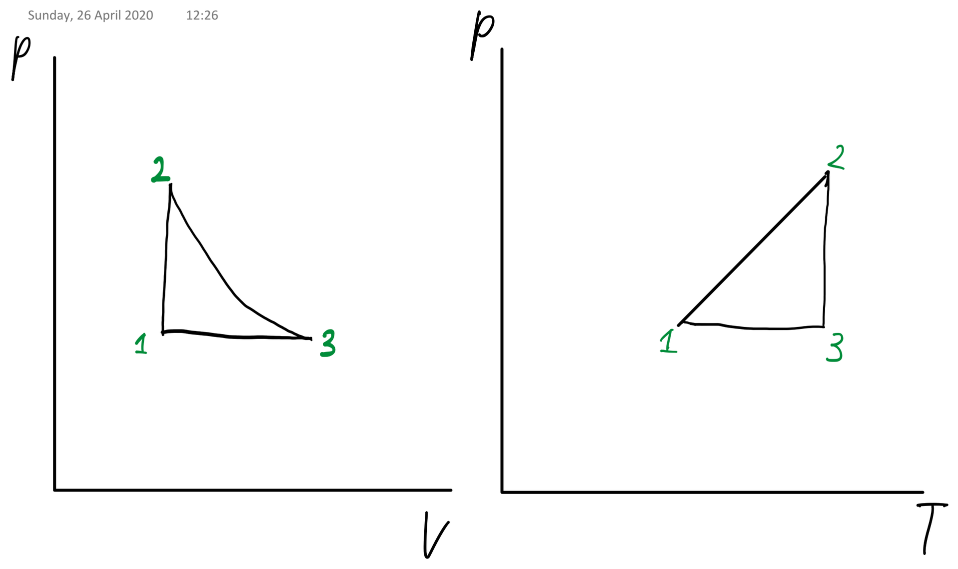
# Exercise 3.6

Sunday, 26 April 2020 12:26




ideal gas: $PV = nRT$

going from

$1 \to 2$ $\quad dW = PdV = P \cdot 0 = 0 \;\Rightarrow\; W = 0$

$2 \to 3$ $\quad dW = PdV = nRT\frac{dV}{V} \;\Rightarrow\; W = nRT_2 \int_{V_2}^{V_3} \frac{dV}{V} = nRT_2 \ln\left(\frac{V_3}{V_2}\right) = nRT_2 \ln\left(\frac{V_3}{V_1}\right)$

$3 \to 1$ $\quad dW = \int_{V_3}^{V_1} P_1 dV = P_1(V_1 - V_3)$

Because $V_1 = V_2$ and $P_2 = 2P_1$, $P_2V_2 = P_2V_1 = nRT_2 = 2P_1V_1 = nR2T_1$

Thus $T_2 = 2T_1$

$$T = \frac{PV}{nR}$$

$$T_1 = \frac{P_1V_1}{nR}$$

$$P_2V_2 = nRT_2 = nR2T_1$$

$$P_3 = P_1$$

$$2T_1 = T_2 = T_3$$

$$P_3V_3 = nRT_3$$

$$P_1V_3 = nRT_1 \cdot 2$$

$$\Downarrow$$

$$V_3 = 2V_1$$

$$W_{23} = nRT_2 \ln\left(\frac{V_3}{V_1}\right) = 2 \times 2 \times 1{,}01 \times 10^5 \times 4 \ln(2) = 1{,}12 \times 10^6 J \qquad (T_2 = 2T_1)$$

$$W_{31} = P_1(V_1 - V_3) = P_1(V_1 - 2V_1) = -P_1V_1 = -2 \times 1{,}01 \times 10^5 \times 4 = -8{,}11 \times 10^5 J$$

$$W = W_{12} + W_{23} + W_{31} = 3{,}13 \times 10^5 J$$