The Second and Third Laws of Thermodynamics – Reading Guide

*section 16.3 in OpenStax*

**Second Law of Thermodynamics**

The change in entropy of the universe can be expressed as:

∆Suniv = ∆Ssyst + \_\_\_\_\_\_\_\_

Does spontaneity of a process depend on the temperature? \_\_\_\_\_\_\_\_\_

Give an example supporting your answer:

State the **Second Law of Thermodynamics**:

In order for a process to be spontaneous, tell how ΔSsurr must change in order to maintain ΔSuniv > 0 for the following.

* A process that emits heat into the surroundings (q*rev* is negative) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*(increases/decreases)* the entropy of the surroundings.
* A process that absorbs heat from the surroundings (q*rev* is positive) \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_*(increases/decreases)* the entropy of the surroundings.

The equation that relates ΔS of the surrounding to the heat exchanged in a reversible reaction (q*rev*) is:

ΔSsurr =

Work through Example 16.4 before completing the next exercise.

A reaction requires a heat transfer of 89.5 kJ to the system and a ∆Srxn = 350.3 J/K. At what temperature (in K) will the reaction be non-spontaneous in either direction? In other words, at what temperature will ∆Suniv be zero?

*(ans. 255 K)*

**The Third Law of Thermodynamics**

State the **Third Law of Thermodynamics**:

Refer back to Chapter 5.3. Define the **standard state conditions** used to determine standard entropies at 298 K for the following.

* Gases
* Solutions

We can calculate ∆S using the equation:

∆S =

Write a balanced equation for the combustion of C2H6. Then use the values in Table 16.2 to calculate the standard state entropy change for this reaction. *(All reactants and products should be gases.)*

*(ans. 93.2 J/K)*

**End of Chapter 16 Practice Problems**

#9, 13a–b, 15, 29, 113

For detailed solutions to these problems, go to the [OpenStax website](https://openstaxcollege.org/textbooks/chemistry/resources) and download the “Student Answer and Solution Guide.”