1) $Q_{gained} = Q_{loss}$

$$\cancel{mc}(100 - T_f) = \cancel{mc}(T_f - 0)$$

$$T_f = 100 - T_f$$

$$T_f = 50^\circ C$$

$$\Delta S_1 = \int_1^2 c(T)\frac{dT}{T}$$

$$= c\ln\left(\frac{273+50}{273+100}\right)$$

$$= c\ln\left(\frac{323}{373}\right)$$

$$\Delta S_2 = \int_1^2 c(T)\frac{dT}{T}$$

$$= c\ln\left(\frac{273+50}{273+0}\right)$$

$$= c\ln\left(\frac{323}{273}\right)$$

$$\Delta S = m\Delta s_1 + m\Delta S_2$$

$$= 5(0.45)\ln\left(\frac{323}{373}\right) + 5(0.45)\ln\left(\frac{323}{273}\right)$$

$$= 0.0545724711 4 kJ K^{-1}$$

$$\approx 0.0546 kJ K^{-1}$$

2) $Q_{gained} = Q_{loss}$

$$100(4.18)(T-22) = 12(0.45)(350-T)$$

$$418T - 9196 = 1890 - 5.4T$$

$$423.4T = 11086$$

$$T = 26.183278\,22^{\circ}C$$

$$\Delta S_{iron} = c\ln\left(\frac{T_2}{T_1}\right)$$

$$= 0.45\ln\left(\frac{26.183278\,22+273}{350+273}\right)$$

$$= -0.330070\,5731\,kJ\,kg^{-1}K^{-1}$$

$$\Delta S_{water} = c\ln\left(\frac{T_2}{T_1}\right)$$

$$= 4.18\ln\left(\frac{26.183278\,22+273}{22+273}\right)$$

$$= 0.058858\,57962\,kJ\,kg^{-1}K^{-1}$$

$$\Delta S = m_i \Delta s_{iron} + m_w \Delta S_{water}$$

$$= 12(-0.330070\,5731) + 100(0.058858\,57962)$$

$$= 1.925011085\,kJ\,K^{-1}$$

$$\approx 1.93\,kJ\,K^{-1}$$

3) $s_{water} = 6.5432\,kJ\,kg^{-1}$

$$x = \frac{s_{water} - s_f}{s_{fg}}$$

$$= \frac{6.5432 - 1.3028}{6.0562}$$

$$= 0.8652950695$$

$h_1 = 3178.3\,kJ\,kg^{-1}K^{-1}$

$h_2 = 417.51 + 0.8652950695(2257.5)$

$= 2370.913619\,kJ\,kg^{-1}K^{-1}$

$\Delta h = h_2 - h_1$

$= 2370.913619 - 3178.3$

$= -807.386306\,kJ\,kg^{-1}K^{-1}$

$\simeq -807.4\,kJ\,kg^{-1}K^{-1}$

4) $V_1 = 0.3\,m^3$

At 450K, $c_p = 1.020\,kJ\,kg^{-1}K^{-1}$,

$c_v = 0.733\,kJ\,kg^{-1}K^{-1}$

$pV = mR_mT$

$120\times10^3 \times 0.3 = m\left(\frac{8.31}{28.96}\times10^3\right)(273+17)$

$m = 0.432615461 2\,kg$

$Q - W = \Delta U$

$0 + W_e - W_b = \Delta U$

$W_e - P_0(V_2 - V_1) = \Delta U$

$W_e = mP_0(v_2 - v_1) + m(u_2 - u_1)$

$W_e = m[u_2 + P_0v - (u_1 + P_0v)]$

$W_e = m(h_2 - h_1)$

$We = mc_p(T_2 - T_1)$

$15\times60\times200\times10^{-3} = 0.432615461 2(1.02)(T_2 - 17)$

$407.9155834 = T_2 - 17$

$T_2 = 424.9155834°C$

$\approx 425°C$

$$4)\ \Delta S = 0.432615461 2(1.02)\ln\left(\frac{273+425}{273+17}\right)+0$$

$$= 0.3875823303$$

$$\simeq 0.388\,kJK^{-1}$$

5) $m = 1.5kg$

$P = 250kPa$

$T = 273 + 40$

$= 313K$

↗2 because volume is doubled

$\Delta s = c\ln\left(\frac{T_2}{T_1}\right) + R\ln\left(\frac{V_2}{V_1}\right)$ → no change in temperature

$= 0 + 0.287\ln 2$ due to unrestrained expansion

$= 0.287\ln 2$

$\Delta S = m\Delta s$

$= 1.5 \times 0.287\ln 2$

$= 0.298398612kJK^{-1}$

$= 0.298kJK^{-1}$