ABBES LAGHROUR UNIVERSITY - KHENCHELA
Faculty of Sciences and Technology
Department of Science of Matter
2nd year License: Physics

جامعة عباس لغرور خنشلة
ABBES LAGHROUR UNIVERSITY KHENCHELA

Correction of the final exam in: Fluids Mechanics

Exercise 1: 5 pts.

1) Calculation of:

weight w; Density ρ; Specific gravity SG.

We have: $m = 60\,kg$, $V = 5\,m^3$.

$\Rightarrow \rho = \frac{m}{V} = \frac{60}{5} = 12\,kg.m^{-3}$ (0.5) (0.5)

$\Rightarrow W = mg = 60 \times 9.81 = 588.6\,N$. (0.5) (0.5)

$\Rightarrow SG = \frac{\gamma_{liquid}}{\gamma_{water}} = \frac{\rho . g}{\gamma_{water}} = \frac{12 \times 9.81}{9810}$ (0.5)

$SG = 0.012$ (0.5)

Or: $SG = \frac{\rho_{liquid}}{\rho_{water}} = \frac{12}{1000} = 0.012$.

2) Calculation of: Weight w:

We have: $V = 2\,l = 2 \times 10^{-3} = 0.002\,m^3$ (0.5)

$d = 0.918 = \frac{\rho_{liquid}}{\rho_{water}} \Rightarrow \rho_{liquid} = 0.918 \times 1000$ (0.5)

$\rho = 918\,kg.m^{-3}$ (0.5)

So: $W = \rho . V . g = 918 \times 0.002 \times 9.81$

$W = 18\,N$ (0.5)

Exercise 2 : 7 pts.

Calculation of : Pressure at point A

$$P_A = ?$$

To calculate P_A we apply the fundamental equation of statics between points : A-B ; A-C ; C-D and D-E. (0,5)

(0,5) $\Rightarrow P_A - P_B = \rho_w \cdot g (h_B - h_A)$; (0,5) $\Rightarrow P_B = P_C = P_{air}$

(0,5) $\Rightarrow P_C - P_D = \rho_{Hg} \cdot g (h_D - h_C)$; (0,5) $\Rightarrow P_D - P_E = \rho_{oil} g (h_E - h_D)$

$S\Theta$: $P_A - P_E = P_A - P_B + P_C - P_D + P_D - P_E = P_A - P_E$.

$\Rightarrow P_A - P_E = \rho_w g (h_B - h_A) + \rho_{Hg} (h_D - h_C) + \rho_{oil} g (h_E - h_D)$ (1) pts

$\Rightarrow P_A - P_E = \rho_w g (0,65) + \rho_{Hg} \cdot g (-0,25) + \rho_{oil} \cdot g (0,60)$ (1)

(0,5) we know that : $d = \frac{\rho_{fluid}}{\rho_{water}} \Rightarrow \rho_{fluid} = d \cdot \rho_{water}$

$S\Theta$:

(0,5) $P_A - P_E = g \cdot \rho_{water} \left(d_w (0,65) - d_{Hg} (0,25) + d_{oil} (0,6) \right)$

$d_w = 1$

(0,5) $P_E = P_{atm} = 10^5$ Pa

$S\Theta$: $P_A = P_{at} + (9,81 \times 1000 \times [0,65 - 13,6 (0,25) + 0,85 (0,6)$

$$\boxed{P_A = 78025,6 \text{ Pa}}$$ (1)

Exercise 03 : 8 pts.

1) Calculation of P_B at B :

$P_B - P_{B'} = \rho g (h_{B'} - h_B)$ (0,5) , $P_{B'} = 1.01.10^5$ Pa.

$\Rightarrow P_B = P_{B'} + \rho g (h_{B'} - h_B)$ (0,25)

So : $P_B = 1.01 \times 10^5 + 1000 \times 9,81 (3 - 0)$

$\boxed{P_B = 1,3 \times 10^5 \text{ Pa}}$ (0,5)

2) Calculation of P_A at A :

$P_A - P_{A'} = \rho g (h_{A'} - h_A)$ (0,5)

$P_A = P_{A'} + \rho g (h_{A'} - h_A)$ (0,25)

So : $P_A = 1.01 \times 10^5 + 1000 \times 9,81 (6 - 0)$

$\Rightarrow \boxed{P_A = 1,6 \times 10^5 \text{ Pa}}$ (0,5)

3) The continuity equation between A and B : $S_A . v_A = S_B . v_B$ (0,5)

$\Rightarrow v_B = \frac{S_A}{S_B} v_A = \frac{D_A^2}{D_B^2} v_A \Rightarrow \boxed{v_B = 4 v_A}$ (0,5)

4) Bernoulli's equation between A and B:

$$P_A + \frac{1}{2}\rho v_A^2 + \rho g h_A = P_B + \frac{1}{2}\rho v_B^2 + \rho g h_B \quad (1)$$

* The flow velocity v_B:

$$\left.\begin{array}{l} h_A = h_B \\ v_A = \dfrac{v_B}{4} \end{array}\right\} \Rightarrow P_A + \rho \frac{v_B^2}{16} \times \frac{1}{2} = P_B + \frac{1}{2}\rho v_B^2 \quad (0,5)$$

$$\Rightarrow \frac{1}{2}\rho\left(\frac{v_B^2}{16} - v_B^2\right) = P_B - P_A$$

$$\Rightarrow v_B = \sqrt{\frac{-32(P_B - P_A)}{15.\rho}} = \sqrt{\frac{-32(1,3-1,6).10^5}{15\times 1000}} \quad (0,5)$$

$$v_B = 8\ m/s \quad (0,5)$$

5) The flow rate Q_V:

$$Q_V = S_A v_A = S_B v_B. \quad (0,5)$$

$$S_B = \pi \frac{D_B^2}{4} = \frac{3,14\times(20\times 10^{-2})^2}{4} = 0,0314\ m^2 \quad (0,5)$$

$$= 3,14\times 10^{-2}\ m^2 \quad (0,5)$$

AN: $Q_V = 0,0314 \times 8 = 0,25\ m^3/s$ (0,5)