M01T.1—Measuring Fundamental Constants

Problem

The problem addressed here is how one can measure Planck's constant and/or Avogadro's number by using principles of statistical mechanics and thermodynamics. The first part should be familiar; the second possibly less so. (Both types of measurements, corresponding to parts a) and b) below, have actually been done!)

a) Assume the you know how to measure light frequency, temperature, and energy. Describe a Gedanken experiment for how you can measure Planck's constant h and Avogadro's number A. Give a formula relating both constants to measured quantities. (You can assume that the gas constant R has been measured as well.)

b) Now instead of light frequency, suppose you can measure heat input at constant volume. Assuming the third law of thermodynamics (what, exactly, does it say?) and knowledge of A, how can you measure h by purely thermodynamic means? Give a formula for h in terms of your proposed measurement.