Chapter 6 - Lecture Worksheet 3

Using standard heats of formation, calculate the standard enthalpy change for the following reaction.

$CO_2(g) + 4H_2(g)$ -----> $CH_4(g) + 2H_2O(g)$

$$\Delta H^0_{rxn} = \Delta H^0_f(CH_4,g) + 2\Delta H^0_f(H_2O,g) - \Delta H^0_f(CO_2,g) - 4\Delta H^0_f(H_2,g)$$

$$= -75 + 2(-242) - (-394) - 4(0)\ \text{kJ} = -165\ \text{kJ}$$

(1) -711 kJ (2) -165 kJ (3) -15 kJ (4) 15 kJ (5) 165 kJ (6) 229 kJ (7) 711 kJ

Using average bond enthalpies estimate the standard enthalpy change for the same reaction.

$CO_2(g) + 4H_2(g)$ -----> $CH_4(g) + 2H_2O(g)$

$$\Delta H^0_{rxn} \approx 2BE(C=O) + 4BE(H-H) - 4BE(C-H) - 4BE(O-H)$$

$$\approx 2(728) + 4(436) - 4(413) - 4(463)\ \text{kJ} = -304\ \text{kJ}$$

Which is more accurate ? Why ?

$\Delta H°$ calculated from $\Delta H°_f$ is more accurate because $\Delta H°$ calculated from bond enthalpies uses AVERAGE bond enthalpies obtained from a number of different compounds in which the bonds arise and are not specific to the compound in question.

	Standard Enthalpy of formation (kJ/mol)
$CH_4(g)$	–75
$CO_2(g)$	–394
$C_2H_2(g)$	+227
$H_2O(g)$	–242
$H_2O(l)$	–286
$NH_3(g)$	–46
HCl(g)	–92
HCl(aq)	-167
$CaCO_3(s)$	-1208
$Ca(OH)_2(aq)$	-1003
$Ca(OH)_2(s)$	-986
CaO(s)	-635
$SO_2(g)$	-297
$SO_3(g)$	-396

	Average Bond Enthalpies (kJ/mol)
H–H	436
N–H	391
N–N	161
N=N	418
N≡N	945
O-H	463
C-O	351
C=O	728
C≡O	1072
Cl-Cl	242
Cl-H	432
Br-Br	193
Br-H	366
C-H	413