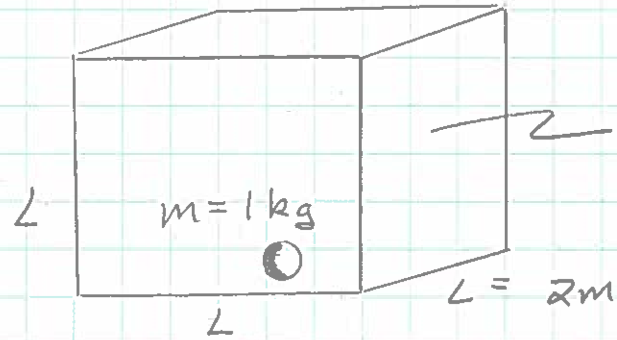


air @
$p = 1\,atm = 1.013 \times 10^5\ Pa$
$T_i = 20^\circ C = 293\,K$
$V = L^3 = 8\,m^3$

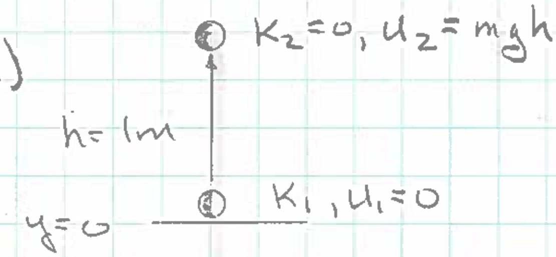
a.) air is ~80% N_2 and ~20% O_2 (both diatomic) $C_V = \frac{5}{2}R$

So, $E_{th} = nC_V T_i = n\frac{5}{2}RT$

and $PV = nRT$

So: $E_{th} = \frac{5}{2}(PV) = \underline{2.026 \times 10^6\ J}$

b.)



Conserve mechanical energy:

$\Delta E = \Delta K + \Delta U = 0$

$K_2 - K_1 + U_2 - U_1$

$K_1 = U_2 = mgh = 9.8\,J$

$\therefore \quad \frac{K_1}{E_{th}} = \underline{4.84 \times 10^{-6}}$

For $\Delta E_{th} = nC_V\Delta T = \frac{5}{2}nR\Delta T = -9.8\,J.$

Now $PV = nRT_i \Rightarrow nR = \frac{PV}{T_i}$

So

$\Delta E_{th} = \frac{5}{2}\frac{PV}{T_i}\Delta T \Rightarrow \Delta T = \frac{2T_i\,\Delta E_{th}}{5PV} = \underline{-1.42 \times 10^{-3}\ K}$

c.) This process does not violate the First Law of Thermodynamics. The Second Law of Thermodynamics doesn't say it will never happen — but it does say that the process is <u>exceedingly</u> <u>unlikely</u> to happen.