

REVIEW QUESTIONS

Chapter 18

1. Calculate the heat of reaction (ΔH^0) in kJ/mol for the reaction shown below, given the ΔH_f^0 values for each substance:

	$\text{NH}_3 (\text{g})$	+	$3 \text{F}_2 (\text{g})$	\rightarrow	$\text{NF}_3 (\text{g})$	+	$3 \text{HF} (\text{g})$
ΔH_f^0 (kJ/mol)	-46.1		0		-125		-271

2. Determine the entropy change (ΔS^0) in J/K for the reaction shown below, given the standard entropies for each:

	$2 \text{SO}_2 (\text{g})$	+	$\text{O}_2 (\text{g})$	\rightarrow	$2 \text{SO}_3 (\text{g})$
S^0 (J/K mol)	248.1		205.03		256.6

3. Given the following thermodynamic data, estimate the temperature ($^{\circ}\text{C}$) at which the reaction shown below becomes spontaneous.



$$\Delta H^0 = +184 \text{ kJ} \quad \Delta S^0 = +166 \text{ J/K} \quad \Delta G^0 = +300 \text{ kJ}$$

4. Calculate the free energy (ΔG^0) in kJ for the reaction shown below, given the ΔG_f^0 values for each substance:

$$4 \text{ NH}_3 (\text{g}) + 5 \text{ O}_2 (\text{g}) \rightarrow 4 \text{ NO} (\text{g}) + 6 \text{ H}_2\text{O} (\text{g})$$

ΔG_f^0 (kJ/mol)	-16.48	0	86.67	-228.59
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5. Methanol can be produced by the reaction shown below, with the following thermodynamic data given at 25°C.

$$\text{CO} (\text{g}) + 2 \text{ H}_2 (\text{g}) \rightarrow \text{CH}_3\text{OH} (\text{l})$$

ΔH_f^0 (kJ/mol)	-110.5	0	-238.6
ΔG_f^0 (kJ/mol)	-137.3	0	-166.2
S^0 (J/mol K)	+197.9	???	+126.8

- a) Calculate ΔG^0 and ΔH^0 for this reaction.

- b) Calculate ΔS^0 (in J/K) for this reaction.

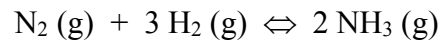
- c) Calculate S^0 for hydrogen.

6. At 25°C the equilibrium constant, K_p , for the reaction below is 0.281 atm.



- a) What is ΔG^0_{298} for this reaction?
- b) If requires 193 J to vaporize 1.00 g of liquid bromine at 25°C and 1.00 atm. Calculate ΔH^0 and ΔS^0 at 25°C for this reaction.
- c) Calculate the normal boiling point of bromine. Assume ΔH^0 and ΔS^0 are not affected by temperature. (*Hint:* At the normal boiling point liquid and vapor are in equilibrium)

8. Production of ammonia from nitrogen and hydrogen gases is an important industrial reaction shown below:



$$\Delta H^0 = -92.38 \text{ kJ}$$

$$\Delta S^0 = -198.3 \text{ J/K}$$

- a) Calculate ΔG^0 for this reaction at 500°C . Assume ΔH^0 and ΔS^0 are not temperature dependent.
- b) Calculate ΔG at 25°C for this reaction if the reaction mixture consists of 1.0 atm of N_2 , 3.0 atm of H_2 and 1.0 atm of NH_3 .