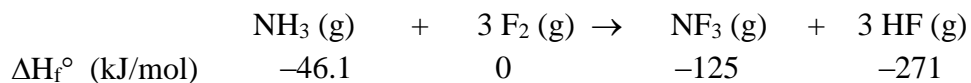


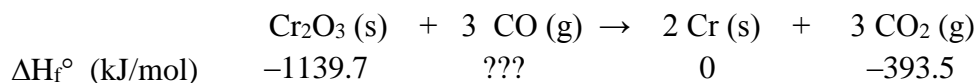
REVIEW QUESTIONS

Chapter 18

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



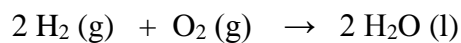
2. Given $\Delta H = +290.7$ kJ for the reaction shown below, calculate the ΔH_f° for CO (g).



3. The air within a piston equipped with a cylinder absorbs 565 J of heat and expands from an initial volume of 0.10 L to a final volume of 0.85 L against a pressure of 1.0 atm. What is the change in the internal energy of the air within the piston?

4. How much work (in J) is required to expand the volume of a pump by 2.5 L against an external pressure of 1.1 atm?

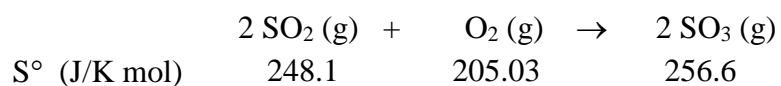
5. Calculate the work associated with the following reaction at 1.00 atm and 25°C. Is the work done by the system or on the system?



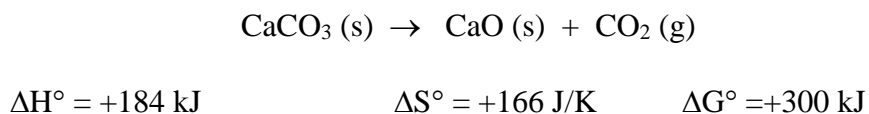
6. The enthalpy change for vaporization of methanol (CH₃OH) at 25°C is 38.0 kJ/mol. If the entropy of methanol vapor at 25°C is 255 J/molK, what is the entropy of the liquid methanol at this temperature?

7. A reaction has $\Delta H_{\text{rxn}} = -107 \text{ kJ}$ and $\Delta S_{\text{rxn}} = 285 \text{ J/K}$. At what temperature is the change in entropy for the reaction equal to the change in entropy for the surroundings?

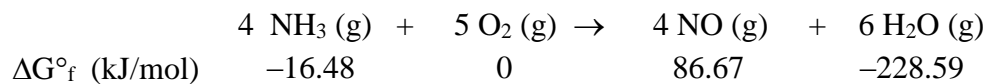
8. Determine the entropy change (ΔS°) in J/K for the reaction shown below, given the standard entropies for each:



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



10. Calculate the free energy (ΔG°) in kJ for the reaction shown below, given the ΔG°_f values for each substance:



11. Methanol can be produced by the reaction shown below, with the following thermodynamic data given at 25°C.

	CO (g) +	2 H ₂ (g) →	CH ₃ OH (l)
ΔH°_f (kJ/mol)	-110.5	0	-238.6
ΔG°_f (kJ/mol)	-137.3	0	-166.2
S° (J/mol K)	+197.9	???	+126.8

a) Calculate ΔG° and ΔH° for this reaction.

b) Calculate ΔS° (in J/K) for this reaction.

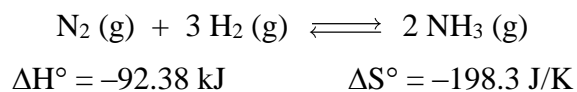
c) Calculate S° for hydrogen.

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



- a) What is ΔG°_{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° and ΔS° at 25°C for this reaction.
- c) Calculate the normal boiling point of bromine. Assume ΔH° and ΔS° are not affected by temperature. (**Hint:** At the normal boiling point liquid and vapor are in equilibrium)

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



a) Calculate ΔG° for this reaction at 500°C . Assume ΔH° and ΔS° 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 .

15. What are the signs of ΔH , ΔS and ΔG for the sublimation of dry ice (solid CO_2) at 25°C ?

16. Using the following data, calculate the value of K_{sp} for $Ba(NO_3)_2$, one of the least soluble of the common nitrate salts.

Species	ΔG°_f
Ba^{2+} (aq)	-561 kJ/mol
NO_3^-	-109 kJ/mol
$Ba(NO_3)_2$ (s)	-797 kJ/mol

17. Show that hydrogen cyanide (HCN) is a gas at $25^\circ C$ by estimating its normal boiling point from the following data:

	ΔH°_f (kJ/mol)	S° (J/molK)
HCN (l)	108.9	113
HCN (g)	135.1	202