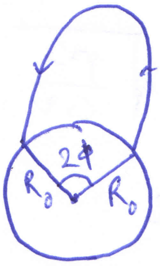
(1)



Distance $= R_0 \times 2\phi = 2R_0\phi$ $[\because s = r\theta]$

(2) Angular momentum.

(3) $F \propto \frac{1}{r^3} \Rightarrow F = -\frac{GMm}{r^3}$

$\therefore V = -\int \vec{F}\cdot d\vec{r} = GMm \int_{\infty}^{R} \frac{dr}{r^3} = GMm \cdot \frac{r^{-3+1}}{-3+1} = -\frac{GMm}{2R^2}$

$\therefore \frac{1}{2} m v_e^2 = \frac{GMm}{2R^2} = \frac{GMR}{R^3}$

$\Rightarrow \boxed{v_e = \sqrt{gR}}$

Again,

$\frac{GMm}{R^3} = mg$

$\Rightarrow g = \frac{GM}{R^3}$

(4) $\epsilon = \frac{v_{max} - v_{min}}{v_{max} + v_{min}} = \frac{v_p - v_a}{v_p + v_a} \Rightarrow \frac{1-\epsilon}{1+\epsilon} = \frac{2v_a}{2v_p}$

$\Rightarrow \frac{0.5}{1.5} = \frac{v_a}{v} \Rightarrow \boxed{v_a = v/3}$

(5) $\epsilon = \frac{v_{max} - v_{min}}{v_{max} + v_{min}} = \frac{30 - 29.2}{30 + 29.2} = \frac{0.8}{59.2} = 0.013$

(6) We know,

$v = \omega r \Rightarrow v = \frac{2\pi}{T} r \Rightarrow T = \frac{2\pi}{v} r$

$\Rightarrow 2r = \frac{vT}{\pi} = \frac{220 \times 10^3 \times 14.4 \times 24 \times 3600}{3.14} = 8.7 \times 10^{10}\, m$

(7) For elliptic orbit,

$v = \sqrt{GM\left(\frac{2}{r} - \frac{1}{a}\right)}$

$r_{max} + r_{min} = 2a$

$\therefore v_{max} = \sqrt{GM\left(\frac{2}{r_{min}} - \frac{1}{a}\right)}$

$= \sqrt{GM\left(\frac{2a - r_{min}}{a r_{min}}\right)}$

$= \sqrt{\frac{GM r_{max}}{a r_{min}}}$

Similarly, $v_{min} = \sqrt{\frac{GM r_{min}}{a r_{max}}}$

We know, $T = 2\pi \sqrt{\frac{a^3}{GM}}$

$\therefore v_{max} \cdot v_{min} = \frac{GM}{a} = \left(\frac{2\pi a}{T}\right)^2$

$\Rightarrow \boxed{a = \frac{T}{2\pi}\sqrt{v_{max} \cdot v_{min}}}$

(8) We know, from Kepler's law, $T = 2\pi\sqrt{\frac{r^3}{GM}}$

Here, $r = a + c + b = a + b + c$

$\therefore T^2 = \frac{4\pi^2}{GM}(a+b+c)^3$

$\Rightarrow \boxed{M = \frac{4\pi^2(a+b+c)^3}{GT^2}}$

(9) For an elliptic orbit, $v = \sqrt{GM\left(\frac{2}{r} - \frac{1}{a}\right)}$

$r = R = 6400 \text{ km} = 6400 \times 10^3 \text{ m}$

~~[illegible]~~

$2a = 80{,}000 \text{ km}$, $M = 6 \times 10^{24} \text{ kg}$

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

$\therefore v = \sqrt{(6.67 \times 10^{-11}) \times (6 \times 10^{24})\left(\frac{2}{6400 \times 10^3} - \frac{1}{40000 \times 10^3}\right)} \text{ m/s}$

~~$\simeq 10{,}957$ m/s~~ $\approx$ 10 km/s

$\simeq 10{,}726$ m/s

(10) Angular momentum Conservation, $L_p = L_a$

$m V_p r_p = m V_a r_a$

$\Rightarrow V_a r_a = V_p r_p = 10.25 \times 6570 = 67342.5 \text{ kg-m}^2/\text{sec}$