Physics 111-01: General Physics I—Mechanics and Thermodynamics
Makeup Test 3
November 28, 2017

Name: ____

All problems *must* begin with either a fundamental principle or with an equation from the equation sheet. If any question is unclear, please ask immediately. Be sure to show your work **clearly**. Partial credit may be given for work *if* it can be understood.

Problem 1: (20 pts.) A piston contains an ideal monatomic gas. The gas is initially at a pressure of 1.20×10^4 Pa, and occupies an initial volume of $0.003\,00\,\mathrm{m}^3$. The cylinder is then heated by adding 180 J of heat at constant pressure so that the cylinder expands to a final volume of $0.009\,00\,\mathrm{m}^3$.

a. (6 pts.) How much work is done by the gas?

b. (6 pts.) What is the change in the thermal energy of the gas?

c. (8 pts.) If the piston contains 9.06×10^{22} atoms of the ideal monatomic gas, what is the change in temperature?

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Name: SOLUTIONS

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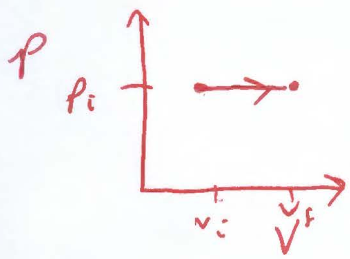
a. (6 pts.) How much work is done by the gas?



$W = p\Delta V = (1.20\times10^4\,Pa)(0.006\,m^3) = \boxed{72\,J}$

b. (6 pts.) What is the change in the thermal energy of the gas?

$Q = W + \Delta E_{th} \Rightarrow \Delta E_{th} = Q - W = 180\,J - 72\,J$

$\boxed{\Delta E_{th} = 108\,J}$

c. (8 pts.) If the piston contains 9.06×10^{22} atoms of the ideal monatomic gas, what is the change in temperature?

Use $\Delta E_{th} = \frac{3}{2} N k_B (\Delta T)$

$\Delta T = \frac{2}{3}\frac{\Delta E_{th}}{N k_B} = \frac{2}{3}\frac{(108\,J)}{(9.06\times10^{22})(1.38\times10^{-23}\,J/K)}$

$\boxed{\Delta T = 57.6\,K}$

OR: $Q = nC_p\Delta T \Rightarrow \Delta T = \frac{Q}{nC_p}$, where $C_p = \frac{5}{2}R$.