T12 SOLUTIONS BY WAITZ

a) $s - s_0 = c_p \ln\left(\frac{T}{T_0}\right) - R\ln\left(\frac{p}{p_0}\right)$

i) ALL WEIGHTS REMOVED INSTANTANEOUSLY

$p_0 = 405.3\ kPa \longrightarrow p = 101.325\ kPa$

$T_0 = 300K \longrightarrow T = 235.4\ K$

$\Delta s = 1003.5 \ln\left(\frac{235.4}{300}\right) - 287\ln\left(\frac{101325}{405300}\right)$

$\boxed{\Delta s = 154.5\ J/kg\text{-}K}$

ii) $p_0 = 405.3\ kPa \longrightarrow p = 101.3\ kPa$

$T_0 = 300K \longrightarrow T = 221K$

$\boxed{\Delta s = 91.3\ J/kg\text{-}K}$

NOTE: DON'T HAVE TO DO 2 STEPS JUST INITIAL & FINAL SINCE s IS A PROPERTY ∴ FUNCT. OF STATE (NOT PATH!)

iii) $\boxed{\Delta s = 0}$ (PLUG IT IN AND CHECK IF YOU LIKE)

SO WHAT DOES THIS TELL US?

AS <u>DEGREE OF IRREVERSIBILITY</u> (FREE EXPANSION IN THIS CASE) INCREASES, <u>WORK ↓</u> AND <u>Δs ↑</u>

ENTROPY IS A MEASURE OF THE <u>LOST OPPORTUNITY TO DO WORK</u>.

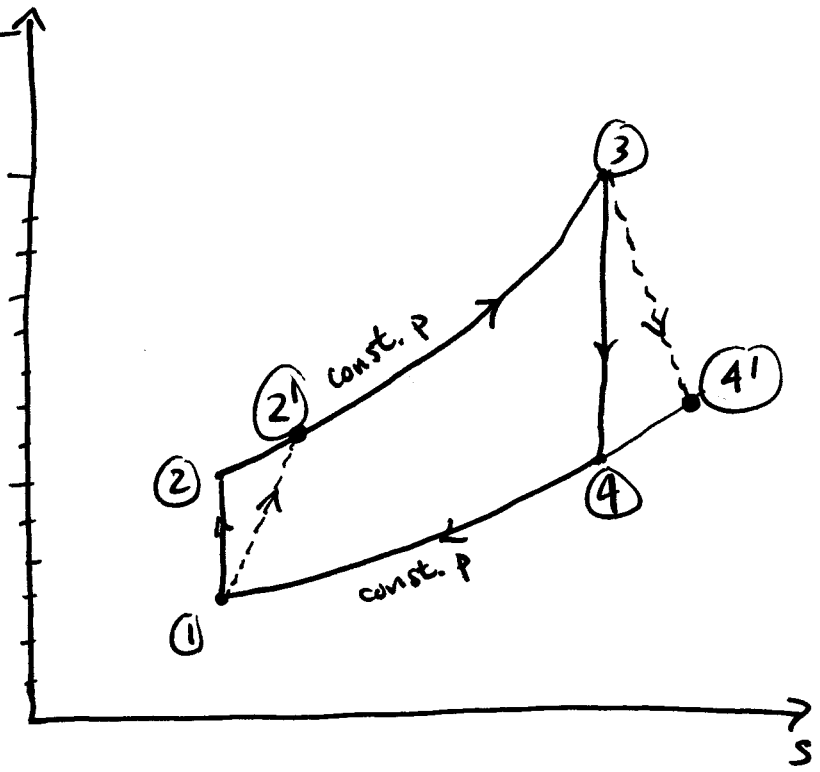
b) $p_1 = 100\ kPa$, $T_1 = 300K$ $\quad \Delta s_{1-2} = 0$

$p_2 = 1300\ kPa$, $T_2 = 624K$ $\quad \Delta s_{2-3} = 810.9\ J/kg\text{-}K$

$p_3 = 800\ kPa$, $T_3 = 1400K$ $\quad \Delta s_{3-4} = 0$

$p_4 = 100\ kPa$, $T_4 = 673K$ $\quad \Delta s_{4-1} = -810.9\ J/kg\text{-}K$

b) & c)



DASHED LINES = IRREV. PROCESSES FOR COMP. & TURB.