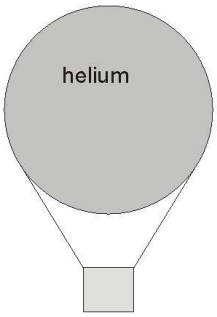
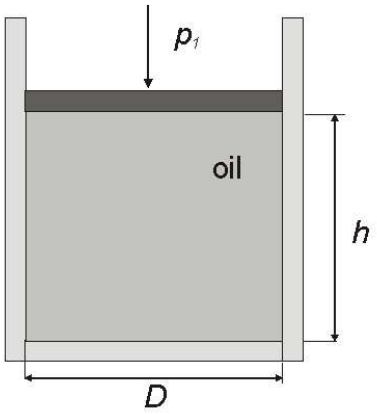
CHARACTERISTICS OF A FLUID.

Ex. 1. A large balloon having a volume of 90.000 m^3 contains helium under standard atmospheric conditions (pressure $p_0 = 101\,kPa$ and temperature $t_0 = 15°C$). Determine the density and total weight of the helium. (Ans. $\rho_{\mathrm{He}} = 0.169\,kg/m^3$; $q_{\mathrm{He}} = 1.49 \cdot 10^5\,N$)



Ex. 2. Calculate density of carbon dioxide at temperature $T_1 = 773\,K$ and under pressure $p_1 = 101325\,N/m^2$, if under the same pressure p_1 and at temperature $T_0 = 273\,K$, its density is $\rho_0 = 1.98\,kg/m^3$. (Ans. $\rho_1 = 0.699\,kg/m^3$)

Ex. 3. Oil is squeezed in a tank. Calculate its coefficient of compressibility β, if pressure p_1 changes from 0 to $2.5\,MN/m^2$ and the initial height of oil $h = 1000\,mm$ decreases by $\Delta h = 1.8\,mm$. (Ans. $\beta = 0.72 \cdot 10^{-9}\,m^2/N$)



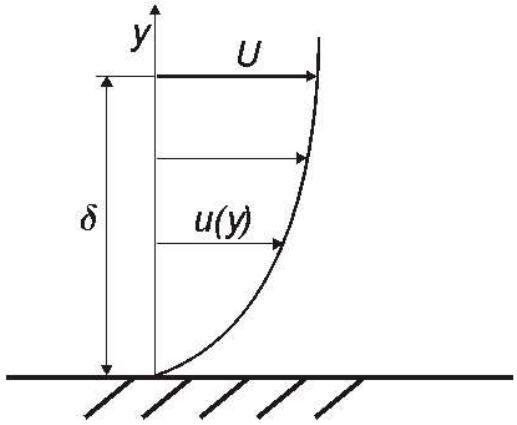
Ex. 4. High-pressure tank has volume of $h_t = 50\,dm^3$. Calculate increment of pressure inside the tank Δp, if it was pumped by $50.5\,dm^3$ of alcohol. Coefficient of compressibility of alcohol is $\beta = 0.122 \cdot 10^{-8}\,m^2/N$.
(Ans. $\Delta p = 8116\,kPa$)

Ex. 5. Calculate density of water at temperature $T = 277.15\,K$, if pressure increases from 1 to $100\,atm$. In calculation use mean coefficient of compressibility of water $\beta = 5.1 \cdot 10^{-10}\,m^2/N$. (Ans. $\rho_2 \approx 1005\,kg/m^3$)

Ex. 6. Calculate increment of density of glycerin $\Delta\rho$, if its temperature in closed tank increased from $T_1 = 293\,K$ to $T_2 = 323\,K$. Coefficient of volume expansion for glycerin is $\alpha = 0.59 \cdot 10^{-3}\,K^{-1}$. (Ans. $\Delta\rho = 22.3\,kg/m^3$)

Ex. 7. Dynamic coefficient of viscosity of oil at temperature $T_2 = 323\,K$ is equal $\mu = 5.884 \cdot 10^{-3}\,N \cdot s/m^2$. Calculate its kinematic coefficient of viscosity ν, if density of oil at temperature $T_1 = 293\,K$ is $\rho_1 = 800\,kg/m^3$. Coefficient of volume expansion for oil is $\alpha = 0.96 \cdot 10^{-3}\,K^{-1}$. (Ans. $\nu = 7.57 \cdot 10^{-6}\,m^2/s$)

Ex. 8. A Newtonian fluid having density $\rho = 920\,kg/m^3$ and kinematic coefficient of viscosity $\nu = 4 \cdot 10^{-4}\,m^2/s$ flows past a fixed surface. The velocity profile near the surface is shown at the figure ($u(y) = U\,\sin(\frac{\pi}{2}\frac{y}{\delta})$). Determine the magnitude and direction of the shearing stress τ developed on the plate. Express answer in terms of U and δ, with U and δ expressed in units of meters per second and meters, respectively. (Ans. $\tau = 0.578\,U/\delta$, N/m^3).



Ex. 9. A cylinder of diameter $d = 122\,mm$ and length $l = 200\,mm$ is placed inside a concentric long pipe of diameter $D = 125\,mm$. An oil film is introduced in the gap between the pipe and the cylinder. What force is necessary to move the cylinder at a velocity of $v = 1\,m/s$? Assume that the dynamic coefficient of viscosity of oil is $\mu = 0.30\,kg/m \cdot s$ and its density is $\rho_o = 900\,kg/m^3$. (Ans. $F = 15.33\,N$)