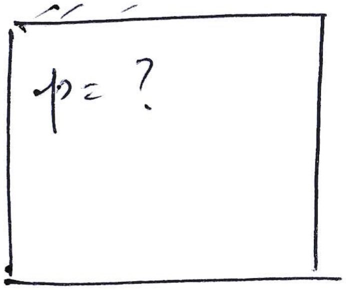
PSYCHROMETRICS



$V = 0.5\,m^3$

$N_2 - 7\,kg$

$CO_2 \rightarrow 22\,kg$

$T = 300\,K$

$pV = n\bar{R}T$

$n_{N_2} = \frac{m_{N_2}}{MW_{N_2}} = \frac{7}{28} = 0.25$

$n_{CO_2} = \frac{m_{CO_2}}{MW_{CO_2}} = \frac{22}{44} = 0.5$

$CO_2 = 12 + 2 \times 16$

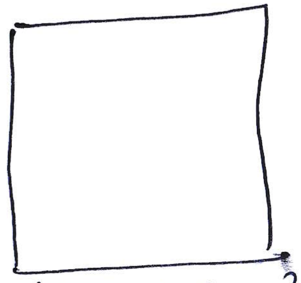
$n = n_{N_2} + n_{CO_2} = 0.75$

$p(0.5) = (0.75)(8.314)(300)$

$p = 3741.3\,kPa$

$\boxed{p = 3.74\,MPa}$

N_2



$V = 0.5\,m^3$

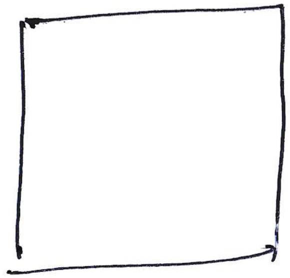
$N_2 = 7\,kg$

$T = 300\,K$

$pV = n\bar{R}T$

$(p)(0.5) = (0.25)(8.314)(300)$

$\Rightarrow p_{N_2} = 1.25\,MPa$



$V = 0.5\,m^3$

$CO_2 \rightarrow 22\,kg$

$T = 300\,K$

$pV = n\bar{R}T$

$(p)(0.5) = (0.5)(8.314)(300)$

$p_{CO_2} = 2.49\,MPa.$

$p = p_{N_2} + p_{CO_2}$

$= 1.25 + 2.49$

DALTON'S LAW

PARTIAL PRESSURES

$$p_{N_2} \forall = n_{N_2} \bar{R} T$$

$$p_{CO_2} \forall = n_{CO_2} \bar{R} T$$

$$p \forall = n \bar{R} T$$

$$\frac{p_{N_2} \forall}{p \forall} = \frac{n_{N_2} \cancel{\bar{R} T}}{n \cancel{\bar{R} T}} \Rightarrow p_{N_2} = \left(\frac{n_{N_2}}{n}\right) p$$

Mole fraction.

Similarly

$$p_{CO_2} = \left(\frac{n_{CO_2}}{n}\right) p$$

$$y_{N_2} \triangleq \frac{n_{N_2}}{n} \, ; \quad y_{CO_2} \triangleq \frac{n_{CO_2}}{n}$$

$$y_{N_2} + y_{CO_2} = 1$$

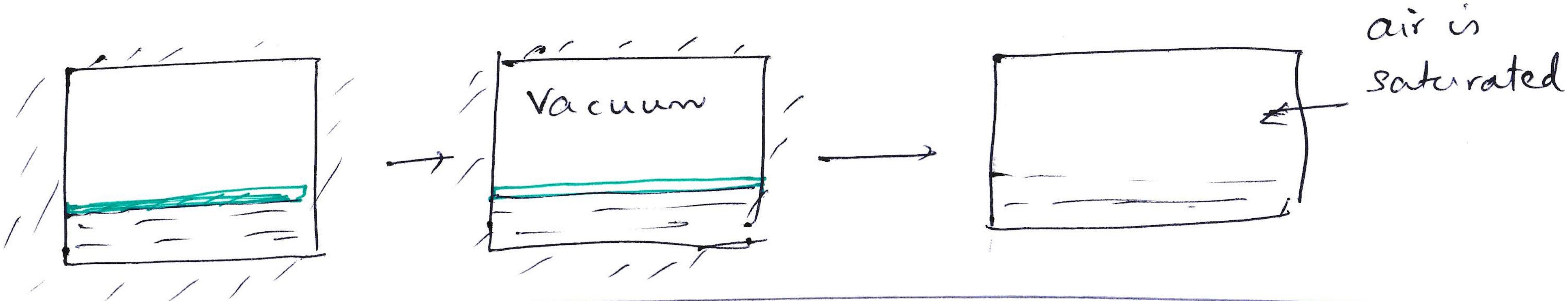
$$p_{N_2} = y_{N_2} p$$

$$p_{CO_2} = y_{CO_2} p$$

In general, if a mixture of gases A, B, C ... with mole fractions ~~A, x_i~~ y_A, y_B ...

$$p_A \sim y_A$$

Vapor pressure



Define Humidity ratio $\omega \triangleq \dfrac{m_v}{m_a}$ ← mass of dry air

Treating both vapor and air as ideal gases,

$(P\forall = mRT)$ $\quad m_v = \dfrac{p_v \forall}{R_v T} \quad m_a = \dfrac{p_a \forall}{R_a T}$

$$\boxed{\omega = 0.622 \frac{p_v}{p - p_v}}$$

$$\omega = \frac{\dfrac{p_v \forall}{R_v T}}{\dfrac{p_a \forall}{R_a T}} = \frac{p_v}{p_a}\frac{R_a}{R_v} = \frac{p_v}{p_a}\frac{\dfrac{\bar{R}}{MW_a}}{\dfrac{\bar{R}}{MW_v}} = \frac{p_v}{p_a}\frac{MW_v}{MW_a} = 0.622\frac{p_v}{p - p_v}$$

$MW_v = 18$
$MW_a = 28.96$
(Since $p_a + p_v = p$)

$[\omega]$ = kg of vapor/kg of dry air

d.a = dry air

Relative humidity $\phi \triangleq \frac{m_v}{m_{v,sat}}$

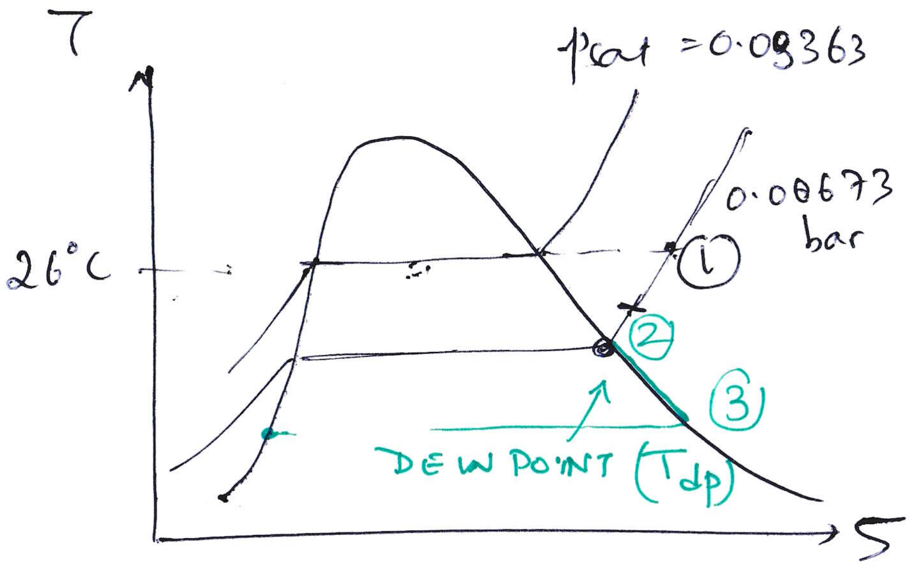
$$= \frac{\dfrac{p_v \forall}{R_v T}}{\dfrac{p_{sat} \forall}{R_v T}}$$

vapor pressure

$$= \frac{p_v}{p_{sat}}$$

$$\boxed{\phi \triangleq \frac{m_v}{m_{vsat}} = \frac{p_v}{p_{sat}}}$$

(5)



$T = 26°C$ $\quad \phi = 20\%$

At $26°C$ $\quad p_{sat} = 0.03363$ bar

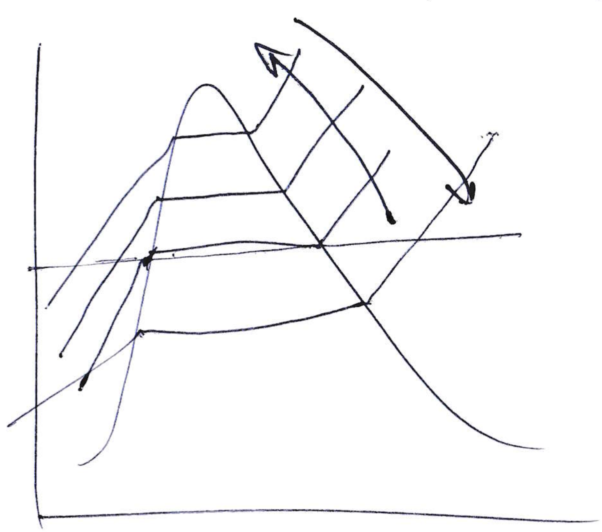
$$\phi = \frac{p_v}{p_{sat}} \Rightarrow 0.2 = \frac{p_v}{0.03363}$$

$$\Rightarrow p_v = 0.00673 \text{ bar}$$

Dew point.

$$T_{dp} = 0.01 + \frac{0.00673 - 0.00611}{0.00813 - 0.00611}(4 - 0.01)$$

$$= 1.23°C$$



$$\omega = (0.622)\frac{p_v}{p - p_v} = 0.622 \frac{0.00673}{1.013 - 0.00673}$$

($p_{atm} = 1.013$ bar)

$$= 4.11 \times 10^{-3} \text{ kg/kg d.a}$$

$$= 4.11 \text{ g/kg d.a.}$$