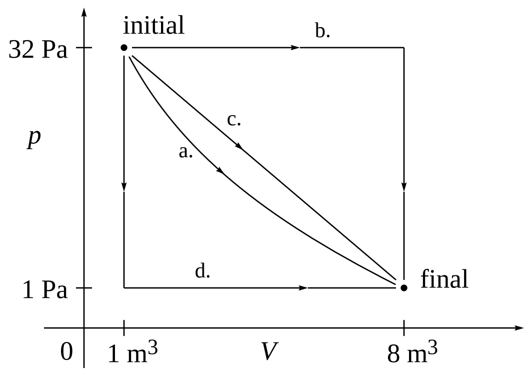
Fluid work



In general we have

$$\text{Work} = \int_{\text{initial}}^{\text{final}} p(V)\, dV,$$

but along path a

$$p(V) = \frac{K}{V^\gamma} \qquad \text{where} \qquad K = p_i V_i^\gamma = p_f V_f^\gamma.$$

Thus the work along path a is

$$\text{Work} = \int_{V_i}^{V_f} \frac{K}{V^\gamma}\, dV = \frac{K}{-(\gamma - 1)} \left[\frac{1}{V^{\gamma-1}} \right]_{V_i}^{V_f} = \frac{K}{-(\gamma - 1)} \left[\frac{1}{V_f^{\gamma-1}} - \frac{1}{V_i^{\gamma-1}} \right] = \frac{p_f V_f - p_i V_i}{1 - \gamma}.$$

Path a is quasistatic and adiabatic, so $Q = 0$ and $\Delta E = Q - W = -W$. Plugging in numbers, $W = 36$ J, $Q = 0$, and $\Delta E = -36$ J.

Now ΔE is the same for all paths. Thus for paths b, c, and d we can find W through "area under the path" and Q through $Q = \Delta E + W$. The results are

path	W	Q
a	36 J	0 J
b	224 J	188 J
c	115.5 J	79.5 J
d	7 J	−29 J