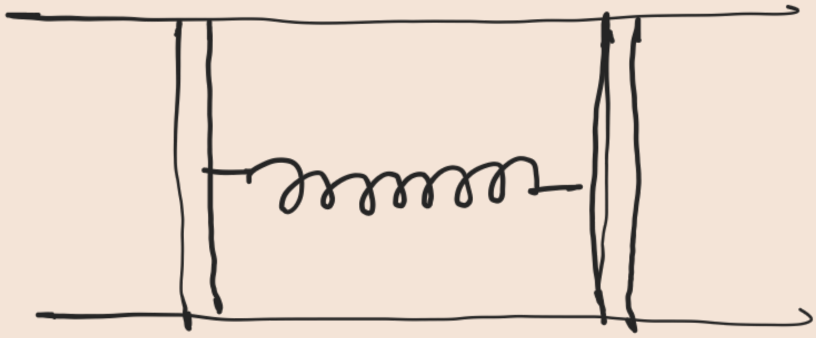


W_{gas} is $\int P\,dV$.

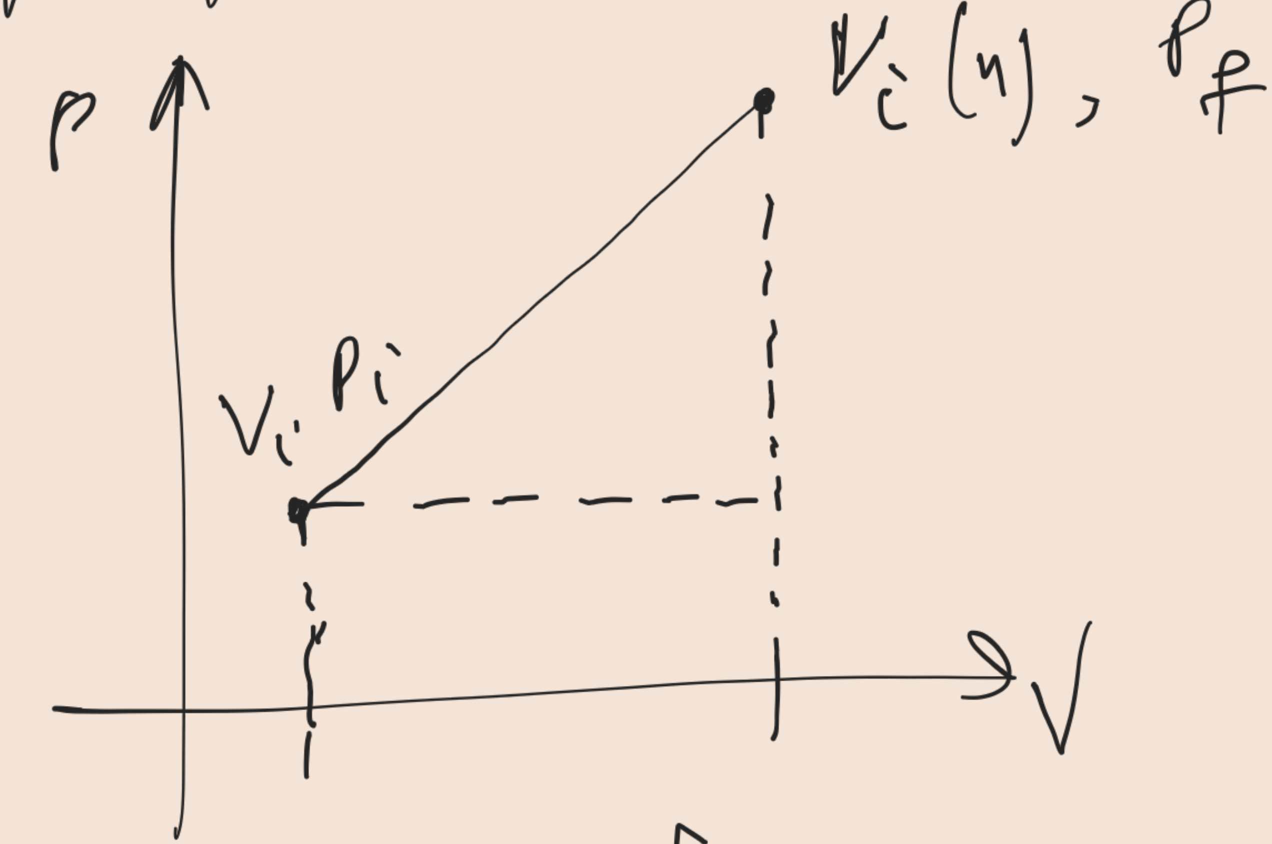
Here if we assume natural length of spring, spring constant & elongation seperately, we will be stuck with three variables & it will be difficult to eliminate.

We see that

$$P = \frac{kx}{A}.$$

Volume is $A(l_0+x) = V$

The above two equations suggest that 'P' is directly proportional to 'V'.



$$W_{gas} = \frac{1}{2}\left[P_f + P_i\right](\eta - 1)V_i$$

2

$$P_i V_i = nRT_1$$

$$P_f \eta V_i = nRT_2$$

$$P_f = \frac{T_2}{\eta T_1} P_i$$

So,

$$\frac{1}{4} P_i \left[\frac{T_2}{\gamma T_1} + 1\right](\gamma - 1) V_i$$

$$= \left\{\frac{(T_2 + \gamma T_1)(\gamma - 1)}{4\gamma T_1}\right\} \underbrace{P_i V_i}_{nRT_1}$$

$$= \left[\frac{(T_2 + \gamma T_1)(\gamma - 1)}{4\gamma}\right] R$$

Rest of the problem is straightforward. Once again, the main crux is NOT assuming three seperate variables.