

Driving forces of reactions are covered in this chapter as are two major thermodynamic functions: the standard change in Gibbs Free Energy, ΔG° , and the standard change in entropy, ΔS° . Together, ΔH° and ΔS° can be used to determine if a reaction is thermodynamically favorable. Big Idea 5 in the AP Chemistry curriculum is about the role of energy in predicting the direction of changes in matter. Although the topics presented in this chapter are some of the more difficult topics in the AP Chemistry curriculum, every part of this chapter needs to be understood.

17.1 Nature's Heat Tax: You Can't Win and You Can't Break Even

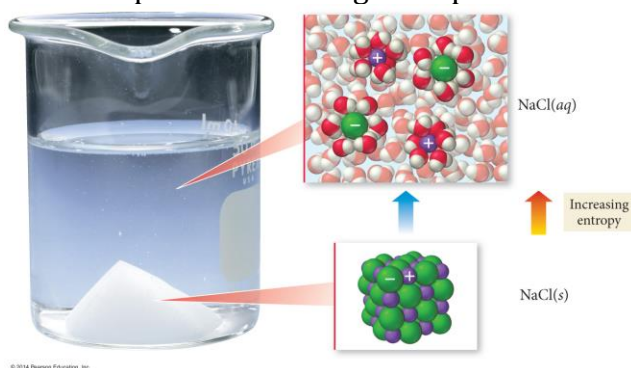
1. What is a heat tax? How does a heat tax apply to the law of conservation of energy?

17.2 Spontaneous and Nonspontaneous Processes

2. Does spontaneity of a reaction indicate the speed of the reaction? Explain.
3. Give an example of a spontaneous process that is thermodynamically favorable that occurs at a very slow rate?
4. How does a catalyst affect spontaneity? Explain.

17.3 Entropy and the Second Law of Thermodynamics

5. Explain how this figure represents an increase in entropy.



6. What is entropy?
7. What is the second law of thermodynamics? Explain the concept of this law in terms of energy randomness.
8. Why is entropy a state function?

9. What conditions result in entropy being a positive value? A negative value?

10. Explain why entropy increases as temperature increases.

11. Identify four processes where entropy always increases.

a.

b.

c.

d.

17.4 Heat Transfer and Changes in the Entropy of the Surroundings

12. What is the relationship between an exothermic process and entropy of surroundings? Explain.

13. What is the relationship between an endothermic process and entropy of surroundings? Explain.

14. Why is entropy temperature dependent? Justify your answer.

17.5 Gibbs Free Energy

15. What is Gibbs free energy?

16. Explain the concept of free energy using the following diagram.

17. Why does a negative ΔG value indicate a spontaneous process?

18. Relate ΔG to the speed of a reaction. Explain your answer.

19. Mathematically explain the value of ΔG under each of the following conditions:

a. Enthalpy positive and entropy negative

b. Enthalpy positive and entropy positive

c. Enthalpy negative and entropy negative

d. Enthalpy negative and entropy positive

17.6 Entropy Changes in Chemical Reactions: Calculating $\Delta S^{\circ}_{\text{rxn}}$

20. What are the standard states for the following:
- Gas
 - Solid
 - Solution
21. What is the third law of thermodynamics?
22. What equation is used to determine the standard state entropy of a reaction?
23. Why is it important to know the state of each substance and the allotrope used in the calculation of the standard state entropy of a reaction?

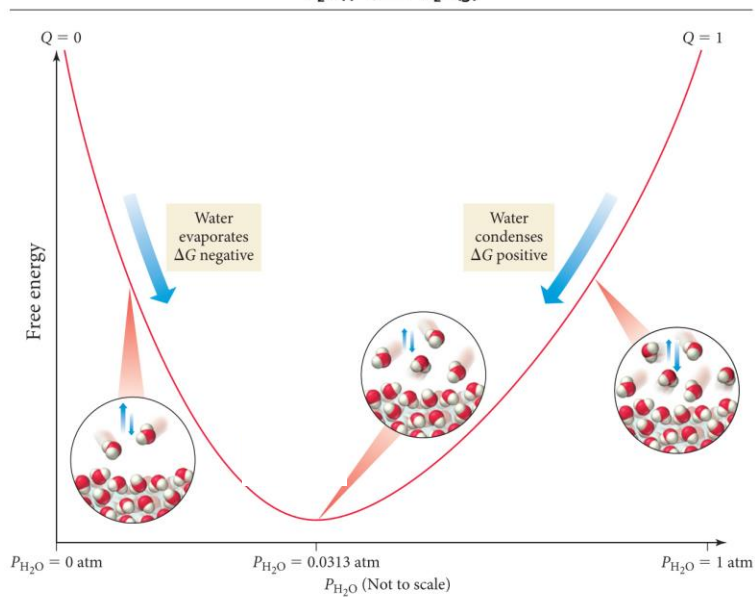
17.7 Free Energy Changes in Chemical Reactions: Calculating $\Delta G^{\circ}_{\text{rxn}}$

24. What is the symbol for the standard change in free energy? What does a negative value indicate about a reaction?
25. What is ΔG°_f ? Explain the differences between ΔG°_f , $\Delta G^{\circ}_{\text{rxn}}$, and ΔG .
26. What are three ways to calculate $\Delta G^{\circ}_{\text{rxn}}$? Include equations in your answer.
27. Explain how to calculate $\Delta G^{\circ}_{\text{rxn}}$ if...
- The reaction coefficients are tripled.
 - The equation is reversed.
 - The reaction is found as a sum of several reactions.
28. Explain why not all free energy is available to perform work.
29. For a reaction with a positive $\Delta G^{\circ}_{\text{rxn}}$, what is required to make the reaction occur?

17.8 Free Energy Change for Nonstandard States: The Relationship Between $\Delta G^{\circ}_{\text{rxn}}$ and ΔG_{rxn}

30. What is the difference between $\Delta G^{\circ}_{\text{rxn}}$ and ΔG_{rxn} ? When should each be used?

31. What is true of ΔG_{rxn} at equilibrium? Explain how to identify equilibrium on the graph.



17.9 Free Energy and Equilibrium: Relating $\Delta G^\circ_{\text{rxn}}$ to the Equilibrium Constant (K)

32. Fill in the chart indicating the sign of each value with the condition listed. In the last column, indicate if the reaction is spontaneous or not.

K Value	$\ln(K)$: + or -?	$\Delta G^\circ_{\text{rxn}}$: + or -?	Spontaneous: yes or no?
$K > 1$			
$K = 1$			
$K < 1$			

33. Explain how to convert from K to $\Delta G^\circ_{\text{rxn}}$.