Solution of problem 1:

1. Temperature T_1 where the cloud ceiling forms

$$T_1 = T_0 \cdot \left(\frac{p_1}{p_0}\right)^{1-\frac{1}{\chi}} = 279\,\text{K} \tag{1}$$

2. Height h_1 of the cloud ceiling:

$$p_0 - p_1 = \frac{\rho_0 + \rho_1}{2} \cdot g \cdot h_1, \text{ with } \rho_1 = \rho_0 \cdot \frac{p_1}{p_0} \cdot \frac{T_0}{T_1}.$$

$$h_1 = 1410\,\text{m} \tag{2}$$

3. Temperature T_2 at the ridge of the mountain.

   The temperature difference when the air is ascending from the cloud ceiling to the mountain ridge is caused by two processes:

   – adiabatic cooling to temperature T_x,

– heating by ΔT by condensation.

$$T_2 = T_x + \Delta T \qquad (3)$$

$$T_x = T_1 \cdot \left(\frac{p_2}{p_1}\right)^{1-\frac{1}{\chi}} = 265\,K \qquad (4)$$

For each kg of air the heat produced by condensation is $L_v \cdot 2.45$ g = 6.125 kJ.

$$\Delta T = \frac{6.125}{c_p} \cdot \frac{kJ}{kg} = 6.1\,K \qquad (5)$$

$$T_2 = 271\ K \qquad (6)$$

4. Height of precipitated water column

$$h = 35\ mm \qquad (7)$$

5. Temperature T_3 behind the mountain

$$T_3 = T_2 \cdot \left(\frac{p_3}{p_2}\right)^{1-\frac{1}{x}} = 300\,K \qquad (8)$$

The air has become warmer and dryer. The temperature gain is caused by condensation of vapour.