) VFR = 10 dm^3/min × $\frac{0.001}{60}$

= 0.000167 m^3/s

Pressure change = 12 bar = 12×10^5 N/m^2

Speed = 1500 rpm × $\frac{1}{60}$ = 25 rps

Nominal displacement = 10 cm^3/rev × 1×10^{-6}

= 1×10^{-5} m^3

Ideal flow rate = nd × speed

= 25 × 1×10^{-5}

= 0.00025 m^3/s

i) Volumetric efficiency = $\frac{\text{Actual flow rate}}{\text{Ideal flow rate}}$ × 100

= $\frac{0.000167}{0.00025}$ × 100

= 66.67%

ii) Fluid power = Q·∂p

Q = 0.000167 m^3/s

∂p = 12×10^5 N/m^2

= 0.000167 × 12×10^5

= 200 Nm/s

iii) Shaft power = T·ω

T = 12.5 Nm

ω = 2 × π × 25

= 157.08 rad/s

SP = 12.5 × 157.08

= 1963.5 W

iv) Overall efficiency = $\frac{FP}{SP}$ × 100

= $\frac{200}{1963.5}$ × 100 = 10.19%

2) Q = 35 dm^3/min × $\frac{0.001}{60}$ =

5.833 × 10^{-4} m^3/s

[illegible] = 1×10^7 N/m^2

O.E = 87% = $\frac{FP}{SP}$ × 100

FP = Q·∂p = 5.833 × 10^{-4} × 1×10^7

= 5,833 Nm/s

then SP = $\frac{FP}{OE}$ × 100

Shaft power = $\frac{5{,}833 \times 100}{87}$

= 6704.98 W

3) Nd = 50 cm^3/rev × 1×10^{-6}

= 5×10^{-5} m^3/rev

∂p = 100 bar = 1×10^7 N/m^2

SP = 15 kW = 15,000 W

O.E = $\frac{FP}{S.P}$ × 100

F.P = Q·∂p

AFR = 35 dm^3/min = 5.833 × 10^{-4} m^3/s

Fluid power = 5.833 × 10^{-4} × 1×10^7

= 5833 Nm/s

O.E = $\frac{5833 \times 100}{15000}$

= 38.89%

Volumetric Efficiency = $\frac{A.FR}{IFR}$ × 100

Ideal flow rate = Nd × speed

speed = 850 rpm × $\frac{1}{60}$

= 14.167 rps

IFR = 5×10^{-5} × 14.167

= 7.0833 × 10^{-4} m^3/s

V.E = $\frac{5.833 \times 10^{-4}}{7.0833 \times 10^{-4}}$ × 100

$= 82.35\%$

4) $z = 24{,}000\,cm = 240\,m$

Jet velocity $= 66\,m/s$

$Q = 17\,l/s \times 0.001 = 1.7 \times 10^{-2}\,m^3/s$

$P = Z = 0$

$P = \frac{\rho Q V^2}{2} = \frac{1000 \times 1.7 \times 10^{-2} \times 66^2}{2} = 28{,}514\,W$

Power supplied from reservoir

i) $P = \rho g Q z = 1000 \times 9.81 \times 1.7 \times 10^{-2} \times 240$

$P = 306072\,W$

ii) Power loss in transmission

Power of reservoir − Power of jet

$= 306072 - 28{,}514$

$= 2{,}293.2\,W$

iii) $h = \frac{PL.T}{\rho g Q}$

$= \frac{2{,}293.2}{1000 \times 9.81 \times 1.7 \times 10^{-2}}$

$= 17.982\,m$

iv) Efficiency $= \frac{P \text{ of jet} \times 100}{P \text{ of reservoir}}$

$= \frac{28514 \times 100}{306072}$

$= 9.231\%$

5) $\rho = 890$

$z = 20{,}000\,cm \times 10^{-2} = 200\,m$

$v = 7\,m/s$

$Q = 220\,l/s \times 0.001 = 0.22\,m^3/s$

$P \text{ of jet} = \frac{\rho}{2} \times AV^3 = \frac{1}{2} \times \rho \times Q V^2$

$= \frac{1}{2} \times 890 \times 0.22 \times 7^2$

$= 979 \times 49$

$= 4797.1\,W$

b ii) Power from reservoir

$= \rho Q z = 890 \times 9.81 \times 0.22 \times 200$

$= 376239.4\,W$

ii) Power from reservoir

$= 890 \times 0.22 \times 200 = 98\ldots$

ii) $= \frac{1}{2} \rho V^2 Q$

$= \frac{1}{2} \times \frac{890 \times 49 \times 0.22}{9.81}$

$= 489\,kg\,m/s$

Power lost in transmission

$= 5870 - 489$

$= 5823\,kg\,m/s$

$h = \frac{5823}{890 \times 0.22} = 29.73\,m$

Efficiency $= \frac{P \text{ of jet}}{\text{supply}} \times 100$

$= \frac{489}{5870} \times 100$

$= 0.83\%$

6) $E = mgh$

$P = \frac{mgh}{A}$

$I = \ldots$

$P = \frac{\pi \times 0.05^2 \times 20 \times 1000 \times 9.81 \times 20}{7.07}$

$P = 708.4\,W$

7) $\rho_m = 19.62$

$d_1 = 0.3m$

$d_2 = 0.2m$

for manometer

$P_1 + \rho_w g z_1 = P_2 + \rho_w g(z_2 - h) + \rho_m g h$

$P_1 - P_2 = 19.62(z_2 - z_1) + 587.423$

for venturimeter

$\frac{P_1}{\rho_w g} + \frac{u_1^2}{2g} + z_1 = \frac{P_2}{\rho_w g} + \frac{u_2^2}{2g} + z_2$

$P_1 - P_2 = 19.62(z_2 - z_1) + 0.803 u_2^2$

$0.803 u_2^2 = 587.423$

$u_2 = \sqrt{\frac{587.423}{0.803}} = 27.05\,m/s$

$C_d = 0.96$

$Q_2 = 27.05 \times \pi \times \left(\frac{0.2}{2}\right)^2$

$= 0.85\,m^3/s$

$Q_1 = C_d Q_2 = 0.96 \times 0.85 = 0.816\,m^3/s$

9) $d_1 = 0.3m$

$A_1 = 0.3^2 \times \frac{\pi}{4} = 0.0707\,m^2$

$P = 400\,kN/m^2$

$h = 10m$

$d_2 = 150mm = 0.15m$

$A_2 = \frac{\pi}{4} \times 0.15^2 = 0.01767\,m^2$

$Q = 40\,l/s = 0.04\,m^3/s$

$Q_1 = A_1 V_1 = A_2 V_2$

$V_1 = \frac{Q}{A_1} = \frac{0.04}{0.0707} = 0.566\,m/s$

$V_2 = \frac{Q}{A_2} = \frac{0.04}{0.01767} = 2.264\,m/s$

$\frac{P_1}{w} + \frac{V_1^2}{2g} + z_1 = \frac{P_2}{w} + \frac{V_2^2}{2g} + z_2$

$\frac{P_2}{w} = \frac{P_1}{w} + \left(\frac{V_1^2 - V_2^2}{2g}\right) + z_1 - z_2$

$= (400 \div 9.81) + \frac{1}{2 \times 9.81} \times (0.566^2 - 2.264^2) + (10 - 0)$

$= 40.77 - 0.24574$

$\frac{P_2}{w} = 44.525m$

$P_2 = 44.525 \times 9.81$

$= 436.8\,kN/m$

10) reading $= 170mm$

$S_{g\,mercury} = 13.6$

$S_{g\,water} = 1.026$

$h = x\left(\frac{S_{g\,merc}}{S_{g\,water}} - 1\right)$

$= 0.17\left(\frac{13.6}{1.026} - 1\right)$

$= 2.083$

$v = \sqrt{2gh} = \sqrt{2 \times 9.81 \times 2.083}$

$v = 6.393\,m/s$