Given: $T_1 = 32°C$; $P = 101{,}3$ kPa; $\varphi_1 = 80\% = 0{,}8$;

$T_2 = 10°C$; $\varphi_2 = 40\% = 0{,}4$ $\dot{V} = 800 \frac{m^3}{min} = 13{,}33 \frac{m^3}{s}$

$R = 287 \frac{J}{kg.K}$; $C_p = 1005 \frac{J}{kg.K}$

Part 1 (a) From saturated steam table we get the saturated pressure at T_1 using interpolation between 30°C and 35°C

$$P_{s_1} = 4{,}246 + \frac{(5{,}628 - 4{,}246)(32-30)}{35-30} = 4{,}799 \text{ kPa}$$

The vapor pressure at T_1: $P_{v_1} = P_{s_1} \varphi_1 = 4{,}799 \cdot 0{,}8 = 3{,}839$ kPa

From saturated steam table we get the dew point temperature at P_{v_1} using interpolation between 3 and 4 kPa

$$T_s = 24{,}08 + \frac{(28{,}96 - 24{,}08)(3{,}839 - 3)}{4-3} = 28{,}17 \text{ °C}$$

(b) From saturated steam table we get vapor enthalpy at T_1 using interpolation between 30°C and 35°C

$$h_{v_1} = 2556{,}3 + \frac{(2565{,}3 - 2556{,}3)(32-30)}{35-30} = 2560 \frac{kJ}{kg}$$

The enthalpies of vapor and liquid at T_2 are:

$h_{v_2} = 2519{,}8 \frac{kJ}{kg}$; $h_{e_2} = 42{,}01 \frac{kJ}{kg}$

Since vapor at T_2 is saturated from steam table we get the vapor pressure at T_2:

$P_{v_2} = P_{sat} = 1{,}2276$ kPa

The specific humidity at T_1 and T_2:

$$\omega_1 = 0{,}622 \frac{P_{v1}}{P - P_{v1}} = 0{,}622 \frac{3{,}839}{101{,}3 - 3{,}839} = 0{,}02450$$

$$\omega_2 = 0{,}622 \frac{P_{v2}}{P - P_{v2}} = 0{,}622 \frac{1{,}2276}{101{,}3 - 1{,}2276} = 0{,}007630$$

The heat removed at the cooling coil is:

$$q_{out} = C_p(T_1 - T_2) + \omega_1(h_{v_1} - h_{e_2}) - \omega_2(h_{v_2} - h_{e_2})$$

$$q_{out} = 1005(32-10) + 0{,}2450(2560 - 42{,}01) - 0{,}007630(2519{,}8 - 42{,}01)$$

$$q_{out} = 64{,}9 \frac{kJ}{kg \text{ dry air}}$$

(c) The mass rate of dry air is given by

$$\dot{m}_g = \frac{(P - P_{v1})\dot{V}}{RT_1} = \frac{(101{,}3 - 3{,}839) \cdot 13{,}33}{287 \cdot (32 + 273{,}15)} = 14{,}84 \frac{kg}{s}$$

So the rate of condensate removal is

$$\dot{m}_e = m_g \omega_1 - m_g \cdot \omega_2 = m_g(\omega_1 - \omega_2)$$

$$\dot{m}_e = 14{,}84(0{,}02450 - 0{,}007630) = 0{,}250 \frac{kg}{s}$$

(d) The specific humidity at the heating coil remains constant: $\omega_3 = \omega_2$.

From psychrometric chart we get the temperature at the exit of heating coil for $\omega_3 = 0{,}00763$ and $\varphi_3 = 40\%$

$T_3 = 24°C$

From steam table we get using interpolation between 20°C and 25°C for vapor

$$h_{v_3} = 2538,1 + \frac{(2547,2-2538,1)(24-20)}{25-20} = 2545 \ \frac{kJ}{kg}$$

The heat rate added at the heating coil is:

$$q_{in} = C_p(T_3-T_2) + w_2(h_{v_3}-h_{v_2})$$

$$q_{in} \simeq 1005(24-10) + 0,007630(2545-2519,8) = 14,3 \ \frac{kJ}{kg \text{ dry air}}$$

Part 2 I cannot do this part