72.4)$

$\frac{1}{2}$① $-\frac{1}{2}$② $+\frac{1}{2}$③ $\quad H_{(g)} + Br_{(g)} \rightarrow HBr_{(g)}$

$$\Delta H_{rxn} = -\frac{1}{2}\Delta H_{rxn,1} - \frac{1}{2}\Delta H_{rxn,2} + \frac{1}{2}\Delta H_{rxn,3}$$

$$= -\frac{1}{2}(436.4) - \frac{1}{2}(192.5) + \frac{1}{2}(-72.4)$$

$$\Delta H_{rxn} = -350.65 \text{ kJ/mol}$$

Overall

$H_{(g)} + Br_{(g)} \rightarrow HBr_{(g)}$ $\quad \Delta H_{rxn} = -350.65$ kJ/mol