11. $W = -P\left(\frac{nRT_h}{P} - \frac{nRT_c}{P}\right) = -nR(T_h - T_c)$

$W = -nR\triangle T = -(0.200\ \text{mol})(8.314\ \text{J/mol}\cdot\text{K})(280\ \text{K}) = -466\ \text{J}$

12. $P = \left(\frac{P_i}{V_i}\right)V,$

(a) $W = -\int_i^f P dV = -\int_{V_i}^{3V_i}\left(\frac{P_i}{V_i}\right)V dV$

$W = -\left(\frac{P_i}{V_i}\right)\left[\frac{V^2}{2}\right]_{V_i}^{3V_i} = -\frac{P_i}{2V_i}(9V_i^2 - V_i^2) = -4P_iV_i$

(b) $PV = nRT$,

$\left[\left(\frac{P_i}{V_i}\right)V\right]V = nRT$

$\therefore T = \left(\frac{P_i}{nRV_i}\right)V^2$

13.

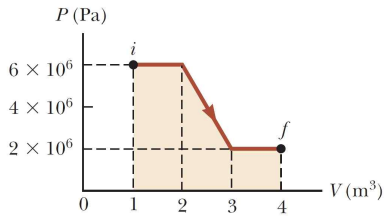

그림 P20.13

(a) $W = -\int P dV$

$= -(6.00\times10^6\ \text{Pa})(2.00\ \text{m}^3 - 1.00\ \text{m}^3) - (4.00\times10^6\ \text{Pa})(3.00\ \text{m}^3 - 2.00\ \text{m}^3)$
$-(2.00\times10^6\ Pa)(4.00\ m^3 - 3.00\ m^3)$

$\therefore W_{i\to f} = -12.0\ \text{MJ}$

(b) $W_{f\to i} = +12.0\ \text{MJ}$

18.

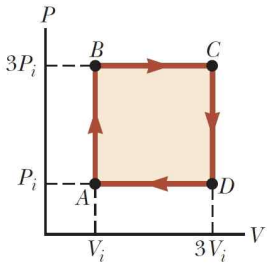

그림 P20.18

(a) $W = W_{AB} + W_{BC} + W_{CD} + W_{DA}$

$= 0 - 3P_i(3V_i - V_i) + 0 - P_i(V_i - 3V_i) + 0$

$= -4P_iV_i = -4nRT_i$

$\therefore W = -4(1.00\ \text{mol})(8.314\ \text{J.mol} \cdot \text{K})(273\ \text{K}) = 9.08\,\text{kJ}$

(b) 초기온도와 마지막 온도는 동일

$\therefore \triangle E_{\text{int}} = 0$, 그리고 $Q = -W = 9.80\ \text{kJ}$