13.1 Radiation
- Demo
- Everything radiates
  - Demo
- Adsorption
  - Demo

13.1.1 Stefan-Boltzmann Law (derivable from fundamental principles)
- Equation
  - Emissivity
  - Stefan-Boltzmann constant
- Ex. 1 The filament of a bulb burns at about 3000 °C = 3273 K and radiates energy at a rate of 60 Watts = 60 J/s. If the emissivity is 0.36, then what must be the surface area?

- Note: something subtle
  - Conceptual Question 1. Curling into a ball on a cold mountain top. How are you affecting your heat loss?

15 Thermodynamics
- Historic motivation
- Definition: Thermodynamics
- Laws

15.1 Thermodynamic Systems and their Surroundings: Vocabulary
- System
- Surroundings
- State of a System

15.2 The Zeroth Law of Thermodynamics
- Thermal Equilibrium
- Zeroth Law

15.3 The First Law of Thermodynamics
- Introductory demo
- Equation 15.1
- Ex. 2 Say in eating 0.85kg of ice, you do 800 J of work crushing it up and your body conducts 416000 J of internal energy into the ice / water. By how much has the internal energy of the ice/water changed?

15.4 Thermal Processes
- Motivational Analogy
  - Classifications: Adiabatic, Isochoric, Isothermal
  - Isobaric – Constant pressure
    - Demo
    - Work
• **Ex. 3** Let's run through some values. Say we took a sealed syringe from room temperature (24 C) and put it in boiling water (100 C). The plunger rises with a fairly uniform speed so that the volume changes from $10^{-3} \text{m}^3$ to $1.2 \times 10^{-3} \text{m}^3$. Given the atmospheric pressure outside the flask ($P_{\text{atm}} = 10^5 \text{Pa}$) and the plunger’s weight 0.098 N and area $3 \times 10^{-6} \text{m}^2$, what is the work the gas in the syringe is doing on the plunger as the gas expands?

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**Ch. 13**

20. The amount of radiant power produced by the sun is approximately $3.9 \times 10^{26} \text{W}$. Assuming the sun to be a perfect ‘blackbody’ sphere with a radius of $6.96 \times 10^8 \text{m}$, find its surface temperature (in kelvins).

**Ch. 15**

1. The internal energy of a system changes because the system gains 165J of heat and performs 312J of work. In returning to its initial state, the system loses 114J of heat. During this return process, (a) how much work is involved, and (b) is work done by the system or is work done on the system?

8. A gas, while expanding under isobaric conditions, does 480 J of work. The pressure of the gas is $1.6 \times 10^5 \text{Pa}$, and its initial volume is $1.5 \times 10^{-3} \text{m}^3$. What is the final volume of the gas?