

Determine the distance the moon is from earth, given:

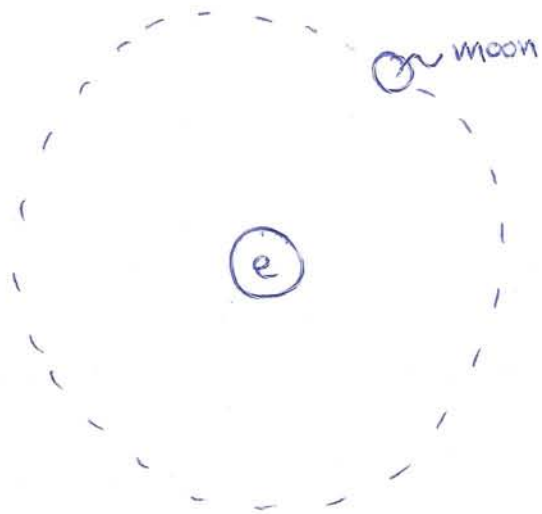
$$m_{\text{earth}} = 5.97 \times 10^{24} \text{ kg}$$

$$m_{\text{moon}} = 7.35 \times 10^{22} \text{ kg}$$

$$G = 6.67 \times 10^{-11} \text{ m}^3/(\text{kg s}^2)$$

$$R_{\text{earth}} = 6371 \text{ km}$$

$$T_{\text{moon}} = 27.3 \text{ days}$$



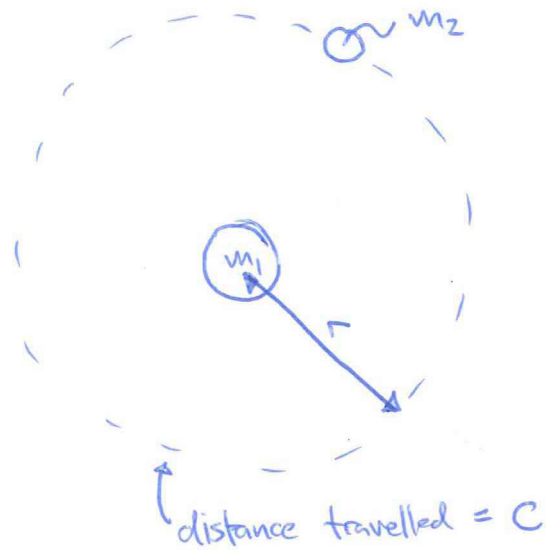
Determine the angular velocity and period of m_2 , given:

$$G = 6.67 \times 10^{-11} \text{ m}^3/(\text{kg s}^2)$$

m_1

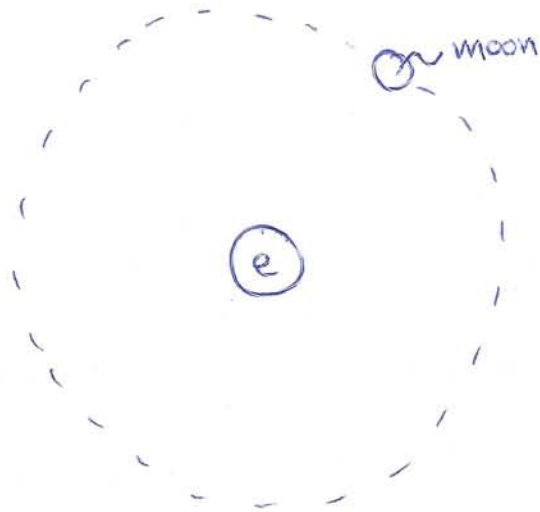
m_2

r

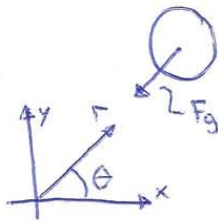


Determine the distance the moon is from earth, given:

$$\begin{aligned} m_{\text{earth}} &= 5.97 \times 10^{24} \text{ kg} \\ m_{\text{moon}} &= 7.35 \times 10^{22} \text{ kg} \\ G &= 6.67 \times 10^{-11} \text{ m}^3/(\text{kg s}^2) \\ R_{\text{earth}} &= 6371 \text{ km} \\ T_{\text{moon}} &= 27.3 \text{ days} \end{aligned}$$



FBD on the moon:



$$\begin{aligned} \sum F_r &= m_a r = -F_g \\ m \left(-\frac{v^2}{r} \right) &= -\frac{G m_e m_m}{r^2} \\ m v^2 r &= G m_e m_m \quad (1) \end{aligned}$$

Moon travels $C = 2\pi r$ in 27.3 days = 2358720 sec. so the

$$\text{Velocity} = \frac{C}{T} = \frac{2\pi r}{2358720} = v \quad (2)$$

Sub eqn. (2) into (1)

$$\left(\frac{2\pi r}{2358720} \right)^2 r = G m_e \quad \Rightarrow \quad r = \sqrt[3]{\frac{(2358720)^2 G m_e}{4\pi^2}} = 382852131 \text{ m}$$

$$r_{\text{surface}} = 382851 - 6371 = 376000 \text{ km}$$

Determine the angular velocity and period of m_2 , given:

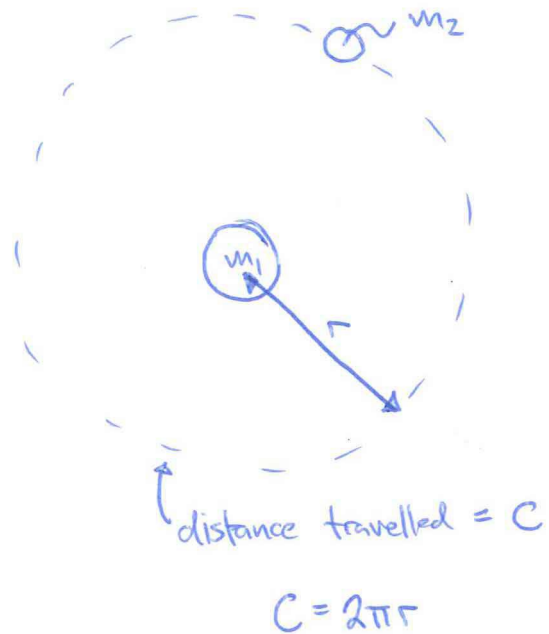
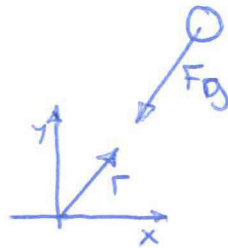
$$G = 6.67 \times 10^{-11} \text{ m}^3/(\text{kg s}^2)$$

m_1

m_2

r

FBD m_2 :



Newton's 2nd Law

$$\sum F_r = m_2(-\omega^2 r) = -\frac{Gm_1 m_2}{r^2}$$

$$\omega^2 r = \frac{Gm_1}{r^2}$$

$$\boxed{\omega = \sqrt{\frac{Gm_1}{r^3}}}$$

Determine period given ω :

$$\omega [\text{rad/sec}]$$

$$T = \frac{1}{\omega} \left[\frac{\text{sec}}{\text{rad}} \right] \left[\frac{2\pi \text{ rad}}{\text{cycle}} \right]$$

$$\boxed{T = \frac{2\pi}{\omega}}$$

Orbit Calculations

Constants

G $6.67\text{E-}11 \text{ m}^3/(\text{kg s}^2)$

	moon to earth	ISS to earth	geosynchronous to earth	earth to sun
m_1	5.97E+24 kg	5.97E+24 kg	5.97E+24 kg	1.99E+30 kg
radius	3.83E+08 m	7000000 m	42164000 m	1.50E+11 m
omega =	0.000 rads/sec	0.001 rads/sec	0.000 rads/sec	0.000 rads/sec
velocity =	1020 m/s	7542 m/s	3073 m/s	29779 m/s
period =	2358710 sec/cycle	5831 sec/cycle	86207 sec/cycle	31564357 sec/cycle
	27.3 days/cycle	0.067 days/cycle	0.998 days/cycle	365.3 days/cycle
omega =		14.8 cycles/day	1.0 cycles/day	