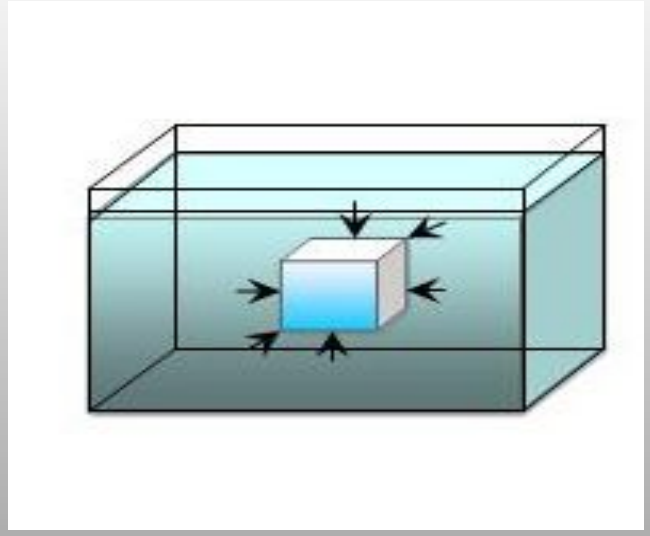
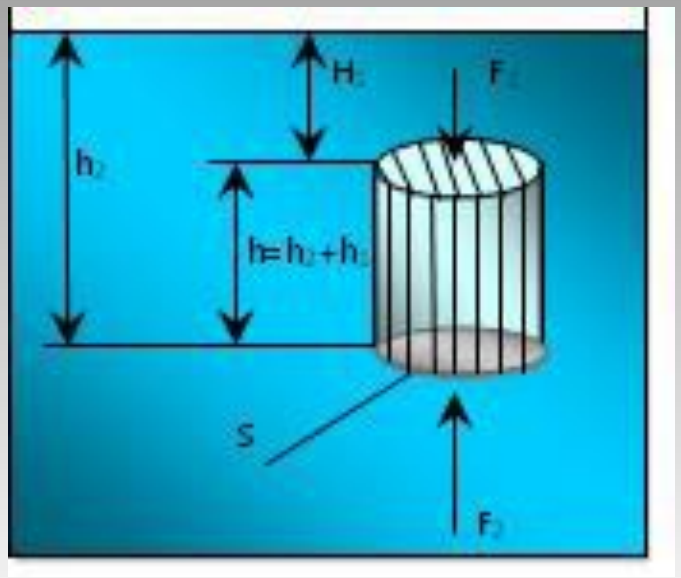
№7 лекция
Тұтас орталар механикасының элементтері



Лекция жоспары

1. *Тұтас орта ұғымы*
2. *Сұйықтар мен газдардың жалпы қасиеттері*
3. *Идеал және тұтқыр сұйық*
4. *Бернулли теңдеу*
5. *Сұйықтардың ламинарлық және турбуленттік ағыны.*
6. *Стокс формуласы.*
7. *Пуазель формуласы.*



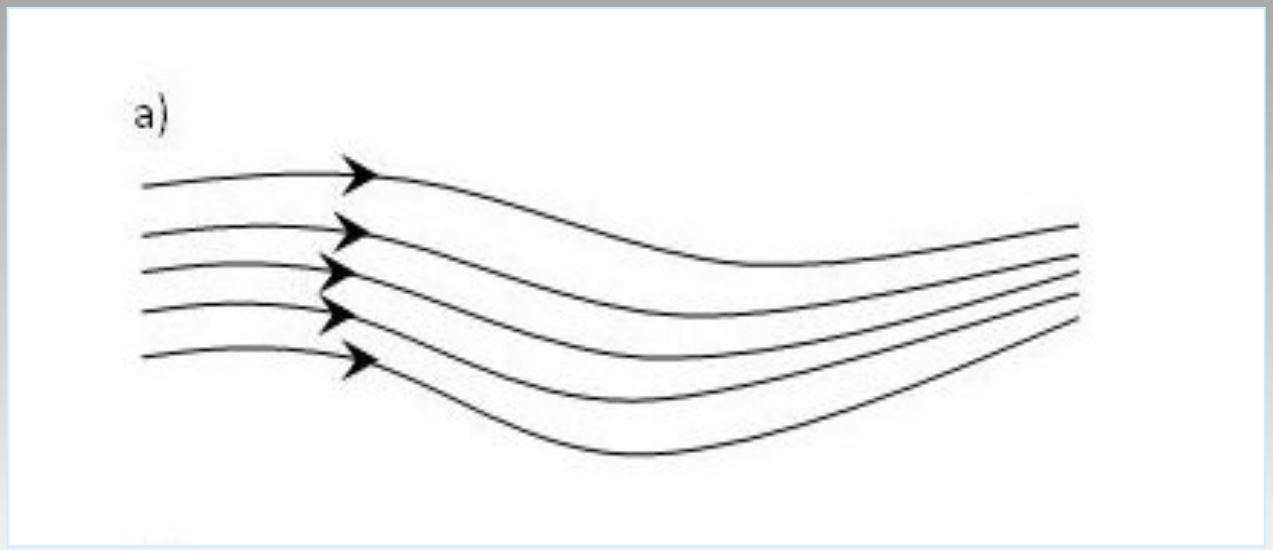
$$P = \frac{\Delta F}{\Delta S} \qquad P = \lim_{\Delta S \to 0} \frac{\Delta F}{\Delta S} = \frac{dF}{dS}$$

$$P = \frac{H}{м^2} = Па$$

$$P = \frac{P}{S} = \frac{\rho g S h}{S} = \rho g h$$ – гидростатикалық қысым

$$P = mg; \qquad m = \rho V = \rho g V = \rho g S h$$

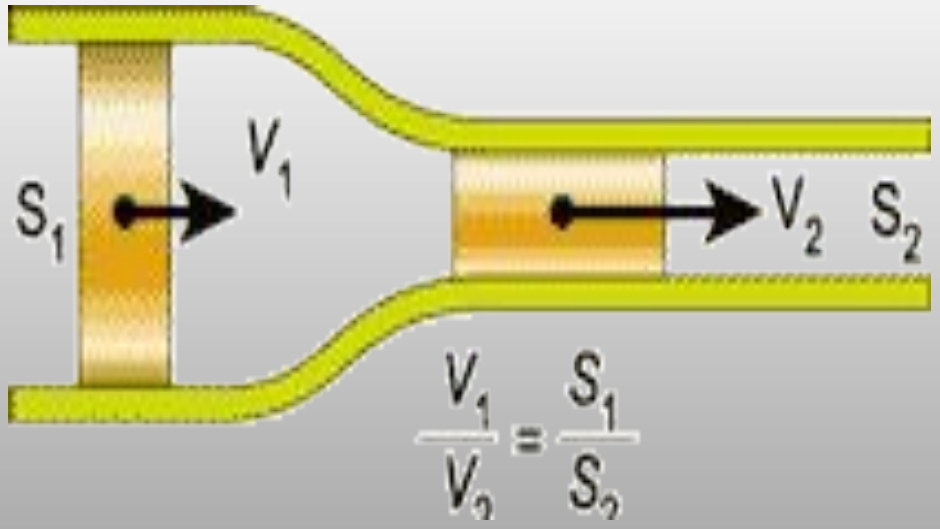
$$F_A = \rho g V$$ - Архимед күші



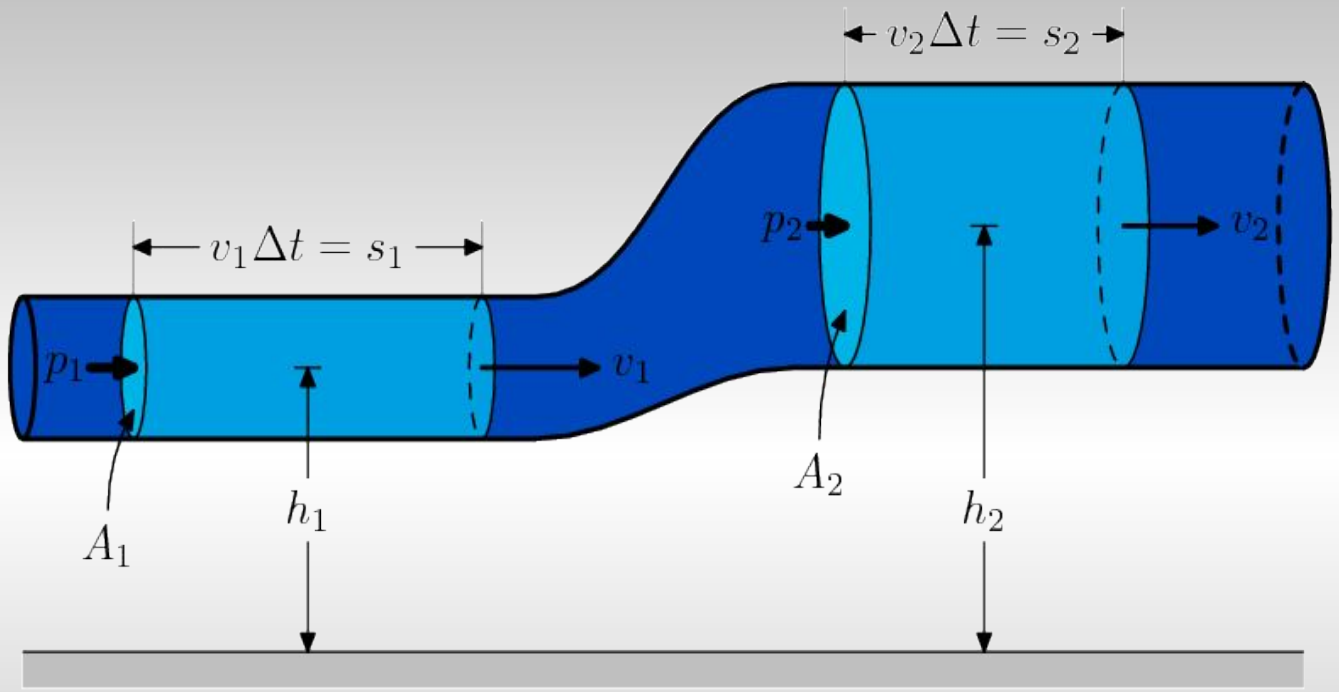
$$S_1 \upsilon_1 = S_2 \upsilon_2$$

$$S_1 \upsilon_1 = const$$

$$\frac{\upsilon_1}{\upsilon_2} = \frac{S_1}{S_2}$$



Бернулли теңдеу



$$A = F\Delta s = pS\Delta s$$

$$A = p_1 S_1 \Delta s_1 - p_2 S_2 \Delta s_2 = (p_1 - p_2)\Delta V$$

$$\Delta E = \left(mgh_2 + \frac{m\upsilon_2^2}{2} \right) - \left(mgh_1 + \frac{m\upsilon_1^2}{2} \right) \qquad m = \rho \Delta V$$

$$\Delta E = \left(\rho \Delta V g h_2 + \frac{\rho \Delta V \upsilon_2^2}{2} \right) - \left(\rho \Delta V g h_1 + \frac{\rho \Delta V \upsilon_1^2}{2} \right)$$

$$\Delta E = A$$

$$\left(\rho \Delta V g h_2 + \frac{\rho \Delta V \upsilon_2^2}{2} \right) - \left(\rho \Delta V g h_1 + \frac{\rho \Delta V \upsilon_1^2}{2} \right) = p_1 S_1 \upsilon_1 - p_2 S_2 \upsilon_2$$

$$\rho g h_1 + \frac{\rho \upsilon_1^2}{2} + P_1 = \rho g h_2 + \frac{\rho \upsilon_2^2}{2} + P_2$$

$$\rho gh + \frac{\rho \upsilon}{2} + P = const$$ -Бернулли теңдеу

Егер $h_1 = h_2$

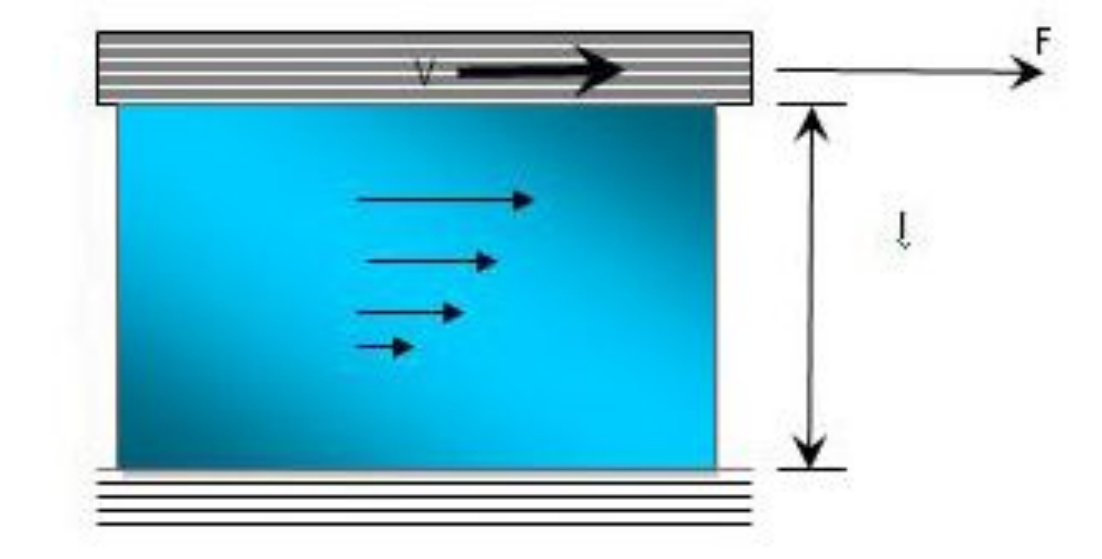
$$\frac{\rho \upsilon_1^2}{2} + P_1 = \frac{\rho \upsilon_2^2}{2} + P_2$$

Р – статикалық қысым

$\frac{\rho \upsilon^2}{2}$ – динамикалық қысым

$\upsilon = \sqrt{2gh}$ – Торичелли формуласы

Ішкі үйкеліс, тұтқырлық

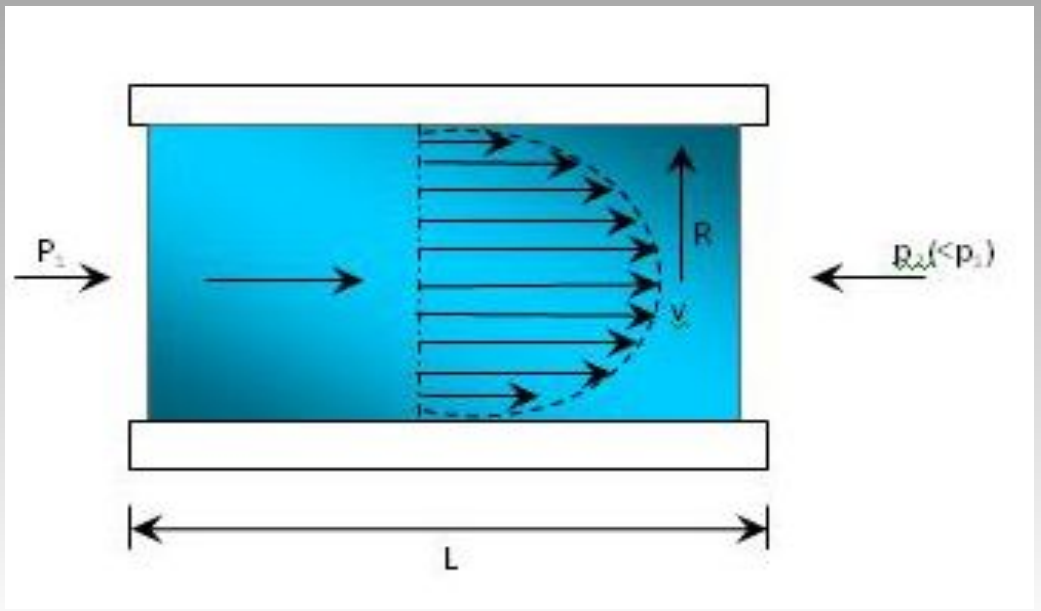


$$F = \eta \frac{d\upsilon}{dt} S$$

– Ньютон теңдеу

η - ішкі үйкеліс коэффициенті, динамикалық тұтқырлық

$\frac{d\upsilon}{dt}$ – жылдамдық градиенті



$$R_e = \frac{\rho \upsilon d}{\eta}$$

$R_e \le 1000$

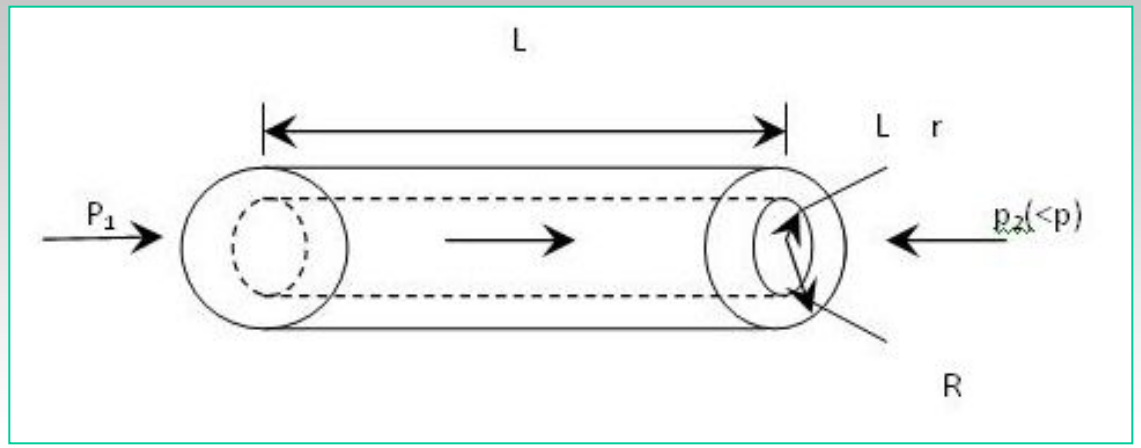
$1000 < R_e < 2000$

$R_e \le 2300$

$$\nu = \frac{\eta}{\rho}$$ – кинематикалық тұтқырлық

$$R_e = \frac{\upsilon d}{\nu}$$

Пуазель формуласы



$$PS = P\pi r^2$$

$$F = (P_1 - P_2)\pi r^2$$

$$F = \eta \left| \frac{d\upsilon}{dr} \right| 2\pi r\square = -\eta \frac{d\upsilon}{dr} 2\pi r\square$$

$$2\pi r\square$$

$$(P_1 - P_2)\pi r^2 = -\eta \frac{d\upsilon}{dr} 2\pi r\square$$

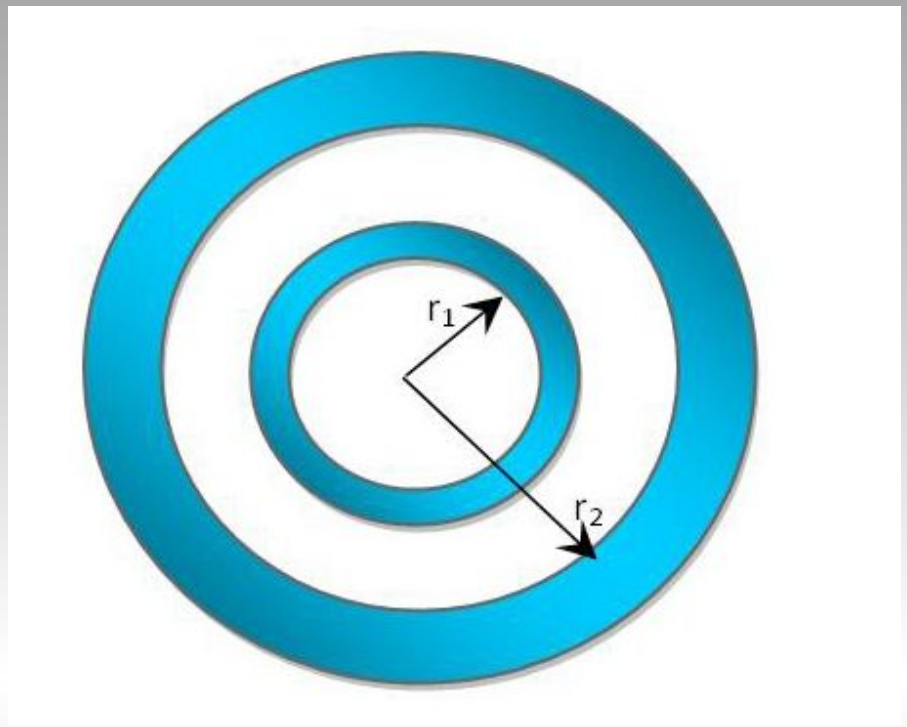
$$d\upsilon = -\frac{p_1 - p_2}{2\eta\square} r dr$$

$$\upsilon = -\frac{p_1 - p_2}{4\eta l} r^2 + C \qquad r = R, \upsilon = 0$$

$$C = \frac{P_1 - P_2}{4\eta l} R^2$$

$$\upsilon(r) = -\frac{p_1 - p_2}{4\eta l}(R^2 - r^2) = \frac{p_1 - p_2}{4\eta l} R^2 (1 - \frac{r^2}{R^2})$$

$$\upsilon_0 = \upsilon(0) - \frac{p_1 - p_2}{4\eta l} R^2 \qquad \upsilon(r) = \upsilon_0 \left(1 - \frac{r^2}{R^2} \right)$$



$$dQ$$

$$2\pi r dr$$

$$\upsilon(r)$$

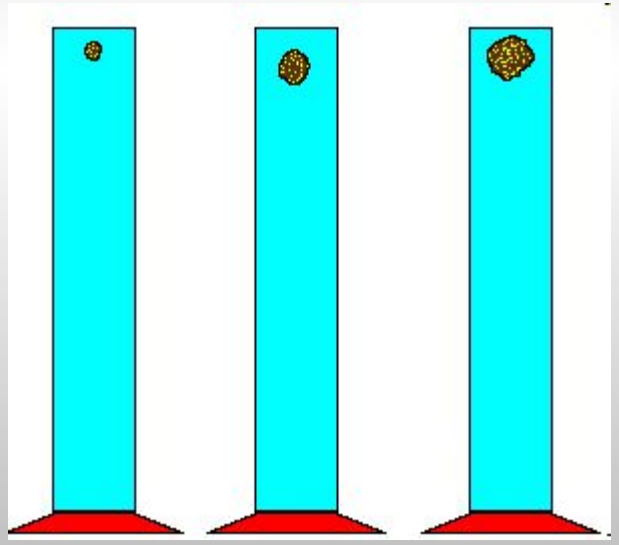
$$dQ = \upsilon_0 \left(1 - \frac{r^2}{R^2}\right) 2\pi r dr$$

$$Q = \int_0^R \upsilon_0 \left(1 - \frac{r^2}{R^2}\right) 2\pi r dr = \frac{1}{2}\pi R^2 \upsilon_0 = \frac{1}{2} S \upsilon_0$$

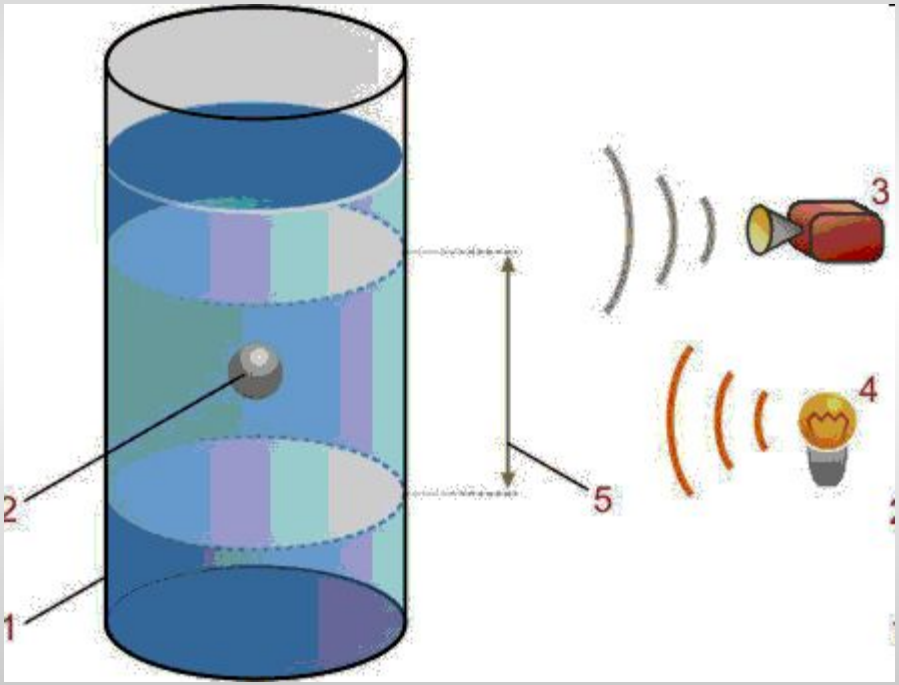
$$\upsilon_{op} = \frac{\upsilon_0}{2}$$

$$Q = \frac{(P_1 - P_2)}{8\eta} \pi R^4$$

– Пуазель формуласы



Стокс заңы



$$F = 6\eta\pi r\upsilon$$

– Стокс формуласы

Көңіл аударғандарыңызға рахмет!