Exercise N° 1 :

1) Continuity equation: $V.S_1 = V.S_2$ therefore: $\frac{V_2}{V_1} = \frac{S_1}{S_2} = \left(\frac{d_1}{d_2}\right)^2 = 4$

2) Bernoulli's equation: $\frac{V_2^2 - V_1^2}{2} + \frac{P_2 - P_1}{\rho} + g.(Z_2 - Z_1) = 0$ Or $Z_1 = Z_2$ & $V_1 = \frac{V_2}{4}$

So $V_2 = \sqrt{\frac{32}{15}.\frac{P_2 - P_1}{\rho}}$ A.N. $V_2 = \sqrt{\frac{32}{15}.\frac{2{,}875.10^5 - 10^5}{1000}} = 20\ m/s$

Exercise N° 2 :

1) Continuity equation : $\frac{\pi.D^2}{4}.V_1 = \frac{\pi.d^2}{4}.V_2$ So the speed $V_1 = \left(\frac{d}{D}\right)^2.V_2$ (1)

2) Bernoulli's equation: Or P₁=P₂= P_atm therefore: $\frac{V_2^2 - V_1^2}{2} - g.H = 0$ (2)

$$\frac{V_2^2 - \left(\frac{d}{D}\right)^4.V_2^2}{2} = g.H$$

$$V_2 = \sqrt{\frac{2.g.H}{1 - \left(\frac{d}{D}\right)^4}}$$

3) If $\left(\frac{d}{D}\right) << 1$ then $V_2 = \sqrt{2.g.H}$ A.N. $V_2 = \sqrt{2.9{,}81.3} = 7{,}67\ m/s$

4) $q_v = \frac{\pi.d^2}{4}.V_2$ A.N. $q_V = \frac{\pi.0{,}01^2}{4}.7{,}67 = 6.10^{-4}\ m^3/s$

Exercise N° 3 :

Part 1: Study of the nozzle

1) Flow velocity: $V_1 = \frac{4.q_v}{\pi.d_1^2}$ A.N. $V_1 = \frac{4.0{,}4.10^{-3}}{\pi.0{,}01^2} = 5\ m/s$

2) Continuity equation: $V_1.S_1 = V_2.S_2 \Rightarrow d_2 = \sqrt{\frac{V_1}{V_2}}.d_1$ A.N. $d_2 = \sqrt{\frac{5}{20}}.10 = 5\ mm$

3) Bernoulli's equation: $\frac{V_2^2 - V_1^2}{2} + \frac{P_2 - P_1}{\rho_{oil}} + g(Z_2 - Z_1) = 0$ or $Z_1 = Z_2$ et $P_2 = P_{atm}$

So $P_1 = P_2 + \frac{1}{2}.\rho_{oil}.(V_2^2 - V_1^2)$ A.N. $P_1 = 10^5 + \frac{1}{2}.800.(20^2 - 5_1^2) = 2{,}5.10^5\ pascal = 2{,}5\ bar$

Part 2 Study of pressure gauge (U-tube)

1) RFH between (1) and (3): $P_3 - P_1 = \rho_{oil}.g.(Z_1 - Z_3)$

$P_3 = P_1 + \rho_{oil}.g.L$ A.N. $P_3 = 2{,}5.10^5 + 800.9{,}81.1{,}274 = 2{,}6.10^5\ pascal = 2{,}6\ bar$

2) RFH between (3) and (4): $P_3 - P_4 = \rho_{merc}.g.(Z_4 - Z_3)$ or $(Z_4 - Z_3) = h$

So $h = \frac{P_3 - P_4}{\rho_{merc}.g}$ A.N. $h = \frac{2{,}6.10^5 - 1.10^5}{13600.9{,}81} = 1{,}2\ m$

Exercise N° 4 :

1) Volume flow : $q_V = V.\frac{\pi.d^2}{4}$ A.N. $q_V = 0,4.\frac{\pi.0,15^2}{4} = 7.10^{-3}\ m^3/s = 7\ L/s$

2) Bernoulli's equation for a perfect incompressible fluid (with exchange of work) :

$$\frac{1}{2}(V_2^2 - V_1^2) + \frac{1}{\rho}.(P_2 - P_1) + g.(Z_2 - Z_1) = \frac{P_u}{\rho.q_v}$$

3) Useful power of the pump: $P_u = q_v.\rho.g.(H_1 + H_2)$

A.N. $P_u = 7.10^{-3}.1000.9,81.(26+5) = 2128,77\ w$

4) Power absorbed by the pump: $P_a = \frac{P_u}{\eta}$ A.N. $P_a = \frac{2128,77}{0,8} = 2661\ w$