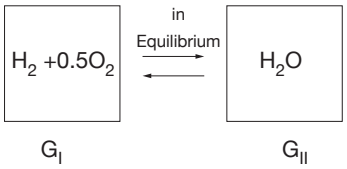
03C REDOX Reactions Amongst Gaseous Species

We shall consider this reaction amongst gaseous species. Calculate the Partial Pressure where hydrogen, oxygen and water vapor are in equilibrium

Species in the above example are: hydrogen, oxygen and water vapor.



At the hydrogen electrode, oxygen, hydrogen and water vapor exist in equilibrium, that is

$$H_2 + \frac{1}{2}O_2 = H_2O$$

$$G_{rhs} = G_{lhs}$$

$$\mu_{H_2O} = \mu_{H_2} + \frac{1}{2}\mu_{O_2} \qquad (7)$$

$$\mu^o_{H_2O} + RT\ell n(p_{H_2O}) = \mu^o_{H_2} + RT\ell n(p_{H_2}) + \frac{1}{2}\left[\mu^o_{O_2} + RT\ell n(p_{O_2})\right] \qquad (8)$$

$$(\mu^o_{H_2O} - \mu^o_{H_2} - \frac{1}{2}\mu^o_{O_2}) + RT\ell n\left(\frac{p_{H_2O}}{p_{H_2}p_{O_2}^{1/2}}\right) = 0 \qquad (9)$$

$$\Delta G^o_{H_2O} + RT\ell n\left(\frac{p_{H_2O}}{p_{H_2}p_{O_2}^{1/2}}\right) = 0 \qquad (10)$$

The left-hand side is tabulated in JANAF tables.

Below is an extract from the JANAF Tables for H_2O at 1 bar (atm) (p.1276, 3rd Ed.)

Water, 10 Bar (H_2O) $H_2O_1(l,g)$

Enthalpy Reference Temperature = T_r = 298.15 K Standard State Pressure = p° = 0.1 MPa

T/K	C_p	S	$-[G-H(T_r)]/T$	$H-H(T_r)$	$\Delta_f H^\circ$	$\Delta_f G^\circ$	Log K_f
	J K^{-1}mol^{-1}			kJ mol^{-1}			
0	at P = 10 bar						
100							
200							
298.15	75.313	69.946	69.946	0.	-285.815	-237.125	41.543
300	75.314	70.412	69.948	0.139	-285.756	-236.823	41.335
400	76.732	92.173	72.906	7.707	-282.580	-220.989	28.858
453.070	79.322	101.872	75.740	11.840	LIQUID <--> REAL GAS		
453.070	46.063	181.988	75.740	48.135	PRESSURE = 10 bar		
500	41.002	186.240	85.819	50.160	-244.579	-209.857	21.903
600	38.430	193.409	103.261	54.089	-245.159	-202.823	17.640
700	38.527	199.328	116.572	57.927	-245.886	-195.477	14.587
800	39.310	204.517	127.247	61.816	-246.618	-188.225	12.290
900	40.357	209.206	136.097	65.798	-247.314	-180.884	10.498
1000	41.517	213.517	143.626	69.891	-247.955	-173.468	9.061
1100	42.714	217.531	150.164	74.103	-248.537	-165.990	7.882
1200	43.900	221.298	155.937	78.434	-249.059	-158.462	6.898
1300	45.045	224.858	161.103	82.881	-249.524	-150.893	6.063
1400	46.134	228.236	165.778	87.441	-249.935	-143.291	5.346
1500	47.155	231.454	170.050	92.106	-250.299	-135.660	4.724
1600	48.104	234.528	173.985	96.869	-250.620	-128.007	4.179
1700	48.981	237.471	177.633	101.724	-250.904	-120.335	3.697
1800	49.786	240.294	181.037	106.663	-251.157	-112.647	3.269