

ME 201

Thermodynamics

Homework 23 Solution

1. Complete the following table for the properties of an air/water vapor mixture.

Solution:

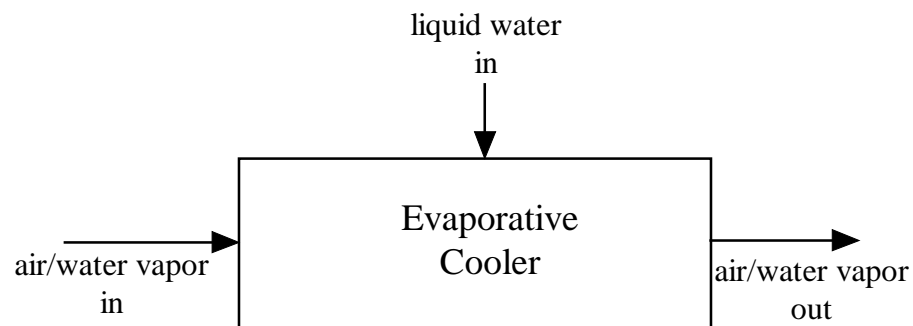
Answers are in **bold**.

$T_{\text{dry bulb}}$ (°C)	$T_{\text{wet bulb}}$ (°C)	Rel.Hum. (%)	ω (kg/kg of dry air)	h_{a-v} (kJ/kg of dry air)
15	6	20	0.002	21
35	25	45	0.016	77
10	10	100	0.00775	29.5
20	13.5	47	0.007	38
31.5	23.5	50	0.015	70

2. Air enters an evaporative cooler at 30°C and 20% relative humidity. How much liquid water (in kg/kg of dry air) at 15°C must be evaporated to cool the air to 20°C and a relative humidity of 70%? (HINT: Neglect the enthalpy brought in with the liquid water)

Solution:

Consider the drawing below:



Now conserving water we have

$$m_{\text{vapor,in}} + m_{\text{liquid,in}} = m_{\text{vapor,out}}$$

or rearranging

$$m_{\text{liquid,in}} = m_{\text{vapor,out}} - m_{\text{vapor,in}}$$

Now dividing by m_{air}

$$\frac{m_{\text{liquid,in}}}{m_{\text{air}}} = \frac{m_{\text{vapor,out}}}{m_{\text{air}}} - \frac{m_{\text{vapor,in}}}{m_{\text{air}}} = \omega_{\text{out}} - \omega_{\text{in}}$$

Going to the Psychrometric chart we find

$$\omega_{\text{out}} = 0.0105 \text{ kg of vapor/kg of dry air}$$

$$\omega_{\text{in}} = 0.0055 \text{ kg of vapor/kg of dry air}$$

Then

$$\frac{m_{\text{liquid,in}}}{m_{\text{air}}} = 0.005 \text{ kg of liquid / kg of dry air}$$