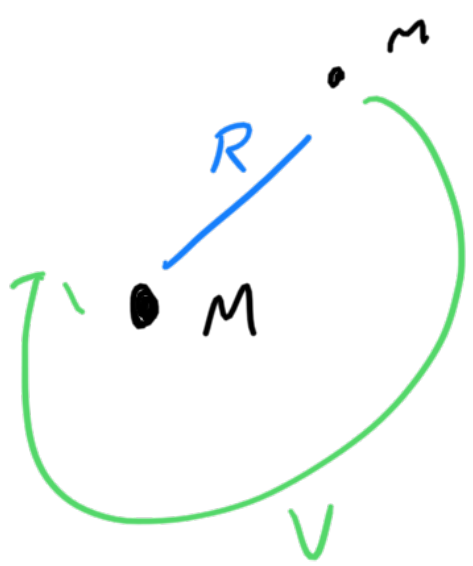


$$a_{cent} = v^2/R$$

$$= a_{grav} = GM/R^2$$

$R \Rightarrow$ $v = \sqrt{GM/R}$

$$T = \frac{C}{v} = \frac{2\pi R}{v} = \boxed{2\pi\sqrt{R^3/GM} = T}$$

Orbits are stable $F \propto R^{-2}$ $F = q R^{-2}$

$$q R^{-2} = F = mv^2/R \Rightarrow v = \sqrt{q/mR} \qquad q = GMm$$

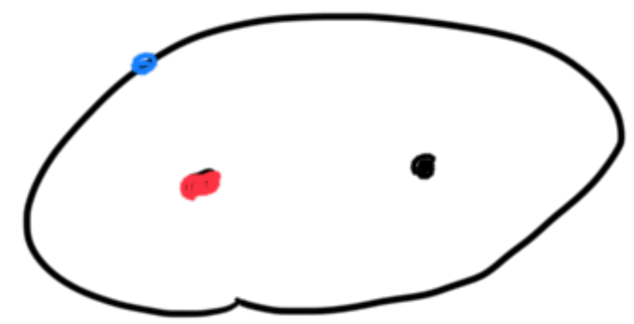
$$v = \sqrt{GM/R}$$

A

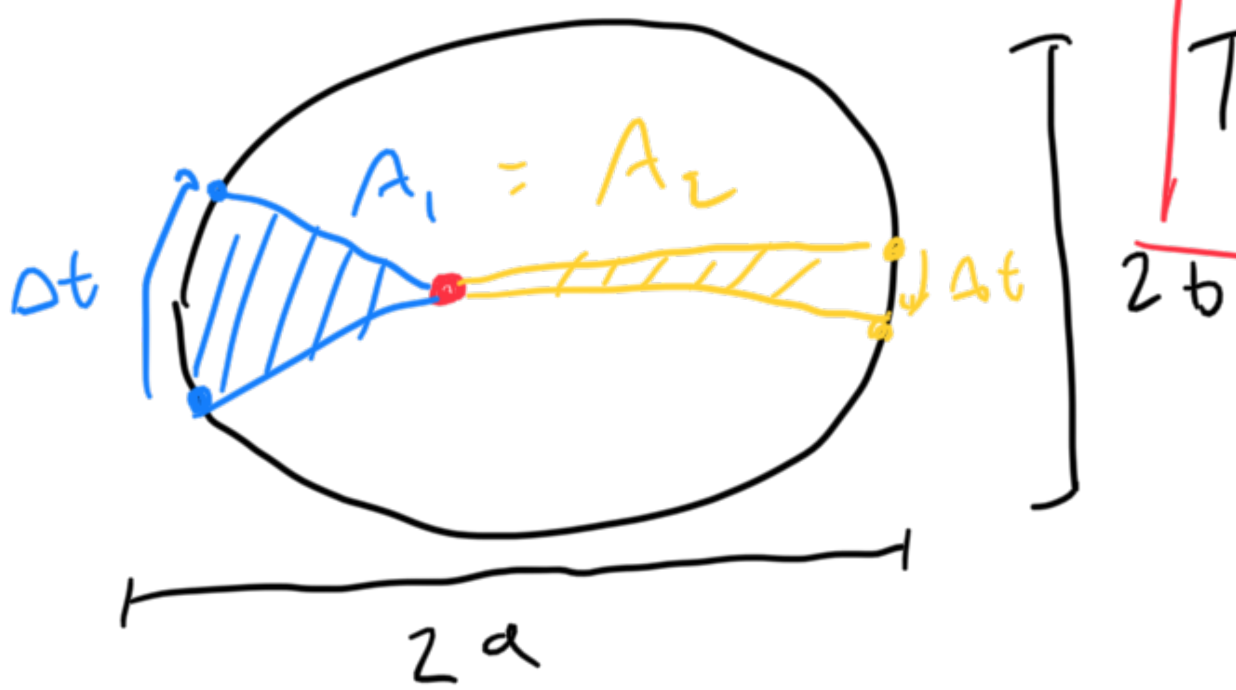
Kepler's Laws.

I. all bound orbits are elliptical

orbited bodies at a focus



II.



$$\boxed{T \cdot \frac{R^2}{2}\frac{d\theta}{dt} = \pi a b}$$

III. $T^2 \propto R^3$

Ellipse → HW

V:

$0 \to \sqrt{GM/R}$ elliptical R = apogee (max. dist)

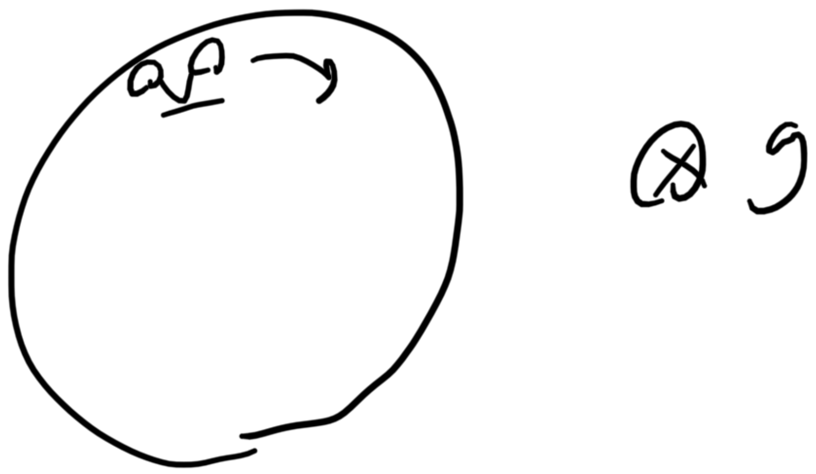
$\sqrt{GM/R}$ circular

$\sqrt{GM/R} \to \sqrt{2GM/R}$ elliptical R = perigree (min. dist)

$\sqrt{2GM/R}$ parabolic (escape speed)

$\sqrt{2GM/R} \to$ "∞" hyperbolic

2017 #1



μ

$$N = \frac{mv^2}{r}$$

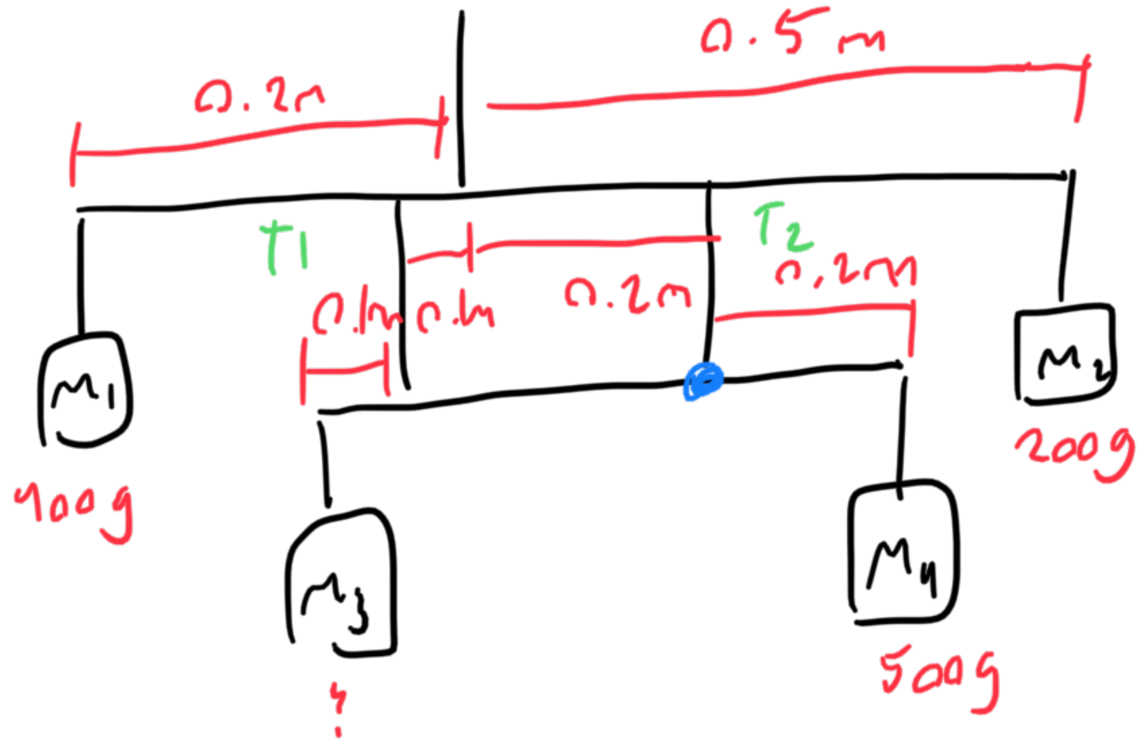
$$F_f = \mu N \geq mg$$

$$\mu \frac{\cancel{m}v^2}{r} \geq \cancel{m}g$$

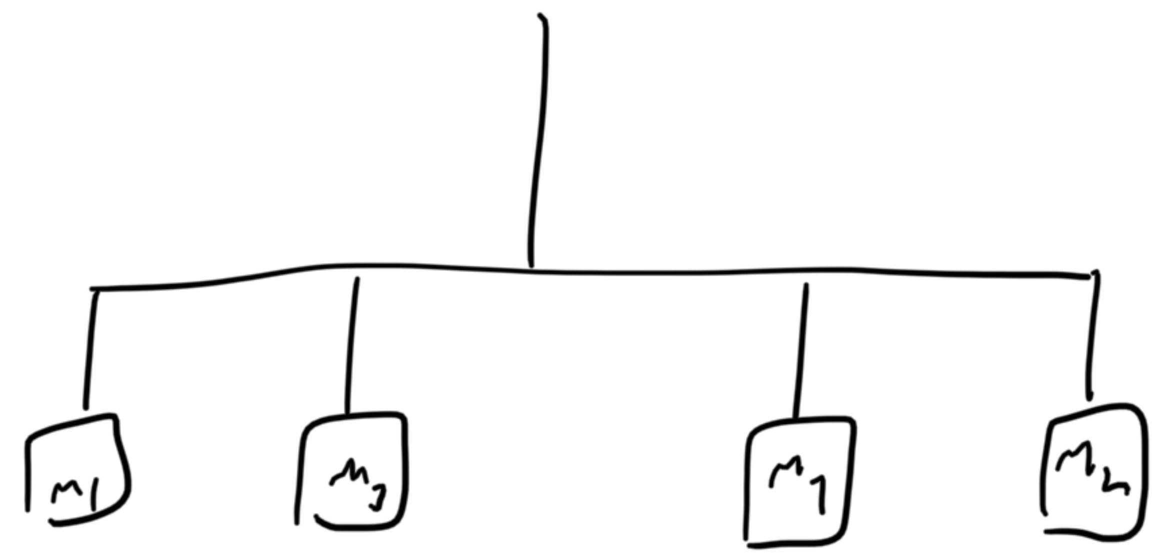
$$\mu \propto v^{-2}$$

$$\mu \propto s^{-2}$$

#6



=

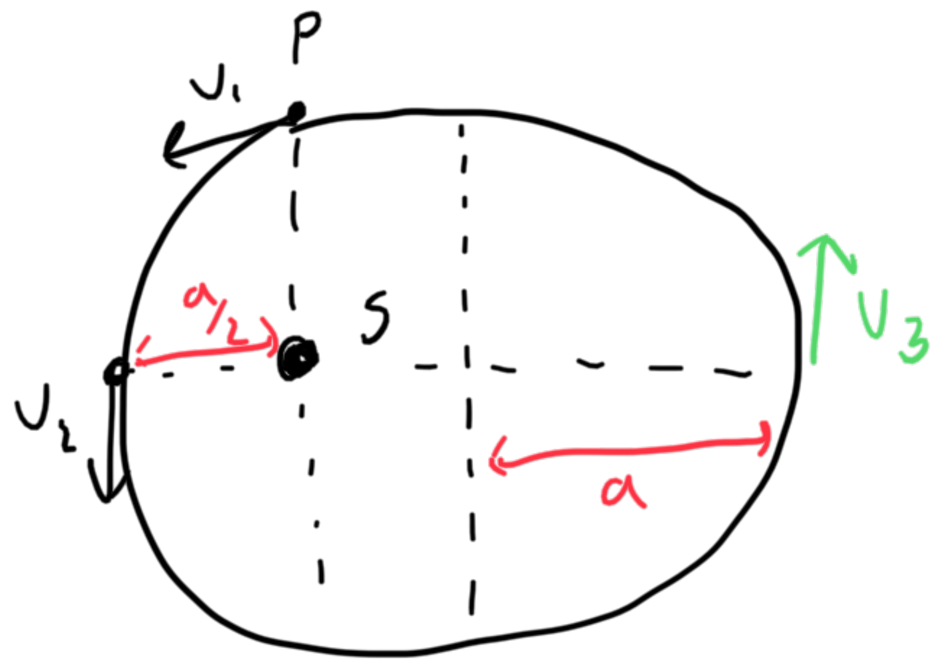


$$(0.4)m_1 g + (0.1)T_1 - (0.2)T_2 - (0.5)m_2 g = 0$$

$$+\left((0.2)m_3 g - (0.1)T_1 + (0.2)T_2 - (0.4)m_4 g = 0\right)$$

$$(0.4)m_1 g + (0.2)m_3 g - (0.5)m_2 g - (0.4)m_4 g = 0$$

#25



given v_1, $v_2 = ?$

$\boxed{\text{vis-viva}}$

$$SP + \sqrt{SP^2 + a^2} = 2a$$

$$SP = 3a/4$$

$$\frac{1}{2} m v_2^2 - \frac{GMm}{a/2} = \frac{1}{2} m v_3^2 - \frac{GMm}{3a/2}$$

$$\frac{m v_2 a}{2} = \frac{3 m v_3 a}{2} \Rightarrow v_3 = v_2/3$$

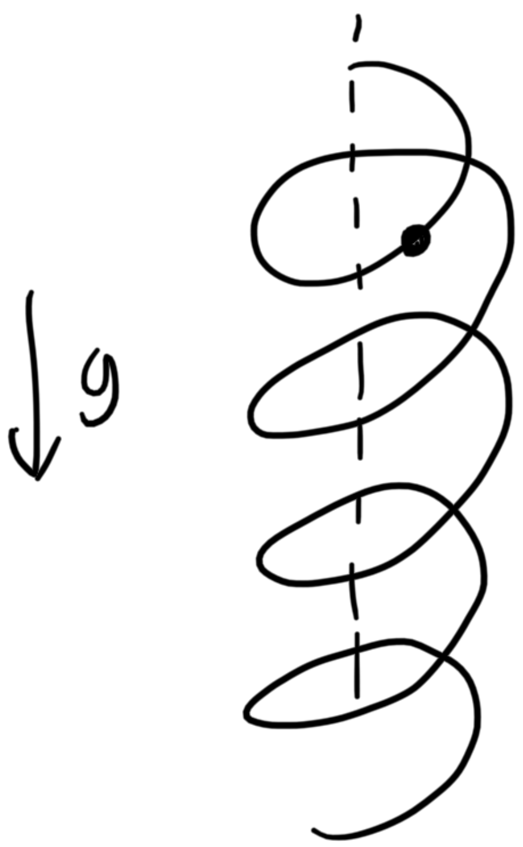
$$\frac{4}{9} m v_2^2 = \frac{GMm}{a/2} - \frac{GMm}{3a/2} = \frac{4GMm}{3a} \Rightarrow v_2^2 = \frac{3GM}{a}$$

$$\frac{1}{2} m v_2^2 - \frac{GMm}{a/2} = \frac{1}{2} m v_1^2 - \frac{GMm}{3a/4}$$

$$v_1^2 = v_2^2 - \frac{4GM}{a} + \frac{8GM}{3a} = GM\left(\frac{3}{a} - \frac{4}{a} + \frac{8}{3a}\right) = \frac{5GM}{3a}$$

$$\frac{v_2^2}{v_1^2} = \frac{9}{5} \Rightarrow v_2 = \frac{3}{\sqrt{5}} v_1$$

2016 # 4



α

$$a_v = g \sin^2 \alpha$$

$$a_h = g \sin\alpha \cos\alpha$$

$$a_h = a_c = \frac{v_h^2}{r} = \frac{(a_h t)^2}{r} = \frac{(g t \sin\alpha \cos\alpha)^2}{r}$$

$$a \propto \sqrt{c_1 + c_2 t^4}$$

#8

I, III depend on R^{-2}

II just conservation of L.

#9

$$mgh = \frac{1}{2}mv^2$$

$$h = R(1-\cos\theta)$$

$$mg\cos\theta \geq \frac{mv^2}{R}$$

$$\cos\theta = v^2/gR \Rightarrow v = \sqrt{\frac{2gR}{3}} = \sqrt{\frac{gD}{3}}$$

$$\theta = 48.2^\circ$$