5.S: The Second Law (Summary)

Learning Objectives

After mastering the material presented in this chapter, one will be able to:

1. Describe a Carnot engine and derive a relationship for its efficiency of converting heat into work, in terms of the two temperatures at which the engine operates.
2. Define entropy and be able to calculate entropy changes for systems (and the surroundings) undergoing changes which are definable as following various pathways, including constant temperature, constant pressure, constant volume, and adiabatic pathways.
3. Relate entropy to disorder in a crystal based on the number of equivalent orientations a single formula unit may take within the crystal.
4. State the Third Law of Thermodynamics, and use it to calculate total entropies for substances at a given temperature.
5. Understand how isothermal compressibility differs from adiabatic compressibility and relate that difference to the measurement of the speed of sound waves traveling through a gas medium.

Vocabulary and Concepts

- adiabatic compressibility
- Carnot cycle
- Clausius theorem
- criterion for spontaneity
- Debye Extrapolation
- efficiency
- entropy
- heat engine
- isentropic
- second law of thermodynamics
- speed of sound
- spontaneous
- spontaneous process
- Third Law Entropy
- Third Law of Thermodynamics

References

1. Biba, E. (2010, February 26). What is Time? One Physicist Hunts for the Ultimate theory. *Wired*. Retrieved from http://www.wired.com/2010/02/what-is-time/
2. Clausius, R. (1879). *The Mechanical Theory of Heat.* London: McMillan and Company.
3. Doc, T. (n.d.). *Isaac Newton*. Retrieved April 2, 2016, from FamousScientists.org: http://www.famousscientists.org/isaac-newton/
4. Mendoza, E. (2016). *Sadi Carnot: French engineer and physicist*. (Encyclopedia Brittanica, Inc.) Retrieved March 30, 2016, from Encyclopædia Britannica Online: http://www.britannica.com/biography/...ench-scientist
5. Newton, I. (1723). *Philosophiae naturalis principia mathematica.* Amstelodamum.
6. O'Connor, J. J., & Robertson, E. F. (1998, September). Retrieved March 30, 2016, from www-groups.dcs.st-and.ac.uk/~...Boltzmann.html
7. O'Connor, J. J., & Robertson, E. F. (1999). *Pierre-Simon Laplace*. Retrieved April 2, 2016, from School of Mathematics and Statistics, University of St Andrews, Scotland: www-groups.dcs.st-and.ac.uk/~...s/Laplace.html
8. Yamashita, I., Tojo, T., Kawaji, H., Atake, T., Linnard, Y., & Richet, P. (2001). Low-temperature heat capacity of sodium borosilicate glasses at temperatures from 13 K to 300 K. *The Journal of Chemical Thermodynamics*, *33*(5), 535-53. doi:10.1006/jcht.2000.0744