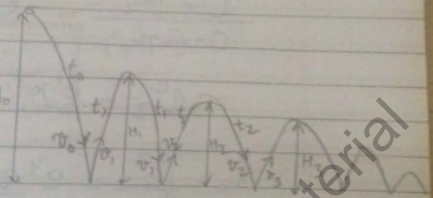
* Bouncing of a Ball on ground:

$v_0 = \sqrt{2gh_0}$

$h_0 = \frac{v_0^2}{2g}$

$t_0 = \sqrt{\frac{2h_0}{g}} = \frac{v_0}{g}$



After 1st impact,

$\frac{v_2 - v_1}{u_2 - u_1} = -e$

$\frac{0 - v_1}{0 - (-v_0)} = -e$

$[v_1 = ev_0 = e\sqrt{2gh_0}]$

$h_1 = \frac{v_1^2}{2g}$

$[h_1 = e^2 \frac{v_0^2}{2g} = e^2 h_0]$

$t_1 = \frac{v_1}{g} = \frac{ev_0}{g} = et_0 = e\sqrt{\frac{2h_0}{g}}$

After 2nd Impact,

$\frac{v_2 - v_1}{u_2 - u_1} = -e$

~~$v_2 - v$~~

$$\frac{0 - v_2}{0 - (-v_1)} = -e$$

$$v_2 = ev_1 = e^2 v_0 = e^2\sqrt{2gh_0}$$

$$h_2 = \frac{v_2^2}{2g} = e^4 \frac{v_0^2}{2g} = e^4 h_0$$

$$t_2 = \frac{v_2}{g} = \frac{e^2 v_0}{g} = e^2 t_0 = e^2\sqrt{\frac{2h_0}{g}}$$

After n^{th} impact,

$$\boxed{v_n = e^n v_0 = e^n\sqrt{2gh_0}}$$

$$\boxed{h_n = e^{2n} h_0}$$

$$\boxed{t_n = e^n t_0 = e^n\sqrt{\frac{2h_0}{g}}}$$ (Time of ascent or descent)

- Total distance travelled:

$$= h_0 + 2h_1 + 2h_2 + 2h_3 + \dots \infty$$
$$= h_0 + 2e^2 h_0 + 2e^4 h_0 + \dots \infty$$
$$= h_0 + 2e^2 h_0 (1 + e^2 + e^4 + \dots \infty)$$
$$= h_0 + 2e^2 h_0 \left[\frac{1}{1 - e^2}\right]$$
$$= h_0 \left[1 + \frac{2e^2}{1 - e^2}\right]$$

$$= h_0\left[\frac{1-e^2+2e^2}{1-e^2}\right]$$

$$\boxed{S = h_0\left(\frac{1+e^2}{1-e^2}\right)}$$

- **Total Time of Flight →**

$$T = t_0 + 2t_1 + 2t_2 + \cdots \infty$$
$$= t_0 + 2et_0 + 2e^2t_0 + 2e^3t_0 + \cdots \infty$$
$$= t_0 + 2et_0(1+e+e^2+\cdots\infty)$$
$$= t_0 + 2et_0\left[\frac{1}{1-e}\right]$$
$$= t_0\left[1+\frac{2e}{1-e}\right]$$
$$= t_0\left(\frac{1-e+2e}{1-e}\right)$$

$$\boxed{T = t_0\left(\frac{1+e}{1-e}\right)}$$

- **Average Speed:**

$$v_{av} = \frac{h_0\left(\frac{1+e^2}{1-e^2}\right)}{\sqrt{\frac{2h_0}{g}}\left(\frac{1+e}{1-e}\right)}$$

$$= h_0\sqrt{\frac{g}{2h_0}}\left[\frac{1+e^2}{(1+e)(1-e)}\cdot\frac{(1-e)}{(1+e)}\right]$$

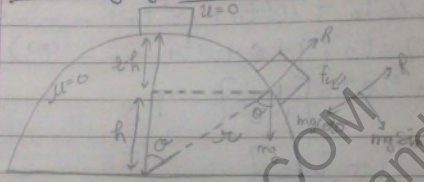
$$\boxed{v_{avg.} = \sqrt{\frac{g h_0}{2}}\left[\frac{1+e^2}{(1+e)^2}\right]}$$

• Average velocity:

$$|\vec{v}_{av}| = \frac{h_0}{\sqrt{\frac{2h_0}{g}}\left(\frac{1+e}{1-e}\right)}$$

$$\boxed{|\vec{v}_{av}| = \sqrt{\frac{gh_0}{2}}\left(\frac{1-e}{1+e}\right)}$$

* Breaking of Contact of Body on Circular Path:



$F_c = mg\cos\theta - R$

$R = mg\cos\theta - F_c$

$R = mg\cos\theta - \frac{mv^2}{r}$

$R = 0$

$mg\cos\theta = \frac{mv^2}{r}$

$r\cos\theta = \frac{v^2}{g}$

$v^2 = u^2 + 2aS$

$v^2 = 0 + 2g(r-h)$

$\cos\theta = h/r$

$\frac{h}{r} = \frac{2g(r-h)}{rg}$

$h = 2(r-h)$

$h = 2r - 2h$

$3h = 2r$

$$\boxed{h_{min} = \frac{2r}{3}}$$

If contact break at topmost point, then

$$F_c = mg - R$$

$$R = mg - \frac{mv^2}{r} = 0$$

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

$$\Rightarrow \boxed{v = \sqrt{gr}}$$