i) $D_1 = \frac{300mm}{1000} = 0.3m$

$A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.3)^2}{4}$

$A_1 = 0.07m^2$

$D_2 = \frac{150mm}{1000} = 0.15m$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.15)^2}{4}$

$A_2 = 0.0176 m^2$

Sg of mercury (SHG) = 13.6

Sg of oil (Sp) = 0.9

Reading from the manometer

(y) = 250mm = 0.25m

The different of head is

$y\left[\frac{SHG}{Sp} - 1\right] = 0.25\left[\frac{13.6}{0.9} - 1\right]$

$h = 3.53m$ of oil

ii) The Discharge of oil

$q = cd \times \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh}$

$Q = 0.98 \times \frac{0.07 \times 0.0176}{\sqrt{0.07^2 - 0.0176^2}} \times \sqrt{2 \times 9.81 \times 3.53}$

$q = 0.1489 m^3/s$

iii) $\frac{P_1}{\omega} - \frac{P_2}{\omega} + (Z_1 - Z_2) = h$

$\frac{P_1 - P_2}{\omega} - 0.3 = 3.53$

$P_1 - P_2 = 3.83 \times \omega$

$\omega = (9.81 \times 0.9) = 8.829$

$P_1 - P_2 = 3.83 \times 8.829$

$= 33.8 kN/m^2$

①

$C_d = 0.96$

$D_1 = 150mm = \frac{150}{1000} = 0.15m$

$D_2 = 75mm = \frac{75}{1000} = 0.075m$

$Z_1 - Z_2 = 150mm = 0.15m$

$Q = 40L/s = \frac{40}{1000} = 0.04 m^3/s$

$A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.15)^2}{4}$

$A_1 = 0.1767 m^2$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.075)^2}{4}$

$A_2 = 4.4178 \times 10^{-3}$

$Q = C_d \times \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \times \sqrt{2gh} \times \sqrt{h}$

$0.04 = 0.96 \times \frac{0.1767 \times 4.4178 \times 10^{-3}}{\sqrt{0.1767^2 - 4.4178 \times 10^{-3}}} \times 2 \times 9.81 \times \sqrt{h}$

$0.04 = 0.96 \times 0.0279 \times 4.42 \times \sqrt{h}$

$\sqrt{h} = \frac{0.04}{0.96 \times 0.0279 \times 4.42}$

$\sqrt{h} = 0.3778$

$h = (0.3778)^2$

$h = 0.1427 m$

But

$$h = \left(\frac{P_1 - P_2}{\omega}\right) + (Z_1 - Z_2)$$

$$0.1427 = \left(\frac{P_1 - P_2}{\omega}\right) - 0.15$$

$$\left(\frac{P_1 - P_2}{\omega}\right) = 0.1427 + 0.15$$

$$\left(\frac{P_1 - P_2}{\omega}\right) = 0.2927$$

$$\therefore (P_1 - P_2) = 0.2927 \times \omega$$

$$= 0.2927 \times (0.8 \times 1000 \times 9.81)$$

$$= 2297.1 \text{ kN/m}^2$$