Foundations of Physics 2B/3C 2019-2020

Thermodynamics – Workshop 1 Problems

Week Commencing 14th October

1. Thermodynamic coordinates and system properties

The first two parts of this problem provide chance to practice using equations of state, and should really serve as revision of last year's material. If you are happy undertaking these manipulations, it would be much more beneficial to use the workshop time to attempt the harder problems: part (c) of this question, which looks at non-standard heat capacities, and those in section 2.

a) 8.0 moles of a diatomic gas are contained in a vessel having a volume of 5.0 litres at room temperature $(300\ \mathrm{K})$.
   i.) Determine the pressure of the gas inside the vessel.
   ii.) The gas undergoes an adiabatic expansion, such that the volume of gas quadruples. What is the new temperature of the gas?

(*Hint*: The adiabatic equation of state is $pV^{\gamma} = \mathrm{Constant}$, and a diatomic ideal gas has $C_p/C_V = 1.4$.)

b) $5.0\ \mathrm{kg}$ of Nitrogen gas (molecular mass $28\ \mathrm{g\ mol^{-1}}$) are compressed at a pressure of $2000\ \mathrm{kPa}$ and kept at a temperature of $90\ \mathrm{K}$. What is the volume of the vessel required to store this amount of gas?

c) Two materials have heat capacities at constant volume given by $C_1 = A$ and $C_2 = BT$, where A and B are constants of appropriate dimensions. If one material is initially at T_1 and the second is at T_2, determine the final equilibrium temperature, T_f of the blocks after they have been placed in thermal contact.