$\boxed{\omega^2 R_e = 0.03}$

1

Gravitation

$\boxed{g_1 h_1 = g_2 h_2}$

$\boxed{g \propto \frac{1}{h}}$

1. $\boxed{F = \frac{G m_1 m_2}{r^2}}$

2. acc^n. due to gravity. $\boxed{g = \frac{G M_e}{R_e^2}}$ $= \frac{4}{3}\pi$

$\boxed{G M_e = g R_e^2}$ $\Rightarrow$ $\boxed{8 \text{ km} \times R_e}$

3. variation of 'g'.

① height.

$$\boxed{g' = \frac{G M_e}{(R_e+h)^2} \quad \text{or} \quad \frac{g R_e^2}{(R_e+h)^2}}$$

when, $h << R_e$

$$\boxed{g' = g\left(1 - \frac{2h}{R_e}\right)}$$

$h >> R_e$

$$\boxed{g' = \frac{g}{\left(1+\frac{h}{R_e}\right)^2}}$$

2) depth $\boxed{g' = g\left(1 - \frac{d}{R_e}\right)}$ for all cases

3) rotation of earth

$$\boxed{g' = g - \underset{0.03}{\omega^2 R_e} \cos^2\theta}$$

'θ' from equator.

4. orbital vel.

$$\boxed{V_o = \sqrt{\frac{G M_e}{(R_e+h)}}}$$

Me / or anything but not mass of any satellite (e.g. moon)

or close to earth surface $\Rightarrow$ $V_o = \sqrt{\frac{G M_e}{R_e}}$ $\Rightarrow$ 8 km $\sqrt{g R_e}$

gR_e

5. kinetic, potential & m. Energy

$\boxed{K = \frac{G M_e m}{2r}}$ $\boxed{U = -\frac{G M_e m}{r}}$ $\boxed{E = -\frac{G M_e m}{2r}}$

$$\boxed{K = |E| = \frac{|U|}{2}}$$

6. work done in moving object from one orbit to other.

$$W_{ag} = + \frac{G M_e m}{2} \left[\frac{1}{r_1} - \frac{1}{r_2}\right]$$

7. work done in moving object from surface to height 'h' above surface.

$$\boxed{W_{ag} = mgh \times \frac{R}{(R+h)}}$$

when $h >> R_e$

$$\frac{mgh}{(1+h/R)}$$

8. w.d. in moving object from surface to circular orbit

$$\boxed{W_{ag} = E_2 - E_1 = E_2 - U_1}$$

(2)

$\boxed{g_e \propto R_e \rho}$

$\boxed{V_e \propto R_e\sqrt{\rho}}$ → mean density

$$T = 2\pi\sqrt{\frac{r^3}{GM}}$$

(a) escape vel :

$$\boxed{V_e = \sqrt{\frac{2GM_e}{R_e}}}$$

$\boxed{V_e = \sqrt{2}\, V_o}$

$8\sqrt{2} = 11.2$ km/sec

a) Escape vel. given to an object located at ht 'h'.

$$\boxed{V_e = \sqrt{\frac{2GM_e}{(R_e+h)}}}$$

b) escape vel. for orbiting body.

$$\boxed{V_e = \sqrt{\frac{GM_e}{R_e+h}}}$$

(c) escape vel. from surface to earth

$$V_e = \sqrt{\frac{2GM_e}{R_e}} = \sqrt{2gR_e}$$

modification

$$\boxed{V_e = \sqrt{\frac{2GM_e}{r}}}$$

a) $V_{given} > V_{escape}$

$$V = \left(\sqrt{n^2-1}\right).V_e$$

vel at interstellar space.

$\left(n = \frac{V_{given}}{V_{escape}}\right)$

b) $V_{given} < V_{escape}$

$$\boxed{h = \frac{n^2 R_e}{(1-n^2)}}$$

from surface of earth

Planetary motion

① $L_{apogee} = L_{perigee}$ (angular momentum is conserved)

$$\boxed{m V_a r_a = m V_p r_p}$$

$$\frac{V_a}{V_p} = \frac{r_p}{r_a} \Rightarrow \frac{V_{min}}{V_{max}} = \frac{r_p}{r_a} \Rightarrow \frac{a(1-e)}{a(1+e)} \Rightarrow \frac{(1-e)}{(1+e)}$$

② mechanical energy in elliptical orbit.

$$\boxed{E = \frac{-GM_s M_p}{2a}}$$

(a = semimajor axis)

③ Speed at any point

$$\boxed{V_{max} = \sqrt{GM_s\left(\frac{2}{r_{min}} - \frac{1}{a}\right)}}$$

Kepler's law

① $\boxed{\frac{\Delta A}{\Delta t} = \frac{L}{2m} = \text{const}}$ m = mass of planet.

② Time pd for elliptical orbit

$$T^2 = \left(\frac{4\pi^2}{GM_s}\right) a^3$$

a semimajor axis

T. pd for circular orbit

$$T^2 = \left(\frac{4\pi^2}{GM_e}\right) r^3$$

③ V_o of Geostationary orbit ⇒ 3.1 km/sec ($h = 6R_e$)

④ $\vec{I} = \frac{\vec{F}}{m}$ | $\vec{E} = \vec{F}/q$

⑤ $\vec{I} = GM/r^2$ | $\vec{E} = kQ/r^2$

⑥ $I = -dV/dr$ | $E = -dV/dr$

2nd kepler's law

$$\boxed{\frac{dA}{dt} = \frac{L}{2m}}$$

L → angular momentum ($I\omega$)

L = angular momentum

earth
← potential graphs are totally inverted from E, potential.

shape of the orbit of a satellite

① $V < V_o$ → spiral path

$V = V_o$ → circular path

$V > V_o$ → elliptical path

~~$V = V_e$~~

$V = V_e$ ⇒ Parabolic path

$V > V_e$ ⇒ hyperbolic path