國立東華大學

Department of Physics
National Dong Hwa University, 1, Sec. 2,
Da Hsueh Rd., Shou-Feng, Hualien, 974, Taiwan

General Physics I, Quiz 7
PHYS10200, Class year100
03-06-2012

Solution Q7

Chapter 22, Serway; ABSOLUTELY NO CHEATING!
Please write the answers on the blank space or on the back of this paper to save resources.

1.

(a) In an adiabatic process $P_f V_f^{\gamma} = P_i V_i^{\gamma}$. Also, $\left(\frac{P_f V_f}{T_f}\right)^{\gamma} = \left(\frac{P_i V_i}{T_i}\right)^{\gamma}$

Dividing the second equation by the first yields $T_f = T_i \left(\frac{P_f}{P_i}\right)^{(\gamma-1)/\gamma}$

Since $\gamma = \frac{5}{3}$ for Argon, $\frac{\gamma-1}{\gamma} = \frac{2}{5} = 0.400$ and we have

$$T_f = (1073\ \text{K})\left(\frac{300\times10^3\ \text{Pa}}{1.50\times10^6\ \text{Pa}}\right)^{0.400} = \boxed{564\ \text{K}}$$

(b) $\Delta E_{\text{int}} = nC_V\Delta T = Q - W_{\text{eng}} = 0 - W_{\text{eng}}$, so $W_{\text{eng}} = -nC_V\Delta T$,

and the power output is

$$P = \frac{W_{\text{eng}}}{\Delta t} = \frac{-nC_V\Delta T}{\Delta t} \text{ or}$$

$$= \frac{(-80.0\ \text{kg})(1\ \text{mol}/0.0399\ \text{kg})(\frac{3}{2})(8.314\ \text{J/mol}\cdot\text{K})(564-1073)\ \text{K}}{60.0\ \text{s}}$$

$$P = 2.12\times10^5\ \text{W} = \boxed{212\ \text{kW}}$$

(c) $e_C = 1 - \frac{T_c}{T_h} = 1 - \frac{564\ \text{K}}{1073\ \text{K}} = 0.475$ or $\boxed{47.5\%}$