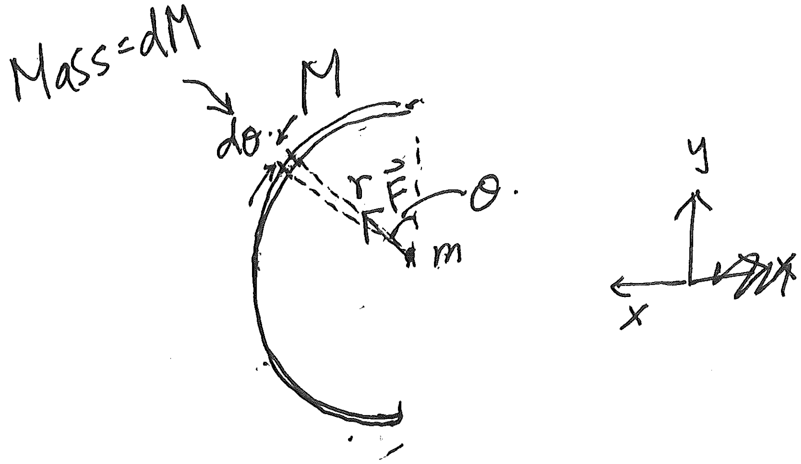


$dF = G\frac{m\,dM}{}$

$$dM = \frac{M}{\pi r} \cdot r\,d\theta$$

① $\vec{F}$ is a vector.

$$dF_x = G\frac{dM\,m}{r^2}\sin\theta \qquad \left(dF_y = \frac{dM\,m}{r^2}\cos\theta\right)$$

Kgm/s²

$$F_x = \int_0^\pi \cancel{dM}\, G\left(\frac{M}{\pi r}\cdot r\,d\theta\right)\frac{m}{r^2}\sin\theta$$

$$= \int_0^\pi G\frac{Mm}{\pi r^2}\sin\theta\,d\theta$$

$$= G\frac{Mm}{\pi r^2}\int_0^\pi \sin\theta\,d\theta$$

$$= G\frac{Mm}{\pi r^2}\left[-\cos\theta\right]_0^\pi$$

$$= G\frac{2Mm}{\pi r^2} \leftarrow \frac{Kg^2}{m^2}\ \text{(without G)}$$

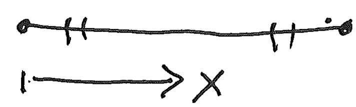
$$dF_x = G\frac{(dM)m}{r^2}\sin\theta.$$

$$\int dF_x = \int G\frac{m\,dM}{r^2}\sin\theta.$$

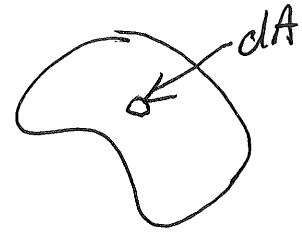
$$F_x = \sin\theta\, G\int \frac{m\,dM}{r^2}$$

Density.

1D density $\quad \lambda = \dfrac{dM}{dx}$



2D density $\quad \sigma = \dfrac{dM}{dA}$ ← Area.



3D density $\quad \rho = \dfrac{dM}{dV}$ ← Volume.

$$\lambda = \frac{M}{L} = \frac{M}{\cancel{2}\pi r} = \frac{dM}{dl}.$$

constant.

$$\frac{dM}{dl} = \frac{M}{\pi r}. \qquad l = r\theta \Rightarrow dl = r\,d\theta$$

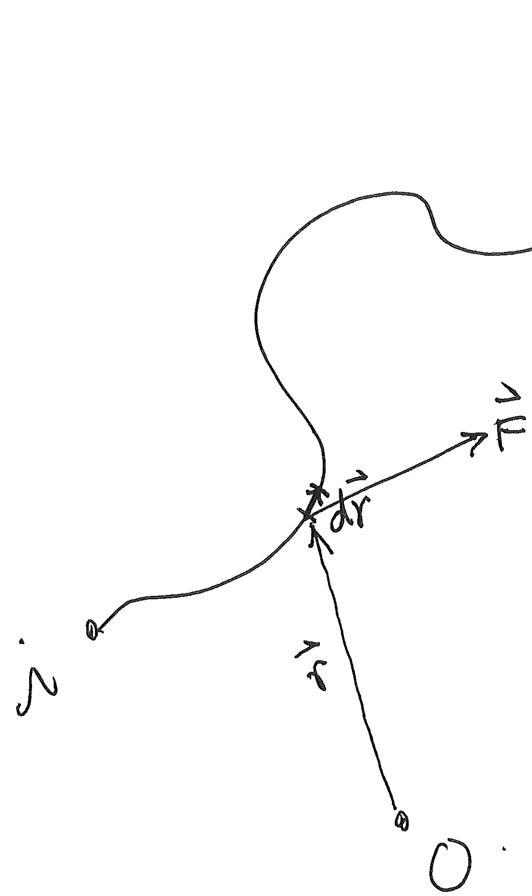
$$\therefore \frac{dM}{r\,d\theta} = \frac{M}{\pi r}.$$

$$\Rightarrow dM = \frac{M}{\pi r} \cdot r\,d\theta = \frac{M}{\pi} d\theta.$$

More complicated example:

$$\lambda = A\cos\theta.$$

$$\frac{dM}{dl} = A\cos\theta \Rightarrow dM = \underbrace{A r \cos\theta\, d\theta}_{(dl = r\,d\theta)}.$$



$$dW = \vec{F} \cdot d\vec{r}$$

$$W = \int_i^f \vec{F} \cdot d\vec{r}.$$

$\vec{F}$ is conservative if

$$\nabla \times \vec{F} = 0.$$

$$\nabla \times (\nabla V) = 0.$$

$$\nabla = \left(\frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}\right).$$

$$\nabla \times \vec{F} = 0 \Rightarrow \vec{F} = -\nabla V$$

$$\nabla \times \vec{F} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ F_x & F_y & F_z \end{vmatrix}.$$

$$\Delta KE = \text{Work done by force}$$

$$\Delta KE \underbrace{- \text{Work done by force}}_{\Delta PE} = 0 .$$

$$\Delta KE + \Delta PE = 0$$

$$\therefore \Delta PE = -\text{Work done by}$$

(Conservative) force