NAME: EGBE AMARIBA OGHORA
MATRIC NO: 18/ENG08/005
DEPARTMENT: BIOMEDICAL ENGINEERING.

(1) $d_1 = 300mm = 0.3m$
$d_2 = 150mm = 0.15m$
$S.g_{oil} = 0.9$
$Cd = 0.98$
$S.g_{Hg} = 13.6$

(a) $A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (0.3)^2}{4} = 0.0707m^2$
$\approx 0.071m^2$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi (0.15)^2}{4} = 0.0177m^2$
$\approx 0.018m^2$

(a) The discharge of oil;
Using, $Q = \frac{Cd\sqrt{2gh} \cdot A_1 \cdot A_2}{\sqrt{A_1^2 - A_2^2}}$

but $h = ?$
$h = P_1 - P_2$
$h = x(S_n - 1)$
$h = 0.25(13.6 - 1)$
$h = 0.25(12.6)$
$h = 3.15m$

Applying the formular,
$Q = \frac{0.98\sqrt{2 \times 9.81 \times 3.15} \times 0.071 \times 0.0177}{\sqrt{(0.071)^2 - (0.0177)^2}}$

$Q = 0.1408 m^3/s$

(b) The pressure difference between the entrance and throat section.

Using, $\left(\frac{P_1 - P_2}{w}\right) + (z_2 - z_1) = h$

$z_2 - z_1 = 300mm = 0.3m$

$$\frac{P_1 - P_2}{w} = 3.15 + 0.3$$

$$\frac{P_1 - P_2}{w} = 3.45$$

$$P_1 - P_2 = 30460.05 \, N/m^2$$

(2.) Relative density $= 0.8$

inlet diameter, $d_1 = 150mm = 0.15m$

throat diameter, $d_2 = 75mm = 0.075m$

flow rate $= 40 litres/s = 0.04 m^3/s$

$Cd = 0.96$

$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (0.15)^2}{4} = 0.01767 \approx 0.0177 m^2$

$A_2 = \frac{\pi d_2^2}{4} = \frac{\pi (0.075)^2}{4} = 4.4179 \times 10^{-3} m^2$

Using $h = \left(\frac{P_1}{w} + z_1\right) - \left(\frac{P_2}{w} + z_2\right)$

$h = ?$

∴ Applying,

$$Q = \frac{Cd A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}}$$

$$0.04 = \frac{0.96 \times 0.0177 \times 4.4179 \times 10^{-3} \times \sqrt{2gh}}{\sqrt{(0.0177)^2 - (4.4179 \times 10^{-3})^2}}$$

$$0.04 = \frac{7.5069 \times 10^{-5} \sqrt{2gh}}{0.01714}$$

$$6.856 \times 10^{-4} = 7.5069 \times 10^{-5} \sqrt{2gh}$$

$$9.1329 = \sqrt{2gh}$$

$$83.41 = 2gh$$

$$83.41 = 2 \times 9.81 \times h$$

$$\frac{83.41}{19.62} = h$$

$$h = 4.25m$$

∴ Applying, $h = \left(\frac{P_1}{w} + z_1\right) - \left(\frac{P_2}{w} + z_2\right)$

$$h = \frac{P_1 - P_2}{w} - (z_2 - z_1)$$

but $z_2 - z_1 = 150mm = 0.15m$

$$\therefore h = \frac{P_1 - P_2}{w} - 0.15$$

$$h = \frac{P_1 - P_2}{7848} - 0.15$$

$$0.15 + 4.25 = \frac{P_1 - P_2}{7848}$$

$$4.4 = \frac{P_1 - P_2}{7848}$$

$$P_1 - P_2 = 34531.2 \text{ N/m}^2$$