Saturation

$$S_i = \frac{\text{volume of phase } i}{\text{pore volume}} = \frac{V_i}{V_p}$$

1-phase (e.g. water) $S_w = \frac{V_w}{V_p} = \frac{V_p}{V_p} = 1$

2-phase (e.g. water & oil)

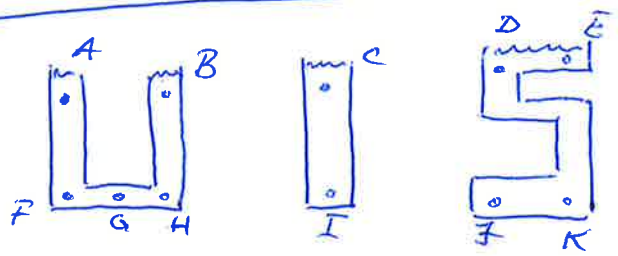
$$\frac{V_w}{V_p} + \frac{V_o}{V_p} = \frac{V_p}{V_p}$$

$$S_w + S_o = 1$$

3-phase $V_o + V_w + V_g = V_p$

$$\Rightarrow S_o + S_w + S_g = 1$$

Pressure

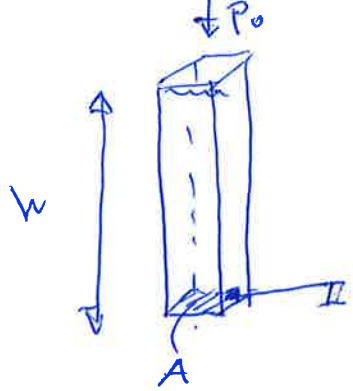


$P_A = P_B = P_C = P_D = P_E$

$P_F = P_G = P_H = P_I = P_J = P_K$

relation between pressure at point C & I!

pressure = Force / area



force in point I: $F = p_0 \cdot A + m_w \cdot g$

$m_w = \rho_w \cdot V = \rho_w \cdot A \cdot h$

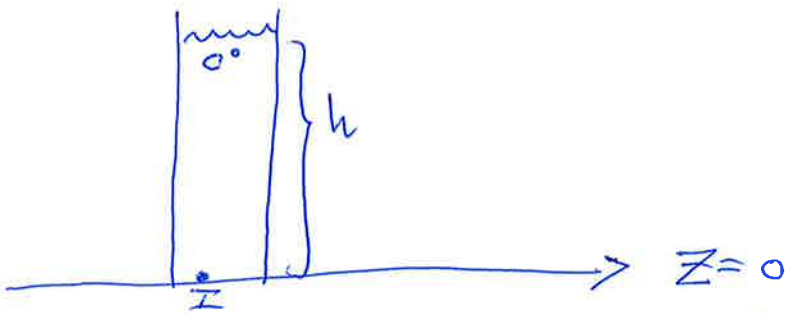
$$P_I = F/A = \frac{p_0 \cdot A + \rho_w g A \cdot h}{A} = p_0 + \rho_w g h$$

useful quantity $\psi = p + \rho g Z$

$\left[\phi = \frac{\psi}{\rho} = \frac{p}{\rho} + gZ \right]$

Z = distance from datum plane

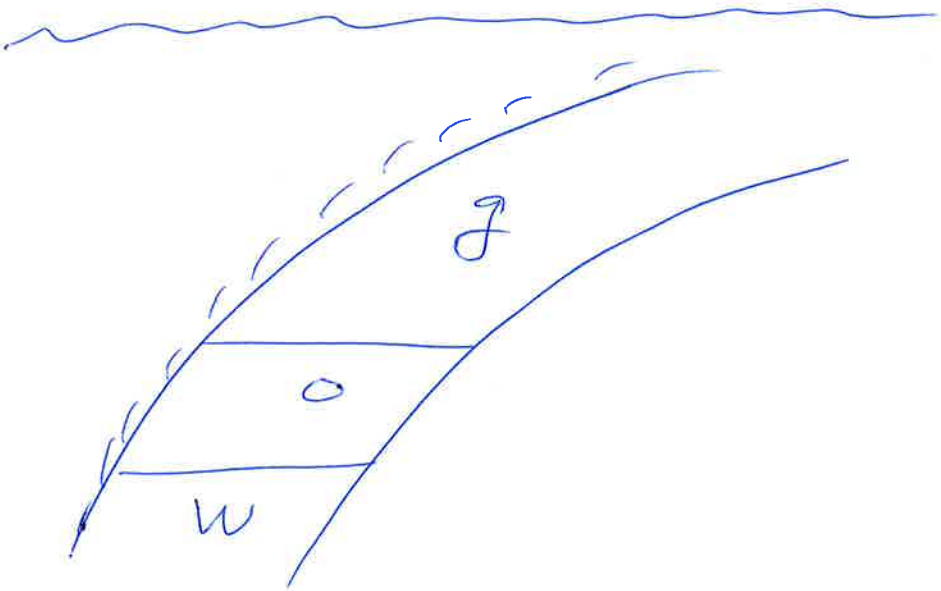
eks:



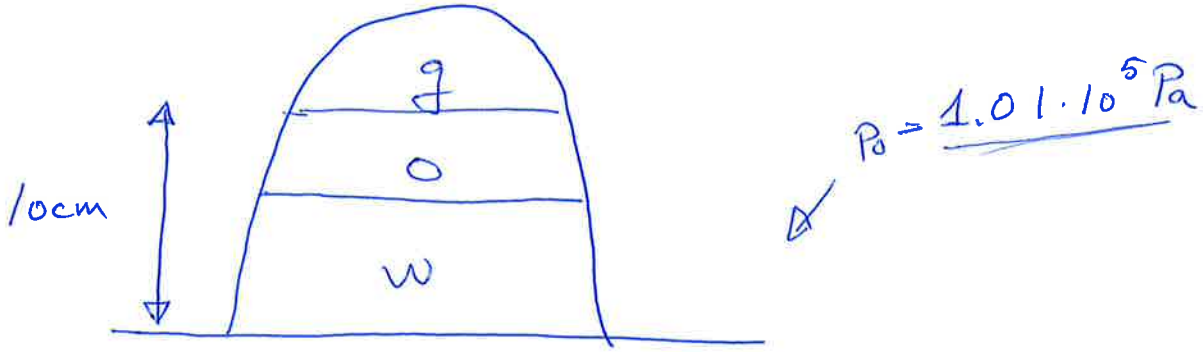
potential in c: $\psi_c = p_c + \rho_w g \underbrace{Z}_{h}$

—"— I: $\psi_I = p_I$

$p_I = p_c + \rho_w g h \Rightarrow \psi_I = p_c + \rho_w g h = \psi_c$



experiment



$\rho_w = \rho_o = 1000 \, kg/m^3$

$\Delta p = \rho_w g h = 10^3 \cdot 10 \cdot 0.1 \, Pa = \underline{10^3 Pa}$

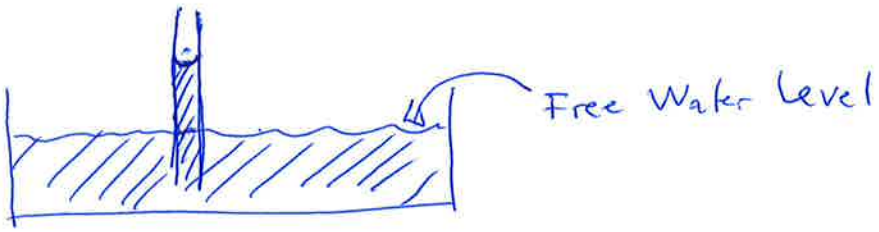
.gas phase expands when the glass is turned

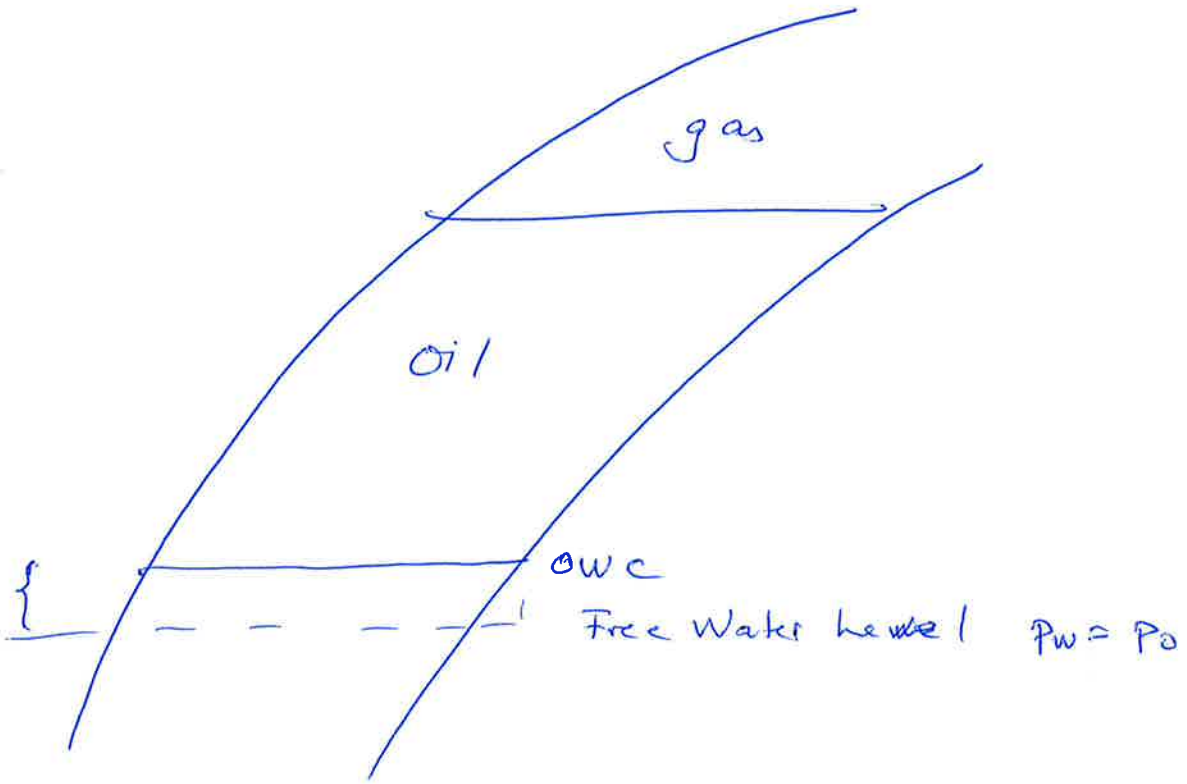
ideal gas $\quad p_i V_i = p_f^g V_f$

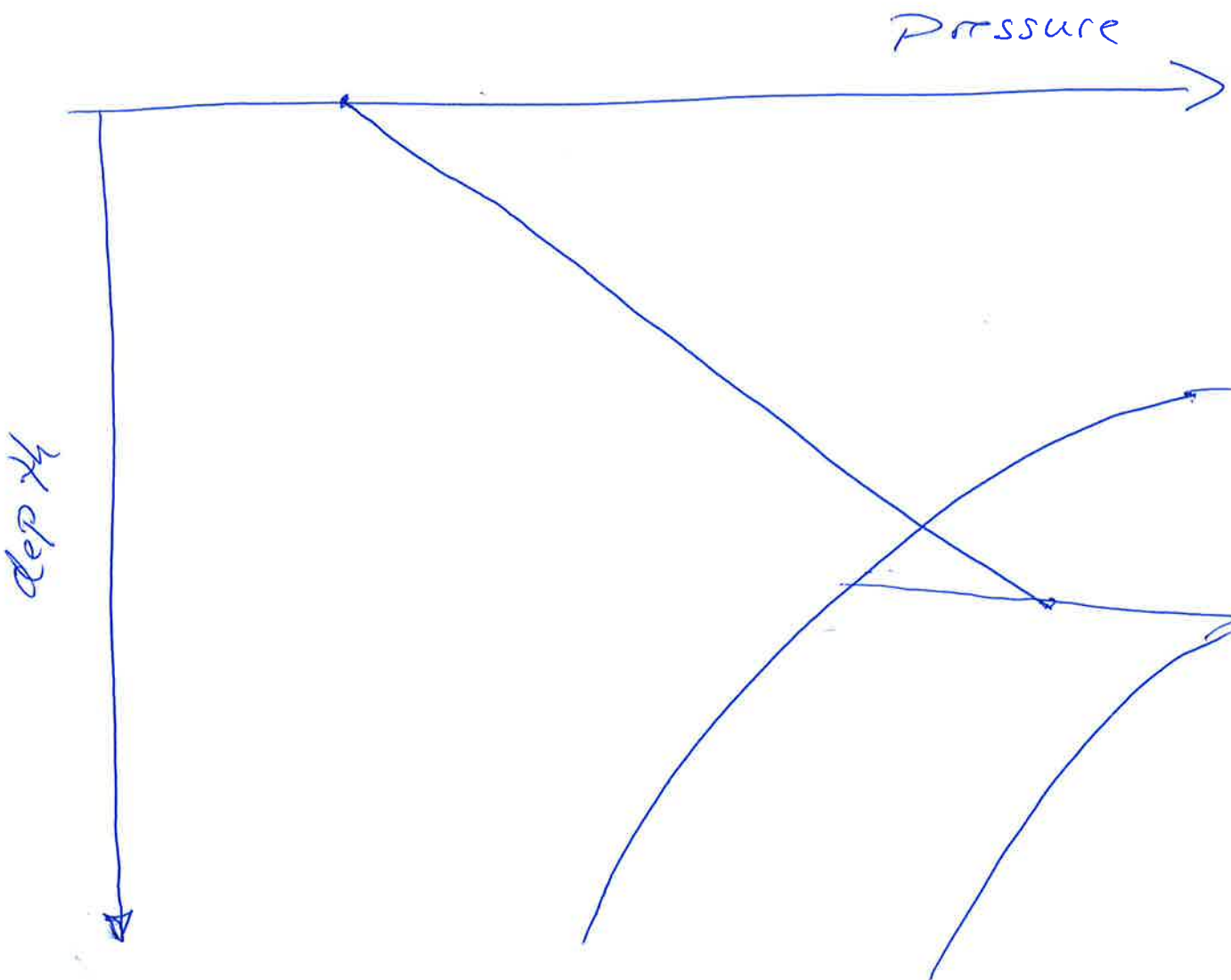
$$p_f^g = p_i \frac{V_i}{V_f} = p_i \frac{V_i}{1.01 V_i} = \frac{1.01 \cdot 10^5 Pa}{1.01}$$

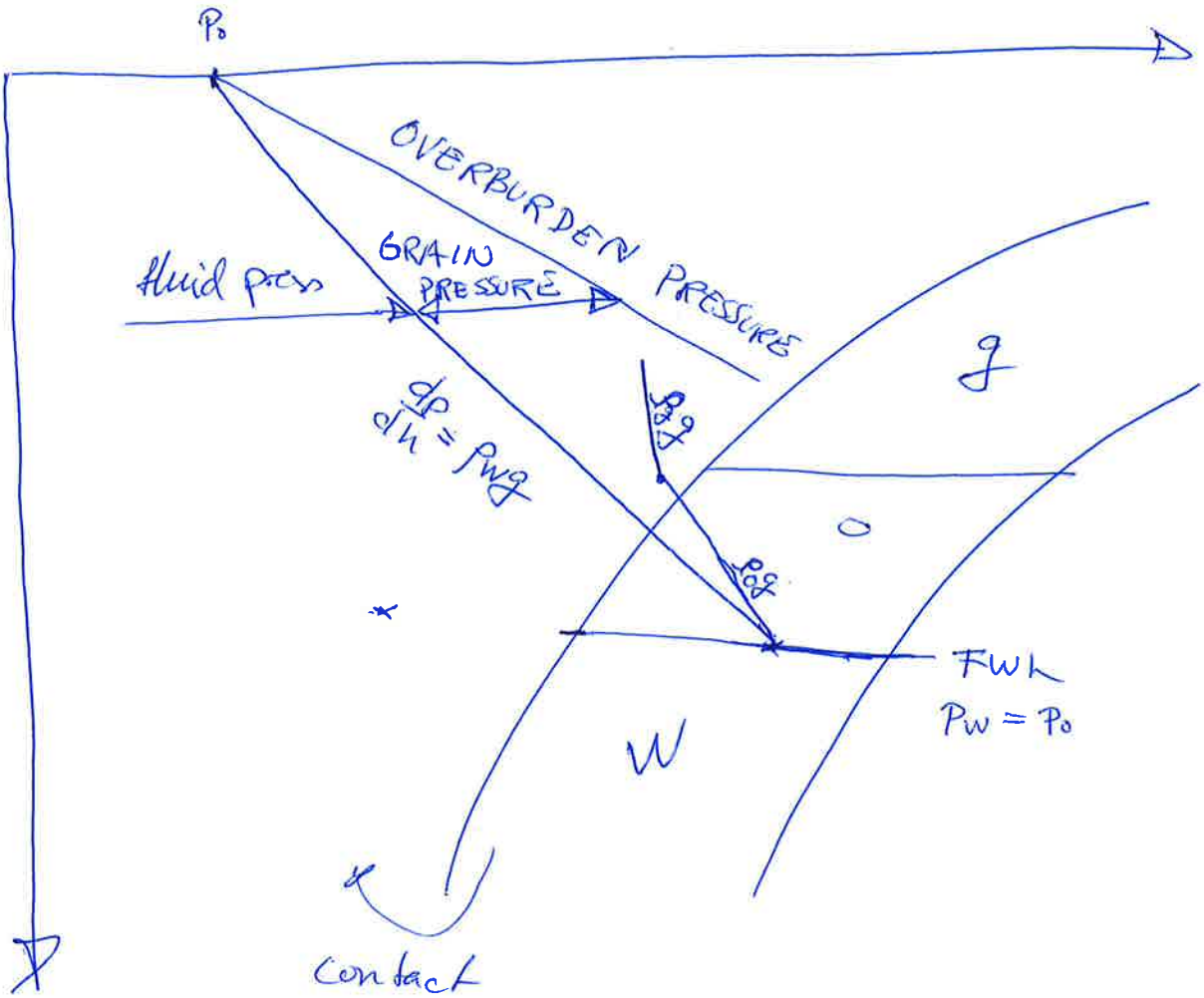
$$\underline{p_f^g \approx 99000 Pa}$$

$p_f^g + \Delta p < 1.01 \cdot 10^5 Pa$


Free Water Level

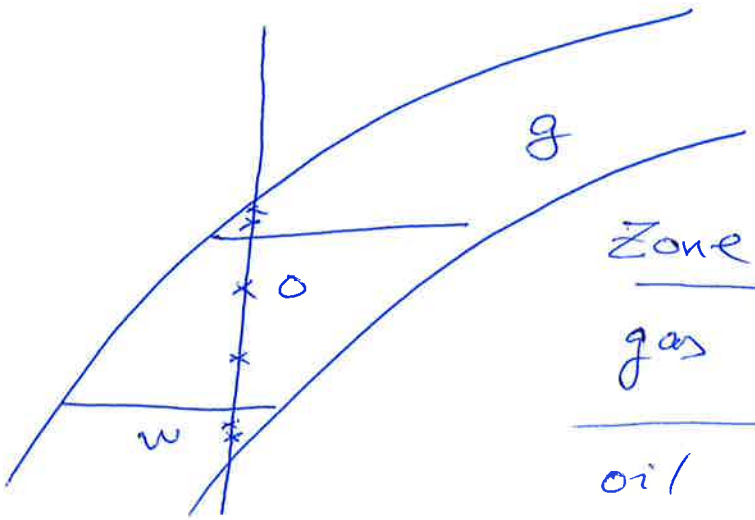

gas
Oil
owc
Free Water level
$P_w = P_o$


Pressure
depth



$$P_w = P_w^\circ + \rho_w g h$$
$$P_o = P^\circ + \rho_o g h$$
$$P_g = P^\circ + \rho_g g h$$

Exam 2009 V oppg 2c



Zone	Depth	Pressure (MPa)
gas	1865	20,07
	1915	20,17
oil	1940	20,33
	1990	20,71
water	2015	20,94
	2065	20,46

Estimate of the height of the oil Zone

for each zone 2 pressures (h_a, P_a) (h_b, P_b)

linear functions $P_x = P_{ref} + \rho_x g h$

$P_x = C_2^x + C_1^x \cdot h$

$$\Rightarrow C_1^x = \frac{P_a - P_b}{h_a - h_b}, \quad C_2^x = P_a - h_a \cdot \frac{P_a - P_b}{h_a - h_b}$$

$$P_w = 10400h - 16 \cdot 10^3$$

$$P_o = 7600h + 5.59 \cdot 10^6$$

$$P_g = 2000h + 16.3 \cdot 10^6$$

OWC: $P_w = P_o \Rightarrow h_{ow} = 2001\,m$

GOC: $P_o = P_g \Rightarrow h_{og} = 1920\,m$

$\Rightarrow$ oil zone $\sim 81\,m$