1) $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$$\frac{310\times10^3(0.025)}{273.15+25} = \frac{P_2(0.025)}{273.15+50}$$

$$P_2 = 335993.6274\,Pa$$

$$P_2 - P_1 = 335993.6274 - 310\times10^3$$
$$= 25993.62737\,Pa$$
$$\simeq 26\,kPa$$

$$pV = mR_mT$$

$$26\times10^3(0.025) = m\left(\frac{8.314}{29}\right)(273.15+50)$$

$$m = 7.014403018$$

$$\simeq 0.007\,kg$$

2a) When the piston begins to move down,

$$P_{air} - P_{piston} - P_{atm} = 0$$

$$P_{air} = \frac{50 \times 9.81}{\left(\frac{0.1}{2}\right)^2 \pi} + 100 \times 10^3$$

$$= 162452.3997$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Since $v_1 = v_2$,

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$\frac{250 \times 10^3}{273.15 + 300} = \frac{162452.3997}{T_2}$$

$$T_2 = 372.43837 15 K$$

$$\approx 372.44 K$$

2b) $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Since $P_1 = P_2$,

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$\frac{\cancel{(0.1)^2}\pi(25\times10^{-2})}{372.43837\,15} = \frac{\cancel{(0.1)^2}\pi h}{273.15+20}$$

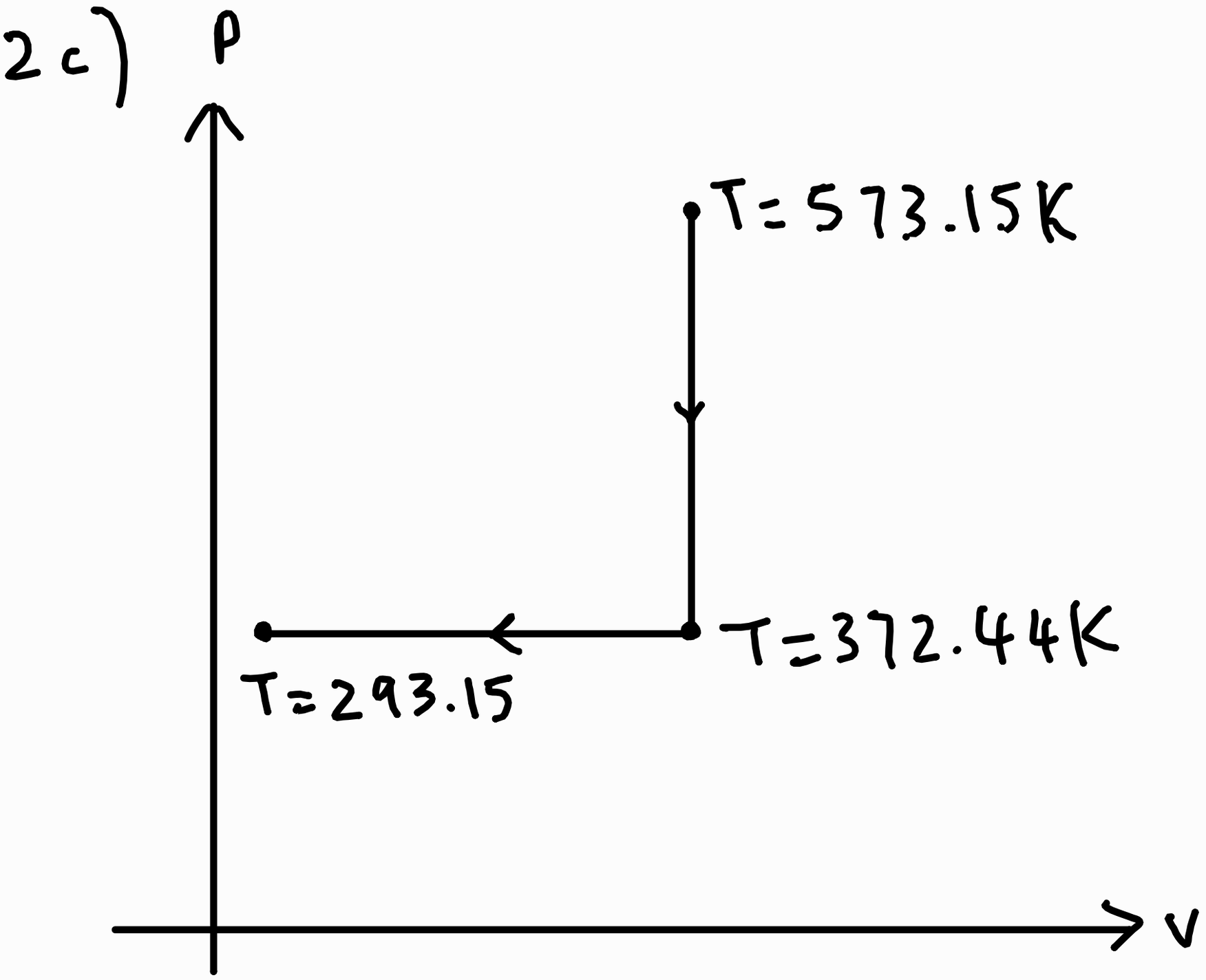
$$h = 19.677715224\ \text{cm}$$

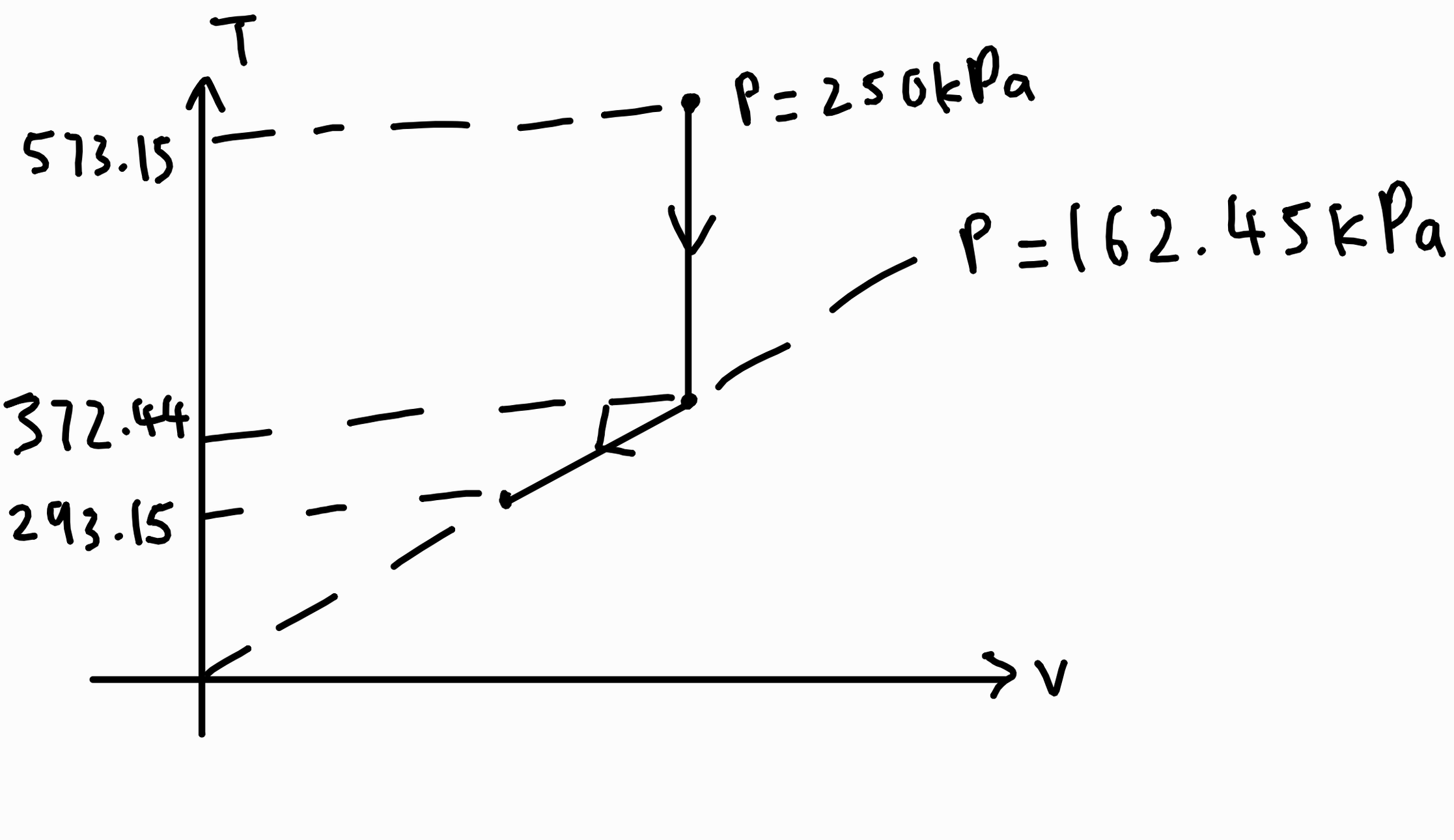
Height piston dropped $= 25 - 19.677715224$

$$= 5.322247757$$

$$\approx 5.3\ \text{cm}$$

2c)


P
T=573.15K
T=372.44K
T=293.15
V


T
P=250kPa
573.15
P=162.45kPa
372.44
293.15
V

3a) Initial pressure

$$= \frac{mR_mT}{V}$$

$$= \frac{0.1\left(\frac{8.3144}{28.97}\times 10^3\right)(273.15+35)}{0.09}$$

$$= 98265.7293\,Pa$$

Increase in pressure $= 250\times10^3 - 98265.7293$

$= 151734.2707\,Pa$

Distance travelled by the piston $= \frac{151734.2707\times 0.05}{15\times10^3}$

$= 0.505780923$

$\approx 0.506\,m$

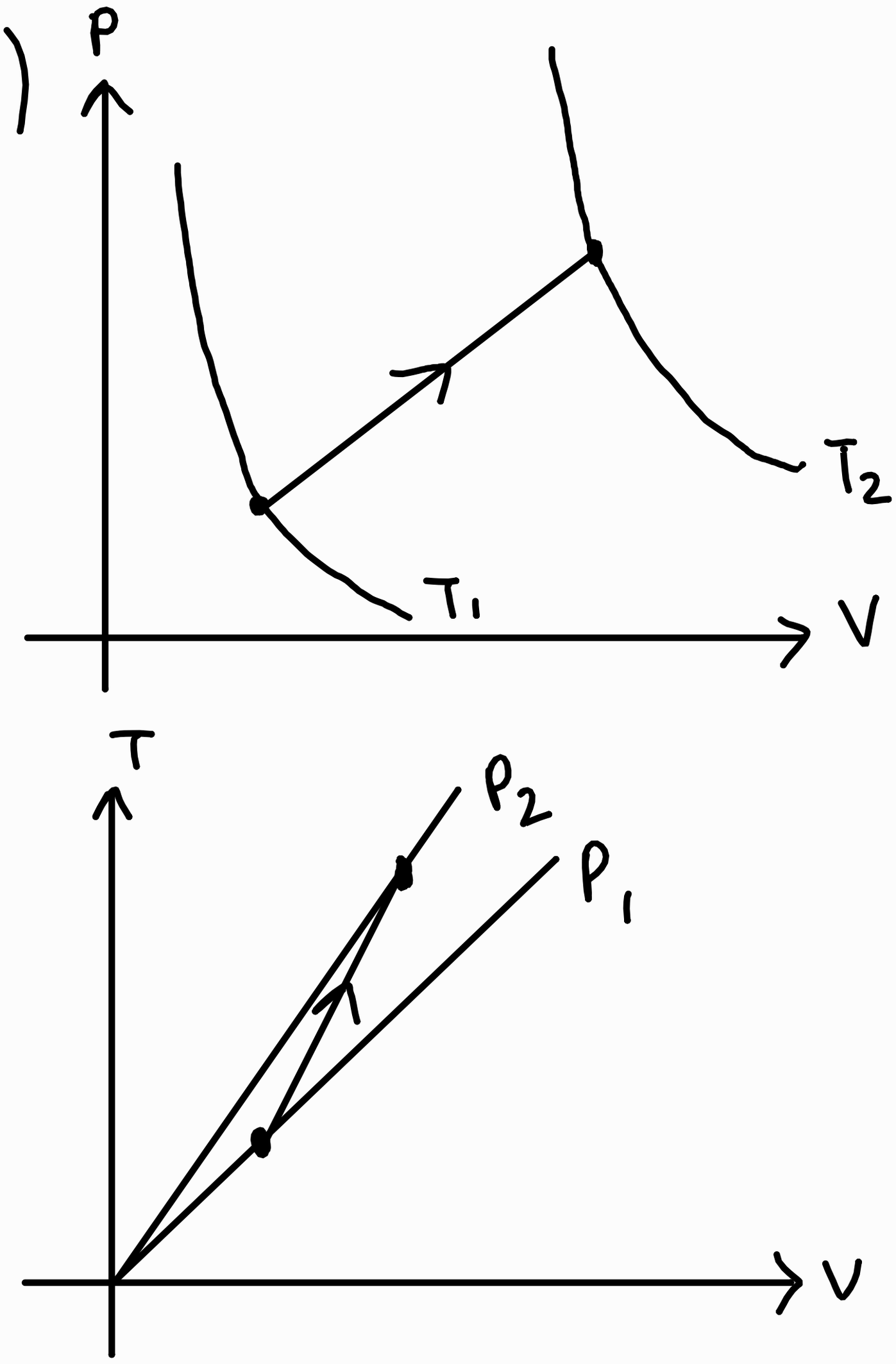
$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{98265.7293(0.09)}{273.15+35} = \frac{250\times10^3\left(\frac{0.09}{0.05}+0.506\right)(0.05)}{T_2}$$

$T_2 = 1004.4\,K$

3b) Distance travelled by the piston = 0.506m

c)



3d) $W = \frac{98265.7293 + 250 \times 10^3}{2} (0.506)(0.05)$

$= 4405.561476$

$\approx 4.4 [kJ]$

$Q = m_{air} c_{v_{air}} (T_1 - T_2) + W$

$= 0.1 (0.718)(1004.4 - 273.15 - 35)$

$+ 4.41$

$= 54.4 kJ$