

# PHYS 250B

## *Ch 20: The Second Law of Thermodynamics*

### **Entropy**

The measure of disorder, associated with temperature, from one state to another.

It is quantified by the ratio of heat flow ( $Q$ ), at a temperature ( $T$ ), denoted by ( $S$ ).

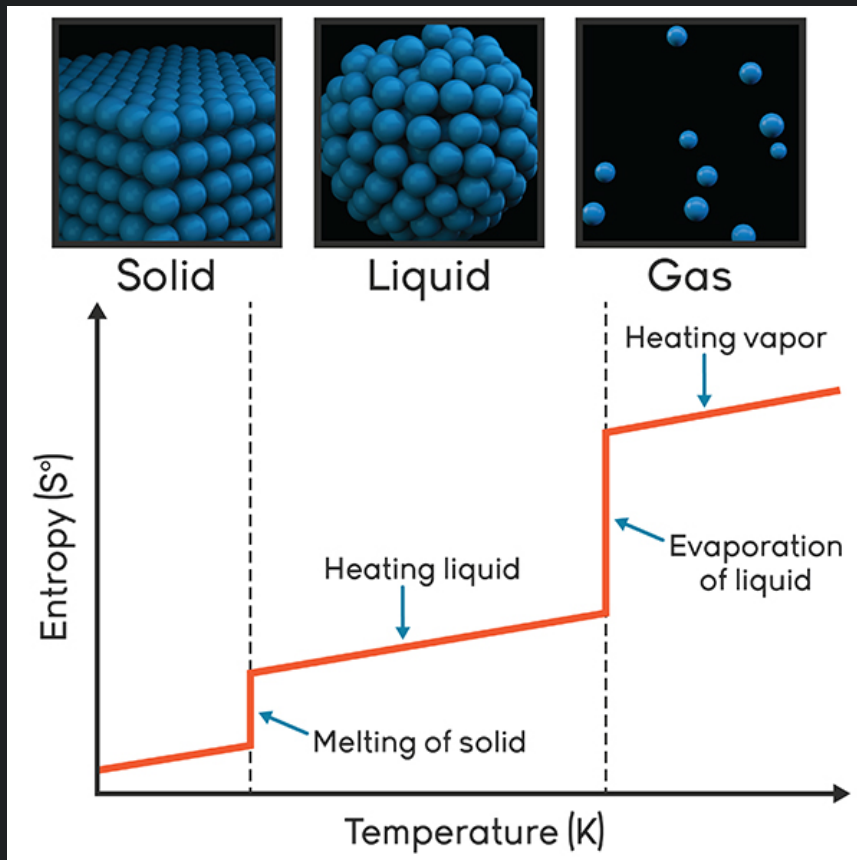
Not a physical quantity, because it is dependent on a change in state.

What do we know if this quantity is equal to 0?

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### Entropy, Phase, & Temperature



Increasing the thermal energy of a body causes phase transitions from less entropic phases to greater.

What are the vertical lines on the graph?

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### Kelvin Temperature Scale

$$T_C / T_H = |Q_C| / |Q_H| = - Q_C$$

### Entropy Equations


$$\Delta S = \int_1^2 (dQ / T) = \int_1^2 (nC_p / T) dT = \int_1^2 (nC_v + nR / T) dT$$

$$\Delta S = S_1 - S_2 = Q / T$$

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**Thermodynamic Entropy**



The diagram shows a ball on a track with a red circle around it, and two 'warm' reservoirs connected by a pipe. The ball is on a track that has a dip and a bump. The red circle is around the ball when it is on the bump. The two reservoirs are labeled 'warm' and are connected by a pipe.

$$\Delta S = \frac{q_{\text{rev}}}{T}$$
$$\Delta S_H = \frac{-|q_{\text{rev}}|}{T_H} \quad \Delta S_C = \frac{|q_{\text{rev}}|}{T_C}$$
$$\Delta S_{\text{univ}} = \Delta S_H + \Delta S_C > 0$$

change in Temperature:

$$\Delta S = \int \frac{C_p dT}{T_H} = C_p \ln \frac{T_2}{T_1}$$

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YouTube. UC Berkley. "First Law of Thermodynamics" Online video clip. *YouTube*, 15 August 2012. Web. 13 September 2014.

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Work, Energy, Entropy

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**Working Principle of  
a Diesel Engine**

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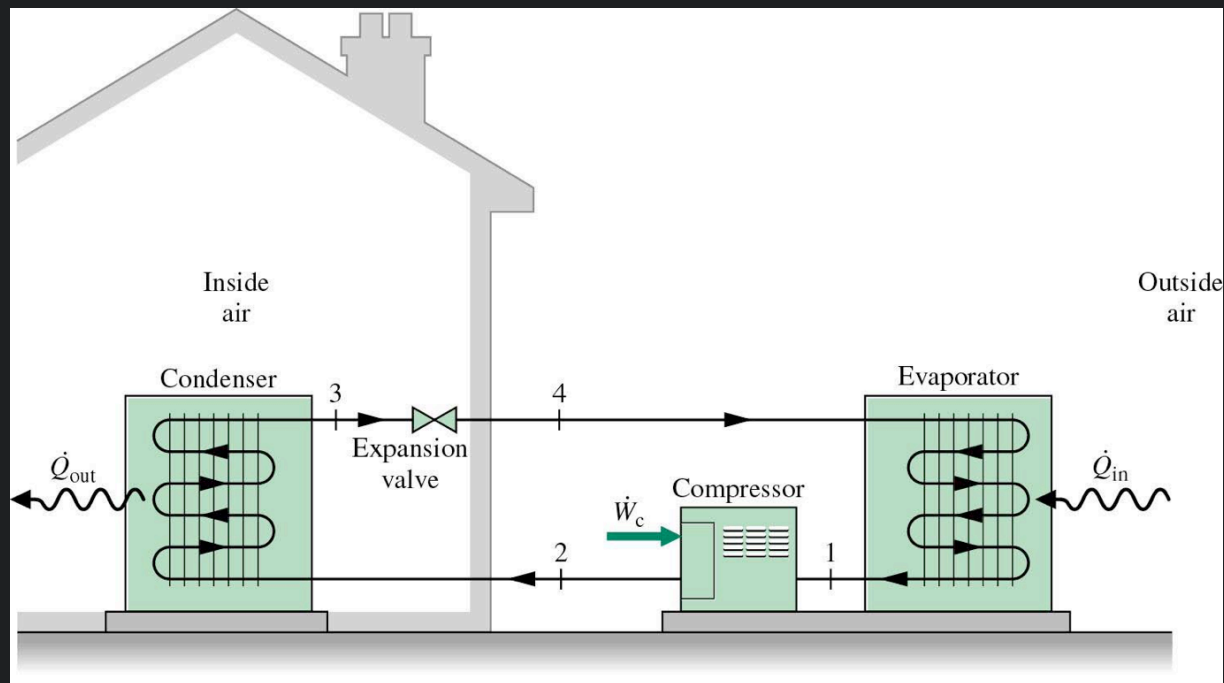
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**Working Principle of  
an Otto Engine**

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### Entropy from Refrigeration



<http://www.mae.wvu.edu/~smirnov/mae320/figs/F10-11.jpg>



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## Summary

- ★ Entropy Formula
- ★ Phase & Temperature

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