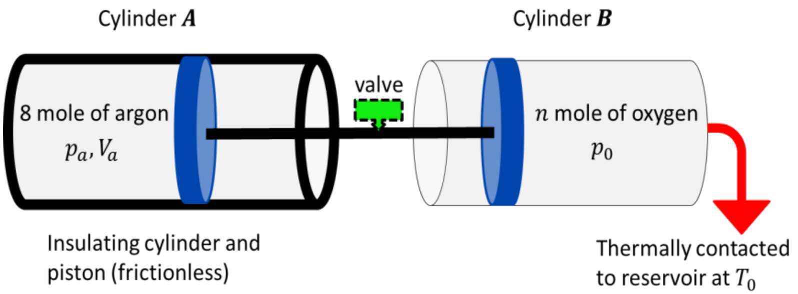
4 . (b) Cylinder A and its piston are thermally insulated from the surrounding and cylinder B is in thermal contact with a heat reservoir at a constant temperature of T_0. The two frictionless pistons are rigidly connected by a thin hollow rod (with negligible volume) and a valve that is closed. Initially, the piston of cylinder A is fixed, and inside the cylinder it consists 8 moles of monoatomic argon gas at a pressure p_a higher than atmospheric pressure p_0 ($p_a > p_0$) and volume V_a. Inside cylinder B, there is an unknown amount (n moles) of diatomic oxygen gas at atmospheric pressure p_0. When the piston of cylinder A is freed, it moves very slowly until equilibrium is achieved with the volume of the argon gas being 8 times higher, and the density of the oxygen has increased by a factor of two. The heat reservoir receives heat transfer of $|Q|$ during the process.



(i) Show that the change of the pressure and temperature of the argon are given by

$$\Delta p = -62 p_0 \quad ; \quad \Delta T = -\frac{3}{4} T_a$$

where p_0 is the atmospheric pressure and T_a is the initial temperature of the argon.

(ii) Finally, the valve on the thin hollow rod is opened. Calculate the final pressure of the mixture of the gases and express it in terms of $|Q|$, T_0 and V_a.

[$p_{\text{total}} = \dfrac{\frac{|Q|}{\ln 2} + 8RT_0}{15V_a}$]

[6 marks]