Q.1. (a) quasi-static compression, no heat addition (no paddle wheel or any other mode of energy addition except quasi-static work) } → reversible

Hence $dS = \frac{\delta Q_{rev}}{T}$

$= 0$

$\Rightarrow S_{final} = S_1°$ — (1)

10 kPa ($T_{sat} = 45.806°C$)

$S_1° = S_g x + S_e (1-x)$

$= 8.1488 \times 0.9 + 0.6412(0.1) = 7.398$

~ 7.4 kJ/kg.K — (0.5)

Hence $S_{final} = S_1°$

$= 7.4$ kJ/kg.K

(30 bar)

from Sat. steam table → $S_{g(3MPa)} = 6.1856$

thus $S_{final} > S_{g(3MPa)}$ — (1)

final state is superheated.

Hence in order to get temp, one has to refer superheated steam table, in my table at 3 MPa, $S_{final} = 7.4$ kJ/kg-K → 560°C

(1.5)

(if your table has not this value you can interpolate between two temp. T_A & T_B for which $S_A < S_f <$

at final state (3 MPa, 560°C) from superheated steam table.,

$u_{final} = 3214.3$ kJ/kg. — (0.5 + 0.5)

u_1 (10 kPa, 45.800°C) $= u_g x + u_e (1-x) = 2437.2 \times 0.9 + 191.8 \times 0.1$

$= 2212.66$ kJ/kg

applying first law

$$\delta Q = \Delta U + \delta W_{\text{by steam}} \quad (1)$$

$\delta Q \to 0$

$$\delta W_{\text{External}} = -\delta W_{\text{system}} = \Delta U = U_{\text{final}} - U_i$$

$$\Rightarrow \quad \delta W_{\text{external}} = 1001.7 \text{ kJ/kg}. \quad (1)$$

(b)