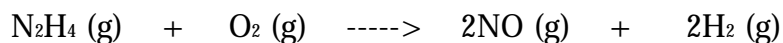


Please read thoroughly and answer all questions. Points available are in parentheses.

(1.) Please consider the following balanced reaction, at 298 K:

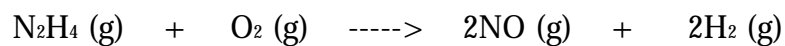


- (a) Please predict the sign of ΔS . Does your answer favor a spontaneous reaction? Which Thermodynamic Law pertains to conservation of energy? Please write an equation which represents the First Law. (10)
- (b) Use the data below to determine ΔH^0 for the reaction. Does your answer favor spontaneity? (5)

	ΔH^0 (kJ/mol)	S^0 (J/mol/K)	ΔG^0 (kJ/mol)
N_2H_4 (g)	+ 95.4	238.4	+ 159.3
NO (g)	+ 90.4	210.6	+ 86.7
O_2 (g)	0	205.0	0

- (c) Now please calculate ΔG^0 for the reaction. Is the reaction spontaneous at 298 K? Why/or not? (5)
- (d) Now please calculate ΔS^0 for the reaction (T = 298 K). (5)
- (e) Please calculate S^0 for H_2 (g). (10)
- (f) If the reaction changes from spontaneous to non-spontaneous at a particular temperature, please determine that temperature. (5)
- (g) At 988 K, what is the maximum amount of theoretically possible work from the reaction of 3.20 g of N_2H_4 (g)? (10)

- (2.) Please consider the following balanced reaction, again, and columns of experimental data, which were measured at 398 K:



$[\text{N}_2\text{H}_4]_t$ (mol L ⁻¹)	t (s)	rate of reaction N ₂ H ₄ (mol L ⁻¹ s ⁻¹)
3.60×10^{-3}	0	
2.35×10^{-3}	10	
1.54×10^{-3}	20	
1.00×10^{-3}	30	
6.55×10^{-4}	40	
4.28×10^{-4}	50	

- (a) Is the reaction homogeneous? Please determine the overall order of the reaction. (15)
- (b) Please determine k at 398 K. (5)
- (c) Please write the rate law expression for the reaction, and fill in the column above headed "rate of N₂H₄ reaction." (5)
- (d) What is the order of O₂ in the reaction? (5)
- (e) Please break down the overall reaction into elementary steps, and encircle the intermediates. Please propose which would be the rate-determining step. (10)
- (f) Please determine the half-life, $t_{1/2}$, (at 398 K) for the reaction, in units of seconds. Is $t_{1/2}$ constant here, or will it vary with temperature? (5)
- (g) What is the concentration of N₂H₄ after 100 seconds? (5)