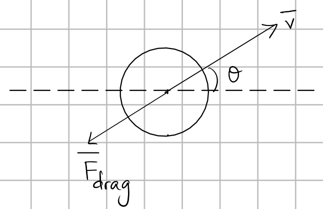
Q 5.)




$\Rightarrow \bar F_{drag} = m\bar a$ ; $\tan\theta = \frac{\dot y}{\dot x} \Rightarrow \sin\theta = \frac{\dot y}{(\dot x^2+\dot y^2)^{1/2}}$

$\cos = \frac{\dot x}{(\dot x^2+\dot y^2)^{1/2}}$

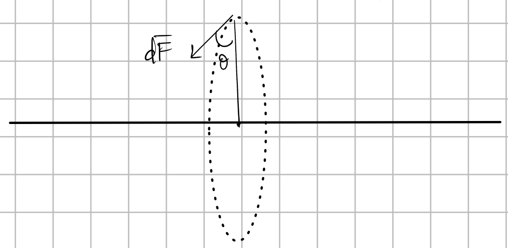
$$\Rightarrow \frac{d\bar v}{dt} = -\frac{\frac{1}{2}\pi R^2 \rho C v^2 \hat v}{m}$$

$$\Rightarrow \boxed{\begin{aligned} \ddot x &= -\frac{1}{2}\frac{\pi R^2 \rho}{m} C (\dot x^2+\dot y^2)^{1/2}\,\dot x \\ \ddot y &= -\frac{1}{2}\frac{\pi R^2 \rho}{m} C (\dot x^2+\dot y^2)^{1/2}\,\dot y \end{aligned}}$$

$\Rightarrow$ system will be ; $W_1 = x$ , $W_2 = y$ , $W_3 = \dot x$ , $W_4 = \dot y$

$$\Rightarrow \begin{aligned} \dot x &= W_3 \\ \dot y &= W_4 \\ \ddot x &= -\frac{1}{2}\frac{\pi R^2 \rho}{m} C (W_3^2+W_4^2)^{1/2}\, W_3 \\ \ddot y &= -\frac{1}{2}\frac{\pi R^2 \rho}{m} C (W_3^2+W_4^2)^{1/2}\, W_4 \end{aligned}$$

Q6.)




$$\bar F = \int d\bar F = -\hat r \int \frac{G m \cos\theta}{x^2+y^2+z^2}\, dM \qquad \cos\theta = \frac{\sqrt{x^2+y^2}}{\sqrt{x^2+y^2+z^2}}$$

only radial part contributes

$$\Rightarrow \bar F = -\frac{GMm}{L}\hat r \int_{-L/2}^{L/2} \frac{dz\,(x^2+y^2)^{1/2}}{(x^2+y^2+z^2)^{3/2}}$$

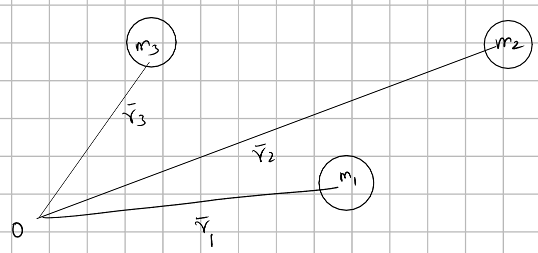
Solving

$$\therefore \bar F = -\frac{GMm}{(x^2+y^2)^{1/2}(x^2+y^2+L^2/4)^{1/4}}\hat r$$

As $\hat r = \frac{x}{r}\hat x + \frac{y}{r}\hat y$

$$\Rightarrow \ddot x = -\frac{GMx}{(x^2+y^2)(x^2+y^2+L^2/4)^{1/4}} \qquad \ddot y = -\frac{GMy}{(x^2+y^2)(x^2+y^2+L^2/4)^{1/4}}$$

Q12.




$$\bar F_1 = \frac{G m_1 m_2}{|\bar r_1 - \bar r_2|^3}(\bar r_1 - \bar r_2) + \frac{G m_1 m_3}{|\bar r_1 - \bar r_3|^3}(\bar r_1 - \bar r_3)$$

$$\bar F_2 = \frac{G m_2 m_3}{|\bar r_1 - \bar r_2|^3}(\bar r_2 - \bar r_1) + \frac{G m_2 m_3}{|\bar r_2 - \bar r_3|^3}(\bar r_2 - \bar r_3$$

$$\bar F_3 = \frac{G m_3 m_2}{|\bar r_3 - \bar r_2|^3}(\bar r_3 - \bar r_2) - \frac{G m_1 m_3}{|\bar r_1 - \bar r_3|^3}(\bar r_1 - \bar r_3)$$

System:

$$\frac{d\bar{r}_1}{dt} = \bar{v}_1 \qquad \frac{d\bar{v}_1}{dt} = \frac{G \quad m_2}{|\bar{r}_1 - \bar{r}_2|^3}(\bar{r}_1 - \bar{r}_2) + \frac{G \quad m_3}{|\bar{r}_1 - \bar{r}_3|^3}(\bar{r}_1 - \bar{r}_3)$$

$$\frac{d\bar{r}_2}{dt} = \bar{v}_2 \qquad \frac{d\bar{v}_2}{dt} = \frac{G \quad m_3}{|\bar{r}_1 - \bar{r}_2|^3}(\bar{r}_2 - \bar{r}_1) + \frac{G \quad m_3}{|\bar{r}_2 - \bar{r}_3|^3}(\bar{r}_2 - \bar{r}_3$$

$$\frac{d\bar{r}_3}{dt} = \bar{v}_3 \qquad \frac{d\bar{v}_3}{dt} = \frac{G \quad m_2}{|\bar{r}_3 - \bar{r}_2|^3}(\bar{r}_3 - \bar{r}_2) - \frac{G m_1}{|\bar{r}_1 - \bar{r}_3|^3}(\bar{r}_1 - \bar{r}_3)$$