PHY 321 FEBRUARY 16, 2022

Earth–Sun: Forces on earth

$$\vec{F}_i^{net} = \underbrace{\vec{F}_i^{ext}}_{=0} + \sum_{j \neq i}^{N} \vec{F}_{ij}$$

$$= -\frac{G M_\odot M_E}{|\vec{r}_\odot - \vec{r}_E|^3} (\vec{r}_\odot - \vec{r}_E)$$

$$\vec{r} = \vec{r}_\odot - \vec{r}_E$$

$$M_\odot = 2.0 \times 10^{30}\,kg$$

$$M_E = 6. \times 10^{24}\,kg$$

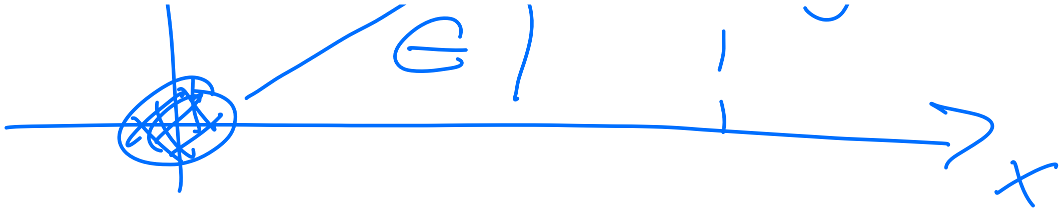
$$|\vec{r}| = 1\,AU = 1.5 \cdot 10^{11}\,m$$

2-DIM

$$|\vec{r}| = \sqrt{x^2 + y^2} = r$$

$x = r\cos\theta$

$y = r\sin\theta$



$$F_x = \vec{F} \cdot \cos\theta$$

$$F_y = \vec{F} \cdot \sin\theta$$

$$a_x = \frac{d^2x}{dt^2} = \frac{F_x}{M_E}$$

$$= -\frac{G \cdot M_\odot \, x}{r^3}$$

$$\boxed{a_x = \frac{dv_x}{dt}} \qquad \boxed{v_x = \frac{dx}{dt}}$$

$$\boxed{a_y = \frac{F_y}{M_E} = -\frac{G M_\odot y}{\left(\sqrt{x^2+y^2}\right)^3} = \frac{dv_y}{dt}}$$

$$\boxed{v_y = \frac{dy}{dt}}$$

scale away $G M_\odot$

assume circular motion

centrifugal Force

$$\frac{\cancel{M_E} v^2}{r} = F = \frac{G M_\odot \cancel{M_E}}{r^2}$$

$$G \cdot M_\odot = v^2 r \qquad r = 1 AU$$

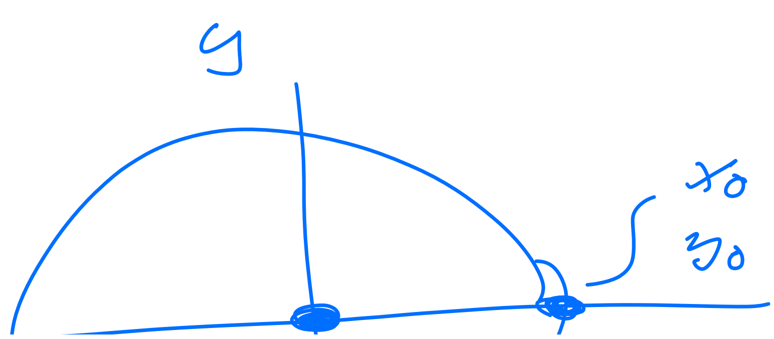
$$v = 2 \cdot \pi \cdot r / 1 yr$$

$$= 2\pi \; 1 AU / 1 yr$$

$$G M_\odot = 4\pi^2 (1 AU)^3 / (1 yr)^2$$

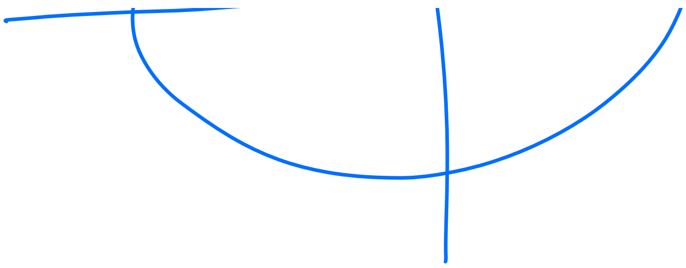
$$a_x = \frac{d v_x}{dt} = -4\pi^2 \frac{x}{r^3}$$

$$a_y = \frac{d v_y}{dt} = -4\pi^2 \frac{y}{r^3}$$



$x_0 = 1 AU$

$y_0 = 0 AU$



x

$v_{0x} = 0$

$v_{0y} = 2\pi$