$d_1 = 20\,cm$
$= \frac{20}{100} = 0.2\,m$

$d_2 = 10\,cm$
$= \frac{10}{100} = 0.1\,m$

$A_1 = \frac{\pi d^2}{4} = \frac{\pi (0.2)^2}{4}$
$= 0.0314\,m^2$

$A_2 = \frac{\pi d^2}{4} = \frac{\pi (0.1)^2}{4}$
$= 0.00785\,m^2$

$P_1 = 17.658\,N/cm^2$
$= 17.658 \times 10^4$
$= 176580\,N/m^2$

$P_2 = 30\,cm$ of mercury
$= -0.3\,m$ of Hg
$= -0.3 \times 13.6$
$h_2 = -4.08\,m$

As $h_1 = \frac{P_1}{\rho g}$
$= \frac{176580}{1000 \times 9.81}$
$= 18\,m$

$\therefore h = h_1 - h_2$
$h = 18 - (-4.08)$
$= 18 + 4.08$
$= 22.08$

$Q = C_d \frac{A_1 A_2}{\sqrt{A_1^2 - A_2^2}} \sqrt{2gh}$
$= \frac{0.98 \times 0.0314 \times 0.00785 \times \sqrt{2 \times 9.81 \times 22.08}}{\sqrt{(0.0314)^2 - (0.00785)^2}}$

$Q = \frac{0.00505}{0.0304}$

$Q = 0.1654\,m^3/s$

Assignment

1) $Z_1 = 0$

$Z_2 = 2.0m$

$V_1 = 5m/s$

$V_2 = 2m/s$

The Pressure, $h_1 \frac{P_1}{w} = 2.5m$

$\frac{P_2}{w} = ??$

$h_f = 0.35 \frac{(V_1 - V_2)^2}{2g}$

$= \frac{0.35(5-2)^2}{2 \times 9.81} = \frac{0.35 \times 9}{2 \times 9.81}$

$= 0.1606m$

Applying Bernoulli's Equatn

$\frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + Z_2 + h_f$

$\frac{P_2}{w} = \frac{P_1}{w} + \frac{V_1^2}{2g} + Z_1 - \frac{V_2^2}{2g} - Z_2 - h_f$

$= 2.5 + \frac{5^2}{2 \times 9.81} + 0 - \frac{2^2}{2 \times 9.81} - 2.0 - 0.1606$

$= 2.5 + 1.274 - 0.204 - 0.1606 - 2.0$

$= 1.4094m$

$= 1.41m$

$\therefore h_2, \frac{P_2}{w} = 1.41m$

$= 1.41m$

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$Q = 0.1655\, m^3/s$

No 3

3) Orifice diameter, $d_0 = 15\,cm$

$= 0.15\,m$

Pipe diameter, $d_1 = 30\,cm$

$= 0.3\,m$ $C_d = 0.64$

$A_0 = \frac{\pi d_0^2}{4} = \frac{\pi (0.15)^2}{4}$

$= 0.01767\, m^2$

$A_1 = \frac{\pi d_1^2}{4} = \frac{\pi (0.30)^2}{4}$

$= 0.070686\, m^2$

Differential head,

$y = 50\,cm$

$= 0.5\,m$

$h = \frac{P}{\rho g} = y\left(\frac{\text{S.G of mercury}}{\text{S.G of water}} - 1\right)$

$= 0.5\left(\frac{13.6}{0.9} - 1\right)$

$= 0.5(12.6)$ $0.5(14.11)$

$= 6.3$ $= 7.06\,m$

$h = 7.06\,m$

$Q = \frac{C_d \times A_1 A_0}{\sqrt{A_1^2 - A_0^2}} \cdot \sqrt{2gh}$

$= \frac{0.64 \times 0.01767 \times 0.07068}{\sqrt{(0.070686)^2 - (0.01767)^2}} \cdot \sqrt{2 \times 9.81 \times 7.06}$

$= \frac{0.0009487}{0.06844}$

$Q = 0.1374\, m^3/s$

$Q = 0.137\, m^3/s$