QUESTION 1

$\delta Z = 2.0\,m$

$V_1 = 5ms^{-1}$ $\quad V_2 = 2ms^{-1}$

$P_1 = 2.5m$ $\quad h = (0.35(V_1 - V_2)^2)/2g$

$P_2 = ?$

Knowing

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

where $\frac{P_1}{\rho g} = 2.5m$

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

$$= 2.5 + \frac{(5^2 - 2^2)}{(2 \times 9.81)} + 2 - \left(\frac{0.35(5-2)^2}{2 \times 9.81}\right)$$

$P/\rho g = 2.5 + 1.07 + 2 - 0.16$

$= 5.57 - 0.16$

$= 5.41m$

QUESTION 2

$D_1 = 20cm = 0.2m$ $\quad P_1 = 17.658N/cm^2 = 176580N/m^2$

$D_2 = 10cm = 0.1m$ $\quad$ Vaccum pressure $= 300mmHg$

$Q_d = ?$ $\quad C_d = 0.98$

$A_1 = \frac{\pi(0.2)^2}{4}$ $\quad A_2 = \frac{\pi(0.1)^2}{4}$

$= 0.0314m^2$ $\quad = 0.00785m^2$

$\frac{P_1}{w} - \frac{P_2}{w} = h$ $\quad \frac{P_1}{w} = \frac{176580}{1000 \times 9.81} = 18m$

$\frac{P_2}{w} = \frac{-13.6 - (1 \times 0.3)}{1}$ $\quad h = 18 - (-13.3)$

$= -13.3$ $\quad = 31.3m$

$$Q = \frac{A_1 A_2 \sqrt{2gh}}{\sqrt{A_1^2 - A_2^2}} = \frac{0.0314 \times 0.00785 \sqrt{2 \times 9.81 \times 31.3}}{\sqrt{(0.0314)^2 - (0.00785)^2}}$$

$= 0.20m^3/s$

Where $C_d = 0.98$

$Q = 0.98 \times 0.20$

$= 0.197m^3/s$

QUESTION 3

$D_o = 15cm = 0.15m$ 500mmHg

$D_i = 30cm = 0.30m$ S.G of Oil = 0.9

$C_d = 0.64$

$Q = ?$

$$h = \frac{13.6 - (0.9 \times 0.5)}{0.9}$$

$$= \frac{13.15}{0.9}$$

$$= 14.6m$$

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

$$= 0.0177 m^2$$

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

$$= 0.0707 m^2$$

$$Q = \frac{C_d \cdot A_o A_i \sqrt{2gh}}{\sqrt{A_i^2 - A_o^2}}$$

$$= \frac{0.64 \times (0.0177 \times 0.0707)\sqrt{2 \times 9.81 \times 14.6}}{\sqrt{(0.0707)^2 - (0.0177)^2}}$$

$$Q = 0.198 m^3/s$$

QUESTION 4

$h_{uw} = 15m$ at 170mmHg

S.G of Hg = 13.6

S.G of salt water = 1.026

$$y = \frac{13.6 - (1.026 \times 170 \times 10^{-3})}{1.026}$$

$$y = 13.08$$

$$h = 15 - 13.08$$

$$= 1.92m$$

$$h = \frac{(V)^2}{2g}$$

$$1.92 \times 2 \times 9.81 = V^2$$

$$V = \sqrt{37.67}$$

$$V = 6.138 ms^{-1}$$

QUESTION 5

Q = 0.05 m³/min
= 8.33 × 10⁻⁴ m³/s

P = 15 bar =
15 × 10⁵ Nm⁻²

Speed of rotation = 1700 rev/min

displacement = 10 cm³/rev

Torque = 15 Nm

(i) Volumetric Efficiency

Ideal flow rate = $10 \times 10^{-6} \times \frac{1700}{60}$

$= 2.83 \times 10^{-4}\ m^3/s$

$V.E = \frac{8.33}{2.83} \times 100\%$

$= 294.5\%$

(ii) Fluid power

$= Q \cdot \delta P$

$= 8.33 \times 10^{-4} \times 15 \times 10^5$

$= 1249.5\ Nms^{-1}$

$= 1.249\ KNms^{-1}$

(iii) Shaft power = $T \cdot \omega$

$\omega = \frac{2 \times \pi \times 170}{60}$

$= 17.80\ rad/s$

Shaft power = $267.03\ Nms^{-1}$

(iv) Overall efficiency = $\frac{1249.5}{267.03} \times 100$

$= 467.9\%$