1a) $x = 0.6$

$v = v_f + x v_{fg}$

$\frac{20 \times 10^{-3}}{m} = 0.001217 + 0.6(0.066667 - 0.001217)$

$m = 0.4939857238$

$\approx 0.494 kg$

b) Final volume $= 2.5(20 \times 10^{-3})$

$= 0.05 m^3$

Final $v = \frac{0.05}{0.494}$

$= 0.1012175 m^3$

At $P = 6000 kPa$,

$v_g = 0.03244 9 m^3$

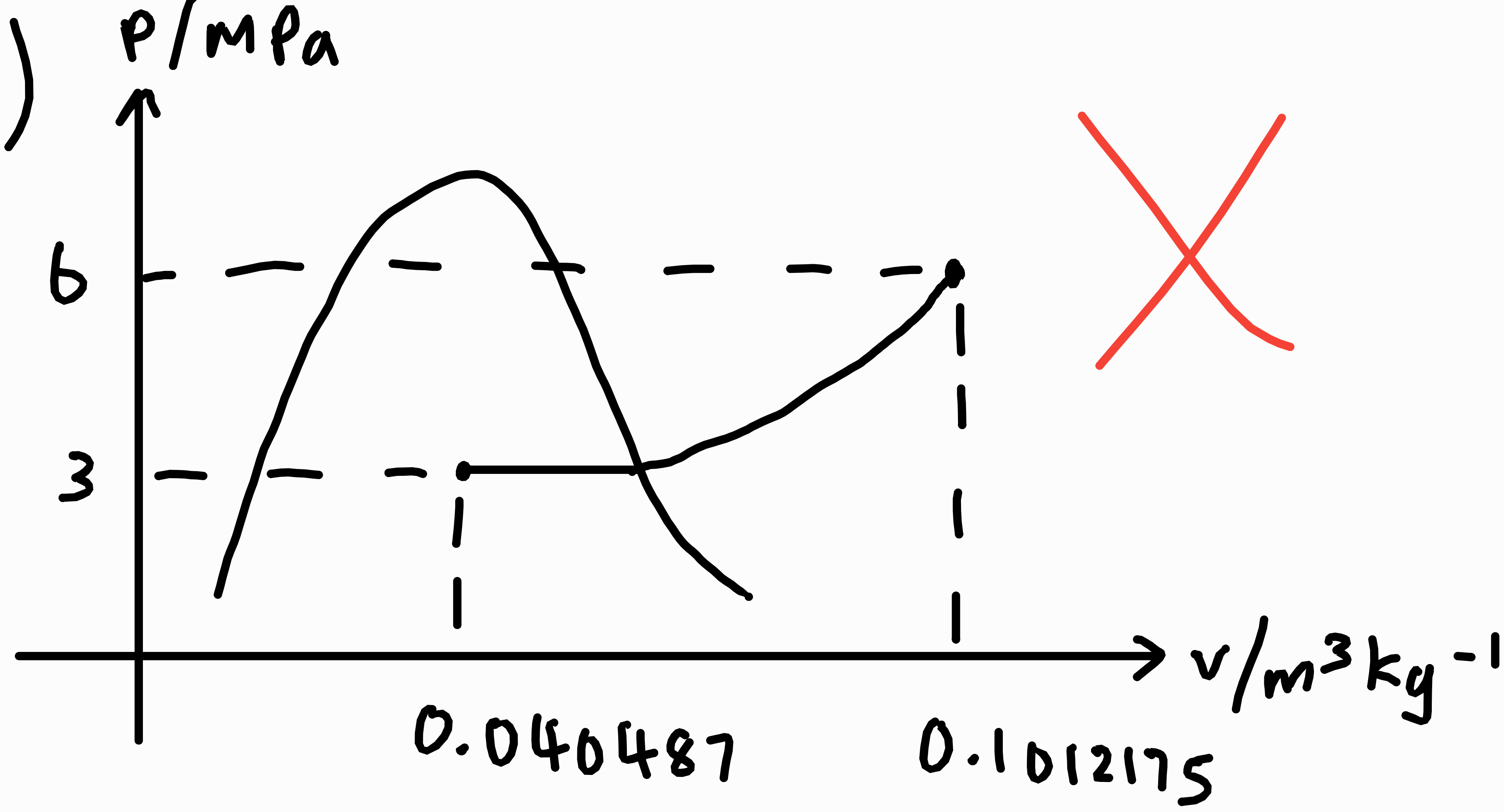
Since $v > v_g$,

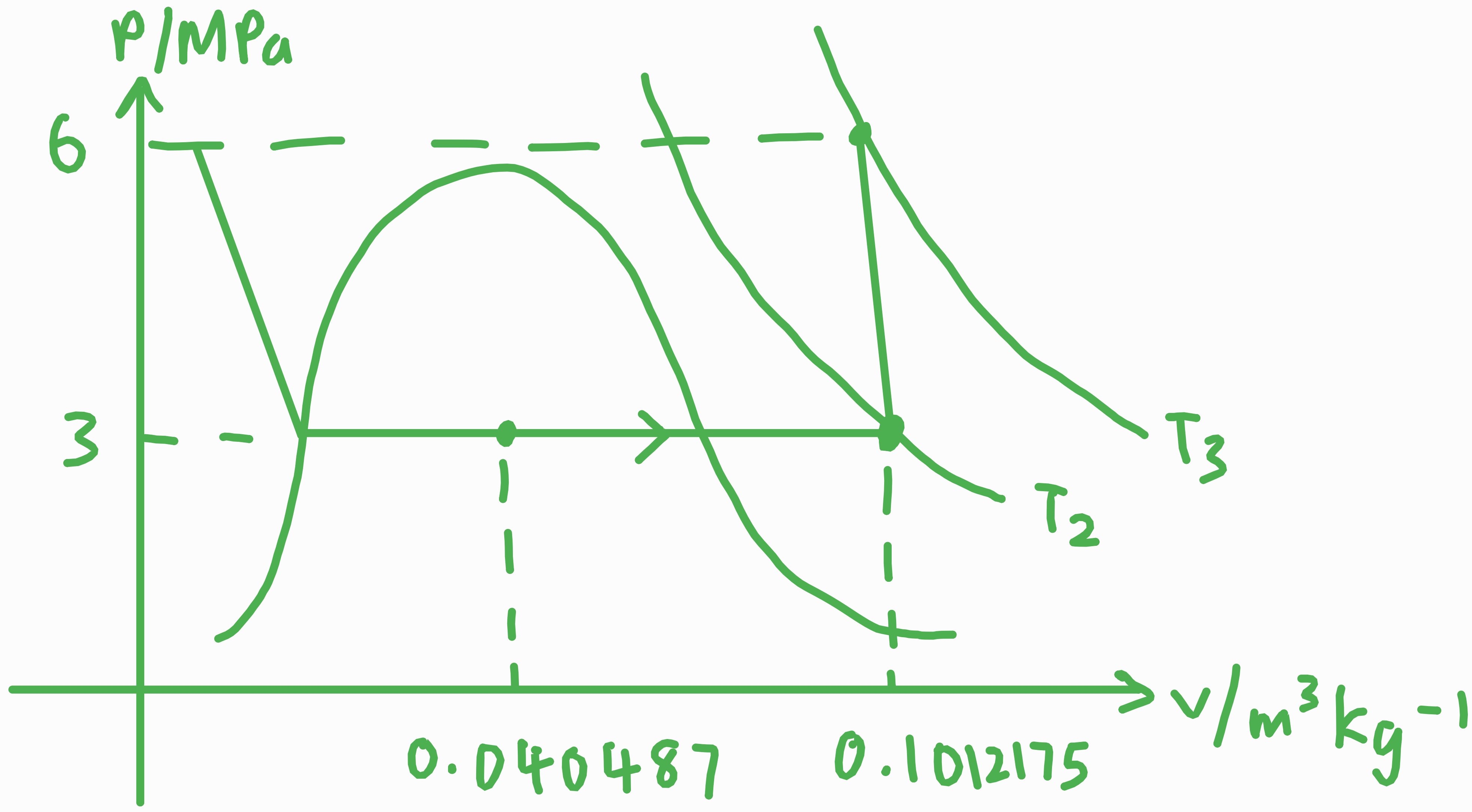
The final state is a superheated vapour.

1c) $$\frac{T_{final} - 1000}{1100 - 1000} = \frac{0.1012175 - 0.09756}{0.10543 - 0.09756}$$

$$T_{final} = 1046.473952$$
$$\approx 1046°C$$

1d)





2a) Initial volume $= 0.02 m^3$

$x = 0.6$

Initial pressure $= 320 kPa$

$$v = v_f + x v_{fg}$$

$$\frac{0.02}{m} = 0.0007772 + 0.6(0.063604 - 0.0007772)$$

$$m = 0.5198413028$$

$$\approx 0.520 kg$$

$$V_f = m(1-x)v_f$$

$$= 0.520(1-0.6)(0.0007772)$$

$$= 0.00016160826$$

$$\approx 0.000162 m^3$$

$$V_g = m x v_g$$

$$= 0.520(0.6)(0.063604)$$

$$= 0.01983839174$$

$$\approx 0.01984 m^3$$

2b) $\Delta V = 0.03 - 0.02$

$(0.2)\Delta h = 0.01$

$\Delta h = 0.05\,m$

Increase in force $= 120 \times 0.05$

$= 6\,kN$

Increas in pressure $= \dfrac{6}{0.2}$

$= 30\,kPa$

Pressure when the piston touches the stopper

$= 320 + 30$

$= 350\,kPa$

The nature of R134a is a liquid-vapour mixture.

2c) $$\frac{350-320}{360-320} = \frac{T_{inter} - 2.46}{5.82 - 2.46}$$

$$T_{inter} = 4.98°C$$

$$\text{Final } v = \frac{0.03}{0.520}$$

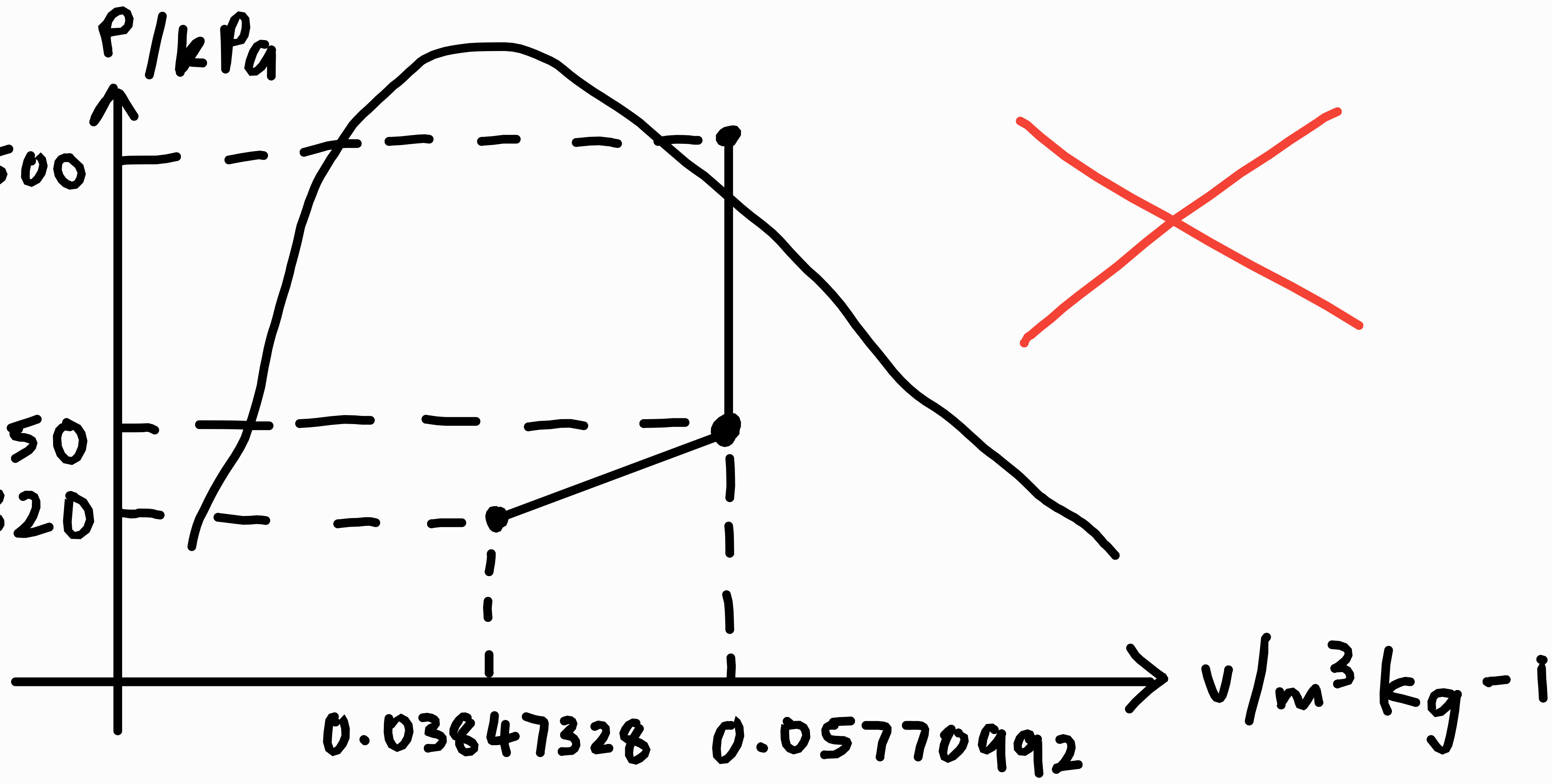
$$= 0.05770992 m^3$$

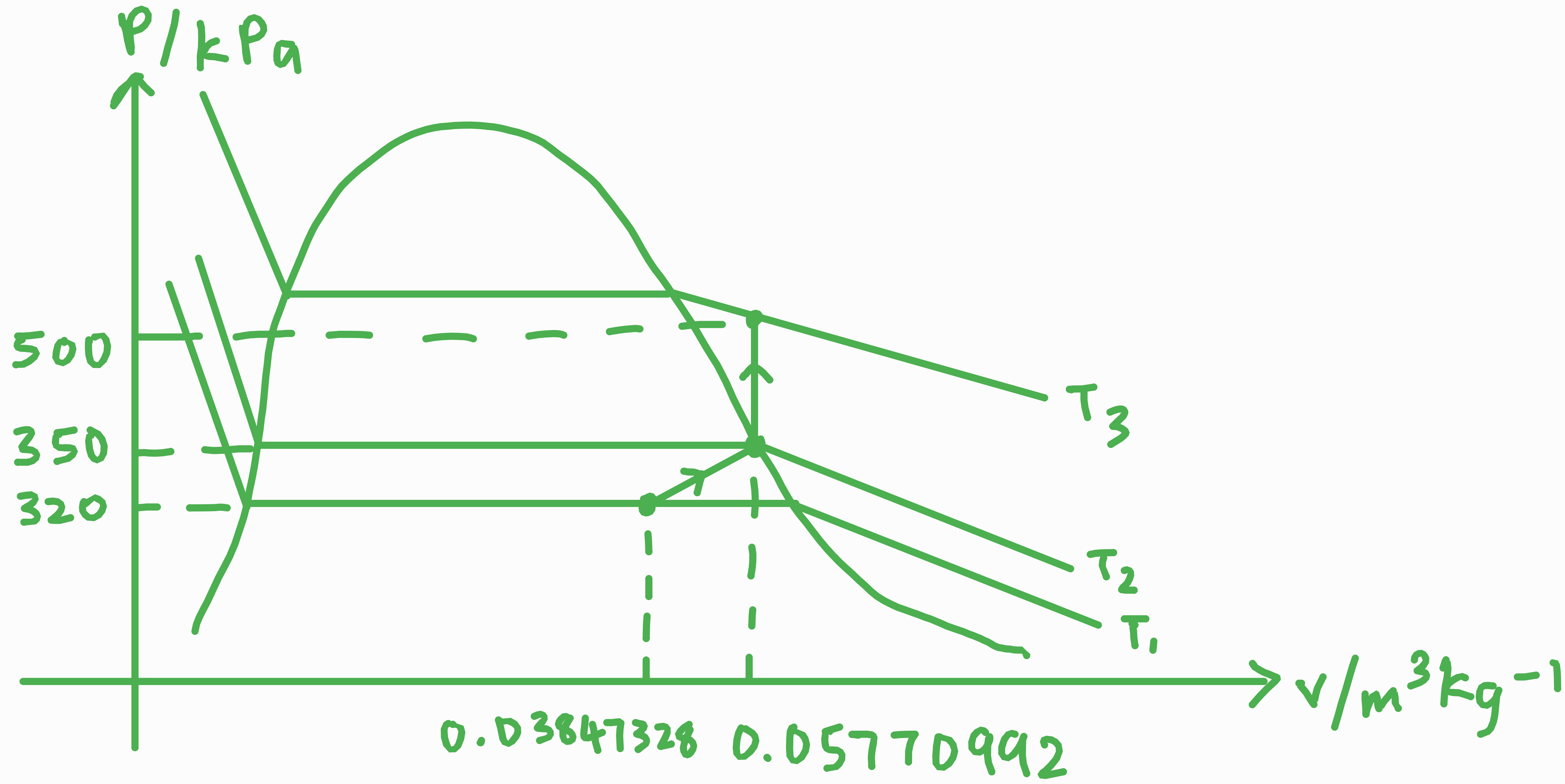
$$\frac{T_{final} - 90}{100-90} = \frac{0.05770992 - 0.056205}{0.05853 - 0.056205}$$

$$T_{final} = 98.14350649°C$$

$$\approx 98.1°C$$

2d)


P/kPa
500
350
320
0.03847328
0.05770992
v/m³kg⁻¹


P/kPa
500
350
320
T3
T2
T1
0.03847328
0.05770992
v/m³kg⁻¹