1a) $P_{g_1} = 1.7057 kPa$ $\phi = 30\%$

$h_{g_1} = 2528.3 kJ/kg$

$P_{g_2} = 3.1698 kPa$

$h_{g_2} = 2546.5 kJ/kg$

$$w = \frac{0.622(0.3)(1.7057)}{95 - 0.3 \times 1.7057}$$

$$= 0.0033684 9804$$

$h_1 = c_p T + w h_g$

$$= 1.005(273.15+15) + 0.0033684 9804 \times 2528.3$$

$$= 298.1073236 \, kJ kg^{-1}$$

$h_2 = c_p T + w h_g$

$$= 1.005(273.15+25) + 0.0033684 9804 \times 2546.5$$

$$= 308.2186303 \, kJ kg^{-1}$$

1a) $\Delta h = 308.218 - 298.107$

$\qquad = (0.111305556 \, kJ \, kg^{-1}$

$P_a v = R_{sp} T$

$v = \dfrac{0.287(273.15 + 15)}{95 - 0.3 \times 1.7057}$

$\qquad = 0.875230677$

$\dot{q} = \dfrac{4}{0.875230677} (10.05)$

$\qquad = 46.21093357 \, kJ \, min^{-1}$

$\qquad \approx 46.2 \, kJ \, min^{-1}$

b) $\phi_2 = \dfrac{w P}{(0.622 + w) P_g}$

$\qquad = \dfrac{0.00337(95)}{(0.622 + 0.00337) \times 3.1698}$

$\qquad = 0.161432898$

$\qquad \approx 16.1\%$

2a) $P_{g_1} = 5.6291 \text{ kPa}$

$h_{g_1} = 2564.6 \text{ kJ kg}^{-1}$

$\phi = 0.3$

$P_v = \phi P_{g_1}$

$\quad = 0.3 \times 5.6291$

$\quad = 1.68873 \text{ kPa}$

$T_{dp} = T_{sat} @ P_v$

$$\frac{1.68873 - 1.5}{2.0 - 1.5} = \frac{T_{dp} - 13.02}{17.50 - 13.02}$$

$T_{dp} = 14.7110208 \, ^\circ C$

$\quad \approx 14.7 \, ^\circ C$

2b) $w = \dfrac{0.622 \phi P_g}{P - \phi P_g}$

$$= \dfrac{0.622 \times 0.3 \times 5.6291}{97 - 0.3 \times 5.6291}$$

$$= 0.0110206281$$

$h_1 = c_p T_1 + w h_{g_1}$

$$= 1.005(273.15 + 35) + 0.011(2564.6)$$

$$= 337.9542528 \text{ kJ kg}^{-1}$$

$\dfrac{14.7 - 10}{15 - 10} = \dfrac{h_{g_2} - 2519.2}{2528.3 - 2519.2}$

$h_{g_2} = 2527.754$

$h_2 = 1.005(273.15 + 14.7) + 0.011(2527.754)$

$$= 317.1577627$$

$\Delta h = 317.1577627 - 337.9542528$

$$= -20.79649014 \text{ kJ kg}^{-1}$$

2b) $P_v = R_{sp} T$

$$v = \frac{0.287(273.15 + 35)}{97 - 0.3(5.6291)}$$

$$= 0.9274454112 \, m^3 kg^{-1}$$

$$\dot{q} = \frac{6}{0.9274454}(-20.79649014)$$

$$= -134.5404693 \, kJ \, min^{-1}$$

$$\approx -135 \, kJ \, min^{-1}$$

3a) $11°C$ from psychrometric chart.

b) $\dot{m}_w = \dot{m}_a(w_1 - w_2)$

$$\dot{m}_{a_1}h_1 = \dot{Q}_{out} + \dot{m}_w h_f + \dot{m}_{a_2}h_2$$

$$\dot{Q}_{out} = \dot{m}_a(h_1 - h_2) - \dot{m}_w h_f$$

$$= \dot{m}_a(h_1 - h_2) - \dot{m}_a(w_1 - w_2)h_f$$

$w_1 = 23.75 \times 10^{-3}$

$w_2 = 8.25 \times 10^{-3}$

$h_f = 42.022 kJ kg^{-1}$

$h_1 = 95.2 kJ$ from psychrometric chart

$h_2 = 32.2 kJ$ from psychrometric chart

$$q_{out} = (95.2 - 32.2) - 42.022(23.75 - 8.25) \times 10^{-3}$$

$$= 62.348659 kJ/kg \text{ of dry air}$$

$$\approx 62.35 kJ/kg \text{ of dry air}$$

3c)
$$\dot{q} = h_3 - h_2$$
$$= 43.2 - 32.2 \text{ from psychrometric chart}$$
$$= 11.0 \text{ kJ} / \text{kg of dry air}$$

4a) $\phi_3 = 57.5\%$ from psychrometric chart

$$w = \frac{0.622 \, \phi P_g}{P - \phi P_g}$$

$$w_1 = \frac{0.622 \times 0.5 \times 2.3392}{103125 \times 10^{-3} - 0.5 \times 2.3392}$$

$$= 0.00713538664$$

$$w_2 = \frac{0.622 \times 0.575 \times 3.1698}{103125 \times 10^{-3} - 0.575 \times 3.1698}$$

$$= 0.0119104149$$

$$\frac{\dot{m}_w}{\dot{m}_a} = 0.00713538664 - 0.0119104149$$
$$= 0.00405565484$$
$$\approx 0.0041$$

5) $\dfrac{m_{a_1}}{m_{a_2}} = \dfrac{h_2 - h_3}{h_3 - h_1} = \dfrac{w_2 - w_3}{w_3 - w_1}$

$\dfrac{8}{10} = \dfrac{34.5 - h_3}{h_3 - 99.9}$

$h_1 = 99.4 \text{ kJ kg}^{-1}$
$h_2 = 34.5 \text{ kJ kg}^{-1}$
$w_1 = 24.75 \times 10^{-3}$
$w_2 = 8.8 \times 10^{-3}$

From psychrometric chart

$8h_3 - 799.2 = 345 - 10h_3$

$18h_3 = 1144.2$

$h_3 = 63.5\dot{6} \text{ kJ kg}^{-1}$

$\approx 63.6 \text{ kJ kg}^{-1}$

b) $\dfrac{8}{10} = \dfrac{w_2 - w_3}{w_3 - w_1}$

$\dfrac{8}{10} = \dfrac{8.6 \times 10^{-3} - w_3}{w_3 - 24.75 \times 10^{-3}}$

$8w_3 - 0.198 = 0.088 - 10w_3$

$18w_3 = 0.286$

$w_3 = 0.015\dot{8}$

≈ 0.0159

5a) From the psychrometric chart,

$$T_3 = 22.8°C$$

5c) $\phi_3 = 90.1\%$