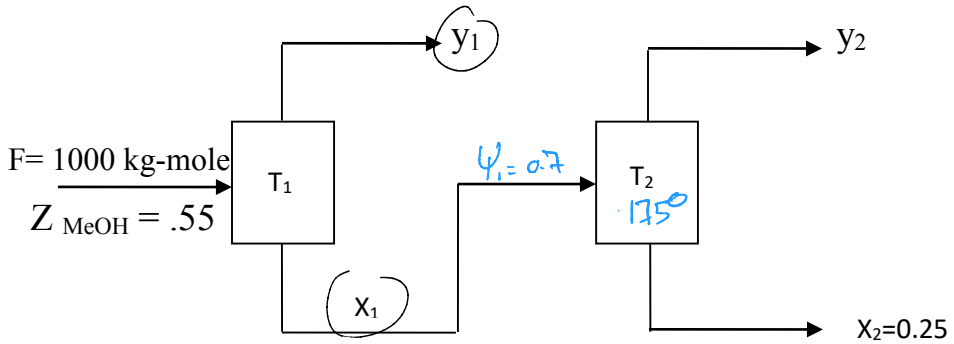
Two flash distillation chambers are connected together as shown in the diagram. Both are at 1 atm pressure. The feed to the first drum is a binary mixture of methanol and water having 55 mole% methanol. Feed flow rate is 1000 kg-moles/hr. The second drum operates with a vapor to feed ratio of 0.7 and the liquid product is 25 mole % methanol. Equilibrium diagrams are given.



a. What are y_1, y_2, x_1, T_1 and T_2?

b. What is the fraction vaporized in the first drum?

(a) $x_1, y_1 > y_2 > T_1 > T_2$

$y_2 \Rightarrow 0.63$ $T_2 = 175^\circ C$

$$y = -\left(\frac{1-\psi}{\psi}\right)x + \frac{z_f}{\psi}$$

$$y = \frac{(1-\psi)}{\psi}x_1 + \frac{z_f}{\psi}$$ ← intercept

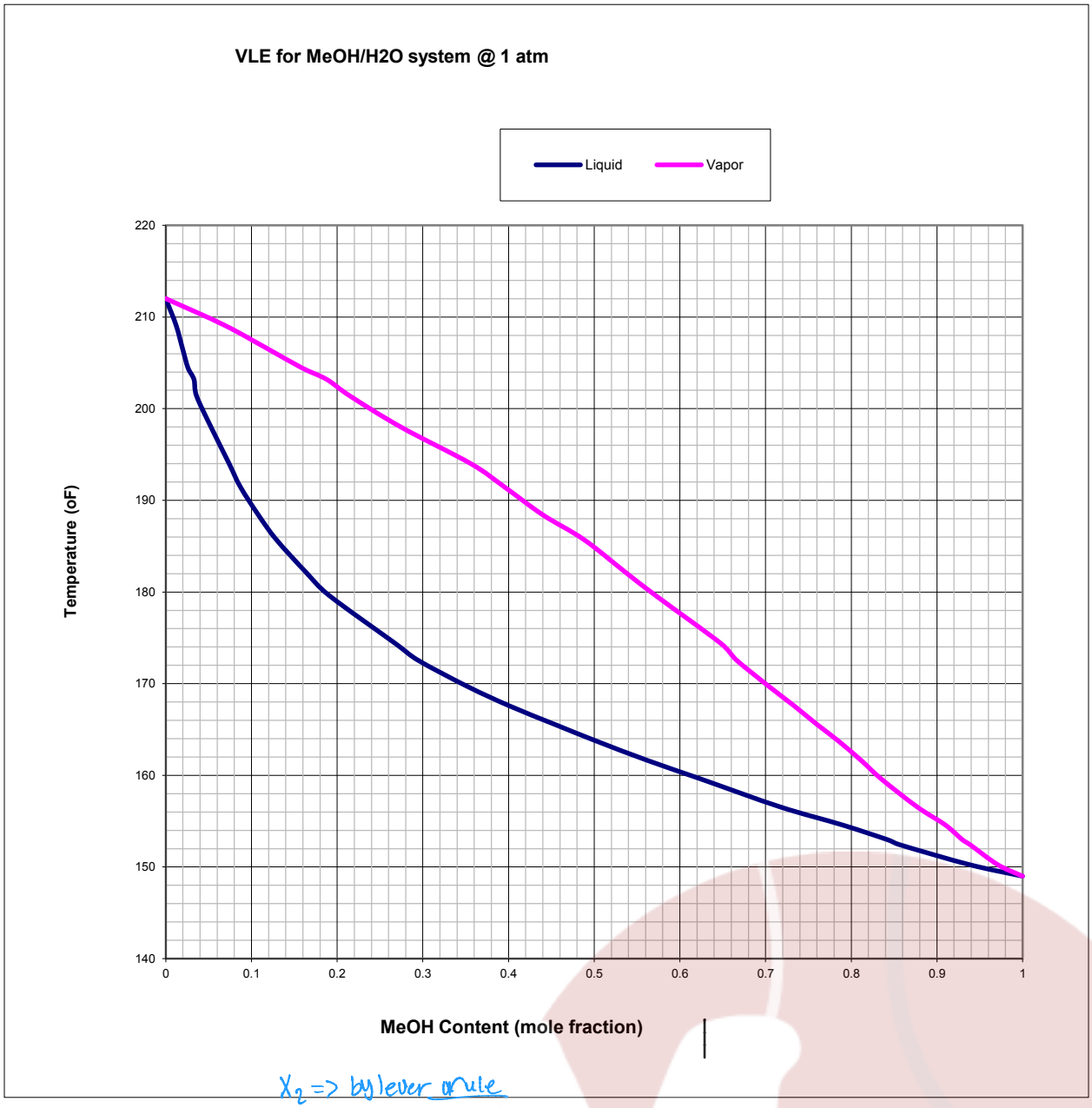
$$y = \left(\frac{3}{7}\right)x_1 + \frac{10}{7}z_f$$

slope

$$0.63 = \frac{3}{7}(0.25) + \frac{10}{7}z_f$$

solve

$z_f = 0.366$



x_2 => by lever rule

$V = 0.7$

$L + V = 1$

$L = (1 - V)$

$z_2 = L x_2 + V_2 y_2$

$z_2 = (1 - V) x_2 + V_2 y_2$

$z_2 = (1 - 0.7) x_2 + (0.7 * 0.623)$

$z_2 = 0.511$

(*) to find Z_2 => by operating Line

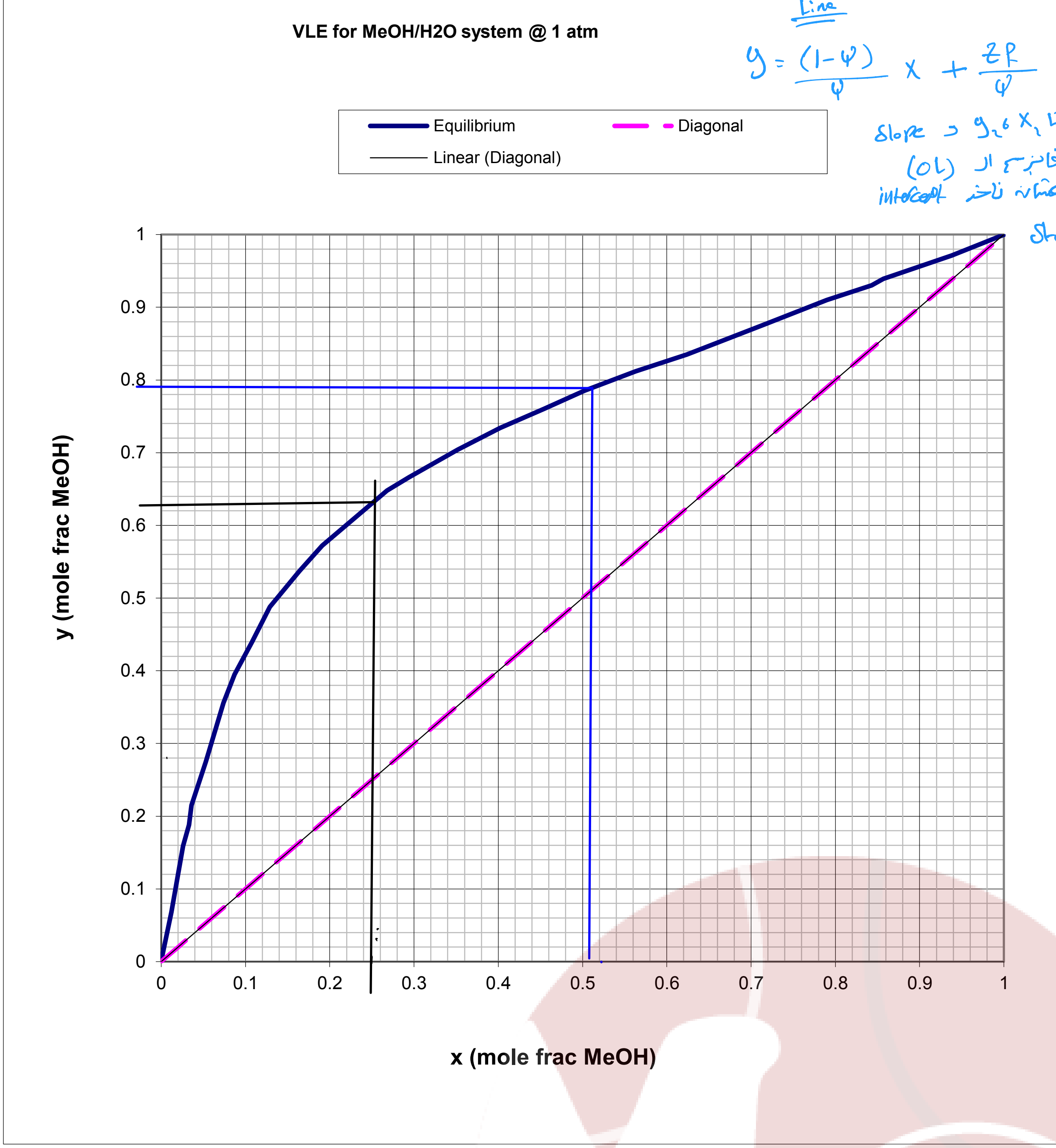
$$y = \frac{(1-\varphi)}{\varphi} x + \frac{ZF}{\varphi}$$

slope => y_2, x_2

(OL)

intercept

slope = $\frac{3}{7}$



Another solution:-

1) $y_2 \Rightarrow$ Equilibrium curve
if not available it would be given
α_2 or, K_2

2) $Zf_2 \Rightarrow$ given $\psi_2 = 0.7$ and y_2 from step (1)

$$Zf = \psi y + (1-\psi)x \xrightarrow[\text{w.r.t}]{\text{solve}} y_2 = \frac{(1-\psi_2)}{\psi_2} x_2 + \frac{Zf_2}{\psi_2}$$

$Zf = 0.5125$

3) Knowing $x_1 = Zf_1 = 0.5125$
$y_1 = f(x_1)$ from equilibrium curve!!

$y_1 = 0.782$

$$y_1 = \frac{(1-\psi)}{\psi} x_1 + \frac{Zf_1}{\psi} \Rightarrow \text{Solve} \Rightarrow \psi_1 = 0.47$$

($\psi_1 \Rightarrow$ → 0.782; x_1 = 0.5125; Zf_1 = 0.55)

$$y = \frac{(1-\psi)x_1 + Zf}{\psi}$$

$$\psi y - (1-\psi)x = Zf$$