Temperature Dependent Heat Capacities and $\Delta H_{reaction}$

$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(g)$

	H_2 (g)	O_2 (g)	H_2O (g)	
$\Delta H^0_{f\,(298)}$ kJ/mol	0	0	−241.8	
ΔH^0 kJ	− 0	− ½ (0)	+ (−241.8)	−241.8 kJ

$$C_P = a + bT + cT^2 + dT^3$$ **Table 2.4 E&R**

C_P	a≡A(1)	b≡A(2)	c≡A(3)	d≡A(4)
H_2 (g)	22.6	.04381	-10.835×10^{-5}	11.710×10^{-8}
O_2 (g)	32.83	-.03633	11.532×10^{-5}	-12.194×10^{-8}
H_2O (g)	33.8	-.00795	2.8228×10^{-5}	-1.3115×10^{-8}
Δ	Δ a= -5.275	Δ b= -.033595	Δ c= 7.8198×10^{-5}	Δ d= -6.9245×10^{-8}

$$\Delta C_P(reaction) = \sum_i \nu_i \left(\bar{C}_P\right)_i$$

$$\Delta C_P(reaction) = \Delta a + \Delta b\, T + \Delta c\, T^2 + \Delta d\, T^3$$

$$e.g.\quad \Delta a = \sum \nu_i a_i$$

$$\Delta a = -a(H_2) - \frac{1}{2} a(O_2) + a(H_2O)$$

$$\Delta H^0_{398K} = \Delta H^0_{298K} + \int_{298}^{398} \Delta C_p(T)\, dT$$

$$\Delta H^0_{398K} = \Delta H^0_{298K} + \left(\Delta a\, T + \Delta b\, \frac{T^2}{2} + \Delta c\, \frac{T^3}{3} + \Delta d\, \frac{T^4}{4} \right)_{298}^{398}$$

$$\Delta H^0_{398K} = \Delta H^0_{298K} + \left(\Delta a\left(398 - 298\right) + \Delta b\, \frac{\left(398^2 - 298^2\right)}{2} + \Delta c\, \frac{\left(398^3 - 298^3\right)}{3} + \Delta d\, \frac{\left(398^4 - 298^4\right)}{4} \right)$$

$$\Delta H^0_{398K} = -283.39\ kJ$$

TABLE 2.4 MOLAR HEAT CAPACITY, $C_{P,m}$, OF GASES IN THE RANGE 298–800 K

Given by

$$C_{P,m}\,(\mathrm{J\,K^{-1}\,mol^{-1}}) = A(1) + A(2)\frac{T}{\mathrm{K}} + A(3)\frac{T^2}{\mathrm{K}^2} + A(4)\frac{T^3}{\mathrm{K}^3}$$

Note that $C_{P,m}$ for solids and liquids at 298.15 K is listed in Tables 2.1 and 2.2.

Name	Formula	C_P° (298.15 K) in J K^{-1} mol^{-1}	A(1)	A(2)	A(3)	A(4)
All monatomic gases	He, Ne, Ar, Xe, O, H, among others	20.79	20.79			
Bromine	Br_2	36.05	30.11	0.03353	-5.5009×10^{-5}	3.1711×10^{-8}
Chlorine	Cl_2	33.95	22.85	0.06543	-1.2517×10^{-4}	1.1484×10^{-7}
Carbon monoxide	CO	29.14	31.08	−0.01452	3.1415×10^{-5}	-1.4973×10^{-8}
Carbon dioxide	CO_2	37.14	18.86	0.07937	-6.7834×10^{-5}	2.4426×10^{-8}
Fluorine	F_2	31.30	23.06	0.03742	-3.6836×10^{-5}	1.351×10^{-8}
Hydrogen	H_2	28.84	22.66	0.04381	-1.0835×10^{-4}	1.1710×10^{-7}
Water	H_2O	33.59	33.80	−0.00795	2.8228×10^{-5}	-1.3115×10^{-8}
Hydrogen bromide	HBr	29.13	29.72	−0.00416	7.3177×10^{-6}	
Hydrogen chloride	HCl	29.14	29.81	−0.00412	6.2231×10^{-6}	
Hydrogen fluoride	HF	29.14	28.94	0.00152	-4.0674×10^{-6}	3.8970×10^{-9}
Ammonia	NH_3	35.62	29.29	0.01103	4.2446×10^{-5}	-2.7706×10^{-8}
Nitrogen	N_2	29.13	30.81	−0.01187	2.3968×10^{-5}	-1.0176×10^{-8}
	NO	29.86	33.58	−0.02593	5.3326×10^{-5}	-2.7744×10^{-8}
	NO_2	37.18	32.06	−0.00984	1.3807×10^{-4}	-1.8157×10^{-7}
Oxygen	O_2	29.38	32.83	−0.03633	1.1532×10^{-4}	-1.2194×10^{-7}